## ACADEMIC CURRICULA

## UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES (With exit option of Diploma)

(Choice Based Flexible Credit System)

**Regulations 2021** 

Volume – 14 (Syllabi for Electronics and Communication Engineering Programme Courses)



## SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India



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## ACADEMIC CURRICULA

**Engineering Science Course** 

**Regulations 2021** 



## SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21CSS201T	201T Course COMPUTER ORGANIZATION AND ARCHITECTURE Course Category			S	ENGINEERING SCIENCES						L 3	L T P C 3 0 0 3						
Pre-requisite Nil Co- requisite Nil Nil						ogres Cours	sive es						Nil						
Course C	Offering Departme	nt	School of Computing	Data Book / Codes / Stand	ards							Nil							
Course Lea	arning Rationale (	CLR): 7/	he purpos <mark>e of learnin</mark> g this co	ourse is to:	1	2	1	2.1	Progra	am Ou	Itcome	s (PO)	)				Pr	ograi	m
CLR-1:	Understand the F	undamentals	s of co <mark>mputers, Me</mark> mory operati	ons and Addressing Modes	1	2	3	4	5	6	7	8	9	10	11	12	S OU	peciti tcom	c es
CLR-2:	Know about Func	tions of Arith	met <mark>ic and Logic</mark> unit	and an and a second second	e		Ŧ	s of	1	lety			¥		0				
CLR-3:	Explore the Opera	ations of Con	ntrol Unit, Execution of Instruction	on and Pipelining	vledç		ent o	ations	ge	soc			oW r		ance	D			
CLR-4:	Classify the Need	for Paralleli	sm, Multicore and Multiprocess	or Systems	- Nov	lysis	mdo	stiga	Usa	and	∞ .		earr	ю	& Fir	arnin			
CLR-5:	Understand the C	oncepts and	I functions of Memory unit, I/O u	nit	eering h	em Anal	n/devel	uct inve lex prob	rn Tool	ngineer	onment		dual & T	nunicati	ct Mgt. 8	ong Lee	<del></del>	2	e
Course Ou	tcomes (CO):	A	t the end of this course, learn	ers will be able to:	ingin	roble	)esig		lode	he e	invird	thics	ivibr	omn	roje	ife L	-OS	-OS	-OS
CO-1:	Identify the comp	uter har <mark>dwar</mark>	e and how software interacts w	th computer hardware	3	2	-		-	-	ш 0	-	-	-	-	-	1	-	- 1
CO-2:	Apply Boolean alg	gebra a <mark>s rela</mark> ircuits	ited to designing computer logic	, through simple combinational and	3	2	2		-	-	-		-	-	-	-	-	2	-
CO-3:	Examine the deta	iled op <mark>eratio</mark>	<mark>n of</mark> Basic Processing units and	the performance of Pipelining	3	-	- 1	- 1	-	-	-	-	-	-	-	-	-	-	1
CO-4:	Analyze concepts	of par <mark>allelis</mark>	m and multi-core processors.		3	-	1	6.2	-	2	<b>-</b>	-	-	-	-	-	-	2	-
CO-5:	Classify the memory system	ory tech <mark>nolo</mark> g	gies, input-output systems and	evaluate the performance of memory	3	2		-	-	-	-	-	-	-	-	-	-	3	-
Unit-1 -			2							-								9	Hour
Introduction using Sign I	to Number Systen Magnitude,1's com	n and Logi <mark>c (</mark> pliment, 2's	Gates: Number Systems- Binar compliment, BCD Arithmetic; Lo	y, Decimal, Octal, Hexadecim <mark>al; Co</mark> des- ogic Gates-AND, OR, NOT, <mark>NAND, N</mark> OF	Grey, BC R, EX-OR,	D,Exc EX-N	ess-3, OR.	ASCII,	Parity;	Binar	y Arithn	netic- /	Additio	n, Subi	traction	, Multij	olicatio	on, Div	vision
Unit-2 -									_									9	Hour
Basic struct	ure of computers: 1 · 8086	Functional U	Inits of a computer, Operational	concepts, Bus structures, Memory addre	esses and	l opera	ations,	assemi	oly lang	juage	, Instru	ctions,	Instru	ction se	equenc	ing, Ac	Idress	ing m	)des.
Unit-3 -			1	A Provinsion of the	1				-		17							9	Hour
Design of A	LU: De Morgan's 1	Theorem, Ad	lders, Multi <mark>plier – Uns</mark> igned, Sig	ned, Fast, Carry Save Addition of summ	ands; Div	ision-	Restor	ing and	d Non- <mark>l</mark>	Restor	r <mark>ing</mark> ; IEE	EE 754	1 Float	ing poi	nt num	bers ar	nd ope	ration	S
Unit-4 -	t: Pasia progosina	unit ALL o	parationa Instru <mark>ation avagution</mark>	Propose instruction Multiple bus organiz	otion Uo	rdwiro	d oontr	ol Con	oration	of oo	atrol oig	nolo I	lioro r	rograr	nmod	ontrol	Dinali	<b>9</b>	Hour Pooio
concepts of	pipelining, Perform	nance. Haza	rds-Data. Instruction and Contr	blanch instruction, multiple bus organiz	auon, na	uwired	u conti	oi, Gen	eralion	01 001	ili or sig	11015, 1	viici 0-µ	logran	nineu c	0111101,	Fipeli	ning. i	Jasic
Unit-5 -	11 0																	9	Hour
Parallelism: Memory loa	Need, types , app ad and Store instruc	olications and ction, Basics	d challenges, Architecture of P of I/O operations. Case study:	arallel Systems-Flynn's classification; Al ARM 5 and ARM 7 Architecture.	RM Proce	essor:	The th	umb ins	structio	n set,	Proces	ssor ai	nd CPI	J cores	s, Instr	uction	Encod	ing fo	rmat,

	1	. CarlHamacher,ZvonkoVranesic,SafwatZaky,ComputerOrganization,5thed.,McGraw-Hill,2015	5.	WilliamStallings, ComputerOrganizationandArchitecture-
Learning	2	. KaiHwang, FayeA. Briggs, ComputerArchitectureandParallelProcessing", 3rded., McGrawHill, 2016		DesigningforPerformance,10thed.,Pearson Education,2015
Resource	<b>s</b> 3	GhoshT.K.,ComputerOrganizationandArchitecture,3rded.,TataMcGraw-Hill,2011	6.	DavidA.PattersonandJohnL.HennessyComputerOrganizationandDesign-
	4	P.Hayes, ComputerArchitectureandOrganization, 3rded., McGrawHill, 2015.		AHardwaresoftwareinterface, 5thed., Morgan Kaufmann, 2014

		Continuous Learning Assessment (CLA)					mativa		
	Bloom's Level of Thin <mark>king</mark>	Form CLA-1 Avera (50	native ge of unit test 0%)	Life-Lon Cl (1	g Learning _A-2 0%)	Final Ex (40% w	amination eightage)		
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	30%	and the second states	30%		30%	-		
Level 2	Understand	30%		30%		30%	-		
Level 3	Apply	20%		20%		20%	-		
Level 4	Analyze	20%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	20%		20%	-		
Level 5	Evaluate		1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1			-	-		
Level 6	Create		the brack			-	-		
	Total	10	100 %		100 % 100 %		100 %		0 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Saminath Sanjai, Borqs Technologies, Inc. Bengaluru		1. Dr.K.Vijaya, , SR <mark>MIST</mark>
		2. Dr.Anitha D. SRMIST



# ACADEMIC CURRICULA

**Professional Core Courses** 

**Regulations 2021** 



### SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21ECC201T	Course Name	e SOLID STATE DEVICES				Cours Catego	se ory	С			PR	OFESS	SIONAI	COR	E		;	- T 3 0	P 0	C 3		
Pre-requ Course	isite es	Nil		Co C	- requisite ourses		Nil		Pr	ogres Cours	sive es						Nil						
Course	Offering Departme	ent		EC	E		Data Book / Co	des / Standard	ls	-						Nil							
Course Le	earning Rationale (	CLR):	The purpo	ose of le	arning this c	ourse is t	o:			2		1.1	Progr	am Ou	tcome	es (PO	)				P	rogra	m
CLR-1:	Learn the principl	es of semi	conductors	s and PN	junction.	01	28		1	2	3	4	5	6	7	8	9	10	11	12	่ S 0เ	pecifi itcom	c es
CLR-2:	CLR-2: Apply the knowledge of PN and special diodes for electronic systems.						ge	0	of	s of	10	iety	bility		rk		e						
CLR-3:	CLR-3: Gain knowledge about basic operation of BJT and its applications						wled	(0	ient o	ation	ge	d soc	staina		n Wo		nano	b		ł			
CLR-4:	CLR-4: Acquire knowledge about basic concepts of FET and its applications.							Kno	alysis	lopr	estig		er an	s Sus		Tear	ion	s S	arnir		l		
CLR-5:	Identify and explo	re the vari	ous technic	ques of s	emiconducto	r fabric <mark>ati</mark> c	on.		ering	n Ana	/deve	ct inve	1 Tool	ginee	ment &		lal &	unicat	Mgt.	ng Le			
Course O	utcomes (CO):	-	At the end	d of this	course, lear	ners will	be able to:	Autor 197	Engine	Probler	Design	Conduc	Moderr	The en	Environ	Ethics	ndividu	Commu	Project	-ife Loi	-SO-1	SO-2	-SO-3
CO-1:	Comprehend the	basic p <mark>rop</mark>	erties of se	emicondu	ictors and PN	l junction.	2 - Oak	2334.2	3	2	-	-		1	-	-	-	-	-	1	1	-	-
CO-2:	Analyze and expe	eriment <mark>ap</mark>	olications o	of special	diodes and F	PN diode.		(E. E.	3	2	-	-	-		-	-	-	-	-	1	1	-	-
CO-3:	Articulate the con Applications	struction ,c	peration, cl	characteri	stics and para	ameters of	Bipolar Junction tr	ansistor and its	3	2		-	-	A	-	-	-	-	-	1	1	-	-
CO-4:	Demonstrate con application.	structio <mark>n,</mark>	operation,	characte	ristics and pa	arameters	of Field Effect Tra	ansistor and its	3	2	8	-0	-	X.7		-	-	-	-	1	1	-	-
CO-5:	<b>:O-5:</b> Explain the fabrication techniques of semiconductor devices in integrated circuits.							3	2	-	-	-	-	-	-	-	-	-	1	1	-	-	
Unit-1 - Se Semicondu	emiconductor Jun uctor: Fermi level, L	<b>ction The</b> Electron ar	ory nd hole cor	ncentrati	on at equilibri	ium, Temp	perature dependen	ce of charge ca	arrier, L	Drift ai	nd diffu	usion o	f carrie	rs, Ha	ll effec	t.PN ji	inction	theory	r: Curre	ent-Vol	tage r	9 elatior	Hour 1ship,
Calculation analysis Unit-2 - Si	n of depletion width	n, potentia <b>odes and</b>	Pn Applie	iode cui	rent, Capacit	ive effects	s in PN junction, E	nergy band str	ructure,	, PN d	lodes:	Termin	hai cha	racteri	stics a	nd par	ameter	s, Dio	de mod	lelling,	DC loi	ad line	э and <b>Hour</b>

Unit-2 - Special Junction Diodes and Pn Applications

Zener diode, Varactor diode, Step recovery diode, Tunnel diode, LED, Laser diode, Pin photodiode, Avalanche Photodiode.Half wave rectifier and Full wave rectifier: Center tapped and Bridge rectifier Operation and derivation of average values of output voltage and current, ripple factor and efficiency, Peak inverse voltage, Transformer Utilization factor. Filters: Inductor and capacitor filters, LC and CLC Filters, Clippers and Clampers, Voltage Multipliers

#### Unit-3 – Bipolar Junction Transistor

Physical structure and device operation of BJT, Current-Voltage characteristics of BJT configurations, Early effect, BJT circuit models: Ebers Moll, Gummel Poon, small signal & hybrid-π, Biasing circuits for BJT: Base bias, Emitter bias, Voltage-divider bias, Collector-feedback bias, BJT as an amplifier and as a switch

9 Hour

#### Unit-4 - Field Effect Transistor

Physical Structure, Device operation of E-MOSFET and D-MOSFET, I-V characteristics of D-MOSFET & E-MOSFET, Derivation drain current and Transconductance, Biasing circuits for MOSFET: Gate bias, Selfbias, Voltage divider bias, MESFET, HEMT, CMOSFET, MOSFET as an amplifier, MOSFET as a switch, FET Models

#### Unit-5 - Fabrication of Semiconductor Devices

Integrated Circuit: Advantages, Limitations, Classification. IC Manufacturing: Material Preparation, Crystal Growing and wafer preparation, Waferfabrication, Testing, Bonding and Packaging. Fabrication of PN diode, BJT and MOSFET 

. . .

	1.	Ben G. Streetman and Sanjay Kumar Banerjee, "Solid State Electronic Devices	4.	R. S. Sedha, "Applied Electronics", S. Chand, 2018.
		Pearson, 7th edition, 2016.	5.	David A. Bell, "Electronic Devices and Circuits", 5th edition, OxfordUniversity Press, 2015.
Learning	2.	Donald A Neamen, Dhrubes Biswas "Semiconductor Physicsand Devices", 4th edition,	6.	Muhammad Rashid, "Microelectronic Circuits: Analysis & Design", 2nd edition, Cengage Learning,
Resources		McGraw-Hill Education, 2012.		2010.
	З.	Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory",	7.	Thomas L. Floyd, "Electronic Devices", Pearson, 9th edition, 2013.
		Pearson Education, 11th Edition, 2013.		
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Learning Assessm	ent 🛛 👘	2 N 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	A STATE OF A	Sector Pro-			
	2		Continuous Learning A	Assessment (CLA)		Cum	matik in
	Bloom's Level of Thinking	Form CLA-1 Avera (50	ative ge of unit test %)	Final Exa (40% we	native amination eightage)		
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice
Level 1	Remember	15%	The second	15%		<mark>15</mark> %	-
Level 2	Understand	25%		15%	- Parent	25%	-
Level 3	Apply	30%		30%		30%	-
Level 4	Analyze	30%		30%		<mark>30</mark> %	-
Level 5	Evaluate			5%		-	-
Level 6	Create	and the second		5%			-
	Total	100	)%	10	0%	10	0 %

Course Designers	E. A. BULL		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
	1. Mr. Saivineeth, ML Accelerator Architect@ Google	1. Mrs. A. Ramya, SRMIST	
		2. Dr. J. Maniula, SRMIST	

9 Hour

9 Hour

Course Code	Course Code         21ECC202T         Course Name         ANALOG AND LINEAR ELECTRONIC CIRCUITS						S	Cour: Catego	se ory	С			PR	OFES	SIONAI	L COR	E			L T 3 0	P 0	C 3
Pre-requi Course	site es	Nil		Co- requisite Courses	e	Nil	-	Pr	ogres Cours	sive ses						Nil	1					
Course	Offering Departme	ent		ECE		Data Book / Co	des / Standar	ds							Nil							
Course Le	arning Rationale	(CLR): T	The purpose o	of learning thi	is course	is to:		1	7	1	2.1.1	Progr	am Ou	utcom	es (PO	)				P	rogra	m
CLR-1:	Understand the o	peration and	d design of tra	nsistor amplifie	er circuits	for a given specification	n.	1	2	3	4	5	6	7	8	9	10	11	12	- S Οι	pecifi itcom	C es
CLR-2:	Discuss the elem	entary conce	epts and chara	acteristics of a	n operatio	onal amplifier	and have				-	3.										
CLR-3:	Introduce the con topologies to un resistances	ncepts of ne iderstand th	ega <mark>tive feed</mark> ba heir properties	ack on amplifie s, such as tr	e <mark>r ci</mark> rcuits, ransfer ga	, and investigate diffe ain, input resistances	rent feedback , and output	wledge		tent of	ations of S	ge	d society	stainability		n Work		nance	Ð.			
CLR-4:	Analyze and desi	gn RC an <mark>d L</mark>	<mark>LC oscill</mark> ator c	ircuits				Kno	alysis	lopn	estig	Use	r an	sus 3		Tear	ion	& Fi	arnir			
CLR-5:	Analyze and desi	gn linear <mark>an</mark> d	<mark>id non-</mark> linear a	pplications of o	op-amp	6		ering	m Ana	/deve	ct inve	n Tool	iginee	ment 8		ual &	unicat	t Mgt.	ng Le			
Course Ou	utcomes (CO):	A	<mark>At th</mark> e end of	this course, l	earners w	vill be able to:	X 59.	Engine	Proble	Design	Condu	Moder	The en	Environ	Ethics	Individ	Comm	Project	Life Lo	PSO-1	PSO-2	PSO-3
CO-1:	Apply the small sig	nal equ <mark>ivale</mark> ı	ent circuit in the	analysis of sing	gle and mu	ultistage transistor ampli	ifier circuits	2	2	3	-	-	-	-	-	-	-	-	-	-	-	3
CO-2:	Infer the DC and	AC cha <mark>racte</mark>	<mark>eristi</mark> cs of oper	rational amplifi	er	22 S 2 H 6	5-1-1	2	2	3	-	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Classify and iden	tify the <mark>suita</mark> l	<mark>able f</mark> eedback i	topologies and	l oscillator	rs as per application.	100	2	2	3	-			-	-	-	-	-	-	-	-	3
CO-4:	Elucidate and des	sign line <mark>ar ar</mark>	<mark>nd no</mark> n-linear	applications of	<sup>f</sup> op-amp	The state of the s		2	2	3	-	-	1	-	-	-	-	-	-	-	-	3
CO-5:	Illustrate the func	tion of ap <mark>plic</mark>	i <mark>cation</mark> specific	ICs	Cert		100	2	2	3	-	-	-	-	-	-	-	-	-	-	-	3
Unit-1 - Si	ngle and Multista	ge Amplifier	ers	Contraction of the								-	-	-							9	Hour
Bipolar Lin π model, lo π model, lo	ear amplifier: Load w- and high-freque w and high Freque	line analysis ncy respons	is <mark>, small-s</mark> ignal se of BJT ampl se analysis of	l models, analy lifiers. MOSFE MOSEET amp	ysis of con T Linear A Difier	mmon-emitter, commo Amplifier: Load line ana	n-base, comm lysis, small-si	on-colle gnal mo	ector a del, ar	mplifie nalysis	rs and of com	multist mon-s	age ar ource,	nplifier comm	s (caso on-gate	ade, c and c	ascode commo	e and E n-drain	Darlingi n ampli	ton) us fiers u	ing H sing h	ybrid- ybrid-
Unit-2 - In	troduction to Line	ar IC's				CARA	1.16			_			-								9	Hour
BJT and M	OSFET differential	amplifier with	th passive and	active loads, I	Internal St	tructure of Op-amp, our	put stages an	d power	ampli	ifiers (	Class-A	and C	lass-A	B pusł	<mark>i-</mark> pull C	omple	mentai	'y ampl	lifier co	nfigura	ation),	Ideal
Unit-3 - Fe	edback Amplifier	ackages, cri s and Oscill	llators	or op-amp, ope	en-loop co	oniigurauoris, non-ideai	enects in op-	anip, Fr	equeri	icy res	ponse d	or an o	p-amp								9	Hour
Negative feedback amplifier: Introduction to feedback and types, advantages and disadvantages of negative feedback, basic feedback concepts, ideal feedback topologies, voltage (shunt- series) amplifier, (shunt-series) amplifier, trans conductance (series-series) amplifiers, transresistance (shunt-shunt)amplifiers, stability analysis of the feedback Circuit (BJT/MOSFET/Op-amp). Oscillators: Principles of oscillators, RC, LC and Crystal oscillators (BJT/MOSFET/Op-amp)											fier, ci oscill	irrent ation,										

#### Unit-4 - Applications of Linear ICs - I

Summing amplifier, subtractor, integrator, differentiator, difference amplifier, instrumentation amplifier, voltage-to-current converter, current-to-voltage converter, comparators, schmitt triggers and Non sinusoidal oscillators, active filters, first order and second order low and high pass filters, band-pass filters, band-stop filters, waveform generators.

#### Unit-5 - Applications of Linear ICs - II

9 Hour

9 Hour

Converters: Weighted -Resistor D/A and R-2R ladder D/A, Analog-to-Digital Converter: Successive approximation A/D Converters, precision rectifiers, clippers, and clampers. Specialized ICs: 555 Timer, functional block, 566 VCO and 565 PLL, Applications of PLL and 555 Timer, voltage regulators-LM78xx, LM79xx, LM723, LM380 power amplifiers.

	1.	David A. Bell, "Electronic Devices and Circuits", 5th ed., Oxford University Press, 2015	5.	D. Roy Choudhry, Shail Jain, "Linear Integrated Circuits", 5th ed., New Age International
	2.	Donald Neaman, "Electronic Circuits: Analysis and Design", 3rd ed., Mc-Graw-Hill Education, 2011		Pvt. Ltd., 2015
Learning	3.	Muhammad Rashid, "Microelectronic Circuits: Analysis and Design", 2 <sup>nd</sup> ed.,	6.	Ramakant A. Gayakwad, "Op-amp and Linear ICs", 4th ed., Printice Hall/Pearson,
Resources		Cengage Learning, 2010		Education,2015
	4.	Robert L. Boylastaed Louis Nashelsky, "Electronic Devices and Circuit Theory", 11th ed.,	7.	Sergio Franco, "Design with Operational amplifiers and Analog Integrated circuits", 4th
		Pearson Education, 2013		ed., Tata Mcgraw-Hill, 2016

Learning Assessm	nent 👘 👘		A STATISTICS IN				
			Continuous Learning A	ssessment (CLA)		Cum	mativa
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (1)	g Learning "A-2 0%)	Final Exa (40% we	nauve amination eightage)
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice
Level 1	Remember	15%	1	15%	W	<u>15%</u>	-
Level 2	Understand	20%		20%	- 2000	20%	-
Level 3	Apply	25%		25%		25%	-
Level 4	Analyze	25%		25%	0	<mark>25</mark> %	-
Level 5	Evaluate	10%		10%		10%	-
Level 6	Create	5%		5%		5%	-
	Total	10	0 %	10	0 %	10	0 %

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
	1. Mr. Saivineeth, ML Accelerator Architect @ Google	1. Dr. E. Sivakumar, SRMIST	
		2 Mr AVM Manikandan SRMIST	

Course	215002027	Course		Course	C		L	Т	Ρ	С
Code	212002031	Name	DIGITAL LOGIC DESIGN	Category	C	FROFESSIONAL CORE	3	0	0	3

Pre-requisite Courses	Ni	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offeri	ng Department	ECE	Data Book / Codes / Standards	1 - Colored 1 - Co	Nil

Course L	earning Rationale (CLR): The purpose of learning this course is to:		-		1	Prog	ram Ou	Itcome	es (PO	)				Р	rogra	m
CLR-1:	Understand binary codes, able to simplify Boolean logic expressions and understand the basic TTL and CMOS gates operate at the component level	1	1 2 3 4 5 6 7 8 9 10 11 12									12	S Oi	ipecif utcon	ic 1es	
CLR-2:	Able to design simple combinational logics using basic gates and MSI circuits	-			f	0	1	у								
CLR-3:	Familiarize with basic sequential logic components: flip-flops, registers, counters and their usage, and able to design of sequential logic circuits.	wledge		ient of	ations o	ge	d society	tainabilit		n Work		Jance	Ď			
CLR-4:	Able to design application level circuits and adopt systematic approach with the use of Sequence etector.	Kno	Ilysis	lopm	estig	Usa	r and	Sus		Tear	.u	& Fii	arnir			
CLR-5:	Know how to implement logic circuits using PLDs	ering	n Ana	/deve	st inve x prol	Tool	ginee	ment 8		lal & .	unicat	Mgt.	ng Lei			
Course O	utcomes (CO): At the end of this course, learners will be able to:	Engine	Problei	Design	Condu	Moderr	The en	Environ	Ethics	Individ	Comm	Project	Life Lo	PSO-1	PSO-2	PSO-3
CO-1:	Simplify Boolean expressions; implement gates as well as other types of IC devices using two major IC technologies, TTL and CMOS.	3			-	3	1.1		-	-	-	-	-	3	-	-
CO-2:	Identify eight basic types of fixed-function combinational logic functions and demonstrate how the devices / circuits can be used in building complete digital systems such as computers.	6 -	2	2	-	3	1		-	-	-	-	-	3	-	-
CO-3:	Understand and design sequential circuits using several types of flip-flops	-	2	2	-	3	-	-	-	-	-	-	-	3	-	-
CO-4:	Design of advanced circuit and Design the advanced sequential logic circuits.	-	2	2	-	3	-	-	-	-	-	-	-	3	-	-
CO-5:	Implement multiple output combinational logic circuits using PLDs; Explain the operation of a CPLD and FPGA.	- 1	2	2	-	3	-	-	-	-	-	-	-	3	-	-

Init-1 - Basics and Logic Family 9	Hour
toolean algebra, Karnaugh Map - Quine McClusky minimization technique (4 -variable) - Logic Families: -Introduction - TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in, fan-out, CMO-	S
Init-2 - Combinational Circuits	Hour
Sombinational logic circuits: Half adder – Full Adder – Half subtractor - Full subtractor – Parallel binary adder - 2's complement subtraction using parallel adders - Multiplexer/Demultiplexer – decoder - encoder	-code
onverters - Magnitude Comparator	
Init-3 - Sequential Circuits 9	Hour
lip-flop and Latch: SR latches- JK flip-flop, D flip-flop, D flip-flop-Master-slave JK flip-flop- Register Counters- Ring counter, Johnson counter-Shift registers (SISO, SIPO, PISO, PIPO)Universal shift reg	gister-
Counters: -Asynchronous/Ripple countersSynchronous counters-Modulus-n Counter -Up-Down counter- State reduction-State assignment	
Init-4 - Advanced Combinational & Sequential Logic 9	Hour
dvance sequential logic: Mealy and Moore model- Analyze and design synchronous sequential circuits - FSM - Sequence detector - Vending Machine – Advanced digital circuits: - Hamming code – Dela	ay in a
pple carry adder - Carry Look Ahead adder -2 Bit Multiplier	

Unit-5 - PLD's and Memory	9 Hour
RAM Memory decoding-ROMBasic concepts: -Programmable Logic Devices (PLDs):-Basic concepts-PROM as PLD-Programmable Array Logic (PAL)Programmable Logic Array (PLA)-FPGA	
	0000

	1.	Morris Mano M, Michael D. Ciletti, "Digital Design with an Introduction to the Verilog	4.	Ronald J. Tocci, "Digital System Principles and Applications", 10th ed.Pearson Education, 2009.
Loorning		HDL", 5th ed., Pearson Education, 2014	5.	Donald P Leach, Albert Paul Malvino, Goutam Saha, "Digital Principles and Applications", 6th ed.,
Dessuress	2.	Charles H Roth (Jr), Larry L. Kinney, "Fundamentals of Logic Design", 5th ed., Cengage		TataMcgraw Hill, 2008
Resources		Learning India Edition, 2010.	11	
	3.	Thomas L. Flovd, "Digital Fundamentals", 10th ed., Pearson Education, 2013		

			Continuous Learning Assessment (CLA)								
Bloom's Level of Thinking		Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Lon CL (1	g Learning LA-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%		15%	-	15%	-				
Level 2	Understand	25%		20%		25%	-				
Level 3	Apply	30%	1.	25%		30%	-				
Level 4	Analyze	30%	bern freeze h	25%		30%	-				
Level 5	Evaluate		1000	10%		-	-				
Level 6	Create		1	5%			-				
	Total	10	0%	10	0 %	10	0 %				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1 Mr. Saivineeth MI. Accelerator Architect @ Google	1 M Maria Dominic Savio SRMIST



Course Code	purse code         21ECC204T         Course Name         SIGNAL PROCESSING         Course				Cou Cate	rse gory	С			PR	OFESS	IONAI	L COR	E		ļ	- T 3 0	P 0	C 3		
Pre-requis Course	site s	Nil	C	co- requisite Course <mark>s</mark>		Nil	1	Progres Cours	ssive ses						Nil	1					
Course C	Offering Departme	ent	E	ECE		Data Book / Codes / Sta	ndards	1						Nil							
Course Lea	arning Rationale	(CLR):	The purpose of I	l <mark>earnin</mark> g this co	ourse is to:			1	Program Outcomes (PO)								Pr	rogra	m		
CLR-1:	Understand the b	asic conce	epts, op <mark>erations ar</mark>	nd types of signa	als and syst	ems	1	2	3	4	5	6	7	8	9	10	11	12	2 Specific Outcomes		
CLR-2:	Analyse the period time system using	dic and ap g laplace t	periodi <mark>c Continuou</mark> transform.	s signals using i	fourier trans	form. Analyse the continu	ious g		of	s of	1	tiety			ork		e				
CLR-3:	Analyse the discr	ete time si	ign <mark>al using D</mark> FT ar	nd discrete time	system usir	g Z-Transform	vled		ent o	ation	ge	soc			۵ ۸		Janc	g			
CLR-4:	Design FIR filter	using wind	lo <mark>wing tech</mark> nique			A STATISTICS	Knov	lysis	mdo	stige	Usa	r anc	8		Tean	.u	& Fir	arnin			
CLR-5:	Design Analog III	R filter, Co	nversion of Analog	g filter to digital I	Filter		eering	em Ana	l/deve	uct inve	in Too	ngineel	nment	L.	lual & <sup>-</sup>	nnicat	t Mgt.	ong Lea	_	0	~
Course Ou	tcomes (CO):		At the end of th	is course, learr	ners will be	able to:	Engine	Proble	Design	Condu	Moder	The e	Enviro Sustai	Ethics	Indivic	Comr	Projec	Life Lo	PSO-`	PSO-2	PSO-3
CO-1:	Summarize the C	Classific <mark>atio</mark>	<mark>on of S</mark> ignals and S	Systems and vai	rious operat	ions on signals	2	3	-	- 1		-	-	-	-	-	-	-	-	-	1
CO-2:	Apply Fourier trai	nsform <mark>and</mark>	<mark>d Lapl</mark> ace transfori	m on solving cor	ntinuous tim	e signals andsystems	100	2		3	-		-	-	-	-	-	-	-	-	2
CO-3:	Apply Discrete Fe	ourier T <mark>ran</mark>	nsform and Z-Tran	sform on Discre	te time sign	als and systems		2	-	3	-	- 1	-	-	-	-	-	-	-	-	2
CO-4:	Design Finite Imp	oulse Re <mark>sp</mark>	oonse Filters using	different types	of windowin	g techniques	1	2	3	102	-	1	-	-	-	-	-	-	-	-	3
CO-5:	Design analog ar	nd digita <mark>l Ir</mark>	<mark>nfinite I</mark> mpulse Res	sponse Filters	1.55		100	2	3	- 1	-		-	-	-	-	-	-	-	-	3
Unit-1 - Cla	assification of Sig	inals and	Systems	of Signala Fur	n da mantal C	innala Unit impulsa, Stan	Dama Va		n o rotio		ianala	Time	Chiffing	Time		in al Ti		ling A		<b>9</b>	Hour
Signal Addi linear, Time	tion and Multiplica Varient and invar	tion. Class ient, Caus	sification of Continu al and Non-Causa	uous and Discre I, Static, and dy	ete time sign namic, Stab	als- Periodic and Aperiod le and unstable systems.	ic, Even an	nd Odd,	Energ	gy and F	ower,	Detern	ninistic	and R	andon	заї, Тії 1, Туре	s of Sy	stems	Linea	ar and	Non-
Unit-2 - An	alysis of Continu	ous Time	(CT <mark>) Signals and</mark>	Systems	And the second second		1.2				120									9	Hour
Fourier Tra	nsform and Invers	se Fourier	Transform, Prope	erties of Fourier	Transform,	Analysis of LTI CT systems Analysis of LTI CT s	em using F	ourier	Transi	form, Fi	Proble	cy Res	sponse,	Impu sing p	lse Re	esponse os of l	e and s	Step re transfe	spons	se, La	place
Unit-3 - An	alysis of Discrete	e Time(DT	) Signals and Sys	stems	j anu r topel	ues, Analysis of LTI CT s	ystern usin	у Lapia		113101111	FIUDIC	1115 50	nving u	sing pi	operu	63 UI L	apiace	liansic	1111	9	Hour
Discrete Fo Frequency system, Inv	ourier Transform (L Fast Fourier Tran erse Z Transform	DFT) and I sform (DIF using Part	Inverse Discrete F -FFT), Linear Cor tial fraction method	ourier Transforr volution and Ci	m (IDFT), Pi ircular Conv	roblems solving on DFT, olution, Z- Transform, Re	Fast Fourie egion of Co	er Tran nverge	sform ence (F	(FFT) - RoC) an	Decim d Prop	ation i erties,	n Time Analys	Fast I sis of L	Fouriei DT sys	r Trans stem us	form (l sing Z-	DIT-FF transfo	T), De orm, Si	cimat tabilit	on in / of a

#### Unit-4 - Finite Impulse Response (FIR) Filter Design

Design of Linear Phase FIR Filters, Frequency Response of FIR Filter- N Odd (symmetric), Frequency Response of FIR Filter- N Even (Symmetric), FIR Filter Design using Windowing Technique, Design of FIR low pass, High pass, Band pass and Band Stop filter Design- Rectangular Window, Hanning Window, Hamming Window and Blackman Window. 9 Hour

### Unit-5 - Infinite Impulse Response (IIR) Filter Design

Introduction to IIR Filters- Comparison between FIR and IIR Filters, Analog IIR Filter design – Butterworth and Chebyshev Filters, Comparison of Properties of Butterworth and Chebyshev Filters, Design of IIR low pass and High Pass filter using butterworth method, Design of IIR low pass and High Pass filter using Chebyshev method, Conversion of Analog filter into Digital Filter- Bilinear Transformation and Impulse Invariance Method

	1.	Alan V Oppenheim, Ronald W. Schafer, "Signals & Systems", 2nd Edition, Printice Hall of India,	3.	AlanV.Oppenheim, Ronald W. Schafer, John R. Buck., "Discrete-Time Signal Processing",
Learning		2015.		2nd Edition, Pearson, 2011.
Resources	2.	JohnG.Proakis, Dimitris G.Manolakis, "Digital Signal Processin: Principles, Algorithms and	4.	B.P. Lathi and Rpger Green, "Linear Systems and Signals", 3rd Edition,
		Principles", 4th Edition, Printice Hall of India, 2001.		Oxford University Press, 2017

•			Continuous Learnin	g Assessment (CLA)		Sum	mativa			
Bloom's Level of Thinking		Forr CLA-1 Avera (5	native age of unit test 0%)	Life-Long CL (10	Learning A-2 %)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice			
Level 1	Remember	15%		15%	· · · · · · · · · · · · · · · · · · ·	15%	-			
Level 2	Understand	25%	Sec. Sec. Sec.	20%		25%	-			
Level 3	Apply	30%		25%	- Permit	30%	-			
Level 4	Analyze	30%		25%		30%	-			
Level 5	Evaluate			10%		-	-			
Level 6	Create			5%		-	-			
	Total	-10	0%	100	)%	10	0 %			

С	Course Designers	5 T								
E	xperts from Industry	Exp	perts from Higher Technical Institutions	Internal Experts						
	1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad,	1.	Dr. Meenakshi, Professor of ECE, CEG, Anna University,	1.	Mr.B. AnandaVenkatesan, SRMIST					
	kumaranuj.anii@gmail.com	1.00	meena68@annauniv.edu							
	2. Mr. Hariharasudhan - Johnson Controls, Pune,	2.	Dr Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	2	Dr.S. Dh <mark>analakshm</mark> i, SRMIST					
	hariharasudhan.v@jci.com		THUL ARE A STUDY OF THE STORE							

9 Hour

Course Code	21ECC205T	Course Name	elec	CTROMAGNETIC T	HEORY AND INTERFERENCE	C	Cours atego	se ory	С			PR	OFESS	SIONA	L COR	E			L T 3 0	P 0	C 3
Pre-requ Cours	isite es	Nil		Co- requisite Courses	Nil		Pr	ogres Cours	sive es						Ni	1					
Course	Offering Departm	ent		ECE	Data Book / Codes / S	Standards	3							Nil							
Course L	earning Rationale	(CLR):	The purpo <mark>se o</mark>	o <mark>f learnin</mark> g this co	urse is to:		-	1			Progr	am Ou	itcome	es (PO	)				P	rogra	m
CLR-1:	Gain knowledge	on the basi	ic concepts and	<mark>l insi</mark> ghts of Electric	field		1	2	3	4	5	6	7	8	9	10	11	12	0	utcom	les
CLR-2:	Gain knowledge Maxwell'sequation	on the basi ons.	ic conc <mark>epts and</mark>	insights of Magnet	ic field and emphasize the significa	ance of					25		ility								
CLR-3:	Interpret the wav	e propagati	tion <mark>in guide</mark> d w	aveguide.			ge		of	is of	0	ciety	inab		Ł		e				
CLR-4:	Acquire the func transmission line	lamental k paramete <mark>r</mark>	kn <mark>owledge</mark> on <sup>*</sup> r calculation.	Transmission Line	Theory and acquire the knowled	edge on	nowled	/sis	pment	tigation	lsage	and so	k Susta		eam W	ç	Financ	ning			
CLR-5:	Acquire knowled related to electro	lge on theo magnetic w	oretical concep vave propagation	ots and analysis te on and Transmissio	chniques to find solutions for pro- n line Theory.	roblems	ering K	m Anal)	/develo	ct inves	n Tool L	igineer a	nment 8		ual & Te	unicatio	t Mgt. &	ng Lear			
Course O	utcomes (CO):		At the end of	this course, learn	ers will be able to:	39.0	Engine	Proble	Design	Condu	Moder	The er	Enviro	Ethics	Individ	Comm	Project	Life Lo	PSO-1	PSO-2	PSO-3
CO-1:	Apply the concep	ots and k <mark>no</mark>	wledge to solve	problems related	o electric field.		- 1	2	3	-		- 16	-	-		-	-	-	-	-	-
CO-2:	Analyze the cond	epts of <mark>Ma</mark>	<mark>ignetic</mark> field and	Maxwell's equation	ns in the real world application.	3		3	2		-	-	-	-	-	-	-	-	-	-	-
CO-3:	Translate the phe	enomen <mark>on d</mark>	<mark>of gui</mark> ded wave	propagation and it.	s mode of propagation.		-	3	2	1.	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Describe the imp	ortance <mark>of t</mark>	<mark>transm</mark> ission lir	ne theory applicable	to low frequency transmission lin	nes.		2	3	- 1	-		-	-	-	-	-	-	-	-	-
CO-5:	Solve transmission	on line para	<mark>ameter a</mark> nd imp	edance matching th	rough analytical and graphical me	ethods.		2	3	-	-	-	×.	-	-	-	-	-	-	-	-
				1																	
Unit-1 – E	Electrostatics			Ordinate and R. Ortha	riant On andiante. Deview of search								Duck						4-1-	9	Hour
continuou	s charge distribution	rectangula 1-Concept-	ar co-ordinate-	due Infinite Line cl	rical Co-ordinate- Review of vect narge	tor calcult	is- Co	ouiomi	os Lav	v and t	eia ini	ensity-	· Probl	em ba	isea oi	1 COUIC	omdsi	aw- El	ectric	tiela a	ue to
Unit-2 - N	lagnetostatics and	Maxwells	Equations	1.1		-15	- Maria	-			150									9	Hour
Energy de	ensity in electrostati	c field- Prol	blem discussio	<mark>n B</mark> iot savart law-	Magnetic field intensity due to Infi	finite line o	harge	е- H- с	lue fini	te and	semi fi	nite lin	e char	<mark>ge-</mark> An	npere':	s circui	ital law	&applic	cation:	Infinit	e line
current- Ir	finite Sheet current	- Infinitely l	long coaxial Tra	<mark>ansmis</mark> sion line- Pro	blem based on ACL.	1.1		1.1	1.4												
Unit-3 - E	lectromagnetic Wa	aves and V	Naveguides	un in langland dieles	tuia Diana waya in francanana Dia			daan	duatar	Drahla	maha		nlana		in loo					9	Hour
rectangula	ar waveguide- recta	ngular wave	equide-Problen	ns	uic- Plane wave in nee space- Pla	ane wave i	n goo	u com	uucior-	PIODIE	ms pa	seu on	piane	waves	1111053	siess, i	ree spa	ice and	u 9000	CONU	ucior-
Unit-4 - T	ransmission Line	Theory and	d Introduction	to Interference																9	Hour
Transmiss EMI/EMC	sion line parameters - Types of EMI/EMC	s- Transmis C - SE, CE -	ssion line equiv - Susceptibility	alent circuit- Expla	nation- Transmission line equation	n derivatio	on- Pr	oblem	discu	ssion	Trans	missio	n line	charad	cteristic	s: loss	less Li	ne- Di	stortio	n less	line -

9 Hour Introduction to impedance matching- Smith chart Introduction- Reflection coefficient, Standing wave ratio Input impedance calculation in smith chart- Practice problems. - Single stub matching Introduction- Procedure for single stub matching- Problems solving in smith chart.

Learning University Press, 2015	Education, 2016
Education, 2006	5. John D.Ryder, "Networks, Lines and Fields", PHI, 2009.

Learning Assessm	ient				1.1						
			Continuous Learn	Sum	motivo						
Bloom's Level of <mark>Thinking</mark>		Form CLA-1 Avera (5)	native age of unit test 0%)	Life-Lonı CL (1	g Learning _A-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	20%		20%		20%	-				
Level 2	Understand	25%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	25%		25%	-				
Level 3	Apply	35%	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	35%		<mark>35</mark> %	-				
Level 4	Analyze	20%	LO Card V	20%	· · · ·	<mark>20</mark> %	-				
Level 5	Evaluate	and the second second				-	-				
Level 6	Create	201 - Yes	1	「「「「「「」」	S	-	-				
	Total	10	0%	10	0%	10	0 %				

Co	urse Designers									
Experts from Industry			perts from Higher Technical Institutions	Internal Experts						
1.	Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad,	1	Dr. Meenakshi, Professor of ECE, CEG, Anna University,	1	. Dr. Sandeep Ku <mark>mar P, SR</mark> MIST					
	kumaranuj.anii@gmail.com		meena68@annauniv.edu							
2.	Mr. Hariharasudhan - Johnson Controls, Pune,	2	Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	2	2. C. T. Manimega <mark>lai, SRM</mark> IST					
	hariharasudhan.v@jci.com	6								



Course Code	Course Code         21ECC211L         Course Name         DEVICES AND DIGITAL IC LAB					irse gory	С			PR	OFESS	IONA	L COR	E		(	- T 0 0	P 4	C 2
Pre-requ Cours	lisite es	Nil	Co- requisite Courses	Nil		Progre Cour	ssive ses						Nil	1					
Course	Offering Departme	ent	ECE	Data Book / Codes /	Standards							Nil							
				and the second		-	1												
Course L	earning Rationale	(CLR): Th	e purpo <mark>se of learnin</mark> g this c	course is to:				1	Progra	am Ou	itcome	s (PO	)	r	r	1	- 5	necif	m ic
CLR-1:	Understand the p	rinciples of Z	ener di <mark>ode and its</mark> application.		1	2	3	4	5	6	7	8	9	10	11	12	Ou	itcom	ies
CLR-2:	Gain knowledge a	about applica	tion <mark>s of PN.</mark>	and an and an	e		f	s of	20	ety			¥		0				
CLR-3:	Explore the chara	acteristics and	l <mark>operation</mark> of BJT and MOSFI	ET.	vledc	,	ent o	ations	ge	soc			oW r		ance	б			
CLR-4:	Acquire knowledg	ge combinatio	nal circuits and its application	1S.	Vor	lysis	mdo	stige	Usa	anc	ø		ean	uo	Ž Fir	urnin			
CLR-5:	Familiarize opera	tions of vario	us sequential circuits.			em Ana	jn/devel	uct inve	ern Tool	angineer	onment ainability	S	dual & T	nunicati	ct Mgt. 8	ong Lea	<del>.</del>	5	ę
Course C	outcomes (CO):	A	<mark>t the</mark> end of this course, lear	rners will be able to:	Enair	Probl	Desig	Cond	Mode	The e	Envir Susta	Ethic	Indivi	Com	Proje	Life L	PSO.	PSO.	PSO.
CO-1:	Demonstrate the	charact <mark>eristic</mark>	s of Zener and its applications	S.	3	2		-	1	-		-	-	-	-	-	1	-	-
CO-2:	Analyze applicati	ons of P <mark>N dio</mark>	de.		3	2	12	-	1	-	-	-	-	-	-	-	-	-	-
CO-3:	Articulate the cha	racteris <mark>tics</mark> a	nd parameters of BJT and MC	DSFET.	3	2		-	1	- 10	-	-	-	-	-	-	1	-	-
CO-4:	Implement differe	nt com <mark>binatio</mark>	onal circuits.		3	2		-	1	1	-	-	-	-	-	-	1	-	-
CO-5:	Design various se	equentia <mark>l circu</mark>	<mark>uits i</mark> n real life.		3	2	1.1	-	1		-	-	-	-	-	-	1	-	-
Unit-1 - Z	ener Diode and Ap	plication	- 2,4	Contraction of the	-					£								12	Hour
Semicono	luctor principles- Pro	perties of PN	- Principle of Zener diode- Ch	aracteristics of Zener diode, Fo <mark>rwa</mark>	ard biasing, Re	/erse B	iasing-	Diodep	arame	ers- I-	V chara	a <mark>cter</mark> is	<mark>tics-</mark> A	oplicat	ion in re	everse	Biasir	ig - Vo	oltage
regulator-	Series, Shunt- Load	l regulation <mark>, l</mark>	ine regulation																
Unit-2 - F	In Applications	vo contro tonr	od Filtors: Canacitivo filtor F	Postification with and without filter	Efficioney ring	lo facto	r Clinr	or: Drin	ciplos	Sorio	s clippo	r Shi	int clini	nor Ri	acod d	linnor	Clamp	12	Hour
clamper.	- Hall wave, Full wav Negative clamper. B	iased clampe	r		Eniciency, hpp	ie iacic	r- Ciipp		icipies,	Selle	s clippe	<i>i, Silu</i>	in cip	Jei, Die	aseu ci	ippei-	Janp	er. Fu	SILIVE
Unit-3 - E	Ripolar Junction Tra	ansistor and	Metal Oxide Semiconductor	r Field Effect Transistor	D' L La		_		1	-								12	Hour
BJT: Prin	ciple, Operation, Ch	aracteristics:	Input characteristics, Output	characteristics- Transistor param	eters- DC load	l line- E	3JT bia	sing: F	ixed bi	as, Co	ollector	feedb	ack bia	as, Em	itter bi	as, Vo	Itage o	divide	r bias
MOSFET	Principle, Operation	n, Characteris	stics: Transfer characteristics,	Drain characteristics, FET parame	eters, MOSFET	Switch	ing											- 10	
Unit-4 - C	ombinational Circ	IIIS ita Addara: L	lalf addar, full a <mark>ddar, Full a</mark> dd	or using half addor. A bit binary par	rallal addar. Er	oodor:	1-2 0	2 000	odor: 2	×1 2×	0 1.1 1	Auttink	ovor 1	·1 Don	aultinlo	vor		12	Hour
Unit-5 - S	compinational circu	its- Auders: H		er using han auder, 4-bit billary par	allel auuel- El	couer:	4^ <u>2</u> , 0'	- Dec	ouer. Z	^4, 3*	0-4.11	numple	exer- I	.4 Den	nunple	Xel		12	Hour
Clock- Fli	p flop: RS, JK, D & 1	- Synchronol	us counters: Up, Down, Up/Do	own, Asynchronous counters: Up, L	Down, Up/Dow	n, Mod	n Cour	iters											

	1.	David A. Bell, "Electronic evices and Circuits", 5th edition, Oxford University Press, 2015.	4.	Morris Mano M, Michael D. Ciletti, Digital Design with an Introduction to the Verilog HDL, 5th ed. Pearson Education. 2014.
Learning Resources	2. 3.	Donald A Neamen, Dhrubes Biswas "Semiconductor Physics and Devices", 4th edition, McGraw-Hill Education, 2012. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education, 11th Edition, 2013.	5.	Charles H Roth (Jr), Larry L. Kinney, Fundamentals of Logic Design, 5th ed., Cengage Learning India Edition, 2010.Thomas L. Floyd, Digital Fundamentals, 10th ed., Pearson Education, 2013.

			С	ontinuous Learnin	g Assessment (CLA	A)				
	Bloom's Level of Thin <mark>king</mark>	CLA-1 Avera exper (3	-A-1 Average of first cycle experiments (30%)		of second cycle iments 0%)	Practical E (40% w	Examination eightage	Final Examination (0% weightage)		
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	
Level 1	Remember		20%	1	20%	-	20%	-	-	
Level 2	Understand		20%	1.3.6.5	20%	-	20%	-	-	
Level 3	Apply		- 30%		30%	-	30%	-	-	
Level 4	Analyze	-	30%	1 A.	30%	-	30%	-	-	
Level 5	Evaluate					Sec. 1		-	-	
Level 6	Create	201-	1. 1	Cr. 15. 10	21-1.1.1	1	-	-	-	
	Total	10	0%	10	0%	10	0%		-	

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
	1. Mr. Saivineeth, ML Accelerator Architect @ Google	1. Mrs. A. Ramya, SRMIST	
		2 Dr. I Maniula SPMIST	



Course Code	ode 21ECC222L Course ANALOG AND LINEAR ELECTRONIC CIRCUITS LAB						cours atego	e ry	С			PR	OFESS	IONAL	COR	E		[ (	- T ) 0	P 4	C 2
Pre-requ Cours	uisite ses	Nil	(	Co- requisite Course <mark>s</mark>	Nil		Pro	ogres:	sive es						Nil						
Course	Offering Departme	ent		ECE	Data Book / Codes /	Standards								Nil							
Course L	earning Rationale	(CLR): <i>Th</i>	he purpos <mark>e of</mark>	learning this cour	se is to:		6	1	A.		Progra	m Ou	Itcome	s (PO	)				Pr	ogra	m
CLR-1:	To understand the	e operation o	of BJT and MO	SFET amplifier	10 200		1	2	3	4	5	6	7	8	9	10	11	12	SI Ou	pecifi	ces
CLR-2:	To study the cond	cept of multi s	stag <mark>e amplifier</mark>	and differential amp	lifier	· · · · ·	e		÷	of	2.	ety			¥		0				
CLR-3:	To understand cla	ass C power	amplifier and o	oscillator		100	/ledg		ent o	tions	ge	soci			Wo		ance	5			
CLR-4:	To study various	opamp config	gurations and c	comparator applicati	ons		Non	lysis	opme	stiga	Usaç	and	∞ŏ		eam	ы	Ĕ	rning			
CLR-5:	To design and im	plement filter	rs and Digital to	o analog converters			ering h	m Anal	/devel	ct inve	n Tool	Igineer	nment		ual & T	unicati	t Mgt. 8	ng Lea			
Course C	Outcomes (CO):	A	t the end of th	his course, learner	s will be able to:		Engine	Proble	Design	Condu	Moder	The er	Enviro	Ethics	ndivid	Comm	Project	_ife Lo	-SO-1	-SO-2	-SO-3
CO-1:	Compile the oper	ation of BJT	and MOSFET	amplifier	Alto bush	34.27	2	-	.2	-	3	1	-	-	-	-	-	-	-	-	
CO-2:	Design multistage	e amplif <mark>ier an</mark>	nd differential a	mplifier	training and the		2		2	-	3	-			-	-	-	-	-	-	-
CO-3:	Implement class	C powe <mark>r am</mark> p	olifier and oscill	lator in electronic ap	plication		2		2	_	3	- 34	-		-	-	-	-	-	-	-
CO-4:	Design linear and	l nonlin <mark>ear a</mark> p	oplication of op	amp		200	2	-	2	-	-	-		-	-	-	-	-	-	-	-
CO-5:	Illustrate filters ar	nd digita <mark>l to a</mark>	nalog converte	ərs	E THE STATE		2	-	2	-	-	2	-	-	-	-	-	-	-	-	-
Unit-1 - P	IT and MOSEET A	mplifior	1					67		· · · · · ·										12	Hour
BJT confi	guration, input char	acteristics, o	utput character	ristics, transient and	alysis, frequency response, co	mmon sour	ce an	nplifie	r with	current	series	feed	back tra	nsien	t and f	requer	icy res	ponse,	comn	non si	ource
amplifier v	with voltage series fe	edback trans	sient and frequ	ency response.							1										
Unit-2 - N	Aultistage Mplifier a	and Different	tial Amplifier	fraguionau raenanca	Pandwidth calculation Differ	ontial ampli	fior fr	auon	01/ 100	00000	oomm	on mo	do goir	diffo	rontial	modo	anin d	000000	n mor	12 lo roir	Hour
ratio	ampiller transient ie	esponsecasc	oue ampimer n	requency response,	Banuwiulin Calculation. Dinere	enuar ampin		equen	cy res	oonse,	comm		ue gain	i, une	renual	moue	yain, u	;0111110;	ΠΠΟΟ	e reje	CUON
Unit-3 - C	lass C Power Amp	lifier and LC	C Oscillator.	2.00	CLARA ST	10.11					1	-								12	Hour
Class C p	ower amplifier trans	ient response	e, Clas <mark>s C pow</mark>	v <mark>er am</mark> plifier frequen	cy response, quality factor, De	sign of LC o	oscilla	tor, fe	edbac	k fractic	n, freq	uency	of osci	illation	1.						
Unit-4 - L	inear and Non4line	ear Applicati	ions of O <mark>pama</mark>	ар				1.21												12	Hour
Inverting	amplifier noninvertin	ng amplifier, v	voltage followe	r, closed loop gain	Inverting comparator, non-in	verting com	parat	or, Sc	hmitt t	rigger,	upper	threst	nold poi	int, lov	ver thr	reshold	point	calcula	tion, n	nonos	stable
multivibra	tor using IC 555, Asi	table multivib	orator, duty cyc. nvortor	<u>le measurement.</u>																12	Hour
Butterwor	th low pass filter free	uencv respo	onse. Butterwor	rth high pass filter fr	equency response. Bandpass	filter. Band	reiect	filter.	R-2R	adder t	vpe dia	nital to	analoo	conv	erter					12	ioui

	1.	David A. Bell, "Electronic Devices and Circuits", 5th ed., Oxford University Press, 2015	5.	D. Roy Choudhry, Shail Jain, "Linear Integrated Circuits", 5th ed., New Age
	2.	Donald Neaman, "Electronic Circuits: Analysis and Design", 3rd ed., Mc-Graw-Hill Education, 2011		International Pvt. Ltd., 2015
Learning	3.	Muhammad Rashid, "Microelectronic Circuits: Analysis and Design" 2nd ed.,	6.	Ramakant A. Gayakwad, "Op-amp and Linear ICs", 4th ed., Printice Hall/Pearson
Resources		Cengage Learning, 2010		Education, 2015 Sergio Franco, "Design with Operational amplifiers and Analog
	4.	Robert L. Boylastaed Louis Nashelsky, "Electronic Devices and Circuit Theory", 11th ed.,	1.0	Integrated circuits", 4th ed., Tata Mcgraw-Hill, 2016
		Peason Education, 2013	÷.,	

			C	ontinuous Learnin	g Assessment (CL)	4)						
	Bloom's Level of Th <mark>inking</mark>	CLA-1 Avera exper (3	ge of first cycle riments 0%)	CLA-2 Average exper (30	e of second cycle iments 0%)	Practical E (40% w	xamination eightage	Final Examination (0% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	-	20%		20%	-	20%	- 1	-			
Level 2	Understand		20%		20%	-	20%	-	-			
Level 3	Apply	-	30%	· 14' -	30%		30%	-	-			
Level 4	Analyze		30%	1.00	30%		30%	-	-			
Level 5	Evaluate		and the second second	C	4		- 44	-	-			
Level 6	Create			10.00		10.0		-	-			
	Total	10	0 %	10	0%	10	0%		-			

Course Designers	March 1112 1 127 1 127 1 127		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
	1. Mr. Saivineeth, ML Accelerator Architect @ Google	1 Mrs. M.K. Srilekha, SRMIST	



Course Code	21ECC301P	Course Name	e MICROPF	ROCESSOR, MIC	ROCONTROL	LER, AND INTERFACIN	G Co Ca	burse tegory	(	2			PR	OFESS	SIONA	L COR	E			<u> </u>	P 0	C 4
Pre-requi Course	isite es	Nil		Co- requisite Courses		Nil	74	Progr Cou	essiv Irses	/e						Ni	1					
Course	Offering Departm	ent		ECE	-	Data Book / Codes / Star	ndards	1							Nil							
Course Le	earning Rationale	(CLR):	The purpose	of learning this	course is to:	-			V	P	1	Progr	am Ou	utcome	s (PO	)				P	rogra	m
CLR-1:	Understand Micr	ocontroller	r interna <mark>l archit</mark>	ecture and its ass	embly langua	ge programming		1 2	2	3	4	5	6	7	8	9	10	11	12	່ S 0ເ	pecifi Itcom	ic Ies
CLR-2:	Learn how to pro	gram micro	ocontroller inte	rfaces in ALP, C	1	10000		e	4		s of		ety			논		0				
CLR-3:	Use ATMEGA 32	28P in their	r p <mark>roject des</mark> igi	1S	1			viedc	outo	בוור כ	stions	ge	soc			oW r		ance	ວ			
CLR-4:	Understand micr	oprocessol	r <mark>internal a</mark> rchi	tecture and progra	amming	A STATISTICS		Vor Vor	eleki	Indo	stiga	Usa	and	∞		Tean	u	& Fir	arnin			
CLR-5:	Learn various int	erfacing ha	ardware's for n	nicroprocessors						Jinuevei ions	luct inve olex prot	ern Tool	engineer	onment	ş	idual & -	municati	ect Mgt.	-ong Lee	-	-2	က္
Course Or	utcomes (CO):		At the end o	f this course, lea	arners will be	able to:			uu l	soluti	Conc	Mode	The e	Envir Susta	Ethic	ndivi	Com	Proje	Life L	-OS-	0Sc	-OS-
CO-1:	Describe micropi	rocessor in	nternal architec	ture and program	ming	2002		- 3	3	-	-	-		-	-	-	-	-	-	2	-	-
CO-2:	Design and imple	ement M <mark>icr</mark>	rocontroller pei	ripheral interface i	in ALP and C.	E 032 E 0		- 3	3	1	- 5	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Design and imple	ement A <mark>TM</mark>	<mark>/IEGA</mark> 328P ba	sed projects	1.3.542	the second second		-		3	-	3	-	-	-	-	-	-	-	3	-	-
CO-4:	Describe micropi	rocessor in	nternal architec	ture and instruction	ons set	and the second sec	1.10	-		3	-	3	-	-	-	-	-	-	-	-	-	-
CO-5:	Identify correct in	nterfacing <mark>h</mark>	<mark>hardwar</mark> e's for	microprocessors	1		1	- 3	3	-	-	3	-	-	-	-	-	-	-	-	-	-
<b>Unit-1 - 80</b> Pin-diagrai	<b>051 Microcontrolle</b> m and architecture	e <b>r</b> of 8051, in	nstruction-sets	of 8051, address	ing modes of {	3051. Assembly language	program	s in 80	51.Ca	ise s	tudies	on adı	dressii	ng mod	es of 8	3051.					9	Hour
Unit-2 - Pe	eripheral Program	ming in 80	051	1 2 2 3							1	17		J							9	Hour
8051 timer interrupts.	* & its programming serial port communication	in ALP & Inication.	C, 8051 Interru	ipts and its progra	amming in ALP	<sup>2</sup> , C, 8051 serial port com	municatio	on and i	ts pro	ograr	nming	in ALF	₽&C,	Interfac	cing Al	DC, Int	erfacin	g DAC	.Case	studies	s on ti	mers,
Unit-3 - A	TMEGA 328P				1000 1	MIL NORTH	1.64					2	-								9	Hour
ATMEGA ( (HC-05), G	328P architecture, SSM Module (SIM9	register file 00A). Usin	e, memory, <mark>ad</mark> a I2C Protocol	d <mark>ressin</mark> g mode, in . Usina Ziabee to	struction sets,	I/O ports, Case studies: less sensors.	interfacir	g with	LCD,	Tem	nperatu	re Sei	nsor D	HT11, I	High-\	/oltage	Devic	e and I	Relay, I	Blueto	oth M	odule
Unit-4 - 80	86 Microprocess	or	9					_		_											9	Hour
Microproce	essor (8086) Pin di	agram, Arc	chitecture, inter	mal <mark>registers, Inte</mark>	rrupts, addres	sing mode, instruction set	ts.															
Unit-5 - M	icroprocessor Inte	erfacing								_											9	Hour
Programm	able peripheral inte	erface-825	5, Programma	ble Interval Timer	-8254, USART	-8251, DMA Controller –	8257/823	37.														

		1.	D. V. Hall, "Microprocessors and Interfacing"   3rd Edition (SIE)	5.	Dr. Yogesh Misra, "Programming and Interfacing with Arduino", Taylor and Francis
		2.	Muhammad Ali Mazidi and Janice GillispieMazidi, "The 8051 – Microcontroller and Embedded	6.	Derek Molloy, "Exploring Raspberry PI, Interfacing with real world", Wiley, 2016
L	_earning		Systems", 7th Edition, Pearson Education, 2011.	7.	Subrata Ghoshal, "8051 Microcontroller Internals, Instructions", Programming and
F	Resources	3.	K. M. Bhurchandi and A. K. Ray, "Advanced Microprocessors and Peripherals with ARM and an		Interfacing, Pearson, ISBN: 978-81-317-3143-7
			introduction to Microcontrollers and Interfacing", Tata MeGraw Hill, 3edition 2015.	8.	Barry B. Brey, "The Intel Microprocessors" 8th Edition
		4.	Raj Kamal, "Embedded systems", Tata McGraw Hill, 2003		

			Co	ntinuous Learning	g Assessment (Cl	LA)					
	Bloom's Level of Th <mark>inking</mark>	Forr CLA-1 Avera (2	native age of unit test 0%)	Project Bas CL (60	ed Learning A-2 )%)	Report and (20	d Viva Vo <mark>ce</mark> 0%)	Final Examination (0% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	20%			10%	-		-	-		
Level 2	Understand	25%			20%	-		-	-		
Level 3	Apply	30%		·	25%		20%	-	-		
Level 4	Analyze	25%		100 A 100	25%	Contraction of the second	30%	-	-		
Level 5	Evaluate	<b>1</b> - 1	-	Co. 10	10%		30%	-	-		
Level 6	Create				· ·		20%	-	-		
	Total	10	0%	100	)%	10	00%		-		

Соі	urse Designers		the second provide the second s	9	
Exp	perts from Industry	Exp	erts from Higher Technical Institutions	Inte	ernal Experts
1	Mr. Anuj Kumar, Bombardier Tra <mark>nsportati</mark> on, Ahmedabad,	1	Dr. Meenakshi, Professor of ECE, CEG, Anna University,	1.	Dr. M J Alam, EC <mark>E, SRMIS</mark> T
	kumaranuj.anii@gmail.com		meena68@annauniv.edu		
2	Mr. Hariharasudhan - Johnson Controls, Pune,	2	Dr. Venkatesan, Sr. Scientist, NIOT,	2.	Dr. B. Manohri, <mark>ECE, SR</mark> MIST
	hariharasudhan.v@jci.com		Chennai, venkat@niot.res.in		



Course Code	e 21ECC302T Course ANALOG AND DIGITAL COMMUNICATION							Cours atego	Durse tegory         C         PROFESSIONAL CORE         L         T           3         0         0         0         0         0								P 0	C 3				
Pre-requi Course	isite es	Nil		Co- requisite Courses		Nil		Pro	ogres Cours	sive es						Nil						
Course	Offering Departm	ent		ECE		Data Book / Codes / S	Standards								Nil							
Course Le	Course Learning Rationale (CLR): The purpose of learning this course is to:								2		11	Progr	am Ou	tcome	s (PO)	)				P	rogra	m
CLR-1:	Introduce to the I	learners the l	basic concepts	<mark>: invo</mark> lved in Comn	munication	n system		1	2	3	4	5	6	7	8	9	10	11	12	2 Outcomes		
CLR-2:	Comprehend the	functionalitie	ies o <mark>f various ra</mark>	adio transmitters a	and receiv	ers		ge		of	s of	1	iety			Ł						
CLR-3:	Realize the proce	ess involved	l in <mark>digital com</mark> n	nunication systems	IS			/ledc		ient o	tions	ge	soci			Wo		ance	5			
CLR-4:	Explore the pass	band transn	mission system	and analyze its pe	erformand	e in terms of probability	of error	Vou	lysis	bmdo	stiga	Usa	and	∞ð		eam	ы	š Fin				
CLR-5:	Get exposed to I	nformation th	theory and char	nnel coding concep	pts			heering !	lem Ana	gn/devel	luct inve olex prob	ern Tool	engineer	onment ainability	ş	idual & T	municati	ect Mgt. 8	-ong Lea	-	-2	e,
Course Ou	utcomes (CO):	1	At the end of t	this course, learn	ners will <b>k</b>	e able to:	11.127	Engi	Prob	Desig	Conc	Mode	The (	Envir Susta	Ethic	ndiv	Com	Proje	Life	SO	SOS	PSO
CO-1:	Explain the vario	us analo <mark>g m</mark>	nodulation techi	niques		the black	Val.	3	6	-	-	-		-	-	-	-	-	2	2	-	-
CO-2:	Analyze the nois	e perfor <mark>man</mark> d	<mark>nce of</mark> radio tran	smitters and recei	ivers			3	3	12	-	-	-	-	-	-	-	-	2	-	3	-
CO-3:	Demonstrate the	demodulatio	ion and detectio	n of received digit	tal data	1. 19 A. A.		3	2	-7-	-	-	- 20	-			-	-	-	-	-	3
CO-4:	Apply the suitable	e passb <mark>and t</mark>	techniques for	real time application	ions		100	3	-	14	-	3		-	-	-	-	-	-	-	-	2
CO-5:	Exposed to the c	concepts of in	information theo	ory and channel ca	apacity			3		3	-	-		-	-	-	-	-	-	3	-	-
			-	211 3	201		_ (1)						-									
Unit-1 - Ar	nalog Modulation	Techniques	S Modulation /	malituda Madulat	tion (AAA)	and its types Canara	tion of AM	1 11/01/	<u></u>	incor	Matha		octor A	Indulat		Von Li	noor L	lathad	(Delor	and I	<u>9</u>	Hour
Demodulat	tion of AM waves (E	Envelop Dete	ector) - Freque	ncy Modulation (FI	иоп (AIVI) M) – Түре	s of FM –Narrow Band F	M (NBFM)	and V	es - L Nide E	Band Fl	Method M (WB	FM) - (	Genera	tion of	or) - r NBFM	Vara	ctor Di	ode Ma	(Baiari dulato	icea iv vr) - De	iodula emodu	llation
of NBFM w	aves (Foster Seel	y Method)- P	Phase Modulati	on (PM)- Generation	ion of PM	from FM and FM to PM	. ,				15	<u></u>								,		
Unit-2 - Ra	adio Transmitters	and Receiv	ver <mark>s</mark>	1	1		1					1									9	Hour
AM Transn	nitter (Low Level ar	nd High Leve	rel) - <mark>FM Transn</mark>	nitter (Direct and Ir	ndirect Me	ethod) - Characteristics a	and functio	ns of a	a rece	iver - A	M Sup	erhete	rodyne	e Recei	ver an	d FM S	Super H	leterod	lyne R	eceive	r - No	ise in
AM and FN	A (Elementary Trea	atment) - Nee	ed for Pre-emp	hasis and De-emp	phasis cire	cuits	1.11		-			1										
Unit-3 - Ba	Init-3 - Baseband and Digital Modulation Techniques 9Hour																					
Baseband Modulation Techniques (PAM, PWM and PPM) - Digital Modulation Techniques - Pulse Code Modulation (PCM) System) - Differential PCM (DPCM) System - Delta Modulation (DM) System - Matched																						
Unit-4 - Passband Transmission System																						
Passband	Transmission System	em Model – F	Passband Mod	ulation Techniques	<mark>s- Ge</mark> nera	tion, Signal Space diagra	am, Detect	ion, P	robabi	ility of E	Error fo	r BFSk	(-BPS	SK – QP	PSK-I	VI-ary F	°SK an	d FSK	(Eleme	entary	Treat	ment)
Unit-5 - In	Unit-5 - Information Theory and Channel Capacity 9 Hour																					
Entropy, In	Sinces - Information Theory and Channel Capacity 9 Hour Entropy, Information rate, Source coding theorem, Shannon-Fano coding, Huffman coding, Mutual information – Shannon's channel capacity theorem																					

	1.	Simon Haykin and Michael Moher, Communication Systems," 5th edition,	4.	Bernard Sklar, "Digital Communication, Fundamentals and Application", PearsonEducation Asia,
Looming		John Wiley & Sons, 2013		2nd Edition, 2001
Deseurose	2.	Singh. R. P & Sapre. S. D, "Communication Systems: Analog & Digital," 3rd edition, Mc	5.	Taub & Schilling, "Principle of Communication Systems", McGraw Hill Inc, 2nd Edition, 2003.
Resources		GrawHill Education, Seventh Reprint, 2016.	6.	John G. Proakis, "Digital Communication", McGraw Hill Inc, 5th Edition, 2008.
	3.	Simon Haykin, "Communication Systems", John Wiley & Sons, 4th Edition, 2008	-	

		Continuous Learning Assessment (CLA)									
	Bloom's Level of Think <mark>ing</mark>	Form CLA-1 Avera (50	native ge of unit test 0%)	Life-Lon Cl (1	g Learning LA-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	25%		15%		15%	-				
Level 2	Understand	25%	States Line	20%		25%	-				
Level 3	Apply	30%		25%		30%	-				
Level 4	Analyze	20%		25%		30%	-				
Level 5	Evaluate		and the second	10%			-				
Level 6	Create			5%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	-	-				
Total		10	0%	10	0 %	100 %					

Cοι	Course Designers											
Exp	erts from Industry	Experts from Higher Technical Institutions	Internal Experts									
1.	Mr. Anuj Kumar, Bombardier Tra <mark>nsportat</mark> ion, Ahmedabad,	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University,	1. Dr. M. Sangeetha, SRMIST									
	kumaranuj.anii@gmail.com	meena68@annauniv.edu										
2.	Mr. Hariharasudhan - Johnson Controls, Pune,	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in										
]	hariharasudhan.v@jci.com											



Course Code	21ECC303T	Co N	ourse ame	VLSI DESIGN AND TECHNOLOGY			Cat	ourse tegory	/	С	PROFESSIONAL CORE						P 0	C 3				
Pre-requi Course	site s	Ni	I	Co- requisit Cour <mark>ses</mark>	e	Nil		Progressive Nil														
Course	Offering Depart	ment		ECE		Data Book / Codes / Star	ndards								Nil							
Course Learning Rationale (CLR): The purpose of learning this course is to:							Program Outcomes (PO) Progr										rogra	m				
CLR-1:	Implement a g	ven logi	c function usi	n <mark>g appropria</mark> te logic	styles for impro	oved performance		1	2	3	4	5	6	7	8	9	10	11	12	S Ou	pecit	IC 1es
CLR-2:	Understand the and as well the	MOSF	ET operation design rul <mark>es.</mark>	and processes in IC i	fabrication, ste	os in the fabrication of MOS	ICs,			X		1		ility								
CLR-3:	Understand Co	ncepts	of thermal oxi	<mark>idat</mark> ion and Si/SiO2 ii	nterface.	1. S. C.	5 K.	ge		of	ls of	-	ciety	inab		Ł		e				
CLR-4:	Concepts of ion implantation, role of the crystals structures, high-energy implants, ultralow energy implants and ion beam heating methods.					ergy -	nowled	/sis	pment	tigatior	Jsage	and so	k Susta		eam W	ç	Financ	ning				
CLR-5:	Use Verilog HL Design, constr	DL as a c uct and	lesig <mark>n-en</mark> try la sim <mark>ulate VL</mark> S	anguage for FPGA in I adders and multipli	electronic des ers.	ign automation of digital circ	uits,	ering K	m Analy	/develo	ct inves ex proble	J Tool L	gineer a	nment 8		ual & Te	unicatio	t Mgt. &	ng Lear			
Course Ou	utcomes (CO):		At the o	end of this course,	learners will b	e able to:		Engine	Proble	<b>Design</b>	Condu	Moder	The er	Enviro	Ethics	Individ	Comm	Project	Life Lo	PSO-1	PSO-2	PSO-3
CO-1:	Examine the or gates designed	haracte I using c	ris <mark>tics of M</mark> O liff <mark>erent lo</mark> gic	S transistors and Ar styles	alyze CMOS	inverter and other complex	logic	- 1	2	3	- 5	-	-	1	-	-	-	-	-	2	-	-
CO-2:	Design and implement digital circuits using Verilog HDL, general VLSI system components, adder cel and multipliers to address the design of data path subsystem					cells		3	8	-3	-	-		-	-	-	-	-	-	-	-	
CO-3:	Explain how the transistors are built, and understand the physical implementation of circuits an understand physics of the Crystal growth, wafer fabrication and basic properties of silicon wafers					and	-	2	3	-	-	11		-	-	-	-	-	-	2	-	
CO-4:	To learn the various lithography techniques and concepts of wafer exposure system, concepts of therma oxidation and Si/SiO2 interface. Dopant solid solubility, diffusion macroscopic point, different solutions t diffusion equation.				ermal ons to	-	3	1	-	-			-	-	-	-	-	2	-	-		
CO-5:	To learn concepts of ion implantation, role of the crystals structures, high-energy implants, ultralow energy implants and ion beam heating methods.				nergy	-	2	2	j.	7	-	-	-	-	-	-	-	2	-	-		

#### Unit-1 - Introduction to Verilog HDL & Coding

Introduction to HDL & Verilog HDL - Introduction to Verilog HDL, modules and ports -Lexical Conventions: White Space and Comments, Operators - Numbers, Strings, Identifiers, System Names, and Keywords -Verilog Data Types: Nets, Register Variables, ConstantsReferencing Arrays of Nets or Regs -Arithmetic Operators, Bitwise Operators, Reduction Operators, Logical Operators, Relational Operators, Shift Operators, Conditional Operator, Concatenation Operator, Expressions and Operands, Operator Precedence -Verilog modeling: Gate-level modeling - Realization of Combinational and sequential circuits -Compilation and simulation of Verilog code -Test bench -Dataflow modeling -Realization of Combinational and sequential circuits -Behavioral modeling -Realization of Combinational and sequential circuits Switch-level modeling -Realization of MOS circuits -Design using FSM -Realization of sequential circuits

#### Unit-2 - MOS Transistor

Generic overview of the MOS device: MOS structure demonstrating (a) accumulation, (b) depletion, and (c) inversion; nMOS transistor demonstrating cutoff, linear, and saturation regions of operation - Static Conditions: The threshold voltage - Dynamic behavior: MOSFET Capacitances- Parasitic Resistances - Non-ideal I-V effects: Mobility Degradation, Velocity Saturation - Channel Length Modulation, Threshold Voltage

B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

20

9 Hour

9 Hour

Effects - Leakage, Temperature Dependence, Geometry Dependence, Subthreshold Current-Short-channel MOSFETs: Hot carriers, LDD - MOSFET scaling - Short-channel effects: NBTI, oxide breakdown - DIBL, GIDL, Gate Tunnel Current.CMOS Inverter Characteristics: Operation and properties of static CMOS inverter - Power Consumption - Dynamic Power Consumption, Total Power Consumption, PDP

#### Unit-3 - VLSI Subsystem Design and Introduction to CMOS Logic Styles

Decoders -Comparators -Adders: Standard adder cells -Ripple Carry Adder (RCA) -Carry Look-Ahead Adder (CLA) -Carry Select /Save/skipAdder (CSL/CSA/ CSK). . Multipliers: Overview of multiplication- types of multiplier architectures -Braun multiplier -Baugh-Wooley multiplier -Wallace Tree multiplier -Booth multiplier CMOS Circuit Design Styles: Static CMOS logic styles -CMOS circuits, pseudo-nMOS, tristate circuits, clocked CMOS circuits -DCVSL, Pass Transistor Logic (PTL) -Dynamic CMOS logic styles: NORA, TSPC

#### Unit-4 - Lithography and Relative Plasma Etching

Optical Lithography, Electron Lithography, X-Ray Lithography, Ion Lithography, Plasma properties, Feature Size control and Anisotropic Etch mechanism, reactive Plasma Etching techniques and Equipment.Deposition, Diffusion, Ion implementation and Metallization Deposition process, Poly silicon, plasma assisted Deposition, Models of Diffusion in Solids, Fick's one-dimensional Diffusion Equations – Atomic Diffusion Mechanism – Measurement techniques – Range theory- Implant equipment. Annealing Shallow junctions – High energy implantation – Physical vapor deposition– Patterning.

#### Unit-5 - Process Simulation and VLSI Process Integration

lon implantation – Diffusion and oxidation – Epitaxy – Lithography – Etching and Deposition- NMOS IC Technology – CMOS IC Technology – MOS Memory IC technology - Bipolar IC Technology – IC Fabrication - NMOS.CMOS Fabrication processor flow- Analytical Beams – Beam Specimen interactions

	1.	S.M. Sze, "VLSI Technology", McGraw Hill fourth Edition. 2008.	5.	Digital Integrated Circuits: A Design Perspective", Pearson Education, 2015.
Looming	2.	James D Plummer, Michael D. Deal, Peter B. Griffin, "Silicon VLSI Technology:	6.	CMOS VLSI Design: A Circuits and Systems Perspective, 4th Edison, Neil Weste, David Harris,
Decourses		Fundamentals Practice and Modeling", Prentice Hall India.2009.		Pearson publication, 2015.
Resources	З.	Wai Kai Chen, "VLSI Technology" CRC Press, 2013.	7.	Douglas A. Pucknell, Kamran Eshraghian, "Basic VLSI Design, 3rd Edison, prentice Hall, 2016
	4.	Jan M. Rabaev, Anantha P. Chandrakasan, Borivoje Nikolić,		

Learning Assessn	nent 🥂	1 A 4 4 4 4 4 7	A State State	State Street							
			Continuous Learning	g Assessment (CLA)	ALL PROPERTY	Summative					
	Bloom's Level of Thinking	Form CLA-1 Avera (50	ative ge of unit test %)	Life-Lon Cl	g Learning LA-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	<u>Th</u> eory	Practice				
Level 1	Remember	15%	-	15%		15%	-				
Level 2	Understand	25%	- 10.	20%	-	25%	-				
Level 3	Apply	30%		25%		30%	-				
Level 4	Analyze	30%		25%		30%	-				
Level 5	Evaluate	1.		10%	- Ur		-				
Level 6	Create		11.	5%			-				
	Total	)%	10	0 %	100 %						

Course Designers											
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts									
	1. Mr. Saivineeth, ML Accelerator Architect@ Google	1. Dr.J. Selvakumar, SRMIST									
	2. Mr. Anuj Kumar, Program elivery ManagerNagarro Software's Pvt Ltd.										

9 Hour

9 Hour

9 Hour

Course Code	urse 21ECC304T Course MICROWAVE AND OPTICAL COMMUNICATION							se ory	С	PROFESSIONAL CORE								- T 3 0	P 0	C 3	
Pre-requi Course	isite es	Nil		Co- requisite Courses	Nil		Pr	ogres Cours	sive es						Nil						
Course	Offering Departm	ent	·	ECE	Data Book / Codes	/ Standards	5							Nil							
Course Le	earning Rationale	(CLR):	The purpose	<mark>of learnin</mark> g this co	urse is to:			1	01.5	1.1	Progr	am Ou	Itcome	es (PO	)				Program		n
CLR-1:	Deliver in depth l	knowledge	ie on micro <mark>wave</mark>	<mark>trans</mark> mission and g	eneration		1	2	3	4	5	6	7	8	9	10	11	12	Ou	tcom	c es
CLR-2:	Propose efficient	methods	s to anal <mark>yze S-pa</mark>	rameters of microw	ave devices	-			1	-	20		>								
CLR-3:	Explore detailed techniques with a	awarene	ess on <mark>measure</mark> n d equipment.	nent techniques an	d to provide complete knowled	lge on the	ge		of	s of		siety	inabilit		Ł		e				
CLR-4:	14: Offer complete information on light transmission through optical fiber and their mechanism and characterization							/sis	oment	igation	sage	and soc	Sustai		am Wo	_	Financ	ning			
CLR-5:	Acquire detailed optical communi	understar cation sys	n <mark>ding on t</mark> he met stem and to gran	hodologies and des t mathematical form	ign considerations of link powe nulation	r budget in	ering Kr	m Analy	n/develop	ct invest ex proble	n Tool U	ngineer a	nment &		ual & Te	unicatio	t Mgt. &	ng Lear			
Course Ou	utcomes (CO):		At the end of	this course, learn	ers will be able to:	139.2	Engine	Proble	Design	Condu	Moder	The er	Enviro	Ethics	Individ	Comm	Projec	Life Lo	PSO-1	PSO-2	PSO-3
CO-1:	Familiarize the c	oncept o <mark>f</mark>	<sup>r</sup> microwave trans	mission and gener	ation	1 F .	3	2	1	-	-	- 16	-	-		-	-	-	3	-	-
CO-2:	Realize systema	tic meth <mark>oc</mark>	<mark>ds to de</mark> sign, and	alyze S-parameters	of microwave devices		3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Identify different microwave meas	measure <mark>n</mark> urements	<mark>ment te</mark> chniques <mark>s and th</mark> e techniq	for determining var	ious parameters and to gain kn I equipment	owledge on	2	-	8	3	-	1	-	-	-	-	-	-	3	-	-
CO-4:	Discover comple characterization	ete inforn and mech	mation on the 1 hanism	undamentals of lig	ght transmission through fibe	r and their	3	2	-	-	-	5.	-		-	-	-	-	3	-	-
CO-5:	Recognize the lir	nk power l	b <mark>udget de</mark> sign co	onsiderations of opt	ical communication system		3	-	2	-	-	-	-	-	-	-	-	-	-	2	-
I Init-1 - In	traduction to Mic	rowavas :	and Sources	6.1		<u> </u>					1									٥	Hour
History of I	Microwave Engine	erina Mici	rowave transmis	sion and Applicatio	ns Microwave Tubes Klystron	amplifier Re	flex k	Ivstro	n oscilli	ators. I	Nagne	tron os	cillator	s IMP	ATT. T	RAPA	TT. Tu	nnel di	ode. G	unn d	liode
Unit-2 - S	Parameters Snaly	sis for N	l-port Microwav	e Devices							<u></u>			•,	,.		,			9	Hour
Scattering	parameter, Direction	onal coup	oler, E plane, H p	lane and Magic Tee	Junctions, Microwave Circula	tors, Isolator:	s, Pha	se shi	fters, A	ttenua	ors an	d Pow	er divid	ders. C	ase st	udy on	Directi	ional c	oupler		
Unit-3 - Mi	icrowave Measure	ements a	nd Equipments	-	and the second second															9	Hour
pedance a measurem	nd Power measur ent	ement, M	leasurement of	Frequency, Attenua	ation, Scattering parameters, V	/ector Netwo	ork An	alyzer	, Signa	al Anal	yzer a	nd Spe	ectrum	Analy	zer Ca	ase stu	dy on	VSWR	and I	mped	ance
Unit-4 - Op	otical Fiber Comn	nunicatio	on Systems 💻																	9	Hour
Introduction	n to Optical fiber co valanche photo dio	ommunica de	ation, Ray theory	trans <mark>mission, Optic</mark>	al fiber modes and configuration	ns, Fiber atte	nuatio	on and	disper	sion m	echani	sms, C	optical :	source	s-LED	and LA	SER L	Diode, (	Optica	deteo	tors-
Unit-5 - O	ptical Link Power	 Budaet A	Analysis																	9	Hour
Digital link-	Point-to-Point link	-System	considerations,	Link power budge <mark>t</mark>	and Risetime budget, Analog lii	nk and analy	sis, W	DM ar	nd Pass	sive de	vices,	Case s	study o	n Poin	t-to-Po	int link	power	budge	t analy	/sis	

	1. Samuel Y. Liao, "Microwave Devices and Circuits", 3rd Edition, Pearson Education, 2013.	5. Keiser G, "Optical Fiber Communication Systems", 5th Edition, 6th Reprint, McGraw Hi
	2. Robert. E. Collin, "Foundations for Microwave Engineering", 2nd edition, Wiley, Reprint 2014.	Education (India), 2015.
Learning	3. Annapurna Das, Sisir K. Das, "Microwave Engineering", 3rd Ed., McGraw Hill, 2015.	6. John M. Senior, "Optical fiber Communications: Principles and Practice", Pearso
Resources	4. David M. Pozar, "Microwave Engineering", 4th Edition, John Wiley & Sons, 2012	Education, 3rd Edition, 2009.
		7. Vivekanand Mishra, Sunita P. Ugale, "Fiber Optic Communication: Systems an
		Components", Wiley-India, 1st edition, 2013

		11	Continuous Learning	Cum	motivo					
	Bloom's Level of Th <mark>inking</mark>	Forr CLA-1 Avera (5	native age of unit test 0%)	Life-Long L CLA- (10%	earning -2 6)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%	A State of the second	15%	1.	15%	-			
Level 2	Understand	25%		25%	124	25%	-			
Level 3	Apply 📃	30%		30%		30%	-			
Level 4	Analyze	30%		30%		30%	-			
Level 5	Evaluate						-			
Level 6	Create		10 345 W		20- 20-	-	-			
	Total	10	0%	100	%	100 %				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad,	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University,	1. Dr. Shanthi Prince, SRMIST
kumaranuj.anii@gmail.com	meena68@annauniv.edu	
2. Mr. Hariharasudhan - Johnson Controls, Pune,	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai,	2. Dr. M. Neelaven <mark>i Ammal,</mark> SRMIST
hariharasudhan.v@jci.com	venkat@niot.res.in	

Course Code         21ECC311L         Course Name         VLSI DESIGN LAB         Course C		Cours Catego	se ory	С			PR	OFESS	IONAL	COR	E		[ (	- T ) 0	P 4	C 2						
Pre-requi Course	isite es	Nil	Co- requi Courses	isite	Nil		Progressive Nil															
Course	Course Offering Department ECE Data Book / Codes / Standa													Nil								
Course Le	Course Learning Rationale (CLR): The nurnose of learning this course is to:									Program Outcomes (PO)										Program		
CLR-1:	Learn Hardware L	Descriptive L	anquaq <mark>e (Verilog/</mark> VHDL	.)			1	2	3	4	5	6	7	8	9	10	11	12	Specific			
CLR-2:	l earn the fundam	ental princir	oles o <mark>f VI SI circ</mark> uit desia	, n in digital and a	analog domain		d)			of	1	sty			<u>×</u>	-	-				53	
CLR-3:	Familiarize fusing	of logical m	nod <mark>ules on FP</mark> GAs	in in digital and a	nalog domant	100	ledge		ent of	tions	ge	socie			Wor		ance	5			Ì	
CLR-4:	Hands on design	on design experience with professional design (EDA) platforms					Von	lysis	opme	stiga	Usac	and	<u>∞</u> ک		eam	u	& Fin	urninç				
CLR-5:	Understand the c	oncept of tra	ansistors are built, and th	e physical imple	mentation of circuits.		ering I	n Ana	/devel	ot inve x prob	Tool	gineer	nment		al & T	unicati	Mgt. 8	ng Lea				
Course Ou	utcomes (CO):	4	At the end of this cours	e, learners will	be able to:	and T	Engine	Probler	Design	Conduc	Aoderr	The en	Enviror	Ethics	ndividu	Commu	Project	ife Loi	SO-1	SO-2	SO-3	
CO-1:	Design and imple	ment di <mark>gital</mark>	circuits using Verilog HD	DL to simulate ar	nd verify the designs.	C. S. C.	3	2	-	-	1	-	-	-	-	-	-	-	1	-	-	
CO-2:	Design general V subsystem	LSI sys <mark>tem</mark>	components, adder cells	and multipliers	to address the design	of data path	3	2	3	-	1	-	2	-		-	-	-	1	-	-	
CO-3:	Examine the char	racterist <mark>ics o</mark>	f MOS transistors				3	2	1-1	-	1	-	-	-	-	-	-	-	1	-	-	
CO-4:	Analyze CMOS in	nverter and c	o <mark>ther</mark> complex logic gates	s designed using	g different logic styles	1	3	2	5	62	1	-	-	-	-	-	-	-	1	-	-	
CO-5:	Use HSPICE con building blocks	nputer a <mark>naly</mark>	rsis program and Verilog	HDL for simula	ition, analysis of MOS	circuits and	3	2	-	-	1	ć	-		-	-	-	-	1	-	-	
<b>Unit-1 - Co</b> Realization	ombinational and	Sequential I and Sequent	Logic Circuit tial Circuits - Realization	of digital circuits	s using behavioural mo	odelling and S	Switch	level l	Modellii	ng - De	sign u:	sing F	SM a <mark>nc</mark>	ASM	charts	;				12	Hour	
Unit-2 - De	esign of VLSI Subs	system -1		alast/aliin adda	r Implementation in LU	DI anto lava	larha	houiou	wal ma	delling	as un the		a no ref. ou		huaia					12	Hour	
Design of A	ADDER- Ripple car	ry adder – ca system – 2	arry save adder – carry s	select/skip addel	- Implementation in HL	DL gate-leve	or be	naviou	irai mo	aeiiing	- syntn	esis re	eport ar	na ana	iysis.					12	Hour	
Realization	n of VLSI Multiplier-	I (Braun and	l booth multiplier) - Reali	zation of VLSI N	Aultiplier-II (Wallace Tre	ee multiplier)	- Impl	ement	ation ir	HDL	ate-le	vel or l	behavio	oural n	nodellii	ng-synt	hesis ı	report a	and an	alysis		
Unit-4 - De	Unit-4 - Design of Computing and Memory Unit 12 Hour																					
Realisation	Realisation of 1K x 8 RAM & ROM- 4K x 16 RAM & ROM – Realisation of 4 bit and high order bit ALU – Implementation in HDL behavioural modelling – synthesis report with analysis.																					
Design and	Jnit-5 - Switch Level Modelling  Design and Analysis of Envertex using CMOS and pool do NMOS with HSDICE. Design and Analysis of AND/NAND gate in DCVSL and Pool to point repetiator legic using LTSDICE. Design and analysis of A insut Dynamia																					
NAND gate	AND gate using HSPICE																					

Learning	1. Verilog HDL- A Guide to Digtial Design and Synthesis, Sameer Palnitkar,	2. Xilinx vivado 2020 Version
Resources	Pearson publication.	3. Questasim - powered by Siemens

Learning Assessm	ent										
			C								
	Bloom's Level of Thinking	CLA-1 Avera experi (3	ge of first cycle riments 0%)	CLA-2 Average expension (3	e of second cycle riments 0%)	Practical E (40% w	Examination eightage	Final Examination (0% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember		20%		20%	1.1	20%	-	-		
Level 2	Understand		20%		20%		20%	-	-		
Level 3	Apply		30%	Sec. Sec. Sec.	30%		30%		-		
Level 4	Analyze		30%	10000	30%		30%	-	-		
Level 5	Evaluate			1. The 1. State	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	-			-		
Level 6	Create			1222					-		
	Total	10	0%	10	0%	10	0%		-		
			100 100	Andre	Star Star		5-8	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			

Course Designers		no la
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Mr. Leela Krishna Thota, Sr. Solution Engineer II, SRG, Synonsys India Pyt 1 td	1 Dr. J. Selvakumar, SRMIST



Course Code	21ECC322L	Course Name	ie e		COMMUN			Cour Catego	se ory	С			PR	OFESS	IONAI	COR	E		[ (	_ T 0 0	P 4	C 2
Pre-requi Course	site s	Nil		Co- requi Courses	site		Nil	Pr	ogres Cours	sive es						Nil						
Course	Offering Departme	ent		ECE		Data Bo	ok / Codes / Stand	ards							Nil							
Course Learning Rationale (CLR): The purpose of learning this course is to:						1	1		211	Progr	am Oi	utcome	s (PO	)				P	rogra	m		
CLR-1:	Afford in depth av	vareness	on various anal	<mark>og m</mark> odulati	on and de	modulation techn	iques	1	2	3	4	5	6	7	8	9	10	11	12	01	pecifi itcom	ic ies
CLR-2:	Familiarize effect	ive metho	ods of di <mark>gital mo</mark>	dulation and	demodula	ation techniques	- Andrewski and	e		4	of	3.	ety			¥						
CLR-3:	Examine detailed	knowledg	lge on microwave	e generatior	n, transmis	ssion and measur	ement techniques	ledg		ent o	tions	e	soci			Mo		ance	5			
CLR-4:	Provide ample ev	idence <mark>o</mark> r	n lig <mark>ht transm</mark> iss	ion through	optical fib	er and their mech	anisms.	Von	lysis opme		stiga	Usaç	and	৵		eam	и	& Fin	arnin			
CLR-5:	Analyze the chara	acteristics	s <mark>of specific</mark> Micr	owave and	Optical de	evices and Compo	nents	ring	Ana	level	inve	Tool	ineer	ment		al & 1	nicati	Mgt. 8	g Lee			
								linee	blem	sign/c	nduct	dern	eng	ironr	S	vidua	Inwu	ject I	Lon	5	0-2	0-3
Course Ou	itcomes (CO):		At the end of	this cours	e, learner	rs will be able to:	- ALGOR	Eng	Pro	Des	Cor	Mod	The	Env	Et	Indi	Cor	Proj	Life	PS(	PSC	PSC
CO-1:	Recognize variou	s analo <mark>g l</mark>	modulation and	demodulati	on techniq	ques	Sec. 1994	2	-	-	-	-	-	-	-	-	3	-	-	3	-	-
CO-2:	Identify systemat	c metho <mark>d</mark>	<mark>ds of di</mark> gital modu	ulation and o	demodulat	tion techniques		-		2	-	-	-	-	-	-	3	-	-	3	-	-
CO-3:	Discover microwa	ave sign <mark>al</mark>	<mark>l gener</mark> ation, trai	nsmission a	nd differer	nt measurement te	echniques	2		1	3	- 1	- 10	-	-		-	-	-	3	-	-
CO-4:	Realize different	charact <mark>eri</mark>	ristics and mecha	anisms of lig	ght transm	ission through fibe	er	2	-	125	3		-	-	-	-	-	-	-	3	-	-
CO-5:	Characterize and	analyze <mark>l</mark>	Microwave and	Optical devi	ces and C	Components		2		3	-	-	-	-	-	-	-	-	-	-	2	-
Unit-1 - Ar	alog Modulation	and Dem	odulation Tech	niques		1.1							£				•	•			12	Hour
Unit-2 - Di	gital Modulation and del	nd Demo	odulation Tech	niaues	1		1111									_					12	Hour
Pulse Code	Modulation and d	emodulat	tion, DM and der	nodulation,	PSK Mod	ulation and demo	dulation, QPSK Mod	dulation ar	nd Der	nodula	tion	1										
Unit-3 - Mi	crowave Commu	nication			10							1									12	Hour
Characteris	stics of Reflex Klys	tron, powe	er distr <mark>ibutio</mark> n in	Directional	coupler, E	E plane, H plane a	nd Magic Tee, Impe	edance me	easure	ment l	by slotte	ed line	metho	d							40	Haur
Characterie	Unit-4 - Uptical Communication 12 Hour																					
Unit-5 - Mi	crowave and Opti	cal Com	munication					opagailon		onun	9 10330	5.	-								12	Hour
Gain and ra	an and radiation pattern of Horn antenna, Characteristics of Filters, Strip line and Parallel line Coupler, Analysis of Analog and Digital Optical Link, Simulation of Optical Communication System using Optilux										Optical	Link, S	Simula	tion of (	Optica	l Com	nunica	tion Sy	rstem u	ising (	Dptilux	(

	1. Singh. R. P & Sapre S. D, "Communication Systems: Analog & Digital," 3rd edition,	3. Samuel Y. Liao, "Microwave Devices and Circuits", 3rd Edition, Pearson Education, 2013									
Learning	McGrawHill Education, Seventh Reprint, 2016.	<ol> <li>Keiser G, "Optical Fiber Communication Systems", 5th Edition, 6th Reprint, McGraw Hill Educatio</li> </ol>									
Resources	2. Simon Haykin and Michael Moher, "Communication Systems," 5th edition, John Wiley	India, 2015.									
	& Sons, 2013.	5. Laboratory Manual									

	Bloom's Level of Thinking	CLA-1 Avera exper (3	ge of first cycle iments 0%)	CLA-2 Average exper (30	of second cycle iments 0%)	Practical E (40% w	Examination veightage	Final Ex (0% we	amination eightage)
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	1.	20%		20%		20%	-	-
Level 2	Understand	~ ~ /	20%	1 m - 1 m	20%	-	20%	-	-
Level 3	Apply		30%	1.22.5	30%	-	30%	-	-
Level 4	Analyze	ALC: NO	30%		30%		30%	-	-
Level 5	Evaluate	-		1.1.1	1.1.1.1.1.1.1			-	-
Level 6	Create	-		6		Const.	-	-	-
	Total	10	0%	10	0%	10	0%		-

Соі	urse Designers			2.10					
Experts from Industry			erts from Higher Technical Institutions	Internal Experts					
1.	Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad,	1.	Dr. Meenakshi, Professor of ECE, CEG, Anna University,		1.	Dr. M. Neelaveni Ammal, SRMIST			
	kumaranuj.anii@gmail.com		meena68@annauniv.edu						
2.	Mr. Hariharasudhan - Johnson Controls, Pune,	2.	Dr. Venkatesan, Sr. Scientist, NIOT, Chennai,		2.	Dr. S. Vasanthadev Suryakala, SRMIST			
	hariharasudhan.v@jci.com		venkat@niot.res.in						


					L	atego	ry	U			FR	UFE 33					:	3 0	0	3
Pre-requisite Nil Co- requisite Nil Courses Nil							ogres: cours	sive es						Nil	1					
Course Of	se Offering Department ECE Data Book / Codes / Standards Nil																			
Course Lear	rning Rationale (	CLR): TH	he purpose of learning this	course is to:			1	1	1.1	Progra	am Ou	itcome:	s (PO)		-			Pi	rograi	m
CLR-1:	Understand the ele	ements of W	/ireless Communication and l	nobile communications		1	2	3	4	5	6	7	8	9	10	11	12	Outcomes		
CLR-2:	Understand the ele	ements of W	/irel <mark>ess Commu</mark> nication and l	nobile communications				1	of	1	ţy	6								
CLR-3:	Analyze how to ap	ply Mobil <mark>e F</mark>	R <mark>adio Wave</mark> Propagation - Sr	all Scale Fading		edge		nt of	ons (		ocie			Nork		nce				
CLR-4:	Study the Capacity	y and Divers	<mark>ity conce</mark> pts in wireless com	nunications	1	alwor	SIS	omer	igati ems	sage	s pu			am /	_	Fina	guir			
CLR-5:	Acquire the knowle systems	edge of Wire	eless System and Standards	nd Understand and design various w	wireless	sering Kr	m Analy	n/develop	ict invest ex proble	n Tool U	ngineer a	nment & nability		lual & Te	unication	t Mgt. &	ong Learr			
Course Outo	comes (CO):	A	t the end of this course, lea	rners will be able to:		ingine	roble	Design	Cond	loder	he ei	inviro	:thics	Jdivic	Comm	rojec	ife Lo	,-OS	SO-2	SO-S
CO-1:	Acquire the knowle	edge o <mark>f Wire</mark>	eless communication and bas	ic cellular concepts	221-1	3	-	-	-	-		-	-	-	-	-	2	-	-	<u>u</u>
CO-2:	Understand` the e	ssentia <mark>l Rac</mark>	lio wave propagation and mo	bile channel models	-	-	3	1			- 1	<i>.</i>	-	-	-	-	2	-	-	3
CO-3:	Familiarize about	Variou <mark>s perf</mark>	ormance analysis of mobile o	ommunication system.		3	2	- 1	-	-	-	-	-	-	-	-	-	-	-	3
CO-4:	Attain the knowled	lge of <mark>Divers</mark>	sity and capacity concepts	A CONTRACT OF A CONTRACT	- 1- C	3	2	5	12	-		-	-	-	-	-	-	-	-	3
CO-5:	Be familiar with ta concepts of wirele	he vari <mark>ous</mark> ss communi	standards of Mobile Comm cation, its design with respec	inication Systems and Explore the to fading and link performance	e various	3	es.	-	-	-		5	-	-	-	-	-	-	-	3
Unit-1 - Intro	oduction to Wirel	ess Comm	unications and Antennas		1					-	-								9	Hour
Introduction Timing diagra strategies- H	to wireless comm am - landline to n landoff and its type	unication an nobile Two- es- Interfere	<mark>d mobil</mark> e radio communicati Timing diagram - mobile to n <mark>ce and syst</mark> em capacityCo	n- Classification of wireless commu nobile- Basic antenna parameters, F Il splitting-Sectoring- Microcell Zone	inications Far field al Concepts	simple nd nea Umbr	ex, ha ar fiel rella C	alf dupl d- Frec Cells- S	ex, duli quency olving F	l duple reuse, Problei	x- Pag secto m on a	ging an pred and antenna	d Coro d omn paran	dless s idirecti neters	system: ional A	s- Cellı ntenna	ular tel is- Cha	ephon annel a	e syst issign	ems- ment
Introduction t	<b>ge Scale Fading</b> to Radio Wave Pro	nagation_l a	arge scale and small scale fac	ing-Friss transmission equation-Free	nronagati	n mod	el-nat	hloss r	nodel-1	wora	, mode		lified n	athlos	s mode	J-Emn	orical n	nodeli	9 I Okun	Hour
Emperical m	odel(Walfish and I	bertoni mode	el)-Piecewise linear model-lo	normal model-Shadowing-Combine	ed pathless	and a	shado	wing-C	Dutage	Proba	bility-C	Cell cov	erage	area-S	Solving	proble	ms-VH	IF/UH	= Ante	ennas
Unit-3 - Sma	all Scale Fading					-		-	-										9	Hour
Introduction Correlator M selective fad	Small Scale multipleasurements-Sma leasurements-Sma ing-Fast and slow	oath propaga all Scale mu fading-Rice	ation-Impulse response mod Itipath measurements-Swep an distribution-Rayleigh distr	el of multipath channel-Small Scale I frequency measurement-Parameter bution-Solving problems(Doppler effe	multipath i rs of mobi ect)- Desig	neasu ile mu n of N	ireme Itipath Iicros	nts-Dir 1 cha <mark>n</mark> i trip Pat	ect Pul nel-Dop tch Ante	se me pler s enna	<mark>asur</mark> ei pread	ment-Sl and Co	ide -S oherer	mall S nt time	cale m -Type	ultipath of fadii	n meas ng: Fla	urement and	nts-S Frequ	liding ıency

### Unit-4 - Improvement of link Performance

### 9 Hour

Introduction to diversity, equalization, and capacity-Space Diversity-Scanning Diversity-Maximal ratio combiner-Equal gain diversity-Rake Receiver-Capacity in AWGN-Capacity of flat fading channels-Equalizer and its mode-Adaptive equalizer block diagram-Type of Equalizers-Introduction to MIMO antennas-Case Study: Recent Trends in Diversity and MIMO antennas 9 Hour

### Unit-5 - Wireless Systems and Standards

AMPS Voice modulation Process- GSM system architecture and its interfaces-GSM frame structure-GSM speech operations input-output-Forward CDMA process- Reverse CDMA process-Multicarrier modulation-OFDM Transmitter Block diagram-OFDM Receiver Block Diagram-Importance of Cyclic Prefix-Case study (Modern Antennas) 

Learning Resources	1 2 3	Rappaport.T.S." Wireless Communications: Principles and Practice", 2nd Edition, Pearson, 2011. John D Kraus, Ronald J Marhefka, Ahmed S Khan "Antenna and Wave Propagation", 4th Edition, Tata McGraw Hill, 2010 Constantine Balanis. A, "Antenna Theory: Analysis and Design", 3rd Edition, John Wiley, 2012.	4 5 6 7	Andreas.F. Molisch., "Wireless Communications", Wiley, 2nd Edition- 2005, Reprint-2014 Andrea Goldsmith, "Wireless Communications", Cambridge University Press, Aug 2005 Schiller, "Mobile Communications", Pearson Education Asia Ltd., Reprint 2012 Lee W.C.Y.," Mobile Communications Engineering: Theory and Applications", McGraw Hill, New York, 2nd Edition , 1998
			-	

Learning Assessme	ent		12.228.25	Sector Sector							
		- 1	Continuous Learning	Assessment (CLA)	1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -	Cum	mativa				
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test )%)	Life-Long CL (10	r Learning A-2 0%)	Final Examination (40% weightage)					
	and the second	Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%	the second second second	15%		15%	-				
Level 2	Understand	25%		20%		25%	-				
Level 3	Apply	30%		25%	- Martin	30%	-				
Level 4	Analyze	30%		25%		30%	-				
Level 5	Evaluate			10%	-		-				
Level 6	Create		· · · · · · · · · · · · · · · · · · ·	5%		-	-				
	Total	10	0%	- 10	0 %	10	00 %				

Course Designers	Company and the second							
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts						
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	<ol> <li>Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu</li> </ol>	1. Dr. Sandeep Kumar P, SRMIST						
<ol> <li>Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com</li> </ol>	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	2. Dr. T. Ramarao, SRMIST						

Course Code	21ECC402P	Course Name	COMF	PUTER COMMUN		VD NETWORK SEC	URITY	Cour Categ	se ory	С			PR	OFESS	IONA	L COR	E			- T 2 1	P 0	C 3
Pre-requi Course	isite es	Nil		Co- requisite Courses		Nil		Pr	ogres Cours	sive es						Nil	1					
Course	Offering Departme	ent		ECE		Data Book / Cod	les / Standar	ds							Nil							
Course Le	arning Rationale (		he nurnos	e <mark>of learnin</mark> g this	course is t	·0·		1	1	1		Progr	am Oı	Itcome	s (PO	)				P	rogra	m
CI R-1:	Introduce the bas	ic concents i	in the field	of computer netwo	orks			1	2	3	4	5	6	7	8	9	10	11	12	S	pecifi	iC
	Provide the function				#R0.				-	Ū		Ŭ	Ŭ	-	Ū	Ŭ	10		12	U	itcom	es
CLR-2.		onal aspects	twork Lavor		-			e De		đ	s of	55	iety			논		e				
CLR-4:	Study the concept	ts in network	k security	protocois	1			wledo	s	nent o	Jation Is	age	d soc			m Wo		inanc	бu			
CLR-5:	Identify the effect	of various m	nalwares ar	nd counter measu	res	- Exercise	1	Kno	alysi	elopr	estig	ol Us;	er an	t &		Tea	tion	& F	earni			
	,					1.1.1.1	100	eering	im An	n/deve	ict inv ex pro	n Too	ngine	nmer nabili		lual &	nunice	t Mgt	ong Le	_	0	~
Course O	utcomes (CO):	A	At the end	of this course, le	arners will i	be able to:	Sec.	Engine	Proble	Design	Cond	Moder	The el	Enviro	Ethics	ndivic	Comm	Projec	ife Lo	,-OSc	-OSc	S-OS
CO-1:	Provide the basic	service <mark>s and</mark>	d concepts	related to internet	working.	14 SH7	1.1.1	2	3	-		-		-	-	-	-	-	-	-	-	-
CO-2:	Explain the basic	OSI model a	architecture	and its lower laye	er functions.	G	Not	2	3	-	- 5	-	-	×.	-	-	-	-	-	-	-	3
CO-3:	Give an insight of	the var <mark>ious</mark> i	Network La	ayer concepts, me	chanisms ar	nd protocols.	1.	3	-	12	- 1	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Gain knowledge i	n the va <mark>rious</mark>	<mark>s for</mark> ms of r	network security	1000	The state of the s	100	3	-	2	- 1 <u>-</u> 11	-		-	-	-	-	-	-	-	-	3
CO-5:	Analyse the effect	ts of intr <mark>usio</mark> i	n, viruses,	firewalls and vario	ous levels of	system security	11.0	3	1	2	-	-	-	-	-	-	-	-	-	-	-	3
Unit d D	ta Communicatio	n and Natur	a ulain ai	-								1									•	Herry
Introductio	n to Data Communication	ication and I	orking Networking	Data transfer m	odes-Serial	and Parallel transm	ission Proto	rols & S	Standa	rds La	vered	Archite	octure	Princir	oles of	Laver	ina & I	Descrin	tion R	rief de	<b>9</b> scrint	ion of
concepts in	n OSI & TCP/IP mo	del, Network	k topologies	s, switching- Circu	it and Packe	t			landa	, uo, Eu	Jorou	in or nico	otaro,	1 morp		Layon	ng a L	ocomp	, <u>В</u>		oonpa	011 01
Case Stud	lies on Network top	ologies		1000	66		-	-		-											0	Hour
Network m	odels. OSI laver ard	chitecture, Da	ata Link La	ver-Introduction, I	Link Layer A	ddressing, Error De	tection, Error	correct	ion, Da	ata link	Contro	I-LLC.	Data	link con	trol-M	IA, flow	contro	l and e	error co	ontrol.	, HDLC	<u></u> ;
Case Stud	<b>lies on</b> Hamming co	ode			. A. (		-INMA	12%	Ĺ	24	1.1											
Unit-3 - Ne	etworking Layer							1	diada.	une a						<u> </u>	( (D) (				9	Hour
Introductio	n to Network Layer, <b>lies on</b> Routina pro	Need for Int tocol-DVR	iternetworki	ing, Addressing-C	asstul, Addr	essing-Classiess, R	<i>couting protoc</i>	cois- Dis	tance	vector	and lin	k state	, Inter	net pro	[0C0I-I	PV4 ai	na IPV	o, borae	er gate	way p	rotocc	)
Unit-4 - Ne	etwork Security																				9	Hour
Email secu	irity, Overview of Po	GP and S/MI	IME, IP Sec	curity, Web <mark>Secur</mark>	ty, Secure S	ocket Layer, Transp	oort Layer Se	curity, S	Secure	Electr	onic Tr	ansact	ion									
case Stud	nes on Secure elec	suonic Transa	action			And in case of the local division of the loc																

Unit-5 - Security Attack Intrusion Detection Techniques, Password Management, Malicious software, Viruses, Worms, and Zombies. Introduction to Firewall Types and Configurations, Trusted System, Port Scanning and Knocking. Case Studies on firewall

Learning	1.	Behrouz A. Forouzan, "Data communication & Networking", Mc-Graw Hill, 5th Edition	3. William Stallings, "Cryptography & Network Security", Pearson Education India, 6th edition 2014
Deseuress		Reprint, 2014.	4. Bruce Schneier, "Applied Cryptography", Pearson Education India, 2nd edition., 2015
Resources	2.	Andrew S. Tanenbaum, "Computer Networks", Pearson Education India, 5th Edition, 2013	5. Bernard Menezes, "Network Security and Cryptography", Cengage Learning, 2010

Learning Assessn	nent		1 1 L			Sec.						
	Bloom's Level of Th <mark>inking</mark>	Forr CLA-1 Avera (2	native age of unit test 0%)	Project Bas CL (6	sed Learning .A-2 0%)	Report and (20	d Viva Voc <mark>e</mark> 0%)	Final Examination (0% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	20%		1.12	10%	-		-	-			
Level 2	Understand	25%			20%	-	-	-	-			
Level 3	Apply	30%		- 14 · -	25%			-	-			
Level 4	Analyze	25%			25%	a starter	-	-	-			
Level 5	Evaluate	- 10 M		Co. 2019	10%			-	-			
Level 6	Create	1000			- 1 - 1 - Ca	10 C - 10	1.1	-	-			
	Total	10	0 %	10	0%	10	0%		-			

Course Designers								
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts						
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad,	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University,	1. Dr.E. Elamaran, Assistant Professor of ECE, SRMIST						
kumaranuj.anii@gmail.com	meena68@annauniv.edu							
2. Mr. Hariharasudhan, Johnson Controls, Pune,	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai,	2. Dr.V. Nithya, Associate Professor of ECE, SRMIST.						
hariharasudhan.v@jci.com	venkat@niot.res.in							



B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

# ACADEMIC CURRICULA

## UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES (With exit option of Diploma)

(Choice Based Flexible Credit System)

**Regulations 2021** 

Volume - 14A (Syllabi for Elecronic and Communication Programme Courses)



## SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

# ACADEMIC CURRICULA

**Professional Elective Courses** 

**Regulations 2021** 



## SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21ECE201J	Course Name	PYTHON AND	) SCIENTIFIC PYTHON	C Ca	ours tego	e ory	E			PROF	ESSIC	)nal e	ELECT	IVE			L T 2 0	P 2	C 3
Pre-requis Courses	site S	Nil	Co- requisite Courses	Nil		Pro	ogres Cours	sive es						Nil						
Course C	offering Departme	ent	ECE	Data Book / Codes / S	tandards								Nil							
Course Lea	arning Rationale (	CLR): 7/	he purpose of learning this c	ourse is to:			đ			Progra	am Ou	utcome	s (PO	)				P	rogra	m
CLR-1:	Explore the pytho	on language	construct and apply them to s	cientific computation		1	2	3	4	5	6	7	8	9	10	11	12	S Ou	pecifi	C
CLR-2:	Interpret File read	ding and writ	ina <mark>usina Pytho</mark> n	and the second second					-	3	~									
CLR-3:	Discuss NumPv I	Features and	1 Applications	A 1000		dge		of	o su		ciety			/ork		ce				
CLR-4:	Describe the Pan solve them with p	das construc ython	ts and Create insights into dif	erent equation-based system mode	els and	Knowle	lysis	lopment	estigatio	Usage	r and sc	æ		Team M	ion	& Finan	arning			
CLR-5:	Generate Randor	n numbers a	and construct simple games us	ing Python		leering	em Ana	gn/deve	uct inve lex prol	ern Tool	enginee	onment	S	dual & .	nunicat	ct Mgt.	ong Le	Ţ.	Ņ	ę
Course Ou	tcomes (CO):	A	<mark>t the</mark> end of this course, lear	ners will be able to:		Engir	Probl	Desig	Cond	Mode	The e	Envir Susta	Ethic	ndivi	Com	Proje	_ife L	-OSc	-SO	0Sc
CO-1:	Apply Python con	nstructs to co	ompute scientific formulas		2414	-	2	-	-	3		-	-	3	-	-	-	3	-	-
CO-2:	Read and write th	ne files <mark>usin</mark> g	Python		- 24	- 1	3	1		3	- 1	1	-	3	-	-	-	-	-	2
CO-3:	Retrieve useful in	nformati <mark>on fr</mark> o	om data using NumPy	1023-022210-001		-	3	1.51	2	3	-	-	-	3	-	-	-	-	-	3
CO-4:	Examine the use	of Pand <mark>as a</mark> ı	nd Translate mathematical moc	lels and systems using difference ec	quations	-	-	523	2	3	2	-	-	3	-	-	-	-	-	3
CO-5:	Compute Probabl	ilities an <mark>d de</mark>	velop simple games	No. of Concession, Name	10	-h		3	-	3	-	-	-	3	-	-	-	3	-	-
	,							1								I			40	
Unit-1 - Pyte Python Bas	thon Basics ics- Pvthon Compo	onents: Varia	bles (integers, floats, strings, E	ooleans, complex), Data Types - Cc	ontainers: li	sts. (	diction	naries.	sets. tu	ples. C	Doerat	ors. Co	ntrol fl	ow: inc	lentatic	n. if. w	hile. fo	r. else	12 - Proc	Hour arams
on simple n	nathematical formu	ilas.	oloo (			010,1				p.00, 0	porat	0.0, 00			omane	,,		., 0.00		
Practice: 1	Programming on	standard ma	thematical functions																	
2.	Programming on	functions			- 15															
Unit-2 - Mo	dules and File I/C	11515 and 100p <b>)</b>	15	The state of the second	1000				1.1	1									12	Hour
Functions: I Data from V <b>Practice</b> : 4.	Def, parameters, k Veb Pages- About Curve Plotting Programs on Anir	eywords, doo Web Pages mation	sstrings, return - programming - Access Web Pages in Progra	with functions - Python classes and ms: Reading Pure Text Files, Extrac	d objects - cting Data	Read from	ding d an H	lata fro TML Pa	m files age - V	– writi /riting a	ng dat a Tabl	ta to file e to File	es – pr e, Rea	ogram ding ai	on file nd Writ	readin ing Spi	g and readsh	writing eet Fil	<u>- R</u> e es	ading
0.	Sound generation	i oi auulo lle	quency																	

Unit-3 - Featu	res and Applications of NumPy	12 Hour
Arrays: Indexir	ng and Slicing, Reading, and writing an array to a file - Statistical <mark>methods in NumPy: Mean, Median, V</mark>	ariance, Standard Deviation, Percentile and Average - Matplotlib: plot, subplot, histograms, Bars,
PieCharts – FF	-T and X-ray image processing	
Practice: 7. Co	ompute Student grades using Dictionary	
8. Re	eading a web page and calculating the average te <mark>mperature</mark>	
9. Pr	ogramming using class	The second se
Unit-4 - Panda	as and Difference Equation Modeling	12 Hour
Pandas: Panda	as Series, Data Frames, Read CSV, Read JSON, Analyzing Data Difference Equation Modeling : Th	e Factorial as a Difference Equation, Fibonacci numbers, Growth of a Population, Payback of a
Loan, Making a	a Living from a Fortune, Logistic Gro <mark>wth</mark>	
Practice: 10.	Real card games using random number generation	
11. 5	Simple Games: Guessing a Number and tic-toc-toe	
12. F	Programming using Pandas	
Unit-5 - Rando	om Process and Game Programming	12 Hour
Random: Draw	<i>i</i> ing random numbers, Dra <mark>wing integ</mark> ers, Computing probabilities, Binomial, Poisson and Normal Distr	ibution, Random walk in 1D and 2D. Simple Games - Guessing a number and Rolling two dice,
tic-toc-toe, sna	ke and apple.	
Practice: 13. H	File Reading and Data Analysis using NumPy	
14. F	Random Walk in one Dim <mark>ension S</mark> pace	
15. N	NumPy signal processin <mark>g: Blurring</mark> an image with a Gaussian filter	
Looming	1. Hans Peter Langtangen, "A Primer on Scientific Programming with Python", Springer, 2014	3. Juan Nunez-Iglesias, Stefan van der Walt, and Harriet Dashnow, "Artof Scientific Python",
Desources	2. Christian Hill, "Learning Scientific Programming with Python", Cambridge University Press,	O'Reilly Media, 2017
Resources	2nd Edition, 20 <mark>20J</mark>	

			Continuous Learning	Assessment (CLA)		Cum	mativa		
	Bloom's Level of Thinking	Form CLA-1 Avera (4)	native ge of unit test 5%)	Life-Long CL (1)	l Learning A-2 5%)	Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%		-	15%	15%	-		
Level 2	Understand	15%			15%	25%	-		
Level 3	Apply	30%	1 m 1 m 1		30%	30%	-		
Level 4	Analyze	20%	110 1 11	AD	30%	30%	-		
Level 5	Evaluate	10%			10%	-	-		
Level 6	Create	10%	-		<mark>10%</mark>	-	-		
	Total	10	0%	10	0%	100 %			

Co	Course Designers												
Ex	perts from Industry	Exp	pe <mark>rts from Higher Technical Inst</mark> itutions	Internal Experts									
1	. Ms. Roshni Rajan, SDE II, Amazon, US.	1.	Dr. Meenakshi, Professor of ECE, CEG, Anna University,	1.	Dr. E. Chitra, SRMIST								
2	. Mr. S. Ashish, Software Engineer, TCS – Digital, Chennal	ai 2.	Dr. Venkatesa <mark>n, Sr. Scientist, NIOT, Chennai, venkat@niot.re</mark> s.in										

Course Code	e 21ECE202T Course Name MICRO- AND NANO-FABRICATION TECHNOLOGIES						Cours atego	se ory	Е	PROFESSIONAL ELECTIVE								C 3				
Pre-requi Course	site s	Nil		Co- requisite Courses	Nil		Pre	ogres Cours	sive es						Nil							
Course 0	Offering Departme	ent		ECE	Data Book / Codes / S	tandards								Nil								
Course Lo	arning Dationala			of loarning this cour	na la fai		-	1			Drogr		teeme						D.			
ClR-1:	Understand thin	film fabricati	tion techniqu	es including PVD and	CVD and to apply the knowle	dge to	1	2	3	4	5	6	7	8 (FU)	9	10	11	12	S Ou	pecifi tcom	C	
CLR-2:	Gain understanding of lithography, etching and ion implantation methods to fabricate, structure a modify the layer.								of	s of	25	lety			¥		0					
CLR-3:	Provide Nanofab	1	vledo		ent c	tions	g	soci			0 Mo		ance	0								
CLR-4:	Apply the knowle	stems	Know	lysis	opme	stiga	Usa	and	৵		[eam	u	& Fin	arninç								
CLR-5:	Learn the significant advances in building micro/ nano structures applicable to their needs.						ering I	eering I	em Ana	/devel	duct inve olex pro	ר Tool	gineel	nment nability		ual & T	unicati	t Mgt.	ng Le;			
Course Ou	itcomes (CO):	omes (CO): At the end of this course, learners will be able to:					Engine	Proble	Design	Condu	Noder	The en	Envirol Sustaii	Ethics	Individ	Comm	Project	Life Lo	PSO-1	PSO-2	PSO-3	
CO-1:	Express the vari	ous laye <mark>ring</mark>	Deposition	Technologies	ALL STOP		3	-	5-4	2	-		-	-	-	-	-	-	3	-	-	
CO-2:	Implement the pa	attern g <mark>enera</mark>	ration using L	Lithography Technique	5	1	3		2	- 5	-	-	-		_	-	-	-	-	-	2	
CO-3:	Demonstrate the	knowle <mark>dge</mark>	on fabricatio	on processes by Self-A	ssembly	Carlo State	3	-	2	-	-	-	-	-	-	-	-	-	3	-	-	
CO-4:	Analyze the devi	ice and <mark>circu</mark>	uit fabrication	Techniques		100	3	-	2	100	-		-	-	-	-	-	-	3	-	-	
CO-5:	Stamping technic	ques and pri	inting importa	ance of nanoscale dev	ices		3		-	2	-		-	-	-	-	-	-	3	-	2	
Unit-1 - De	position Technol	logies		12		1					6	-								9	Hour	
The Origin	of Thin-Film Tech	nnology, The	ermal Physic	al Vapor Deposition (1	hermal PVD), Molecular Beam	Epitaxy	(MBE	), Puls	sed La	ser De	oositio	n, Pla	sma an	d Arc	Physic	cal Vap	or Dep	positior	1- Spu	ttering	g, Ion	
Beam Depo	osition, Chemical	Vapor Depos	sition, Atomic	c Layer Deposition., So echniques	ligel Technology, Electrochemic	cal and C	hemic	al Rea	action	Deposi	tion				_					9	Hour	
Etching Tec	chnolgies Basics, V	Net-Chemica	al Etching-Pr	oceses, Dry Etching-Pl	ysical Dry Etch, Chemical Dry E	tch, Mech	nanica	l and l	Mecha	nicall-C	hemic	alEtch	i <mark>ng, Litl</mark>	nograp	hy-Op	tical Li	thograp	ohy, X-	Ray L	thogr	aphy,	
Direct write	Lithoraphy, Scanr	ning Probe B	Based Lithogr	<mark>raphy, Nano Imprint Litl</mark>	ography			-	_		100	-										
Unit-3 – Na	ano-Fabrication b	by Self-Asse	embly	mbly Process Chamics	I Physical and Colloidal Solf A	scombly	Static	and	Junam	ic Solf	Accor	nhlyDi	ractad	Solf Ag	somhl	V Polo	odf D	ofacto i	n Solf	<b>9</b>	Hour	
Nanosyster	n Building Blocks	liillabiicalilli	, Jeii-Assei	indry Frocess, Chemica	ii, Friysical, and Collolual Sell-A	ssembly,	Static		Jynan	ic Sell-	ASSE	loryDi	lected a		SCIIIDI	<i>y,</i> 1\0/e	OUI De		1 3611-	ASSE	пюту,	
Unit-4 - De	evice Circuit Fabi	rication																		9	Hour	
isolation, Concept of self-alignment, MOS fabrication with self-alignment, Requirements of device isolation, Local and global planarization using chemical-mechanical polishi Usage of isolation and biasing of inverter, 'Latch up' concept for inverter, Design rules for CMOS Introduction to silicon-on-insulator (SOI), On chip fabrication processes c									v treno ning, Fo of pass	ch isola abricat sive col	ition (S ion pro mpone	STI) pro cess o nts.	f CMC	es for OS inv	local erter,							

### Unit-5 - Stamping Techniques for Micro and Nano-Fabrication

Stamping Techniques, High Resolution Stamps, Printing Processes, fluids in printing processes, flexographic printing, gravure printing, Micro contact Printing and Nano transfer printing, screen printing, inkjet printing, Examples of printed devices, Comparison of printed devices with lithographically fabricated devices, Concept of hybrid printed electronics, Future of printed low-cost electronics.

Learning Resources	1. 2. 3.	Hans.H. atzen. Volker Saile. Jurg Leuthold, "Micro and Nano Fabrication Tools and Processes", Springer Berlin Heidelberg 2016 Bo Cui, "Recent advances in Nanofabrication Techniques and Applications", InTech Publisher, 2011 Sorab. K. Gandhi, "VLSI Fabrication and Principles", McGraw Hill,	4. 5. 6.	Sami Franssila, "Introduction to Microfabrication", Wiley Publications, 2015. Ampere A Tseng, "Nanofabrication Fundamentals and Applications", World Scientific Publishing 2008 A G Davies and J M T Thompson, "Advances in Nanoengineering Electronics, Materials and Assembly",Imperial College Press, 2007

Learning Assessm	ient									
		N 2 1	Continuous Learning	Assessment (CLA)		Cuman	mati in			
	Bloom's Level of Thinking	Form CLA-1 Avera (50	ative get of unit test %)	Life-Long CL (1)	g Learning _A-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		15%		15%	-			
Level 2	Understand	25%	1.	20%		25%	-			
Level 3	Apply	30%	HO BEACHD	25%		30%	-			
Level 4	Analyze	30%		25%	· · · · ·	<u>30%</u>	-			
Level 5	Evaluate	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		10%		-	-			
Level 6	Create			5%	-	-	-			
	Total	100	)%	10	0 %	100	) %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
P.2	1. Mr. Raji Kumar, Sr. Manager Core Corporation (Airtel)	1. Dr.J.K. Kasth <mark>uri Bha,</mark> SRMIST



B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

Course Code	Course Code         21ECE203J         Course Name         SMART SENSORS AND DEVICES FOR AGRICULTURE							E	PROFESSIONAL ELECTIVE							C 3				
Pre-requis	site s	Nil		Co- requisite Courses	Nil	P	rogres Cours	sive es						Nil						
Course (	Offering Departn	nent		ECE	Data Book / Codes / Stand	ards							Nil							
Course Le	arning Rationale	e (CLR): 7	The purpo <mark>se of</mark>	<mark>learnin</mark> g this c	ourse is to:	T	Program Outcomes (PO)									Program		m		
CLR-1:	Know sensors agricultural data	for agriculture	re and their bas	<mark>sic d</mark> esign chara	cteristics to build a network for collecti	<sup>ng</sup> 1	2	3	4	5	6	7	8	9	10	11	12	S Ou	pecifi Itcom	c ies
CLR-2:	Provide fundam	ental knowled	edge <mark>of remote</mark> s	ensing sensors-l	based devices in agriculture	ge		J.	s of	18	iety			Ł		æ				
CLR-3:	Expose the stud	vledç		ent o	ation	ge	soc			n Wo		Jano	þ			Ì				
CLR-4:	Impart the evolu	Impart the evolution of intern <mark>et technol</mark> ogy and the need for IoT devices in Agriculture							estig	Usa	r and	ø,		Tear	U	& Fii	arnir			
CLR-5:	Design and dev	elop AI, Edge	<mark>e, and lo</mark> T-base	d devices for sus	tainable development in agriculture	leering	neering I lem Ana		uct inve lex prol	ern Tool	enginee	ronment	(0	dual & .	nunicat	ct Mgt.	ong Le	5	2	ę
Course Ou	tcomes (CO):		At the end of t	his course, lear	ners will be able to:	Engir	Probl	Desig	Cond	Mode	The e	Envir Susta	Ethic	ndivi	Comr	Proje	_ife L	-OSc	-OSc	-OSc
CO-1:	Evaluate the ch	aracterist <mark>ics o</mark>	of different type:	s of sensors use	d in agriculture	3	-	-	-		-	-	-	-	-	-	-	-	-	-
CO-2:	Realize the nee	d for rem <mark>ote</mark> s	sensing sensors	s for smart agricu	Ilture	3	1	1		-	- 10	3	-	-	-	-	-	-	-	-
CO-3:	Apply nanosens	ors-base <mark>d de</mark>	<mark>evice</mark> s for precis	tion agriculture b	ased on the farmer's requirements	3	- 1	-	-			3	-		-	-	-	2	1	-
CO-4:	Design and dev	elop loT- <mark>base</mark>	ed sensor syste	m for agriculture	monitoring	3	-	$\leq \epsilon^{-1}$	43	-		3	-	I	-	-	2	-	-	-
CO-5:	Develop Al, Edg	ge, and F <mark>og c</mark>	computing-base	d loT networks fo	or Agriculture applications	3	-	2	-	2		-	-	-	-	-	-	-	-	2
Unit-1 - Se	nsor Fundamen	tals and Cha	aracteristics							<u></u>	1	-		-					12	Hour
Introduction sensors, pl	n to sensors, type H sensors, Accele <b>n:</b> Application of t	es of sensors, prometer sens	s, performance c sors, Nanosens priculture - Soil m	characteristics, a ors, Nano bioser	nd applications - Location sensors, Opti nsors, Application of sensors. for monitoring plants, Electronic soil sen	cal senso	rs, Ele	ctroche water	emical s	ensor	s, Mec	hanical	senso	ors, Die	electric	soil m	oisture	sens	ors, A	irflow
Unit-2 - Re	mote Sensina S	ensors for P	Precision Agric	ulture	of monitoring plants, Electronic son sent	5013 10 00	1130170	water.		1									12	Hour
Classification sensors, Line Practice of	on of remote sens DAR <b>n</b> : Application of (	Sors, Selection	on of sensor para	ameters, Spatial	resolution, Spectral resolution, Radiome rs for precision agriculture	tric resol	ıtion, T	empora	al resoli	ution; (	Optical	l infrare	d sens	sors, G	PS sei	isors, i	Agricul	tural te	emper	ature
Unit-3 – Na	ano Sensors in A	Agriculture	,, , ignouncului co					-											12	Hour
Nanopartic	les, Nanoparticles	s based nano	osensors for agr	iculture, Nanosei	nsors in pesticide detection in soil, Nano	biosenso	rs – ba	sic prin	ciple a <mark>r</mark>	nd cha	racteri	stics. N	anobio	osenso	ors for I	nicrobi	al dete	ction i	in soil.	
Practice of	n: Application of s	sensors for de	letection of humi	idity of soil, pesti	cide residue, nutrient requirement and cr	op pest i	dentific	ation												
Unit-4 - IO	I-based Devices	In Agricultu	ure omnononto loT	Paging and Char	restariation of InT and its Applications in	Agricultu	ro loT	Doguir	omonto	loour		hollong	00 10	T Aroh	itaatur	no tour	ordo ur	hong	12 12	Hour
loT, G-loT Practice of	Applications, G-lo n: loT devices for	T challenges	s, and opportuni applications and	ities, Need for a sprecision farmin	smart e-monitoring system for agriculture g.	e, Case s	udy on	loT ba	ased mo	, issue nitorin	ig syst	ems, R	eseard	ch Cha	llenge	53 IUW8 S	ai us ul	uari yi	CUIII	y, u-

### Unit-5- AI, Edge, and IoT Frameworks for Agriculture

A fog computing-based IoT framework for prediction of crop disease using big data analytics Renewable energy and AI-powered IoT - Architecture and system design, User operability, Applications, Advantages, and Limitations

Practice on: Smart Precision farming application using AI, Edge and IoT.

	1. Ajith Abraham, Sujata Dash, Joel J.P.C. Rodrigues, Biswaranjan Acharya, Subhendu Kumar	4.	Annamaria Castrignano, Gabriele Buttafuoco, Raj Khosla, Abdul Mouazen, Dimitrios
Loarning	Pani "Al, Edge and IoT-based Smart Agriculture", Elsevier Science, 2021		Moshou, Olivier Naud, "Agricultural Internet of Things and Decision Support for Precision
Posourcos	<ol><li>D.D. Sahu , "Remote Sensing: Techniques in Agriculture", Agrobios (India) 2008</li></ol>		Smart Farming", Elsevier Science, 2020.
Resources	3. Adil Denizli, Tuan Anh Nguyen, Susai Rajendran, Ghulam Yasin, Ashok Kumar,	5.	Rajesh Singh, "Internet of Things (IoT) Enabled Automation in Agriculture:
	"Nanosensors for Agriculture, Elsevier Science, 2021		Enabled Automation in Agriculture" New India Publishing Agency- Nipa , 2018

			Continuous Leanning	Assessment (CLA)		•	<i>P</i>			
	Bloom's Level of Thinking	Forn CLA-1 Avera (45	ative ge of unit test %)	Life-Long CL (1)	Learning A-2 5%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	20%		100 100 100 100	10%	20%	-			
Level 2	Understand	20%	Min North Co		10%	20%	-			
Level 3	Apply	30%	200 E		30%	30%	-			
Level 4	Analyze	20%	1	からいた主義	30%	<u>30%</u>	-			
Level 5	Evaluate	10%			20%		-			
Level 6	Create	No. Cash	-	1000		-	-			
	Total	10	)%	10	0%	10	0 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Dr.V. Mynavathi, Assistant Professor, TANUVAS	1. Dr. T. Deepa, Associate Professor, ECE, SRMIST



B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

Course Code	21ECE204T	Course Name	se OPTOELECTRONICS						Cour Categ	se ory	E	PROFESSIONAL ELECTIVE								C 3			
Pre-requi Course	isite es	Nil		Co- requisit Courses	e		Nil		P	rogres Cours	sive es						Nil	1					
Course	Offering Departme	ent	·	ECE		D	ata Book / Codes	s / Standa	rds							Nil							-
						- A			1	1.0	1.00												
Course Le	earning Rationale (	CLR): T	The purpose	of learning th	is course	e is to:				6	1		Progr	am Ou	Itcome	s (PO)	)				- PI	rograi	n
CLR-1:	Identify the workir	ng and natur	ure of optical	wave and optica	al <mark>s</mark> emico	onductors	26		1	2	3	4	5	6	7	8	9	10	11	12	Ou	itcom	es
CLR-2:	Analyze the worki	ing principle	iples of different photonic sources						ge		of	s of	2.	siety			ork		e	Í			
CLR-3:	Analyze the worki	nalyze the working principles <mark>of different</mark> photonic detectors							wled	6	lent	ation	ge	d soc			n We		nanc	b			
CLR-4:	Create knowledge	Create knowledge about various optoelectronic applications								lysi	ndo	stig	Use	ano	ø		[ear	on	ы Хо	arnir			
CLR-5:	Familiarize the co	ncepts of op	o <mark>ptoelect</mark> ronic	integrated circ	uits		1.00		ring	Ana	level	inve	Tool	ineel	nent ability		al & _	nicati	Mgt.	g Le			1
				and the second s				1995	inee	lem	ign/c	duct blex	ern	eng	taina	S	/idu	nmu	ect I	Lon	-	-2	-3
Course Or	utcomes (CO):	A	At the end o	f this course, i	learners	will be a	ble to:		Eng	Prot	Des	Con	Mod	The	Sus	E	Indiv	Con	Proj	Life	PSC	PSC	PSC
CO-1:	Define the basic o	concept <mark>s of</mark> d	<sup>r</sup> optics and s	emiconductor o	ptics.	1	o bas	\$54.	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-2:	Demonstrate the	working prin	inciple of vari	ous photonic so	urces and	nd display	devices.	5.3	3	3	1	2	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Analyze the princ	iple an <mark>d ope</mark>	eration of vai	rious detectors a	and noise	e associa	ed with it.		3	3	2	3	-	- 10	-	-		-	-	-	-	-	3
CO-4:	Interpret the vario	ous opto <mark>elec</mark> i	<mark>ctroni</mark> c modu	lators, switches	, and inte	erconnect	S.	100	3	2	3			-	-	-	-	-	-	-	-	-	2
CO-5:	Apply the concept	ts of int <mark>egrat</mark>	ated optoeled	tronic compone	nts and it	its applica	tion in various fie	lds.	3		3	3	-	2	-	-	-	-	-	-	-	-	3
				2	-Cen	14.5		1 - 5															
Unit-1 - W	ave Nature of Ligh	t and Solid	d-State Phys	ICS	oraion	Sollmaia	aquation and Cr	uchu ogur	tion C	noll'o l	044.04	d Tota	Intorn	ol Dof	laction		Supe	rnooitiv	on and	Interfe		9	Hour
Diffraction	Principles - Fraunh	ofer Diffracti	tion - Diffract	ion Grating - Fr	ersion	nds in soli	ds - Energy hand	s in solids	- Condu	ction n	aw ar	s in sen	nicond		- Ontica		ess in	semici	onducti	orslı	inction	Theo	ves -
Unit-2 - Di	isplav Devices and	l Liaht Sour	urces	on ording En	orgy barr		io Energy band	o in conde	Conda	ouonp		5 111 0011	noona	401010	opilo		000 111	0011110		10 00	monori	9	Hour
Photo Lum	ninescence, Cathod	e Luminesce	cen <mark>ce, Elect</mark> r	o Luminescenc	e, Injectio	on Lumin	escence - Plasma	a Display,	Liquid C	rystal	Displa	ys, Nur	neric L	Display	's <mark>- LE</mark> E	D Princ	iples -	- Hom	ojunctio	on LEC	), Hete	rostru	cture
LED – Cho	pice of LED Material	ls and Struct	ctur <mark>es – LED</mark>	Efficiencies and	d Lumino	ous Flux –	Solving Problem	s - Laser: (	Operatin	g prind	ciple, E	missio	n and /	Absorp	tion of	Radiat	ion, Po	opulati	on Inve	rsion, i	Optica	l feed	back,
Threshold	Condition, Semicon	ductor Lase	ers, Heterost	<mark>ructure</mark> Laser D	iode		16 1 10	10.1214	1.1		_		22										
Unit-3 - O	ptical Detection De	evices				1.00					1.0			_								9	Hour
Principle o	f Photo Detection –	Responsivit	ity and Quan	tum Efficiency –	- Photoco	onductors	<ul> <li>Photo diodes -</li> </ul>	The PIN	Photodic	ode – A	Avalan	che Pho	otodioc	le – Pr	inciples	s and S	Structu	res – F	leteroji	unction	Photo	odiode	S –
Photocond	luctive detectors - N	ioise in phot	todetectors -	Detector perfor	mance p	parameter	s - Detectors for I	ong wavel	engtn op	peratio	n, wav	elength	select	ive de	tection	- Char	ge Col	upiea L	Jevice	(CCD).	<u> </u>	0	Haur
Introductio	n – Analog and Dig	uialors anu ital Modulati	tion - Floctr	Devices	ors _ prin	ncinles _ d	plactro ontic affac	t _ Maano	to ontic	dovico	s _ Ac	ousto c	ntic m	odulat	ore _ n	rincinle	<u> </u>	ousto	ontic A	ffoct_	Rama	<b>y</b> n Natl	h and
Bragg type	Bragg type modulators - optical switching and logic devices – Faraday Rotation – Optical Isolators – Nonlinear Optics and Second Harmonic Generation.																						
Unit-5 - Op	ptoelectronic Integ	rated Circu	uits (OEIC) a	and Applicatio	ns												·					9	Hour
Introduction – Need for Integration - Hybrid and Monolithic Integration – Slab and Strip waveguides – Basic IO structu Application of Opticelectronic integrated circuits								iral elen	nents –	Guide	ed wave	device	es and	active	couple	rs – Ini	tegrate	d Tran	smitter	's and l	Recei	vers–	
, ppiloudol		mogratod bi	mouno.																				

Learning	1.	S. O. Kasap, "Optoelectronics & Photonics: Principles & Practices", 2nd edition, Pearson Education, 2013.	3.	J. Wilson and J F B Hawkes "Optoelectronics- An Introduction", 3rd edition, Pearson Education Taiwan Ltd, 2010.
Resources	2.	Pallab Bhattacharya "Semiconductor Optoelectronic Devices", 2nd Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2009.	4.	R. P. Khare, "Fiber Optics and Optoelectronics", Oxford University Press 2004.

			Continuous Learning	g Assessment (CLA)		Sum	Summative				
	Bloom's Level of Thin <mark>king</mark>	Form CLA-1 Avera (50	native ge of unit test 1%)	Life-Long CL (1	g Learning LA-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	10%		10%		10%	-				
Level 2	Understand	20%	Attace line	15%		15%	-				
Level 3	Apply	35%	1.000	30%		30%	-				
Level 4	Analyze	35%		30%		30%	-				
Level 5	Evaluate		and the second	10%		10%	-				
Level 6	Create			5%	the second second	<mark>5</mark> %	-				
	Total	10	0%	10	0 %	100 %					

Course Designers		2
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1 Mr. Saivineeth MI. Accelerator Architect @ Google	1 Dr S Sathiyan SPMIST



Pre-requisite Course         Nil         Co-requisite Course         Nil           Course Offering Department         ECE         Data Book / Codes / Standards         Nil           Course Offering Department         ECE         Data Book / Codes / Standards         Nil           Course Offering Department         ECE         Data Book / Codes / Standards         Nil           Course Clearning Rationale (CLR):         The purpose of learning this course is to:         Progressive Curse:         Progressive Department         Nil           CLR-1:         Unline the fundamentals of quantum physics to understand how alons and molecules are formed         1         2         3         4         5         6         7         8         9         10         11         12         0 <th>Course Code</th> <th colspan="2">se 21ECE205T Course FLEXIBLE ELECTRONICS Name</th> <th></th> <th>Cour Categ</th> <th>se ory</th> <th>E</th> <th colspan="7">PROFESSIONAL ELECTIVE</th> <th>- T 3 0</th> <th>P 0</th> <th>C 3</th>	Course Code	se 21ECE205T Course FLEXIBLE ELECTRONICS Name			Cour Categ	se ory	E	PROFESSIONAL ELECTIVE							- T 3 0	P 0	C 3					
Course Offering Department       ECE       Data Book / Codes / Standards       Nil         Course Learning Rationale (CLR):       The purpose of learning this course is to:       Program Outcomes (PO)	Pre-requi Course	isite es	Nil		Co- requisite Courses		Nil	P	rogres Cours	sive es						Nil						
Course Learning Rationale (CLR):       The purpose of learning this course is to:       Program Outcomes (PO)       Program Outcomes (PO)<	Course	Offering Departmo	ent		ECE	Data Boo	ok / Codes / Standar	ds							Nil							
Curve Claiming Retrollate (CR).       Interpretation of unanum physics to understand how atoms and molecules are formed       1       2       3       4       5       6       7       8       9       10       11       12       2       3       4       5       6       7       8       9       10       11       12       2       3       4       5       6       7       8       9       10       11       12       2       3       4       5       6       7       8       9       10       11       12       2       3       4       5       6       7       8       9       10       11       12       2       3       4       5       6       7       8       9       10       11       12       2       3       4       5       6       7       8       9       10       11       12       10       9       10       11       12       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       10       11       12       10       10       10       10       10       10<	Course Lo	arning Pationalo			of loarning this co	ureo is to:	11-11	1		12		Progr	am Ou	teomo	e (DO	۱				P	rogra	m
CLR-1:       Outline the indicatentials of quantum physics to understand how atoms and molecules are tormed       1       2       3       4       5       6       7       6       9       10       11       12       Outcom         CLR-2:       Illustrate the basics of charge transport and charge injection in an amorphous material       0       9       <			(OLN).			uise is to.	ulas are formed	1	2	2		-Toyla		7	<u>о (го</u>	)	10	44	10	Specific		ic
CLP.2:       Illustrate the basics of charge transport and charge injection in an amorphous material <ul> <li></li></ul>									2	3	4	Э	0 /	1	0	9	10	11	12	Ou	itcom	ies
CLR-3:       Introduce the concepts of organic light emitting diode       Introduce the concepts of thin film transistor         CLR-4:       Explain the different methods of fabrication for organic devices and their characterization       Introduce the concepts of thin film transistor         Course Outcomes (CO):       At the end of this course, learners will be able to:       Introduce the principles of quantum physics to understand the behavior of atoms and molecules in a semiconductor       3       3       - <td colspan="7"><b>CLR-2:</b> Illustrate the basics of charge transport and charge injection in an amorphous material</td> <td>dge</td> <td></td> <td>of</td> <td>o su</td> <td>18</td> <td>ciet</td> <td></td> <td></td> <td>/ork</td> <td></td> <td>e</td> <td></td> <td></td> <td></td> <td></td>	<b>CLR-2:</b> Illustrate the basics of charge transport and charge injection in an amorphous material							dge		of	o su	18	ciet			/ork		e				
CLR-4:       Explain the different methods of fabrication for organic devices and their characterization       V <th< td=""><td>CLR-3:</td><td colspan="6">LR-3: Introduce the concepts of organic light emitting diode</td><td>wlea</td><td>s</td><td>nent</td><td>jatio ns</td><td>age</td><td>d so</td><td></td><td></td><td>∕ E</td><td></td><td>inan</td><td>bu</td><td></td><td></td><td></td></th<>	CLR-3:	LR-3: Introduce the concepts of organic light emitting diode						wlea	s	nent	jatio ns	age	d so			∕ E		inan	bu			
CLR-5:       Introduce the concepts of thin film transistor       Image: Second	CLR-4:	CLR-4: Explain the different methods of fabrication for organic devices and their characterization						Knc	alysi	elopr	estic blen	I Us	er an	۲ &		Tea	tion	&F	ami			
Course Outcomes (CO):       At the end of this course, learners will be able to:       Image: Course outcomes (CO):       At the end of this course, learners will be able to:         Col:       Apply the principles of quantum physics to understand the behavior of atoms and molecules in a semiconductor       Image: Course outcomes (CO):       Image:	CLR-5:	CLR-5: Introduce the concepts of thin film transistor						leering	em Ana	jn/deve	uct invi lex pro	rn Too	anginee	onmen	6	dual &	nunica	ct Mgt.	ong Le	5	5	e
Apply the principles of quantum physics to understand the behavior of atoms and molecules in a semiconductor       a b       b       b       b       c<	Course Ou	utcomes (CO):		At the end of	this course, learn	ers will be able to:	A amonth	Engir	robl	Desig	Cond	lode	he e	Envir	Ethics	ndivi	Comr	roje	ife L	-OS	-OS	-OS
CO-2:       Analyze transport and Injection phenomenon for an organic semiconductor material       3       3       -	CO-1:	Apply the princip semiconductor	oles of o	quantum physics	to understand the	ə behavior of atoms	s and molecules in a	3	3	-	-	-	1	-	-	-	-	-	-	-	-	-
CO-3:       Gain knowledge on organic light emitting diode       3       3       -	CO-2:	Analyze transpor	t and In <mark>j</mark> e	ection phenomena	on for an organic s	emiconductor materia	al	3	3				-	-	-	-	-	-	-	-	-	-
CO-4:       Acquire knowledge on different aspects of fabrication and characterization       3       -	CO-3:	Gain knowledge	on orga <mark>r</mark>	<mark>nic light e</mark> mitting di	iode			3	3	1-1	- 1	-	-	-	-	-	-	-	-	-	-	-
CO-5:       Utilize the concepts of MOSFET to understand organic thin film transistor       3       3       -	CO-4:	Acquire knowledg	ge on di <mark>f</mark>	f <mark>ferent as</mark> pects of f	fabrication and cha	racterization		3		54	425	-		-	-	-	-	-	3	-	-	-
Unit-1 - Quantum Mechanics, Atoms and Molecules       S         Brief history to Flexible Electronics, Quantum Mechanics: Basic Postulates, Infinite Potential Well, Finite Quantum Well, Coupled Quantum Well, Tunnelling, Atoms: Hydrogen Atom, Spin and Orbital A         Momentum, Spin-Orbit Coupling, Multi-Electron Atoms, Molecules: Hydrogen Molecule, Molecular Orbitals, Common Organic Molecules, Polymers, Optical Process: Selection Rules, Radiative Li         Absorption/Emission, Two Spin States         Unit-2 - Transport and Injection         Transport, Free Electron, Electron in 1D Periodic Lattice, Effects of Disorder, Field Effect Mobility, Multiple Trap Release Model, Time of Flight, Grain- Boundary Potential Barrier Model, Variable Range H         Model, Mobility due to Hopping, Gaussian, Disorder Model, Mobility Empirical Model, Injection: Barrier Height, Interface Dipole, Barrier Height Lowering, Conventional Injection Models, Thermionic Emirations, Microscopic Hopping Picture         Unit-3 - Organic Light Emitting Diode (OLED)       9         Performance Parameters, Power Conversion Efficiency, Quantifying Colour, OLED Basic Operation, Quantum Efficiency, Bilayer Device, Impact of SPIN on optical transitions, Phosphorescence, Forster I       9         Unit-4 - Fabrication and Characterization       9         Waterial: Debracer and Characterization       9         Material: Debracer and Characterization       9         Unit-4 - Fabrication and Characterization       9         Material: Debracer and Characterization       9         Material: Debr	CO-5:	Utilize the concep	ots of M	O <mark>SFET to</mark> underst	and organic thin fil	m transistor	- A	3	3		-	-			-	-	-	-	-	-	-	-
Brief history to Flexible Electronics, Quantum Mechanics: Basic Postulates, Infinite Potential Well, Finite Quantum Well, Coupled Quantum Well, Tunnelling, Atoms: Hydrogen Atom, Spin and Orbital A Momentum, Spin-Orbit Coupling, Multi-Electron Atoms, Molecules: Hydrogen Molecule, Molecular Orbitals, Common Organic Molecules, Polymers, Optical Process: Selection Rules, Radiative Li Absorption/Emission, Two Spin States Unit-2 - Transport and Injection Transport, Free Electron, Electron in 1D Periodic Lattice, Effects of Disorder, Field Effect Mobility, Multiple Trap Release Model, Time of Flight, Grain- Boundary Potential Barrier Model, Variable Range H Model, Mobility due to Hopping, Gaussian, Disorder Model, Mobility Empirical Model, Injection: Barrier Height, Interface Dipole, Barrier Height Lowering, Conventional Injection Models, Thermionic Em- Tunnelling, Limitations, Microscopic Hopping Picture Unit-3- Organic Light Emitting Diode (OLED) Performance Parameters, Power Conversion Efficiency, Quantifying Colour, OLED Basic Operation, Quantum Efficiency, Bilayer Device, Impact of SPIN on optical transitions, Phosphorescence, Forster I Transfer, Multi-layer OLED structure, Dexter Energy Transfer, Polymer LED, Degradation of OLED, OLEDDisplays. Unit-4 - Fabrication and Characterization Motorial, Delymost, Polymer and Characterization	Unit-1 - Qı	uantum Mechanic	s. Atom	s and Molecules			112					1									9	Hour
Unit-2 - Transport and Injection Transport, Free Electron, Electron in 1D Periodic Lattice, Effects of Disorder, Field Effect Mobility, Multiple Trap Release Model, Time of Flight, Grain- Boundary Potential Barrier Model, Variable Range H Model, Mobility due to Hopping, Gaussian, Disorder Model, Mobility Empirical Model, Injection: Barrier Height, Interface Dipole, Barrier Height Lowering, Conventional Injection Models, Thermionic En Tunnelling, Limitations, Microscopic Hopping Picture Unit-3- Organic Light Emitting Diode (OLED) Performance Parameters, Power Conversion Efficiency, Quantifying Colour, OLED Basic Operation, Quantum Efficiency, Bilayer Device, Impact of SPIN on optical transitions, Phosphorescence, Forster I Transfer, Multi-layer OLED structure, Dexter Energy Transfer, Polymer LED, Degradation of OLED, OLEDDisplays. Unit-4 - Fabrication and Characterization	Brief histor Momentum Absorption	ry to Flexible Elect n, Spin-Orbit Coup //Emission. Two Sp	ronics, ( oling, Mu in States	Qu <mark>antum M</mark> echan ulti-Electron Atorr	vics: Basic Postula 1s, Molecules: Hy	tes, Infinite Potential drogen Molecule, M	l Well, Fi <mark>nite Q</mark> uantu Iolecular <mark>O</mark> rbitals, C	m Well ommon	, Coup Orga	oled Qu nic Ma	iantum Decules	Well, , Poly	Tunne mers,	elling, A Optica	toms: al Pro	Hydro cess:	ogen A Selecti	tom, S <sub>i</sub> on Ru	pin an Ies, R	d Orbi adiativ	tal Ar e Life	ngular etime,
Transport, Free Electron, Electron in 1D Periodic Lattice, Effects of Disorder, Field Effect Mobility, Multiple Trap Release Model, Time of Flight, Grain- Boundary Potential Barrier Model, Variable Range H Model, Mobility due to Hopping, Gaussian, Disorder Model, Mobility Empirical Model, Injection: Barrier Height, Interface Dipole, Barrier Height Lowering, Conventional Injection Models, Thermionic Err Tunnelling, Limitations, Microscopic Hopping Picture Unit-3- Organic Light Emitting Diode (OLED) Performance Parameters, Power Conversion Efficiency, Quantifying Colour, OLED Basic Operation, Quantum Efficiency, Bilayer Device, Impact of SPIN on optical transitions, Phosphorescence, Forster I Transfer, Multi-layer OLED structure, Dexter Energy Transfer, Polymer LED, Degradation of OLED, OLEDDisplays. Unit-4 - Fabrication and Characterization Metarials: Dolumers and email melanals. Experience of Methods. Interduction to B15004. (Semicanductor Dermetric Analysis). Transfer, Andreas, T	Unit-2 - Tr	ansport and Injec	tion		100							140									9	Hour
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Unit-3- Organic Light Emitting Diode (OLED) Performance Parameters, Power Conversion Efficiency, Quantifying Colour, OLED Basic Operation, Quantum Efficiency, Bilayer Device, Impact of SPIN on optical transitions, Phosphorescence, Forster in Transfer, Multi-layer OLED structure, Dexter Energy Transfer, Polymer LED, Degradation of OLED, OLEDDisplays. Unit-4 - Fabrication and Characterization	Model, Mo Tunnelling	bility due to Hoppi Limitations Micro	ng, Gau sconic H	Jssian, Disorder N Jopping Picture	Model, Mobility Em	ipirical Model, Injecti	ion: Barrier Height, I	nterface	e Dipol	le, Bar	rier Hei	ght Lo	owerin	g, Con	ventioi	nal Inje	ection	Models	, Ther	mionic	; Emi	ssion,
Performance Parameters, Power Conversion Efficiency, Quantifying Colour, OLED Basic Operation, Quantum Efficiency, Bilayer Device, Impact of SPIN on optical transitions, Phosphorescence, Forster Transfer, Multi-layer OLED structure, Dexter Energy Transfer, Polymer LED, Degradation of OLED, OLEDDisplays. Unit-4 - Fabrication and Characterization	Unit-3- Or	ganic Light Emitti	ng Diod	le (OLED)					1.00												9	Hour
Transfer, Multi-layer OLED structure, Dexter Energy Transfer, Polymer LED, Degradation of OLED, OLEDDisplays. Unit-4 - Fabrication and Characterization	Performan	ce Parameters, Po	wer Cor	version Efficiency	γ, <mark>Quantifying</mark> Colc	our, OLED Basic Ope	eration, Quantum Effi	ciency,	Bilaye	er Devi	ce, Imp	act of	SPIN	on opti	cal tra	nsition	s, Pho	sphore	scenc	ə, Fors	ster E	inergy
	Transfer, N	Aulti-layer OLED st	ructure, l	Dexter Energy Tra	ansfer <mark>, Polymer L</mark> E	D, Degradation of OL	LED, OLEDDisplays.														•	Harris
waterials. Formers and small molecule, Fauncation Method, Unaracterization Methods, Infroduction to Biodua (Semiconductor Parametric Analyser). Transfer and Ultifult Unaracteristics of Metal	Materials:	Polymers and sm	all mole	cule. Fabrication	Method, Characte	erization Methods Ir	ntroduction to B1500	A (Ser	nicond	uctor F	Parame	tric Ar	nalvsei	r). Trar	nsfer a	and Or	utout (	Charact	eristic	s of N	9 letal	Oxide
Semiconductor FET and Extract Threshold Voltage, Mobility and Transconductance, Capacitance Voltage and Capacitance Frequency Characterization of MOSFET, Frequency Response	Semicondu	ictor FET and Extra	act Three	shold Voltage, Mo	bility and Transcor	nductance, Capacitan	nce Voltage and Capa	citance	Frequ	iency (	Charact	erizatio	on of N	/OSFE	T, Fre	quency	/ Resp	onse				0,1100

### Unit-5- Thin Film Transistor (TFT)

Brief History of TFT, Introduction to Hydrogenated Amorphous Silicon, Basic Organic FET Structure and Operation, OFET Fabrication, OFET Structures: Top vs. Bottom Contacts, Work Function Considerations, Characteristics of Gate Dielectrics, Encapsulation, Self-Aligned OFETs, Parameter Extraction, Characterization, Gate Sweep/Transfer Characteristic, Drain Sweep/Output Characteristic, Capacitance, Gate Leakage, OFET Applications, Organic Field-Effect Sensors, Design and Technology of Organic Field-Effect Sensors, Applications for Organic Field-Effect Sensors, Printing Technologies.

	1.	Robert Eisberg and Robert Resnick, "Quantum Physics of Atoms, Molecules, Solids,	4.	Joannis Kymissis, "Organic Field Effect Transistors: Theory, Fabrication and Characterization", 1st
Loarning		Nuclei, and Particles", 2nd ed., wiley, 2006		ed., Springer, 2009
Becourses	2.	S. C. Tse, C. H. Cheung, S. K. So, "Organic Electronics", 1st ed., CRC Press, 2009	5.	Brajesh Kumar Kaushik, Brijesh Kumar, Sanjay Prajapati, Poornima Mittal, Organic Thin-Film
Resources	3.	Alastair Buckley, "Organic Light Emitting Diodes Material devices and Applications", 1st		Transistor Applications: Materials to Circuits, 1st ed., CRC Press, 2020.
		ed., Woodhead Publishing, 2013		

Learning Assessm	nent	~ ~ ~	129122-017								
				Summotivo							
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test %)	Life-Long CL (1)	g Learning LA-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	60%		40%		30%	-				
Level 2	Understand Company	40%	10 64.8 64	40%		<mark>40</mark> %	-				
Level 3	Apply			20%		30%	-				
Level 4	Analyze			たっとなたら	S - W		-				
Level 5	Evaluate	1 1 2 2				-	-				
Level 6	Create	The second				-	-				
	Total	100	)%	10	0 %	100	)%				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Sandeep Patil EspinNanotech Solutions, IIT Kanpur	1. Dr. KP Pradhan, IIIDM, Kanchipuram	1. Dr. Rajesh Aga <mark>rwal, SRM</mark> IST
2. Dr. Amrendra, Keysight Technologies, Bangalore	2. Dr. Vivek, IIITDM, Kanchipuram	2. Dr. Soumya Ranjan, SRMIST



B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

Course Code	Course 21ECE301T Course NANOSCALE ELECTRONIC DEVICES		Cou Cate	urse gory	E		PROFESSIONAL ELECTIVE							P 0	C 3							
Pre-requi Course	site s		Nil		Co- requisite Courses	Nil		Progressive Nil														
Course (	Offering Depar	tment			ECE	Data Book / Codes / St	andards								Nil							
Course Le	arning Ration	ale (CL	R):	The purpose	of learning this co	ırse is to:		. 7	1.4	5	P	rogra	am Ou	itcome	s (PO	)				P	rogra	m
CLR-1:	Identify the ne	ed and	l effects	s of devic <mark>e mi</mark>	niaturization		1	2	3	7	4	5	6	7	8	9	10	11	12	S	pecifi	C 05
CLR-2: Understand the principles of Carbon Nanotubes and their applications						0			y c	Б		ety			¥				00	teom	53	
CLR-3:							eda	2	ent of		suoi	е	socie			Wor		ance	-			
CLR-4:	Create insights to the concepts of spin nanoscale devices				Mon	VSis	bme	. inco	ems	Jsag	and	প্র		eam	E	Ĕ	rning					
CLR-5:	R-5: Analyze the design considerations of phase-change devices					m Anal	/develo	ns of invice	et inves	n Tool I	ngineer	nment å nability		ual & T	unicatio	t Mgt. 8	ong Lea					
Course Ou	tcomes (CO):			At the end o	f this course, learn	ers will be able to:		roble	Design	solutio		Aoder	The er	Enviro	Ethics	ndivid	Comm	rojec	life Lo	-SO-1	2-0Sc	S-OS
CO-1:	CO-1: Realize the importance of scaling of devices					A Shere have be	3	2	-	0, 0	-	. 7	-	-	-	-	-	-	-	-		2
CO-2:	Identify the pl	nysical	prop <mark>erti</mark>	<mark>ties an</mark> d applic	ations of Carbon nar	otubes.	3		1		-	-	1	-	-	-	-	-	-	2	-	-
CO-3:	Analyze the p	erforma	ance me	easur <mark>es of va</mark>	rious devices through	gate and channel engineering	3	-			-	3	- 10	-	-		-	-	-	-	-	3
CO-4:	Choose appro	opriate	appl <mark>icat</mark>	<mark>tion o</mark> f the Spi	n Nanoscale Electro	nic Devices	3	3	1.5		-	-	1	-	-	-	-	-	-	-	-	3
CO-5:	Understand t	ne desię	gn c <mark>ons</mark>	<mark>siderati</mark> ons of <sub>l</sub>	phase-change device	S	3	16	-		-	2	1	-	-	-	-	-	-	-	-	2
Unit-1 - Fu	ndamentals o	f Nano:	scale E	Electronic Dev	vices	and the second se	2	v.e.					÷	<u>.</u>		-					9	Hour
Free Electro Materials, C (NEGF), De	on Theory and Quantum Confii ensity function	Quantu nement Theory.	m The <mark>o</mark> in Low-	o <mark>ry,Origi</mark> n of Ba -Dimensional i	andgap in Solids, Nea Material, Density of S	arly Free Electron Model, Approxima tates in Bulk Materials, Semiconduc	ate Measure ctor Nanostr	e of Bar ructure	nd Gaµ s, Met	o, Eff allic I	fective Nanos	Mass structu	s Appr ires, C	oximati Carbon I	on, Tig Nanos	<mark>tructur</mark>	ding Aµ res, No	oproxin n-Equii	nation, librium	Low-D Green	imens 1's Fur	ional ction
Unit-2 - Ca	rbon Nanotub	es and	Their L	Dev <mark>ice Appl</mark> i	cations		1.1					1									9	Hour
Physical Pr	operties of Car Transistors (C	bon Na	anotube:	es, Ballistic Tra	ansport and Quantun	Conductance in CNTs, CNT Two-	Probe Devic	ces, Do	ping I	neth	ods ai	nd teo	chniqu	es, Tra	nsport	prope	rties of	f two-pi	obe C	NT De	vices,	CNT
Unit-3 - Ga	te and Chann	el Engi	neered	l Nanoscale E	Electronic Devices		CIVIT IIILEICI	JIIIEUL	<u>s, civi</u>	IVIE	mone	5			-						9	Hour
Introduction MOSFET, I Engineering	to Nanoscale Double-Gate (L Strained Lay	Device, DG) MC er Muli	Electro SFET, tigate M	ostatic Effects, Trigate (TG) Aulti-Material I	Threshold Voltage F MOSFET, Gate-All-A MOSEET, Multigate N	Coll-Off, Leakage Currents, Gate Lea round (GAA) MOSFET, Gate and Julti-Material Tunnel FET	akage Curre Channel En	nt, Sut gineer	othresl ing Te	nold i chnie	Leaka ques,	ge Cu Gate-	irrent, Oxide	Junctio Stack,	n Leal Gate	kage C Metal	urrent, Work I	Silicor Functio	n-On-In n Engi	sulato neerin	r, Muli g, Ch	tigate annel
Unit-4 - Sp	in Nanoscale	Electro	onic De	vices and Th	eir Applications																9	Hour
Introduction Switching N	n to Spintronics Aechanism in N	s, Giant ITJ, Lo	: Magne gic-In M	etoresistance Memory Archit	(GMR) and Its Appli ecture, Spin Field-Ef	cations, Tunnel Magnetoresistance fect Transistor, Multi-Gate Spin Fiel	e (TMR) and Id-Effect Tra	l Its Ap Insistor	plicati ; Spin	ons, -FE1	Spin T-Base	<mark>Inject</mark> ed Log	ion Ef gic De	ficiency sign	ı, Spin	Devic	es, Ma	agnetic	Tunne	l Junc	tion (I	ИТЈ),

 Unit-5 - Phase-Change Devices and Their Applications
 9 Hour

 Phase-Change Memory (PCM), Overview of Phase-Change Material Properties, Scaling of Phase-Change Memory Devices, PCM Device Architecture, PCM-Based Logic Gate Design, OR Gate Design Using PCM
 9 Hour

 Logic, NOR Gate Design Using PCM Logic, Memristor, Silicon Nanowire-Based Memristive Devices, Memristor-Based Logic Design, Resistive Random-Access Memory (RRAM), Physical Structure of RRAM.
 9 Hour

	1.	Khurshed Ahmad Shah, Farooq Ahmad Khanday "Nanoscale Electronic Devices and	4.	Ban P. Wong, Anurag Mittal, YuCao, Gren Starr, "Nano- CMOS Circuit and Physical Design", John
		Their Applications", CRC Press, 2021.		Willey and sons Publication, 2005
Learning	2.	Rainer Waser (Ed.), "Nanoelectronics and Information Technology", Wiley- VCH, Third,	5.	George W. Hanson, "Fundamentals of Nanoelectronics", Prentice Hall, 20073.Karl Goser, Peter
Resources		Completely Revised and Enlarged Edition, 2012.		GlÖsekötter, Jan Dienstuhl, "Nanoelectronics and Nanosystems", Springer, 2004
	3.	Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic," Digital Integrated	6.	Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, "Introduction to Nanoelectronics:
		Circuits 2nd edition", Pearson, 2000		Science, Nanotechnology, Engineering, and Applications", Cambridge University Press, 2012

earning Assessn	nent	N. 2. A.	1000		and the second						
			Continuous Learning	Assessment (CLA)		Summativa					
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test %)	Life-Long CL (10	y Learning A-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%		15%		15%	-				
Level 2	Understand	25%	to bus w	25%		<mark>25</mark> %	-				
Level 3	Apply	30%	a strong	30%		30%	-				
Level 4	Analyze	30%	1	30%		30%	-				
Level 5	Evaluate	1 1 1 2 2 3				- 11	-				
Level 6	Create	The Constant	-			-	-				
	Total	10	)%	10	0 %	100 %					

Course Designers		A Start Start
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Mr. Saivineeth, ML Accelerator Architect @ Google	1. Dr. J. K. Kasthuri Bha, SRMIST
		2. Dr. Arijit Bardhan Roy, SRMIST



B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

Course Code	21ECE302J Course REAL TIME OPERATING SYSTEMS Course		rse gory	E	PROFESSIONAL ELECTIVE							C 3							
Pre-requi Course	site es	Nil	Co- requisite Courses	Nil	F	Progres Cours	sive ses						Nil						
Course	Offering Departme	ent	ECE	Data Book / Codes / S	Standards							Nil							
Course Le	arning Rationale	(CLR): 7	he purpos <mark>e of learnin</mark> g this co	urse is to:		2			Progra	ım Ou	itcome	es (PO	)				P	rogra	m
CLR-1:	Introduce Real Ti	ime Operatin	ng Syste <mark>ms (RTOS)</mark> and the Proc	ess management	1	2	3	4	5	6	7	8	9	10	11	12	S Ou	pecifi utcom	ic 1es
CLR-2:	CLR-2: Acquire knowledge of threading and process synchronization.						+	of	34	ety			¥						
CLR-3:	-3: Outline different scheduling algorithms and deadlock							tions	e	soci			Mo		ance	0		ł	
CLR-4:	-4: Infer various memory management concepts for RTOS						opme	stiga	Usa	and	æ		eam	ы	& Fin	Inin		ł	
CLR-5:	CLR-5: Develop sample projects based on RTOS applications						devel	t inve	Tool	lineer	ment ability		al & T	nicati	Mgt. 8	g Lea		ł	
Course Outcomes (CO): At the end of this course, learners will be able to:					Enginee	Problem	Design/	Conduc Somplex	Aodern	The enc	Environ	Ethics	ndividu	Commu	Project	-ife Lon	-SO-1	2-02	so-3
CO-1:	Develop knowled	lge abou <mark>t R</mark> T	OS and the Process Manageme	nt	3	3	-	-	2	7	-	-	-	-	-	-	-	-	-
CO-2:	Apply the concep	ots of thr <mark>eadi</mark>	ing and synchronization for embe	dded applications.	3	3	$\langle \mathcal{C} \rangle$	-	2	-	-	-	-	-	-	-	2	-	-
CO-3:	Illustrate the cond	cepts an <mark>d re</mark>	quirements of Scheduling		3	1.1	3	-	2	- 10	-	-		-	-	-	2	-	-
CO-4:	Analyze the mem	ory ma <mark>nage</mark>	ement for RTOS	Association of the	3	-	3	-	2	-	-	-	-	-	-	-	2	-	-
CO-5:	Implement the kn	nowledg <mark>e in r</mark>	related sample use cases	1.5.1.5.	3		3	-	2	200	-	-	-	-	-	-	-	-	-
Unit-1 - Ini	troduction to Rea	l Time Oper	ating Systems and Process	and the second sec	-910				1	-	<u>.</u>							12	Hour
Operating Computing Communic Practice o	system concepts, Environments, RT ation.	Fundamenta TOS, Proces Programmin	al and Functions, Evolution of C ss State and Control block, Proc	perating Systems, Operation, Str ess Scheduling Queues and Sch	ructure and A edulers, Proc	rchitect ess Cre	ture of eation a	Compu and Ter	ter Sys minatic	stems, on, Int	OS S er Proc	tr <mark>uct</mark> ur cess C	e and Commu	Opera inicatio	tions, n IPC,	Kernel Client	Data - Ser	Struc ver Sy	tures, ystem
Unit-2 - Th	reading and Proc	ess Synchr	ronization		- 25				15									12	Hour
Threads C Synchroniz <b>Practice o</b>	Verview, Multiproc zation, Mutex Locks <b>n</b> Threading and S	cessor Progr s, Semaphor Synchronizati	ram <mark>ming and M</mark> ultithread model res, Monitors - Implementation Us ion	ls, Thread Libraries and Implicit sing Semaphores	Threading, Is	sues i	n Threa	ading, S	Synchro	onizat	ion Co	ncepts	s, The	Critica	al Sect	ion Pro	oblem,	Haro	dware
Unit-3 - Sc	cheduling and Dea	adlocks	- 1 - 10															12	Hour
Scheduling Avoidance, <b>Practice o</b>	g Concepts and Cr , Deadlock Detection <b>n</b> Scheduling algor	riteria, Algori on and Reco rithms.	ithms for Scheduling, Thread an wery from Deadlock	d Multiprocessor Scheduling, Rea	al Time sched	luling,	Deadlo	cks- Ch	aractei	rizatio	on, Han	dling l	Deadlo	ocks, D	eadloc	k Prev	rention	, Dea	≀dlock

### Unit-4 - Memory Management

Memory Hardware Organization, Memory Allocation, Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table, Overview of Virtual Memory, Demand Paging, Page Replacement Algorithms, and Allocation of Page Frames, Thrashing, Kernel Memory Allocation

### Practice on Memory Management

### Unit-5 - RTOS Applications

Real time systems: Data acquisition system, Real time systems: Data acquisition system, Performance metrics, Audio Input/Output, Priority Scheduler, Multi-level Feedback Queue, Starvation and aging, Priority inversion and inheritance, Overview of available RTOS, RTOS for Digital Signal Processing - Examples and Discussion, RTOS for Control Systems - Examples and Discussion **Practice on** Application programs using RTOS

- CALC +

	1.	Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Concepts,	3.	Andrew Sloss ET all, "ARM system developer's quide", Elsevier, 2004.
Learning		Tenth edition, Wiley, 2018	4.	Quing Li, "Real time techniques for embedded systems", CMP Books, 2003.
Resources	2.	Jonathan Valvano, "Real time operating systems for ARM Cortex-M Microcontrollers,	5.	K. C. Wang, "Embedded and Real time operating systems", Springer, 2017.
		Embedded systems - Volume 3", ARM Educational Media, 2017.		

			Continuous Learning	Assessment (CLA)		Summativo				
	Bloom's Level of Thinking	Form CLA-1 Avera (45	native ge of unit test 5%)	Life-Long CL (1	g Learning _A-2 5%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1	20%	<u>15</u> %	-			
Level 2	Understand	25%			20%	<mark>25</mark> %	-			
Level 3	Apply	30%			25%	30%	-			
Level 4	Analyze	30%			25%	<u>30</u> %	-			
Level 5	Evaluate	-		A 144.0	10%		-			
Level 6	Create	and the second	- 47		1111	-	-			
	Total 100 %			10	0 %	100 %				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Mr. Anuj Kumar, Program Delivery Manager, Nagarro Software's Pvt Ltd.	1. Dr. Sudhanya P, SRMIST
		2. Dr. K. Vadivukarasi, SRMIST

12 Hour

Course Code	21ECE303T	Course Name	9	MEMS TECHNOLOGIES			ourse tegory		E	PROFESSIONAL ELECTIVE						_ T 3 0	P 0	C 3			
Pre-requis Course	site s	Nil	Co	o- requisite Courses	Nil		Progr Cou	essi Irses	ive s						Nil						
Course C	Offering Departmo	ent	E	CE	Data Book / Codes	/ Standards								Nil							
Course Lea	arning Rationale	(CLR):	The purpose of le	earning this cours	e is to:		12	t	4.	F	Progra	am Ou	itcome	s (PO	)				P	rogra	m
CLR-1: Familiarize with MEMS materials and their properties							1 2	2	3	4	5	6	7	8	9	10	11	12	0 0	pecifi itcom	c es
CLR-2:	2: Study the various micro machining techniques								of	s of	2.	iety			¥		a)				
CLR-3:	-3: Explore the micro device manufacturing process						vledç		ent o	ations	ge	soc			oW ۲		lance	g			
CLR-4:	Impart knowledge	e of the pri	inc <mark>iple and c</mark> oncept	s of micro sensor a	nd actuators	1.00	Knov	elekin.	lopm	estiga olem	Usa	r anc	৵		Tean	U	& Fir	arnin			
CLR-5:	R-5: Examine the design methodologies used in MEMS devices use cases					ering		deve s	t inve k prol	Tool	jinee	ment		al & .	nicat	Mgt.	g Le				
					100 C	1000	blam		sign/c	nduct	dern	eng	viron	<mark>cs</mark>	vidu	nmu	ject I	Lon	-1	0-2	0.3
Course Ou	tcomes (CO):		At the end of this	s course, learners	will be able to:	10.37	ц Ц Ц	2	Des	S Cor	Mo	The	Sus	뛾	Indi	S	Pro	Life	PS(	PS(	PS
CO-1:	Select appropriat	'e MEM <mark>S n</mark>	<mark>materia</mark> ls according	to the application	ALC: No. S.	6.54	3 2	?	-		-	-	-	-	-	-	-	-	2	-	-
CO-2:	Determine suitab	le micro <mark> m</mark>	<mark>nachini</mark> ng technique	s			2 -	è.	3	-	-	-	-	-	-	-	-	-	-	3	-
CO-3:	Demonstrate the	micro d <mark>evi</mark>	<mark>ice ma</mark> nufacturing a	and assembly proce	ess		2 -		3	-	-	- 20	-	-		-	-	-	-	3	-
CO-4:	Analyze and ado	pt appro <mark>pri</mark>	<mark>iate m</mark> icro sensor a	nd actuators princi	ole for optimum design	5	2 -		3	-	-	-	-	-	-	-	-	-	-	3	-
CO-5:	Validate the MEN	/IS devic <mark>es</mark>	<mark>s design</mark> and fabrica	ation methodologies	s used in use cases	1.1	2 -		3	-	-	2	- 10	-	-	-	-	-	-	2	-
Unit-1 - Pro	operties of MEMS	Materials	s	Impurities in Silies	Dreparties of Silicon on	L Collium Area	nido [	Dalum		Deluin	ida D				0110	Domila	ma 1/a	no otra	. et ure	9	Hour
Titanium di	oxide. Silver. Svnti	hetic amor	- <mark>Crystar derects – 1</mark> rohous silica. Iron o	xide. Pigments. Ca	rbon Fullerenes and Nanotu	ibes	riiue - r	oiyi	ner –	Polyilli	iue, P	wiwA,	PDNS	, LCP,	500,	Paryle	ne, na	no sin	icture	mater	iais -
Unit-2 - Fa	brication Techno	logy								15	-7									9	Hour
Bulk Microl ultrasonic a driven bulk semiconduc	Machining: wet etc igitation in wet etc processing. Surfa ctors and thin film	hing of sili hing- stop ace Micron transition -	icon- <mark>Isotropic</mark> etchi layers for dopant e machining: Thin film – wet etching of no aver for metals -Ele	ng-anisotropic etch elective etchants. F n processes-nonme n-metallic thin film- ctro doposition (E r	ing-alkali hydroxide etchant Porous-silicon formation –an etallic thin film for microma metallic thin film for microm	s-ammonium istrophic wet chining –silico achining - Re	hydroxia etching on dioxic sistive e	le-te of po de – vapo	tra m prous silico pratio	ethyl ar alumin on nitrio n – E -	nmoni um-an le - sil beam	ium hy istrop licon c evapo polatin	droxide	e (TM) etchir - poly sputte	AH)-eth ng - qu vcrysta r depo	hylene artz-va Iline di sition-c	diamin pour p amond compar	e pyro hase e - poly ison of	chated etches silicor f evap	chol (E . RLE n and oration	EDP)- laser other n and

### plating. Unit-3 - Fabrication Technology – II

Bonding Processes: Anodic Bonding-Anodic bonding using deposited glass-silicon fusion bonding-other bonding and techniques-compound processes using bonding. Sacrificial Processes and Other Techniques: Sticking problem during wet releasing-prevention of sticking-phase change release methods-geometry-examples of sacrificial processes - Sacrificial LIGA process:

### Unit-4 - MEMS Sensing and Actuation Mechanics

Electromechanical effects: Piezoresistance - Piezoelectricity - Shape memory alloy-Thermal effects: Temperature coefficient of resistance - Thermo-electricity – Thermocouples – Micro fluidics: - Squeeze film damping - Surface tension and bubbles -Devices: pumps, valves, mixers -Integrated fluidic systems: BioMEMS. 9 Hour

### Unit-5 - Application – Use Case Study

Design and analysis of piezoresistive Pressure Sensors, Design and analysis of Capacitive Principal Accelerometer, pressure sensor, Actuator Design of Piezoelectric Principle Accelerometer, sensor, Actuator Design of microfluidic devices, Design and analysis of thermal sensing and actuation, Analysis of MEMS packaging

	1.	Madou, Marc J. "Fundamentals of microfabrication and nanotechnology, three-volume set".	6.	G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre, "Micro and
		CRCPress, 2018.	1994 A	Smart Systems", Wiley India, First Edition, 2010.
	2.	Hsu, Tai-Ran." MEMS and microsystems: design, manufacture, and nanoscale engineering".John	7.	Julian W.Gardner, Vijay K.Varadan, Osama O.Awadel Karim, "Microsensors MEMS
Learning		Wiley & Sons, 2008.		and Smart Devices", John Wiley & sons Ltd., 2001.
Resources	3.	Liu, Chang. "Foundations of MEMS". Pearson Education India, 2012.	8.	Mohamed Gad - el- Hak,"The MEMS HAND book", CRC press 2005 Vikas
	4.	Senturia, Stephen D. "Microsystem design. Springer Science & Business Media", 2007	10	Choudhary, Krzysztof Iniewski, "MEMS Fundamental Technology and Applications",
	5.	Charles P.Poojlejr Fran K J.Owners, "Introduction to Nano Technology", Willey student Edition	100	1st EditionPublished by CRC Press, April 21, 2017.
		2008.	1.1	

Learning Assessm	ent 📃 👘	V 1 1 1 1	C. S. ANDIN	all and a second second	the second se						
			Continuous Learning	Assessment (CLA)	12 A -	Sum	mativa				
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (1)	g Learning .A-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice				
Level 1	Remember	15%	and the second se	15%		15%	-				
Level 2	Understand	25%		20%	-	<mark>2</mark> 5%	-				
Level 3	Apply	30%		25%		<mark>3</mark> 0%	-				
Level 4	Analyze	30%	-	25%		30%	-				
Level 5	Evaluate		- 110-	10%	-	-	-				
Level 6	Create	Sec.		5%	1.1	E #-	-				
	Total	10	0%	10	0%	10	0%				

Course Designers	The CARA STREET	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Mr. Anuj Kumar, Program Delivery Manager, Nagarro Software's Pvt Ltd.	1 Dr. P. Eswaran, SRMIST

Course Code	Course Code         21ECE304T         Course Name         CYBER-PHYSICAL SYSTEM FRAMEWORK								Cour Categ	se ory	E			PRO	ESSI	onal e	ELECT	IVE			- T 3 0	P 0	C 3		
Pre-requis Course	site 18	MAB101	r		Co- requis Courses	ite			Nil		Pi	rogres Cours	sive ses						Ni	I					
Course C	Offering Departme	nt			ECE			Data Bo	ok / Codes	/ Standard	ds							Nil							
							-	-	1	-	1	1	1.												
Course Le	arning Rationale (	CLR):	The purp	oose of	<mark>learnin</mark> g t	his cou	urse is to:					1	20	2.1	Prog	ram Oi	utcome	es (PO	)				P	rogra	m
CLR-1:	CLR-1: Obtain cyber-physical systems fundamentals and principles knowledge as building blocks to promot further design and implementation of more complex real time systems.							o promote	1	2	3	4	5	6	7	8	9	10	11	12	S Ol	pecifi itcom	ic Ies		
CLR-2:	Understand cyber processor.	r physical	systems	design	for synchi	ronous	model wit	th specific	c case stuc	dy for arm	0			of	0	ty	ability		~						
CLR-3:	In what way cyber	r physical	sy <mark>stems a</mark>	<mark>are</mark> cruc	ial for the o	optimal	performa	nce of asy	ynchronous	model.	edge		nt of	suo		ocie	tain		Vor		nce			1	
CLR-4:	Comprehend the	cyber p <mark>hy</mark>	sical syste	ems des	sign and im	plemer	ntation in d	dynamical	l models.	1	lowle	SIS.	mer	igatio	sage	s pu	Sus		am /	_	Final	jing		l	
CLR-5:	Hybridization of technologies.	cyber pl	nysical sy	ystems	which wil	l help	the stud	lents to	anticipate	upcoming	eering Kr	em Analy	n/develop	uct invest	rn Tool U	ngineer a	onment &		dual & Te	nunicatior	ct Mgt. &	ong Leari	~	5	3
Course Ou	tcomes (CO):		At the e	nd of th	nis course	learne	ers will be	e able to:	5.3	059	Engin	Proble	Desig	Condu	Mode	The e	Enviro	Ethics	Individ	Comm	Projec	Life L	PSO-	PSO-:	PSO-3
CO-1:	Understand the ba	asics o <mark>f c</mark> y	<mark>/ber p</mark> hysi	ical syst	ems.						-	3	1	-	-		-	-	-	-	-	-	-	-	-
CO-2:	Design synchrono	ous mo <mark>del</mark>	<mark>s for R</mark> eal	Time a	pplications	( and )	1.1		14		-	3	3	-	-	- 10	-	-	-	-	-	-	-	-	-
CO-3:	Design Asynchror	nous m <mark>od</mark>	els for Rea	al Time	applicatior	IS.	100		2.40	100	-	-	2	3	-	3	-	-	-	-	-	-	-	-	-
CO-4:	Develop Deep Un	derstan <mark>di</mark>	<mark>ng on s</mark> ele	ection o	<sup>f</sup> hardware	and so	oftware's fo	or designir	ng dynamic	al systems.		-	2	3	-	3	-	-	-	-	-	-	-	-	-
CO-5:	Come up with cos	t effective	<mark>e, reliabl</mark> e,	robust	and f <mark>eas</mark> ib	le desig	gns for <mark>r</mark> ea	al world pro	oblems.	12.5			2	3	-	3	-	-	-	-	-	-	-	-	-
l Init-1 - Int	roduction to Cybe	r Physic:	al System	15	See.									_	1	-			_					12	Hour
Introduction CPS, Wirele	To Cyber-Physica ess Sensor Network	I Systems ks Techno bicle Tra	s, Cyber-P blogy and i	hysical its appli tem (A	System Recation in C	equiren PS, Pov	ments, Inte werline Co	eroperabili ommunica	ity, Survival ation, Smart	bility, Real Cities And	Time S Interne	ystem et Of E	, Inter veryth	net Of ing, Ut	Things iquitou	(IOT), s Com	Radio puting l	Freque Fundar	ency la nental	lentifica s, Auto	ation T nomou	echnolo s Syste	ogy an ems In	d its ı Ubiqı	use in uitous
Unit-2 - Sv	nchronous Model		Jaing Oyse					1.71	1						112	-								12	Hour
Synchronou	ıs model overview,	Reactive	Compone	ents, Va	riables, Va	luations	s, Express	ion and E.	Execution, E	xtended-St	ate Ma	chines	, Prop	erties	Of Con	nponen	ts, Var	ious Ty	pes of	compo	onents,	Task (	Graphs	s And	Await
Dependenc	ies, Composing Co	mponent	s, Output	Hiding,	<mark>Synch</mark> rono	us Des	signs (Syn	chronous	Circuits, Ci	ruise Contro	ol Syste	ems, S	Synchr	onous	Networ	ks).			·						
Unit-3 - As	ynchronous Mode	el							_					_										12	Hour
Unit-3:: Asy Assumption	nchronous Proces S. Asvnchronous C	s overviev Coordinati	v, States, on Protoco	Interna ols. Lea	l <mark>Actions, E</mark> der Electio	xecution n. Relia	ons, Exten able Trans	nded State smission.	e Machines, Wait Fee C	, Operation Consensus.	s On P Safetv	rocess Specif	s, Bloc ficatioi	king V ns <mark>. Inv</mark>	s Non-l ariants	Blockir Of Tra	ig Syno nsition	chroniz Svster	ation, I ns. Sa	Deadlo fetv Mo	ocks, Sl Snitors	hared I	Nemor	y, Fai	rness
Unit-4 - Dy	namical System			,		,								.,				- )						12	Hour
Overview of	of dynamic systems	s, Continu	ious Time	e Model	, Continuo	usly Ev	volving Inp	puts and	Outputs, M	lodels with	Distur	bance,	Com	posing	Comp	onents	Stabil	ity, Lin	ear S	<i>ystems</i>	Linea	rity, Sc	lution	s Of L	inear
Differential	Equations and stat	oility, Desi	gning Cor	ntrollers	, Open Loc	p Vs F	eedback (	Controller,	, PID Contr	ollers, Anal	ysis Te	chniqu	ues, B	arrier (	Certifica	ates.									

### Unit-5 - Hybrid Systems

Hybrid Dynamical Model, Zeno Behavior, Designing Hybrid Systems, Automated Guided Vehicle, Obstacle Avoidance with Multi Robot Coordination, Multi Hop Control Networks, Linear Hybrid Automata, Pursuit Game problem, Timed Automata, Model Of Timed Automata.

Learning	1. Rajeev Alur, "Principles of Cyber Physical Systems", 1st Edition, MITPress 2015.	3. Edward D Lamie, "Computing Fundamentals of Cyber Physical Systems", 2nd Edition, Newnes
Resources	2. Raj Rajkumar , "Cyber Physical Systems," 2nd Edition, Elsevier 2015	Elsevier Publication.

Learning Assessme	ent		100		2					
			Continuous Learning	Assessment (CLA)		Sum	mativa			
	Bloom's Level of Th <mark>inking</mark>	Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (10	g Learning _A-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	10%		10%		10%	-			
Level 2	Understand	15%		15%		15%	-			
Level 3	Apply	25%	and the second	25%		20%	-			
Level 4	Analyze	25%		25%	25 A. 1.	20%	-			
Level 5	Evaluate	15%	Service Service	15%	·	20%	-			
Level 6	Create	10%		10%		<mark>15</mark> %	-			
	Total	10	0 %	10	0%	100 %				

Course Designers								
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts						
1. Mr. Athif Shah, Chairman, Abe Semicondutor, abechennai@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Dr. Md Jawaid Alam, SRMIST						
<ol> <li>Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI, Imadank@gmail.com</li> </ol>	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in							



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Course Code	Course Code         21ECE305J         Course Name         MACHINE LEARNING ALGORITHMS							Cours Catego	se ory	Е			PROF	ESSIO	NAL E	ELECT	IVE		l	- T 2 0	P 2	C 3
Pre-requi Course	site Is	Nil		Co- requisite Courses		Nil		Pr	ogres Cours	sive es						Nil						
Course	Offering Departm	ent	1	ECE		Data Book / Codes	/ Standard	s							Nil							
-						m half it has		100		1										<del></del>		
Course Le	arning Rationale	(CLR):	The purpos	<mark>e of learnin</mark> g this	course	is to:			1	1	211	Progra	am Ou	Itcome	s (PO	)				P	rogra	m
CLR-1: Provide a basis for understanding machine learning								1	2	3	4	5	6	7	8	9	10	11	12	01 01	pecifi itcom	ic ies
CLR-2:	Learn various re	gression a	and clas <mark>sificati</mark>	<mark>on al</mark> gorithms in su		d learning	-	ge	5	of	s of	20	ciety			ork		e				
CLR-3:	Gain knowledge	about clas	ssifica <mark>tion usir</mark>	ng decision trees a	nd ense	mble learning	SMA	vled		ent	ation	ge	soc			No.		anc	D			
CLR-4:	Acquire knowled	ge abou <mark>t</mark> d	clu <mark>stering alg</mark> o	rithms and reinford	cement l	learning		Knov	alysis	lopm	estiga	Usa	r and	8		Tearr	ion	& Fir	arnin			
CLR-5:	Explore the conc	epts behir	n <mark>d Bayesia</mark> n le	earning		1000		sering	em Ane	n/deve	ict inve ex pro	n Tool	nginee	nment		lual &	nnicat	t Mgt.	ong Le			~
Course Ou	utcomes (CO):		At the end	of this course, lea	arners v	will be able to:	are 17	Engine	Proble	Design	Condu	Moder	The el	Enviro Sustai	Ethics	Indivic	Comm	Projec	Life Lo	PSO-`	PSO-2	PSO-0
CO-1:	Understand the t	oasic ter <mark>m</mark>	<mark>inologie</mark> s in m	achine learning		Siles burg	(34.2	3	1	1		2	-	-	-	-	-	-	-	-	1	-
CO-2:	Analyze data cla	ssificatio <mark>n</mark>	<mark>i using</mark> supervi	ised learning	3.80	100		3	1	e.	-	2	-	-	-	-	-	-	-	-	2	-
CO-3:	Articulate the wo	rking of <mark>de</mark>	<mark>ecision</mark> tree cla	assifier and ensem	ible lear	ning					3	2	- 10	-	-	-	-	-	-	-	1	-
CO-4:	Gain the knowled	dge of va <mark>ri</mark>	<mark>ious un</mark> superv	ised and reinforce	ment lea	arning algorithms	510		-		3	2	1	-	-	-	-	-	-	-	1	-
CO-5:	Demonstrate the	Bayesian	<mark>i learnin</mark> g tech	nique	1.1	The state of the s	1.1		2	14	3	1		-	-	-	-	-	-	-	2	-
				1	No.		1.5		67				5								- 40	
Unit-1 - Int	troduction to Mac	hine Leai	rning						1					. 0	.cu:				D:	Mania	12	Hour
– General   Practice: I	orinciples in machi	ne learnin ne learnin	ig - Feature ex ig - Feature ex	traction - Training,	, testing	and validation set - k-fold	cross valida	tion - c	confus	ion ma	atrix - Pe	erforma	ance n	y - Ove netrics -	- ROC	curve	s unde	rnung	– Bias	variar	ice tra	laeon
Unit-2 - Su	inervised I earnin	01033 Vali na		aluation of perion	lance m		-			-	-	-				-					12	Hour
Regression: Linear regression. Logistic regression - Stochastic gradient descent - Classification: K-nearest neighbor algorithm -Support Vector Machine: Linear SVM. Soft SVM. Nonlinear SVM. Multiclass SVI									SVM -													
Naïve Baye	es.	<i>,</i> 0	U	, i i i i i i i i i i i i i i i i i i i	in the second	1 Mill And		Ŭ									,		,			
Practice: I	mplement linear re	gression,	logistic regres	<mark>sion, k-</mark> nearest ne	ighbor,	SVM, Naïve Bayes.	11.1	1														
Unit-3 - De	ecision Trees & E	nsemble	Learning	1				_	diana dia												12	Hour
Binary deci	ision trees: Impurit	y measure	es - Gini impur	rity index, Cross-er	tropy in	npurity index, misclassifica	tion impurity	index	– Ens	emble	learnin	g: Ran	dom F	orest, /	Adabo	ost, Gr	adient	tree bo	costing	, votin	g clas	sifier.
Init-4 - IIr	npiement decision	nina & Re	ning, bayging	l earning	si, Auan	oost, voling classifier.															12	Hour
Clusterina:	K-means clusterin	ng, Hierard	chical clusterin	ng - Gaussian Mixt	ure Mod	el - Reinforcement learning	g - Dimensio	onalitv	reduct	tion: Ll	DA. PC	A. ICA.	Rand	om pro	iectior	15.						
Practice: I	mplement k-means	s ustering,	, hierarchical d	lustering.				,			,	, ,		1.1.	,							

### Unit-5 - Bayesian Learning

Formulation of Bayesian learning: Bayesian inference, maximum a posterior estimation, sequential Bayesian learning – Conjugate priors – Approximate inference: Laplace's method, Variational Bayesian methods – Gaussian processes – nonparametric priors, regression and classification. Practice: Demonstrate Bayesian inference

	1.	Ethem Alpaydin, "Introduction to machine learning", Fourth Edition, MIT press, 2020.	4.	Shai Shalev-Shwartz, and Shai Ben-David, "Understanding machine learning: From theory to
Loorning	2.	Hui Jiang, "Machine Learning Fundamentals: A Concise Introduction", First Edition,		algorithms", Third Edition, Cambridge university press, 2015.
Decourooo		Cambridge University Press, 2021.	5.	Marsland, Stephen. "Machine learning: an algorithmic perspective". Second Edition, CRC press,
Resources	3.	Giuseppe Bonaccorso, "Machine learning algorithms: Popular algorithms for data		2014.
		science and machine learning", Second Edition, Packt Publishing Ltd, 2018.	6.	Kevin P. Murphy, "Machine learning: a probabilistic perspective", FirstEdition, MIT press, 2012.

Learning Assessn	nent		Continuous Loornin	Accompant (CLA)							
	Bloom's Level of Thinking	Forn CLA-1 Avera (4)	native ge of unit test 5%)	Life-Long CL	g Learning A-2 5%)	Summative Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%	10 - A 100		15%	15%	-				
Level 2	Understand	25%	the base is		25%	25%	-				
Level 3	Apply	30%	The second	10 C	30%	30%	-				
Level 4	Analyze	30%	1	わられた主義	30%	30%	-				
Level 5	Evaluate	1 N. 1 - 1 - 1	A CONTRACTOR OF A CONTRACT			-	-				
Level 6	Create	No. And	-	10 Mar 19 G		-	-				
	Total	10	0%	10	0%	10	0 %				
		101 101 101									

Course Designers		1.925
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Mr. Anuj Kumar, Program Delivery Manager, Nagarro Software's Pvt Ltd.	1. Dr. R. Jansi <mark>, SRMIST</mark>



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Course Code	Irse 21ECE401T Course ADVANCE DIGITAL SYSTEM DESIGN						Cour Categ	se ory	E			PROF	ESSIC	onal e	ELECT	IVE			L T 3 0	P 0	C 3			
Pre-requi	isite es 18ECC	103J/18ECC	212JI	Co	o- requisite courses			Nil		P	rogres Cours	sive es						Nil	1					
Course	Offering Departm	nent		E	CE		Data B	Book / Code	s / Standar	ds			-				Nil							
Course Lo	orning Dationals			and of l	arning this	oouroo i	in to:			1		1.0		Drogr	am ().	toom		<u> </u>				Р	roara	m
Course Le	Sourse Learning Rationale (SER). The purpose of rearining this course is to.								-				Flogi			5 (FU	)	10		40	- s	pecif	ic	
CLR-1:	Explore the adva	anced Boolea	an theoren	ns for ic	gic simplifica	tion and	implementa	tion		1	2	3	4	5	6	1	8	9	10	11	12	Οι	utcom	ies
CLR-2:	Analyze the forn circuits	nal procedure	s for the a	analysis	and design o	f synchro	onous and as	synchronous	s sequential			1		10		ility								
CLR-3:	Understand con combinational a	cept of Progr nd sequentia	rammable I l <mark>ogic circ</mark>	Device cuits usi	s (PROM, Pl ng them	LA, PAL,	, CPLD and	FPGA) and	implement	edge		nt of	ions of	Φ	society	stainab		Work		ance				
CLR-4:	Adopt systemati of digital circuits	c approach v and systems	vith the us s	se of AS	SM chart ASN	MD chart,	, RTL repres	sentation for	the design	Knowl	alysis	elopme	estigat blems	I Usag	er and s	t & Sue		Team	tion	& Fina	arning			
CLR-5:	Apply VHDL as	a design- <mark>entr</mark>	<mark>y lang</mark> uag	ge for Fl	PGA in electro	onic desi	ign a <mark>utomati</mark>	on of digital	circuits	eering	em An	in/deve	uct inv lex pro	rn Too	inginee	onmen	(0	dual &	nunica	ct Mgt.	ong Le	5	2	ę
Course O	utcomes (CO):		<mark>At th</mark> e end	d of thi	s course, lea	arners w	ill be able to	o:	Nº4	Engin	Probl	Desig	Cond	Mode	The e	Envir	Ethic	Indivi	Comr	Proje	Life L	PSO-	PSO-	-OS4
CO-1:	Apply advanced	theorem <mark>s to</mark>	simplify th	he desig	n aspects of	various <sub>l</sub>	practical circ	cuits		3		2	-		- 16	1	-	-	-	-	-	-	-	-
CO-2:	Analyze synchro	onous se <mark>quer</mark>	<mark>ntial c</mark> ircuit	ts and w	rite VHDL Co	ode	1.00		5 J 1	3	2	2	-	-	-	-	-	-	-	-	-	1	-	-
CO-3:	Analyze Asynch	ronous s <mark>eque</mark>	<mark>ential</mark> circı	uits and	construct cire	cuit using	g VHDL	-		3	2	2	1	-		-	-	-	-	-	-	1	-	-
CO-4:	Implement vario	us digital <mark>circ</mark>	<mark>uits u</mark> sing:	Progra	mmable Logi	c Device	s			3	2	2	-	-		-	-	-	-	-	-	-	-	-
CO-5:	Demonstrate FF	GAs and Co	<mark>nstruc</mark> t dig	gital circ	uits using VH	IDL	ALC: N			3	2	3	-	3			-	-	-	-	-		-	1
linit-1 - E	unansian Theorem	me and Stat	o Tablos	10											í								٥	Hour
Shannon's	Expansion theore	em and its an	plications	. Conse	nsus theoren	n. R Ree	d-Muller Ex	pansion tec	hnique. Muli	iplexer	logic a	as fund	tion ae	nerato	rs. Imr	lem <mark>en</mark>	tation (	of Muli	tiple ou	tout lo	aic fun	ctions.	Mea	lv and
Moore ma	chines, State diag	rams, State ta	abl <mark>e, Stat</mark> e	e reduct	ion and state	assignm	nent techniq	ues.		-					, <b>p</b>						,	,		,
Unit-2 - VI	HDL Modeling							100	Service States					14									9	Hour
Introductio	n to VHDL, Entity a	and Architect	ure descri	iption, V	HDL Data typ	bes and C	Operators, C	oncurrent, S	equential A:	ssignm	ent Sta	atemen	ts, Typ	es of N	lodellir	n <mark>g in</mark> VI	HDL, B	ehavic	oral, da	taflow a	and str	uctura	l mod	elling,
Unit-3 - Synchronous and Asynchronous Sequential Design 9 Hou										Hour														
Synchrono	ous Sequential De	sign system	, Models	of Syn	chronous Se	quential	Design sys	tem, Algorit	hmic state	machir	ie, Syl	nthesis	from	ASM	Chart,	analys	is of A	Asynch	ironous	s sequ	ential	circuit,	Des	ign of
IInit-4 - Pi	rogramable I ogic	al Devices a	and Hazar	rds in V	HDI			ietastability.					-										9	Hour
Static haza	ards, Dynamic haz	ards, Essent	ial hazard	ls. Proai	amming loaid	c device i	families, des	signing sync	hronous sec	uentia	circui	t usina	PROM	, Proa	ramma	ble Ar	ray Loo	aic (PA	L), Prc	gramn	nable A	Array L	ogic (	PAL).
Unit-5 - Fl	PGA logic Family	-,		,	5 - 5		,	0 0						,			,			0.0			9	Hour
FPGA-Xilii	nx FPGA, Xilinx 30	000 series FP	'GA, Xilinx	x 4000 s	eries FPGA,	Design of	of sequential	l circuits (us	ing VHDL),	Introdu	ction to	CAD,	Basic	CAD o	peratic	on.								

Learning Resources	1. 2. 3. 4.	Charles H. Roth, Jr. University of Texas at Austin. Larry L. Kinney, "Fundamentals of Logic Design", 7th ed., Cengage Learning, 2012 Richard S. Sandige, Michal L. Sandige, "Fundamentals of digital and computer design with VHDL", McGrawHil, 2014 Mark Zwolinski, "Digital system Design with VHDL", 2nd edition, Prentice Hall, 2004. Jayaram Bhasker, "A VHDL Primer", 3rd ed., Prentice Hall, 2011	5. 6. 7.	Charles. H. Roth, Jr, "Digital Systems Design using VHD"L, CENGAGE Learning, 2010 Morris Mano M, Michael D. Ciletti, "Digital Design with an Introduction to the Verilog HDL", Pearson, 2014. Xilinx Vivado TCAD Tool. https://www.xilinx.com/support/documentation- navigation/design- hubs/dh0010-vivado-simulation-hub.html
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		1111	Continuous Learning	Assessment (CLA)		Summative Final Examination (40% weightage)				
	Bloom's Level of Thin <mark>king</mark>	Forn CLA-1 Avera (5)	native ge of unit test 0%)	Life-Lon Cl (1	g Learning LA-2 0%)					
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%	Alter and the	15%		15%	-			
Level 2	Understand	25%		20%		25%	-			
Level 3	Apply 📃	30%		25%		30%	-			
Level 4	Analyze	30%		25%		30%	-			
Level 5	Evaluate	- 5		10%		-	-			
Level 6	Create	- II	10 245 NO	5%		-	-			
	Total	10	0%	10	0 %	10	0%			

Co	ourse Designers	And States Contact House I have been	
E	xperts from Industry	Experts from Higher Technical Institutions	Internal Experts
1	. Mr. Vikas Verma, Physical design Engineer, Mediatek, vikas.verma@mediatek.com	1. Dr. G. P. S. C Mishra, Associate Professor, NIT Raipur, Chhattisgan	1. Dr. Manish Verma, SRMIST
2	. Mr. Mahesh Malewale Tanaji, Physical Design Engineer, mahesh.tanaji.malewale@intel.com	2. DR. Shivendra Yadav, Assistant Professor, SVNIT, Surat, Gujrat	2. Dr. Damodar Panigrahy, SRMIST



Course Code	21ECE402T	CE402T Course SEMICONDUCTOR DEVICE MODELING					Cours	se ory	Е			PROF	ESSIC	onal e	ELECT	IVE			- T 3 0	P 0	C 3
Pre-requi Course	isite es	Nil	Co- requ Cours <mark>e</mark>	isite s	Nil		Pr	ogres Cours	sive es						Nil						
Course	Offering Departme	ent	ECE		Data Book / Codes /	Standards	1							Nil							
					a half have			1	1												
Course Le	earning Rationale	(CLR):	The purpose of learning	g this cours	e is to:				1		Progr	am Ou	tcome	es (PO	)				- S	rograi	m ic
CLR-1:	Determine the ch	aracteristic	cs of se <mark>miconductor</mark> when	deviations i	from equilibrium occur.		1	2	3	4	5	6	7	8	9	10	11	12	Oi.	itcom	es
CLR-2:	Derive the mather to generation, rec	matical rel combinatio	lations <mark>formed from</mark> the ex n, an <mark>d drift and</mark> diffusion p	cess carrier process.	s in unit volume of semicondu	ictor due			N.	of	20	ţ	ability								
CLR-3:	Develop ambipola	ar transpor	rt equations which describ	es the beha	vior of excess electrons and h	noles.	dge		t of	Suc	1	ocie	aina		Vork		JCe				
CLR-4:	<ul> <li>Analyze the structure, characteristics, qualitative and quantitative understanding of the operation of a MOSEFT</li> </ul>							lysis	opmen	stigatic	Usage	and so	& Sust		Feam V	uo	& Finar	arning			
CLR-5:	Model MOS trans	sistor by i <mark>n</mark>	cluding various short-char	nnel effects	45 - 127		eering	em Ana	n/devel	uct inve ex prot	n Tool	ngineeı	nment		lual &	nunicati	t Mgt.	ong Lea	_		~
Course Ou	utcomes (CO):		At the end of this cours	se, learners	will be able to:		ingin	roble	Desig		lode	he el	inviro	thics	pivipu	omn	rojec	ife Lo	OS	5-0S	SoS
CO-1:	Apply the density doping concentra	v of qua <mark>ntu</mark> tions and t	im states for determining temperature.	the position	of Fermi energy level as a fu	unction of	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-2:	Understand the semiconductor cr	basic t <mark>rar</mark> ystal.	nsport mechanisms for c	determining	the current-voltage characte	eristics of	3	2		-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	Analyze the beha coordinates	avior of <mark>no</mark>	nequilibrium electron and	l hole conce	entration as function of time a	and space	3	2	Č.		-	10	N'A	-	-	-	-	-	-	-	2
CO-4:	Develop the math to-source voltage	hematical r of MOS tr	relation between the drain ransistor.	n current, the	e gate-to-source voltage, and	the drain-	-	2	3	-	1-1	4	-	-	-	-	-	-	-	-	2
CO-5:	Examine the effe	cts of seco	o <mark>nd order</mark> effects in short o	channel MOS	S transistor		-	2	3	-	-	•	-	-	-	-	-	-	-	-	2
Unit-1 - Th	ne Semiconductor	in Equilib	prium		2 - 2					1	4									9	Hour
Statistical I p0 Equation Degenerate Derivation, Unit-2 - Ca	Mechanics - Statisti ons, The Intrinsic C e and Nondegener Variation of EF wit arrier Transport Pl	ical Laws, Carrier Col ate Semico th Doping ( <b>henomen</b> a	Fermi-Dirac Probability Funcentration, Intrinsic Ferri onductors; Statistics of Do Concentration and Tempe	unction, Dist mi-Level Pos onors and A erature.	ribution Function and the Fern sitions; The Extrinsic Semico cceptors - Probability Function	ni Energy, ( nductor - E n, Complete	Charg Equilib e Ionii	e Carr prium zation	riers in Distrib and F	Semic oution o reeze-(	onduct f Elect Dut; Cl	tors-Ec rons a harg <mark>e N</mark>	quilibriu nd Ho Neutral	um Dis les, Th lity, Po	tributic ne n0p sition d	on of El 0 Prod of Fern	ectrons luct, Tl ni Energ	s and F he Fer gy Lev	loles, mi-Dira el - Ma	The no ac Inte athem <u>9</u>	0 and egral, atical
Carrier Dri	ft - Drift Current De	ensity, Mob	pility Effects, Conductivity,	Velocity Sa	turation, V-I Characteristics; (	Carrier Diffu	usion	- Diffu	sion C	Current	Densit	y, Tota	I Curre	ent Der	nsity; C	Graded	Impuri	ty Dist	ributio	n - Inc	Juced
Electric Fie	eld, The Einstein Re	elation, The	e Hall Effect												-		-				
Unit-3 - No	onequilibrium Exc	ess Carrie	ers in Semiconductors	Corriero	Continuity Equations Time De	nandant Di	ff. color	- Fau	tions	Amahin			+ Der	h cotia	of the	Amph:-	alar T-		+ <b>F</b> au:-	9	Hour

Carrier Generation and Recombination, Characteristics of Excess Carriers - Continuity Equations, Time-Dependent Diffusion Equations; Ambipolar Transport - Derivation of the Ambipolar Transport Equation, Limits of Extrinsic Doping and Low Injection, Applications of the Ambipolar Transport Equation, Dielectric Relaxation Time Constant; Shockley-Read-Hall Theory of Recombination, Surface Effects - Surface States, Surface Recombination Velocity.

### Unit-4 - MOS Transistor

9 Hour

The Two-terminal MOS structure, Energy-Band Diagrams, Depletion Layer Thickness, Work Function Differences, Flat-Band Voltage, Threshold Voltage, Charge Distribution, Capacitance - Voltage Characteristics - Fixed Oxide and Interface Charge Effects, MOSFET Operations - Current Voltage Relationship Concepts and Mathematical Derivation, Velocity Saturation, Ballistic Transport. 9 Hour

### Unit-5 - Advanced Topics in MOSFET's

Effect of Gate and Drain Voltages on Carrier Mobility in the Inversion Layer, Channel Length Modulation, MOSFET Breakdown and Punch-through, Subthreshold Current, MOSFET Scaling, Nonuniform Doping in the Channel, Threshold Voltage of Short-channel MOSFETs, Small Signal Analysis - Meyers Model, Small Signal Equivalent Circuit of MOSFET Amplifier.

	1 Donald Neamen, Dhrubesh Biswas, "Semiconductor Physics and Devices", McGraw Hill, 4th Ed. 2012	4 S M Sze and K N Kwok "Physics of Semiconductor Devices." 3rd edition
Learning	<ol> <li>Nandita Dasgupta and Amitav Dasgupta, "Semiconductor Devices: Modelling and Technology"</li> </ol>	John Wiley&Sons, 2006.
Resources	Prentice-Hall of India Pvt.Ltd; 1st Ed, 2004.	5. Y. Tsividis and C. McAndrew, "MOSFET modeling for Circuit Simulation",
	3. G. Streetman, and S. K. Banerjee, "Solid State Electronic Devices," 7th edition, Pearson, 2014.	Oxford University Press, 2011.

Learning Assessm	nent	~ /	A Read Press								
			Continuous Learning	Assessment (CLA)		Sum	mativa				
	Bloom's Level of Thinking	Forr CLA-1 Avera (5	native nge of unit test 0%)	Life-Long L CLA- (10%	earning 2 )	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice				
Level 1	Remember	20%		20%		20%	-				
Level 2	Understand	20%	608 TO	20%		20%	-				
Level 3	Apply	40%	A Contract of the	40%		40%	-				
Level 4	Analyze	20%		20%	3	20%	-				
Level 5	Evaluate	C	and the second	LE STORY	- "		-				
Level 6	Create					-	-				
	Total	10	0%	e 100 %	6	10	0%				

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
	1. Mr. Saivineeth, ML Accelerator Architect @ Google	1. Dr. Maria Jossy A, SRMIST	



Course Code	21ECE403T Course MICROWAVE INTEGRATED CIRCUITS							Cours atego	se ory	E			PROF	ESSIO	NAL E	ELECT	IVE			L T 3 0	P 0	C 3
Pre-requi Course	isite es	Nil		Co- requisite Course <mark>s</mark>		Nil		Pr	ogres Cours	sive es						Nil						
Course	Offering Departme	ent		ECE		Data Book / Codes /	Standards	5	-					_	Nil							
							1	-	-	1		_			(5.6)					D	oara	
Course Le	earning Rationale (	CLR): 11	he purpose	of learning this	course is t	0:				1		Progr	am Ou	itcome	s (PO	)	r –	<u> </u>		- S	pecifi	ic
CLR-1:	Understand the b	asic concept	ts of transmi	<mark>ssion l</mark> ines and m	natching circ	uits.		1	2	3	4	5	6	7	8	9	10	11	12	Oi.	itcom	es
CLR-2:	Design of microw	ave passive	devi <mark>ces.</mark>			and the second	-	ge		of	s of	$\mathbf{z}_{i}$	iety			ork		е				
CLR-3:	Gain knowledge o	on diodes, <mark>B</mark>	JT and FET.		1		2616	vled	(0	lent o	ation	ge	d soc			n Mo		Janc	b			
CLR-4:	Explain the construction and working of oscillators and mixers.						25-1	Kno	lysis	opn	stig	Usa	and	∞		[ear	u	& Fi	arnir			
CLR-5:	Summarize the co	oncepts of <mark>M</mark>	<mark>/IC fabri</mark> catic	on and packaging	1.	12000		ering	i Ana	devel	t inve	Tool	linee	ment		al &	nicati	Mgt.	g Le			
				the second se	_		100	inee	olen	ign/	uduc	lern	enç	iron	S	vidu	nmu	ect	Lon		)-2	-33
Course Or	utcomes (CO):	A	<mark>At the</mark> end o	f this course, le	arners will l	be able to:	10.27	Eng	Prol	Des	Con	Moc	The	Env	Et	Indi	Con	Proj	Life	PSC	PS(	PSC
CO-1:	Describe the func and design of ma	lamentals of tching c <mark>ircuit</mark>	f transmissic its	n line theory, Sn	nith chart an	d its interpretation in th	e analysis	3	3		-	5-		-	-	-	-	-	I	-	I	2
CO-2:	Analyze microwa	ve pass <mark>ive d</mark>	<mark>levic</mark> es, anal	ysis and design c	of filters	6 . The h	611	З	•	2	-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	Apply the knowled of Amplifiers.	dge of <mark>micr</mark> o	owave active	components and	d familiarize	the methodologies on t	the design	3	1	2		-		_	-	-	-	-	I	-	I	2
CO-4:	Analyze various o	oscillato <mark>rs an</mark>	<mark>nd mi</mark> xers.	-	2.55			3	1	1.57	-	-		-	-	-	-	-	-	-	-	-
CO-5:	Illustrate the fabri	cation o <mark>f MIC</mark>	<mark>C dev</mark> ices ar	nd packaging tech	hniques			3		1	-	-	1	-	-	-	-	-	•	-	-	-
llnit-1 - Er	undamental Conce	nts of Trans	smission L	ines and Matchi	na Circuite		-						-								٥	Hour
Conventior	nal Frequency Band	ds. Lumped a	and Distribu	ted Circuits. Lum	ped Elemen	t Circuit Model For a Tr	ansmission	Line.	Field	Analys	sis of T	ransmi	ssion	Lines. L	ossles	s Terr	ninate	d Lines	. Two	Port N	etwor	k and
S-paramet	ers, Striplines, Micr	ostrip Lines,	, <mark>Smith C</mark> har	t, Matching with I	Lumped Elei	nents, Single-Stub Tuni	ing	,											,			
Unit-2 - Po	ower Dividers, Cou	plers and F	Filters	1			-														9	Hour
Basic Prop	erties of Dividers ar	nd Couplers,	, Th <mark>e T-Junc</mark>	<mark>tion</mark> Power Divide	er, The Wilki	nson Power Divider, The	e Quadratur	e (90°	) Hybi	rid Cou	ıpler, T	he 180	• Hybr	i <mark>d C</mark> oup	o <mark>ler</mark> , Fi	lter De	sign by	the In	age Pa	arame	ter Me	thod,
Filter Desig	gn by the Insertion I	Loss Method	<u>l, Filter Tran</u>	sformations, Filte	er Implement	ation.	11.11		-	-	1.1	1			_							
Unit-3 - Ac	tive Devices and	Amplifier De	esign					<u>, ,</u>	01.1						,						9	Hour
PIN Diode,	Varactor Diode, 10	innel Diode,	IMPATT DI	ode, IRAPATI D	Jiode, Gunn	Diode, BJT, FET, TWO F	Port Power	Gains	, Stad	ility Ci	rcles, I	ransist	or Am	plifier D	esign,	Powe	r Ampi	itiers			0	Hour
Basic Osci	illator Models Eive	t Frequency	( Oscillators	Dielectric Resor	ator Oscilla	ors VIC Tuned Oscilla	tor Voltage	Cont	rollad	Oscilla	ator G	inn Ele	mont	Oscillat	or Ra	sic Co	nconto	of Mix	ore Fi	ronuor		main
Considerat	tions. Sinale-Ended	Mixer Desia	an. Sinale-Ba	alanced Mixer. Do	ouble-Balan	ced Mixer	ior, voltago	Cont	loncu	OSCIIIC	<i>101,</i> <b>0</b>		mom	Osomul	ы, Ба	310 00	ncopia		013, 11	cyuch		mann
Unit-5 - M	IC Fabrication and	Packaging	<u>, , - ,</u> 1																		9	Hour
Substrate and Electri	Materials, Etching cal Connections	Technology L	Laminated F	lastic Plates, Thi	in Film Hybr	id Circuits, Thick Film H	Hybrid Circu	iits, Se	emicol	nducto	r Sapp	hire Te	chnolo	ogy, Mo	nolithi	c Micr	owave	Integra	ated Ci	rcuits,	Pack	aging

Learning Resources	1. 2.	David M. Pozar, "Microwave Engineering", Fourth Edition, John Wiley & Sons, Inc, 2011. Reinhold Ludwig, and Pave1 Bretchko "RF Circuit Design: Theory and Application", II	4. 5.	Hoffman R.K. "Handbook of Microwave Integrated Circuits", Artech House, Boston, 1987. Matthew M. Radmanesh, "Radio Frequency and Microwave Electronics", Pearson Education, Il Edition 2002
Resources	3.	Edition, Pearson Education, 2011 Thomas H Lee, "Planar Microwave Engineering", Cambridge University Press, 2004	6.	Samuel. Y. Liao, "Microwave Circuit Analysis and Amplifier Design", Prentice Hall. Inc., 1987.

			Continuous Learning	Assessment (CLA)		Summotivo				
	Bloom's Level of Thinking	Form CLA-1 Avera (50	ative ge of unit test %)	Life-Lon Cl (1	g Learning _A-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		15%		15%	-			
Level 2	Understand	25%	the ser line	25%		25%	-			
Level 3	Apply	30%		30%		30%	-			
Level 4	Analyze	30%		30%		30%	-			
Level 5	Evaluate		and the second	and the second second			-			
Level 6	Create	-		A	and the second	-	-			
	Total	100	)%	10	0 %	10	0%			

Course Designers	Part 21 10 1 10 10 10 10 10 10 10 10 10 10 10	2
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1 Mr. Saivineeth MI. Accelerator Architect @ Google	1 Dr. K. V. Phani Kumar SRMIST



Course Code	Durse Code         21ECE404T         Course Name         TERAHERTZ DEVICES AND APPLICATIONS					Cor Cate	urse gory	E			PROFESSIONAL ELECTIVE						1	L T 3 0	P 0	C 3	
Pre-requisite Courses         21ECE211T         Co- requisite Courses         Nil								Progre Cour	ssive ses						Nil						
Course Offering Department ECE Data Book / Codes / Stand						ards							Nil								
Course L	earning Rationale (	CLR):	The purp	ose <mark>of learnin</mark> g this	course is t	o:		1	1	51	Prog	jram O	utcome	s (PO	)				P	rogra	m
CLR-1: Understand the background of terahertz technology						1	2	3	4	5	6	7	8	9	10	11	12	0ı	utcom	c es	
CLR-2:	Study terahertz so	ources a	nd dete <mark>ctors</mark>	s based on electronics	and photo	nics	e		f	s of	1	lety			ĸ		0				
CLR-3:	Analyze the opera	ation of te	erahe <mark>rtz con</mark>	nponents such as ant	ennas and	filters	vledc	,	ent o	tions	ge g	soci			oW r		ance	0			Ì
CLR-4:	Interpret the terah	nertz sp <mark>e</mark>	ctro <mark>scopy a</mark>	nd imaging	( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( )		Non	lysis	do	stige	Usa	and	ઝ		earr	on	& Fir	arnin			
CLR-5:	Identify the applic	the applications of terahertz technology in wireless communication, sensing and analysis		heering	em Ana	gn/devel	ions luct inve	ern Tool	engineer	onment ainability	Ş	idual &	municat	ect Mgt.	Long Lei	-	5	-3			
Course O	utcomes (CO):		At the en	d of this course, lea	rners will	be able to:	Enai	Prob	Desi	Conc	Mode	The (	Envir Sust	Ethio	Indiv	Com	Proje	Life I	PSO	PSO	PSO
CO-1:	Interpret the conc	epts of <mark>t</mark> e	<mark>erahertz</mark> tecl	hnology	5	10 Bur 134	3	2	-		-	-	-	-	-	-	-	-	3	-	-
CO-2:	Analyze the work	ing prin <mark>ci</mark>	i <mark>ple of d</mark> iffere	ent types of terahertz	signal sour	ces	-	3	10	2	-	1	-	-	-	-	-	-	2	-	-
CO-3:	CO-3: Examine the working mechanism of different types of terahertz detectors						3	2	-	-	- 10	-	-	-	-	-	-	2	-	-	
CO-4:	Illustrate the prac	tical im <mark>pl</mark>	ementation	of fabrication of comp	onents and	l circuits for terahertz systems		-3	10	-	-		2	-	-	-	-	-	-	-	3
<b>CO-5:</b> Summarize different applications of terahertz technology for imaging, sensing and communications							<u>, E</u>	1	2	2	-	- 24	-	-	-	-	-	-	-	2	-
l Init-1 - In	troduction to Tera	hertz Te	chnology	1	Contan .	10 C	-				-	-								9	Hour
Electroma	gnetic radiation and	propaga	ition fundam	entals, Introduction to	THz, Tera	hertz Band, Terahert <mark>z Term</mark> ino	logy, Pr	opertie	s of TH	Iz Wa	res, Ke	y techn	ological	issues	s for Te	erahert	z techr	ology,	Advai	ntages	s, and
limitations	of terahertz waves,	Material	properties a	<mark>at mm and sub-mm fr</mark>	equencies									_							Harris
Terahertz	sources based on e	electroni	cs: Diodes.	transistors. resonant	tunnelina d	liodes. vacuum electronics: Te	ahertz	source	s bas	ed on	ohoton	ics: Noi	n-linear	crvsta	ls. aua	antum	cascad	le lasei	rs. pla	sma-t	nour Dased
source; Te	erahertz sources bas	sed on op	ptoele <mark>ctronic</mark>	cs: Photomixer, photo	conductive	antenna and its types; Noises	at terah	ertz fre	quenc	ies in d	lifferen	t source	es		-, 1				-, 1		
Unit-3- Te	erahertz Detectors			1	10.00	ARA STUD	1.1	_	-	1										9	Hour
Terahertz	detectors based on	electroni	cs: HOT elec	ctron bolometer, Hete	rodyne SIS	receivers: Theory and design,	Superco	onductir	ng tuni	ng circ	uitries,	HEB he	eterodyn	ie rece	ivers:	Theory	and de	esign, 1	Ferahe	ertz MI	MICs:
Unit-4 - F	abrication Technol	ogies ar	id Terahert	z Components			-			-										9	Hour
Introductio	on to terahertz fabri	cation te	chnologies,	Terahertz componer	ts: Metama	terials and plastic fibers, HEN	IT cryo	genic a	mplifie	ers: Th	eory a	nd desi	gn, Ante	ennas,	Filters	s, Wav	reguide	s, Bea	m Spl	itter, I	Beam
Combiner,	, Polarizer, Mirrors, I	solator,	Circulator, C	Cameras																	
Terahertz	applications: THz S	<b>ns</b> nectrosci	onv-Time-Di	omain and Frequency	-Domain 1	erahertz Imaging-Active and n	assive	Real-Ti	me Im	adind	Tomo	ranhic	Imanino	1 TH7	Comm	unicat	ion-Mo	dulatio	n Schi	9 0000	<u>nour</u>
Modulation	n Systems, THz Rac	lars-Puls	se Radars, C	CW Radar, Industrial a	applications	, Space communication, Cuttin	g-edge	teraher	tz tecl	nolog	es		inaging	, 1112	Comm	anodi		aalatio	1 00/10		001

	1.	J.S. Rieh, "Introduction to Terahertz Electronics". Springer Nature, 2020.	4	K. Sakai, "Terahertz Optoelectronics", Springer, 2004.
Learning	2	A.Rostami, H. Rasooli, H. Baghban, "Terahertz Technology: Fundamentals and	5	HJ. Song, T. Nagatsuma, "Handbook of Terahertz Technologies, Devices and applications", Pan
		Applications", Germany, Springer, 2011.		Stanford Publishing Pte. Ltd., 2015.
Resources	3	R. E. Miles, P. Harrison, D. Lippens, "Terahertz Sources and Systems ", Dordrecht:	6	D. Saeedkia, "Handbook of Terahertz Technology for Imaging, Sensing and Communications",
		Kluwer, Springer, 2000.		Woodhead Publishing, 2013.
			1	

			Cum	mativa					
	Bloom's Level of Thin <mark>king</mark>	Form CLA-1 Avera (50	native ge of unit test 1%)	Life-Long CL (1)	g Learning A-2 0%)	Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%		15%		15%	-		
Level 2	Understand	25%	States Sale	20%		25%	-		
Level 3	Apply	35%		35%		35%	-		
Level 4	Analyze	25%		30%	-	25%	-		
Level 5	Evaluate		and the second second	and the second second		-	-		
Level 6	Create			A		-	-		
	Total	10	0%	10	0%	100 %			

Course Designers		2
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.1	1. Mr. Saivineeth, ML Accelerator Architect @ Google	1. Mr. Harish Chandra Kumawat, SRMIST



B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

Course Code         21ECE220T         Course Name         WIRELESS AND OPTICAL SENSORS	21ECE220T Course Name WIRELESS AND OPTICAL SENSORS					PROFESSIONAL ELECTIVE								P C 0 3	
Pre-requisite         Nil         Co- requisite         Nil           Courses         Nil         Courses         Nil	P	rogres Cours	sive es						Nil	1					
Course Offering Department ECE Data Book /	Codes / Stand	lards							Nil						
			1	100										1	,
Course Learning Rationale (CLR): The purpose of learning this course is to:			5	100	2.1	Progr	am Ou	tcome	es (PO	)			1	Pi	ogram
CLR-1: Comprehend the basic knowledge on Electromagnetic wave propagation and proper wireless sensors for indoor applications	ties for design	of 1	2	3	4	5	6	7	8	9	10	11	12	S Ou	tcomes
CLR-2: Gain awareness on various RF components and wireless devices used in wireless Ne	tworks					15		ility							
CLR-3: Realize the working principle of optical waveguides and adaptive optics for o measurement purposes	ptical propertie	es ege		nt of	ions of	l Usage	er and society	t & Sustain <mark>ab</mark>		Work		ance			
CLR-4: Understand the optical fiber based various sensor configurations for physical and of applications	hemical sensir	ng Moul	lysis	elopme	estigati blems					Team	tion	& Fina	arning		
CLR-5: Upsurge the knowledge on various optical sensors ranging from simple switches to Ho	Upsurge the knowledge on various optical sensors ranging from simple switches to Holography		em An	in/deve	uct invi lex pro	arn Too	enginee	onmen	s	dual &	nunica	ct Mgt.	ong Le	÷	9 9
Course Outcomes (CO): At the end of this course, learners will be able to:	20.94	Engir	Probl	Desig	Cond	Mode	The	Envir	Ethic	ndivi	Comr	Proje	-ife L	-OS	-OSO SO
<b>CO-1</b> : Calculate the wireless networks parameters and optimize the free space wireless of indoor networks	ommunications	s in 3	1	-	-	-	-	-	-	-	-	-	-	-	- 2
CO-2: Design wireless transceivers using RF, Bluetooth, IEEE802 Sensors for indoor commu	inications	3	-	2	-	-	1	-	-	-	-	-	-	-	- 2
CO-3: Explain various optical waveguide concepts along with adaptive optics		3	-	1	4.20	-	4	-	-	-	-	-	-	-	- 2
<b>CO-4:</b> Realize Optical fiber based sensing mechanisms for physical and chemical application	S	3	12	1	-	-		-	-	-	-	-	-	-	- 2
CO-5: Comprehend various optical sensors ranging from switches to holography	1772	3	-	2	-	ì	1	-	-	-	-	-	1	-	- 2
Unit-1 - Wireless Sensors Basic Concepts						-									9 Hour
Electromagnetic wave propagation. Power aspects of Free-space propagating and link analysis. An	tenna Characte	eristics. R	eflectio	on. Atr	nospher	ic. refr	action.	Diffrac	ction of	felectr	omaan	etic wa	ves. In	dore p	ropagation
of EM Waves, Frequency allocation.							, ,				- J		)		- <b>1</b> - <b>3</b>
Unit-2 - RF Components						125									9 Hour
Amplifiers, Attenuators, Filters, Frequency Multiplexers, Modulators and detectors, Antennas, Pha Networks, Bluetooth, IEEEE802 Sensors	se detectors, F	Power div	iders a	and cor	nbiners	, Rran	sceive	rs, Wir	eless i	Moderr	ns. Wir	eless il	nstrum	ents a	nd sensors
Unit-3 - Optical Sensing and Measurement				-		-		-							9 Hour
Overview of optical sensing, Principle of optical metrology, Optical waveguide sensors, Intensity me	easurement, Int	terferome	tric me	asurer	nents, F	luores	scence	measu	uremer	nt, surf	ace Pla	asmon	measu	remer	t, Adaptive
optics and wavefronts sensing, Multyphoton microscopy										-					
Unit-4 - Fiber Optic Sensors	amatri Fibar a	ntia aana	0.40. 1001	Itiplay	ing Die	tribute	d fib or	ontio		, Fibe	Duo a				9 Hour
chemical sensor. Industrial fiber strain gauge sensor	orneiry, Fiber d	opuc sens	ors mu	liupiex	ing, Dis	unpule	a iiber	oplics	sensor	S, FIDE	я вгад	g grau	ng sen	sors, c	plical liber
Unit-5 - Various Optical Sensors and its applications	Unit-5 - Various Optical Sensors and its applications														
Switches, Displacement, Velocity, Temparature, Strain, Spectrometry, Refractometry, Speckle patt	Switches, Displacement, Velocity, Temparature, Strain, Spectrometry, Refractometry, Speckle pattern interferometry, Holography.														

Learning	1.	Eren, H., "Wireless Sensors and Instruments: Networks, Design, and Applications". CRC	2.	Haus, J., "Optical Sensors: Basics and Applications". Wiley, 2010.
Resources		Press, 2018.	3.	Faramarz Farahi, Jose Luis Santos, "Handbook of Optical Sensors", CRC Press, 2014

Learning Assessm	ent									
		Summotivo								
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (10	g Learning _A-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	30%	-	30%	C	30%	-			
Level 2	Understand	40%		40%		40%	-			
Level 3	Apply	20%		20%		20%	-			
Level 4	Analyze	10%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	10%		10%	-			
Level 5	Evaluate	1997 - 19		A CONTRACTOR OF			-			
Level 6	Create	× /					-			
	Total	10	0%	10	0%	100 %				
			the second		the second se					

Course Designers		a second for	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr. Bandaru Ramakrishna, SRMIST	


Course Code	Course         21ECE221T         Course         RADAR AND NAVIGATIONAL AIDS           Code         Name         Course         Course						ourse	e ry	E	PROFESSIONAL ELECTIVE     L     I     P     C       3     0     0     3								C 3			
Pre-requis Courses	site s	Nil	Co- requis Courses	te	Nil		Pro	gres	sive es						Nil						
Course C	Offering Departn	nent	ECE		Data Book / Codes / Star	ndards								Nil							
Course Lea	arning Rationale	e (CLR): 7	The purpo <mark>se of learnin</mark> g t	nis course is	to:		Program Outcomes (PO)									Program		m			
CLR-1: Gain Knowledge on the basics of Radar System							1	2	3	4	5	6	7	8	9	10	11	12	Ou	pecifi	c es
CLR-2:	CLR-2: Explore the knowledge of different types of Radar								÷	of	2.	ety			¥						
CLR-3:	Interpret the various detection schemes								ent o	tions	ge	soci			No Mo		ance	D			
CLR-4:	Understand the functions of Radar transmitters and Receivers							lysis	mdo	stiga	Usa	and	∞ð		earr	uo	& Fin	inin			
CLR-5:	CLR-5:         Introduce the fundamentals of navigation system and remote sensing						ering h	m Ana	/devel	ct inve ex prob	1 Tool	gineer	nment nability		ual & T	unicati	t Mgt. 8	ng Lea			
Course Ou	tcomes (CO):		At the end of this course,	learners will	be able to:	17	Engine	Proble	Desigr solutio	Condu	Moder	The er	Envirol Sustaii	Ethics	Individ	Comm	Project	Life Lo	PSO-1	PSO-2	PSO-3
CO-1:	Describe the pri	inciple op <mark>erat</mark>	<mark>tion of</mark> Radar with the help o	of range equat	tion and parameters	1.11	3	2			-		-	-	-	-	-	-	2	-	-
CO-2:	Apply Doppler p	principle t <mark>o ra</mark>	<mark>dars</mark> and hence compreher	d the features	s of different types of radar		3	2	1.	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Analyze the rec	eption of <mark>Rad</mark>	<mark>lar si</mark> gnals under noise and	different prop	agation modes		2	-	3	-	-	- 10	-	-	-	-	-	-	-	2	-
CO-4:	Illustrate the fur	nctions of <mark>vari</mark>	ious parts of Radar transmi	ters and Rece	eivers	1	3	2	-	-	-		-	-	-	-	-	-	2	-	-
CO-5:	Examine the pri	inciple of <mark>navi</mark>	<mark>igation</mark> with aids of various	navigation sys	tems and basics of remote se	nsing	3	2	1.4	- 1	-	2	-	-	-	-	-	-	-	2	-
Unit-1 - Int Introduction Section of T Antenna Pa Unit-2 - MT	roduction to Ra a-Basic Radar- R Targets-Simple T arameters- System T and Pulse Dop	dar Equation adar Frequer argets- Rada m losses-Mic opler Radar	ncies -Applications of Rada r Cross Section of Targets rowave plumbing loss, Ante	r- The Simple Complex Targ nna loss, Sig	form of Radar Equation- Rao gets Transmitter Power- Rada nal Processing loss- System I	lar Block r cross osses-D	k Dia Sectio Dopple	gram- on Flu er pro	Recei ctuatic cessinț	ver No. ons- Sw g, Colla	se- Si erling psing,	gnal- t Targe Opera	o-Noise t Model ator loss	e Ratio - Tran s, prop	- Integ smitter agatio	ration Powe n Effec	of Rad r- Pulse ts	ar Puls e Repe	ses- R tition I	9 adar ( Frequi 9	Hour Cross ency- Hour
Introduction Medium, an to Tracking.	n to Doppler Rada nd Low prf Dopple .Accuracy- Case	ar- Introductio er- Other Dop study on wea	n to <mark>MTI Rada</mark> r- Delay –Lir pler Ra <mark>dar Topics-</mark> Trackin ather rada <mark>rs- Case s</mark> tudy or	e Cancellers- g with Radar- weather rada	Doppler Filter Banks- Digital M Mono pulse Tracking- Two Co ars	MTI Proc oordinat	cessir e amp	ng- Mo olitude	oving T e comp	arget L arison	Detecto monoj	or - Lin oulse t	nitations racking-	to Mī - Conie	l Perfo cal Sca	ormano an and	e- Puls Seque	se Dop ntial Lo	pler R obing-	adar- Limita	High, itions
Unit-3 - De	tection of Signa	ls in Noise		- 1 Jan-				1.21												9	Hour
Detection o Receivers- Phase Code	f Signals in Noise Signal Managem ed pulse compre:	e -Detection C ient- Propaga ssion-Introdu	Criteria- Probabilities of Dete tion Radar Waves- Atmosp ction to clutter- Surface Clu	ction and Fal heric Refraction tter Radar equ	se Alarm- Matched Filter Rece on- Standard propagation- Nor uation	eiver- De nstanda	erivati rd Pro	on of opaga	Match tion- A	ed filter mbigu <mark>i</mark>	freque ty Diag	ency re gram- l	esponse Pulse co	e- Auto ompre	omatic ssion-	Detect Linear	or- Cor FM pul	nstant-l Ise con	False npress	Alarm ion- E	Rate linary
Unit-4 - Ra	dar Transmitter	and Receive	er																	9	Hour
Radar Tran Other aspe	smitters and Rec cts of Radar Trar	ceivers- Linea nsmitter- The	ar Beam Power Tubes-Ref Radar Receiver - Receiver	ex Klystron- L noise Figur <mark>e-</mark>	inear Beam Power Tubes-Tv Super heterodyne Receiver-	VT- Soli Link bu	id Sta dget a	te RF analys	Powe	<mark>r Sour</mark> d A and I	es- M Aixers	lagneti - Duple	ron -Cro exers- F	ossed Receiv	Field A er Prot	Amplifie ectors	ers- Otl - Radai	her RF r Displa	Powe ays	r Sou	rces-

# Unit-5 - Radio Navigation and Introduction to Remote Sensing

Introduction - Four methods of Navigation .- Positioning- Errors in Direction Finding- - Automatic Direction Finders- Hyperbolic Systems of Navigation-Loran-C - The Decca Navigation System -Decca Receivers -Range and Accuracy of Decca – TACAN - TACAN Equipment - Case study on Airborne Tactial networks- Instrument Landing System (ILS) – Case study on mismatch of ILS – Foundations of Remote Sensing – Energy interactionswith Earth Surface Features – The Global Positioning System (GPS) - Characteristics of Remote sensing – Geographic Information Systems – Case Study in application of remote sensing and GIS in precision agriculture.

	1.	Merrill I. Skolnik," Introduction to Radar Systems", 3rd Edition Tata Mc Graw-Hill 2008	5.	Mark, Richards.A, "Fundamentals of radar signal processing", Mc-Graw Hill, Electronic
	2.	R.B. Underdown and David Cockburn, "Ground Studies for Pilots: Radio Aids",6th Edition,		Engineering, 1st Edition, 2005.
Learning		Blackwell Publishing, 2011	6.	Jenny L. Reed, Aaron D. Lanterman, John M. Trostel," Tutorial: Weather Radar: Operation and
Resources	3.	Myron Kayton, Walter R.Fried, "Avionics Navigation Systems", Second Edition, Wiley-		Phenomenology", IEEE Aerospace and Electronic Systems Magazine, Vol: 32, 7, 2017.
		India Edition, 2010.	7.	Lillesand, Thomas, Ralph W. Kiefer, and Jonathan Chipman. "Remote sensing and image
	4.	N.S.Nagaraja, "Elements of Electronic Navigation Systems", 2 <sup>nd</sup> Edition, TMH, 2000.		interpretation", John Wiley & Sons, 2015.

			Continuous Learning A	Assessment (CLA)		Summotivo				
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test 1%)	Life-Long CL (1)	g Learning "A-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice			
Level 1	Remember	20%		20%	· · · · · · · · · · · · · · · · · · ·	15%	-			
Level 2	Understand	30%	5	30%		25%	-			
Level 3	Apply	30%		30%		30%	-			
Level 4	Analyze	20%		20%		30%	-			
Level 5	Evaluate		-	in the second second	-	-	-			
Level 6	Create			A PARA		-	-			
	Total	100	0%	10	0%	10	0%			

## Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts						
1. Mr. Anuj Kumar, Bombardier Transportation,	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University,	1. Dr. S. Vasanthadev Suryakala, SRMIST						
Ahmedabad,kumaranuj.anii@gmail.com	meena68@annauniv.edu							
2. Mr. Hariharasudhan - Johnson Controls,Pune,	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	2. C. T. Manimegalai, SRMIST						
hariharasudhan.v@ici.com	COLUMN AND A COLUMN AND A COLUMN							

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Course Code	rse 21ECE222T Course ADHOC AND SENSOR NETWORKS				Cor Cate	irse gory	E PROFESSIONAL ELECTIVE L T P C 3 0 0 3									C 3			
Pre-requi Course	site s	Nil	Co- requisite Courses	Nil		Progres Cours	ssive ses						Nil						
Course (	Offering Departme	ent	ECE	Data Book / Codes /	Standards					-		Nil							
Course Le	arning Rationale	(CLR): The	e purpos <mark>e of learnin</mark> g this cou	rse is to:		Program Outcomes (PO)											Pi	rogra	m
CLR-1:	Know about the A	d hoc Networ	ks	10 200	1	2	3	4	5	6	7	8	9	10	11	12	Specific Outcomes		c es
CLR-2: Learn the various aspects in MAC Layer and the concept of Quality of Service							f	s of	1.	iety			¥		a)				
CLR-3:	vledo	,	ento	ations	ge	soc			oW r		ance	b							
CLR-4:	R-4: Predict insights of Sensor network							stiga	Usa	r anc	৵		Tean	UOI	& Fir	arnin			
CLR-5:	Analyze various a	aspects Hybrid	Inetworks and routing configura	tion	eering	em Ana	jn/devel	uct inve lex prot	rn Tool	engineel	onment	0	dual & <sup>-</sup>	nunicat	ct Mgt.	ong Lea	~	5	ę
Course Ou	tcomes (CO):	At	the end of this course, learne	rs will be able to:	Enair	Probl	Desig	Cond	Mode	The e	Envir Susta	Ethic	Indivi	Comr	Proje	Life L	-OSC	-SC	-OS-
CO-1:	Describe about A	d hoc N <mark>etworl</mark>	ks and various routing protocols	used in Ad hoc networks	194		-	-	-	1	3	-	-	-	-	2	2		-
CO-2:	Know the various	functio <mark>nal are</mark>	eas such as MAC Layer and QO	S	3	1.2	2	-	-		-	-	-	-	-	-	-	3	-
CO-3:	Interpret the ener	gy man <mark>ageme</mark>	ent protocols in Ad hoc Networks			100	12	3	-	-30	-	-	-	-	-	-	-	2	-
CO-4:	Summarize about	t the Se <mark>nsor n</mark>	<mark>et</mark> work and its associated protoc	cols.	3	-	10	-	-		-	-	-	-	-	-	-	2	-
CO-5:	Analyze various ł	nybrid n <mark>etwork</mark>	s and its routing protocols.	1920	310		2	3	1	1	-	-	-	-	-	1	1	-	-
Unit-1 - Aa	l Hoc Wireless Ne	tworks	1.1.1.1		-	1.62			-	-								9	Hour
Cellular and networks, E protocols w	d Ad hoc Wireless Design goals of a M rith scheduling med	Networks, App AC protocol fo chanisms.	plications of Ad hoc Wireless Ne or ad hoc wireless networks. Clas	tworks, Issues in Ad hoc Wirele ssifications of MAC protocols, C	ss Networks .N ontention base	IAC Pro d proto	otocol f cols, Co	or Ad ho ontentio	oc Neti n base	works ed prot	- Issues ocols w	s in De ith res	signing ervatic	g a MA on mec	C prote hanism	ocol foi is and	<sup>r</sup> Ad ho Conter	oc Win ntion k	eless ased
Unit-2 - Qu	ality of Service in	Ad hoc Wire	eless Networks	finations of OoS colutions, MA	C Lover colutio	n olu	tor TD		== 001	2110		Not	vork L	overor	lution	000	routing	9 7. prot	Hour
Ticket Base	ear-nine Traine Support, issues, and chanenges in providing QoS, Classifications of QoS solutions. MAC Layer solution - cluster TDMA, IEEE 802. THE, DBASE, Network Layer solution -QOS routing protocols, icket Based QOS Routing protocols, Predictive location-based QOS routing. QOS frame work, QOS models, QOS Resource Reservation Signaling, INSIGNIA- Operation of INSIGNIA framework, INORA-Coarse are class based fine feedback scheme. SWAN-Model, Proactive RTMAC.																		
Unit-3 - En	Init-3 - Energy Management 9 Hour																		
Need for er Power Mar Network lay schemes, F	reed for energy management, Classifications of Energy Management Schemes, Battery Management Schemes, Data link layer solution-Lazy packet scheduling scheme, Battery Aware MAC protocol. Transmission <sup>2</sup> ower Management Schemes-Data link layer solution, Dynamic power adjustments policies, Distribute topology control Algorithm Construct distributed power control loop, Centralized Topology control Algorithm letwork layer solution-common power protocol, Minimum power consumption routing, Minimum battery cost Routing. Higher Layer solution, System power management scheme – Processor power management schemes, Power saving Modes, Power Aware Multi-Access Signaling. Device power Management Scheme-Low Power Design of Hardware, Hard Disk Drive (HDD) power consumption.																		

### Unit-4 – Wireless Sensor Networks

Introduction – Applications of sensor networks, Comparison with Ad hoc wireless network, Issues, and challenges in designing sensor network. Sensor Network Architecture – Layered Architecture, Clustered Architecture, Data Dissemination, Flooding, Gossiping, Rumour Routing, Sequential Assignment Routing, Cost field approach, Data Gathering, Direct Transmission, Binary scheme, Chain Based Three level scheme .MAC protocols for sensor Networks-Self organizing MAC, CSMA Based MAC Location Discovery-Indoor and sensor network localization. Quality of Sensor Networks-coverage, Exposure. Recent Trends in Sensor Networks-Energy Efficient Design, synchronization, Transport Layer Issue, Security-Localized Encryption and Authentication protocols (LEAP), Intrusion Tolerant Routing in Wireless Sensor Network (INSENS). Real-Time communication – SPEED Protocol and RAP protocols.

### Unit-5 – Next Generation Hybrid Wireless Architectures

Classification of Hybrid architectures, multi-hop cellular network (MCN) Architecture, Mobile assisted data forwarding (MADF) Architecture, iCAR architecture, Hybrid wireless Network (HWN) Architecture, The SOPRANO architecture, and the A-GSM architecture. Routing in Hybrid wireless network- Base assisted ad hoc routing (BAAR), Operation of BAAR protocol. Base driven multi-hop bridging protocol (BMBP), Message used BMBP procedure. Pricing in Multi-Hop wireless networks. Power control scheme in Hybrid Wireless Networks – Issues in using variable power in IEEE 802.11, Power optimization scheme, Load Balancing in Hybrid Wireless Networks- Preferred Ring Based Routing Scheme, preferred inner Routing Scheme (PIRS), Preferred outer Ring Routing Scheme (PORS), Preferred Destination/Source Ring Based Routing Schemes.

	1.	Siva Ram Murthy C., Manoj B.S, "Ad hoc Wireless Networks – Architectures and Protocols",	3.	C.K. Toh, "Ad hoc Mobile Wireless Networks", 7th ed., Pearson, 2007
Learning		2 <sup>nd</sup> ed.,Pearson, 2006	4.	Thomas Brag, Sebastin Buettrich, "Wireless Mesh Networking", 3rd ed., O'Reilly Publishers,
Resources	2.	Feng Zhao, LeonidasGuibas," Wireless Sensor Networks", 1st ed., Morgan Kaufman		2007
		Publishers, 2004	100	

Learning Assessm	ient 🔰			1							
		and the second second	Continuous Learning	Assessment (CLA)		Sumr	motivo				
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native age of unit test 0%)	Life-Long CL (10	r Learning A-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice				
Level 1	Remember	15%		15%		<mark>1</mark> 5%	-				
Level 2	Understand	25%		25%	1.0	25%	-				
Level 3	Apply	30%	- 17	30%	and the second se	30%	-				
Level 4	Analyze	30%	- 110-	30%	-	30%	-				
Level 5	Evaluate			-	1. 1. 1. 1. 1.		-				
Level 6	Create	1. 1. 2. 1.				-	-				
	Total	10	0%	10	0 %	100	0 %				

Course Designers	AND TAKEN THEAP. FROM	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Mr. Saivineeth, ML Accelerator Architect @ Google	1 Dr.K. Vijayan, SRMIST

9 Hour

Course Code	Course Code         21ECE223T         Course Name         SATELLITE COMMUNICATION AND BROADCASTING								Cours atego	e ry	E	PROFESSIONAL ELECTIVE							C 3				
Pre-requi Course	site es	Nil		Co- requis Courses	ite		Nil		Pro	ogres: Course	sive es						Nil						
Course	Offering Departme	ent		ECE		Data E	Book / Codes / St	andards								Nil							
Course Le	arning Rationale	(CLR): 7	The purpo	se <mark>of learnin</mark> g t	his course	e is to:			-	đ			Progra	am Ou	itcome	s (PO	)				Pi	rogra	m
CLR-1:	CLR-1: Study the background and orbital mechanics of satellite communication systems								1	2	3	4	5	6	7	8	9	10	11	12	00	itcom	c es
CLR-2:	Investigate satelli	te links and	l iden <mark>tify ar</mark>	<mark>eas to</mark> improve l	ink perforn	nance			Je		of	s of		iety			¥		0				
CLR-3:	3: Identify the various propagation effects and access techniques for satellite communication links								vledç		ento	tions	ge	soc			Wo		ance	D			
CLR-4:	Interpret the applications of satellite communication in VSAT systems, satellite TV, and radios							<b>Vou</b>	lysis	mdo	stige elem:	Usa	and	~~~		ean	uo	& Fir	arnin				
CLR-5:	<ul> <li>A. Interpret the upplications of satellite communication in Volar Systems, satellite 14, and radios</li> <li>Explore the concepts of satellite navigation and packet communication</li> </ul>							neering I	em Ana	gn/devel ons	uct inve lex prob	ern Tool	angineer	onment ainabilit <mark>v</mark>	S	dual & J	nunicati	ct Mgt. 8	ong Lea	<u>-</u>	5	က္	
Course Ou	utcomes (CO):	/	At the end	of this course	, learners	will be able t	0:	. 27	Engir	Probl	Desiç	Cond	Mode	The e	Envir Susta	Ethic	ndivi	Comr	Proje	_ife L	ŌSc	-SO	-OSc
CO-1:	Interpret the cond	ept and ope	<mark>eratio</mark> n of s	atellite commun	ication sys	stems	Buse Vi	4	2	2	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	Analyze satellite	launchin <mark>g, li</mark> i	<mark>ink d</mark> esign,	link availability,	and interfe	erence	100		-	2	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	Examine the mec communication	hanism <mark>of m</mark>	nultiple acc	cess techniques	, propagati	ion effects, and	d their impact on s	satellite	2	-	2	-	-	A		-	-	-	-	-	2	-	-
CO-4:	Illustrate the prac	tical im <mark>plem</mark>	<mark>nenta</mark> tion o	f VSAT and DBS	S systems	22.113	-		3	2	-	2	-		-	1	-	-	-	-	-	-	3
CO-5:	Review the satell	ite com <mark>muni</mark>	<mark>lication</mark> nav	igation and glob	al position	ning system ap	plications	5	3	2		-	-		-		-	-	-	-	-	2	-
Unit-1 – O	verview of Satellit	e Commun	nication	ilana farra da llida		0.4.%									a shi ta	1	4 - 4'-		4 4 -	.1		9	Hour
orbit. telem	nistorical developme netrv. tracking. com	ents, trequei mand and m	ncy allocat nonitorina.	power systems.	services.	Orbital mecha cation subsyst	nics: Kepier's law 'ems. transpondei	rs, orbitai rs. satelli	paran te ante	neters ennas	, юок а . eauip	angie a ment re	etermi eliabilit	nation v and	, ordita spa <mark>ce (</mark>	i pertu qualific	rbatior cation	is, ordi	t contro	o syste	em, ge	ostati	onary
Unit-2 – Sa	atellite Link Desig	n		,	1.00						,	<u>, e</u>		/ ••		1						9	Hour
Basic trans	mission theory, sys	stem noise te	tem <mark>peratur</mark> budget ovr	e and G/T ratio,	design of c	downlinks, sate	ellite systems usir	ng small	earth s	station	ns uplin	k desig	n, cari	rier to	noise ((	C/N) ra	atio, de	sign oi	satelli	e links	for sp	ecifie	d C/N
Unit-3 – P	ropagation Effects	s and their l	Impact on	Satellite-Earth	links	120	11151	111		-		1	1	-								9	Hour
Quantifying	g attenuation and d	epolarization	n, rain and	ice effects, clou	id attenuat	tion, troposphe	eric and ionosphe	ric scintil	lation,	predi	ction of	f XPD,	oropag	gation	impairr	nent c	ounter	measu	res Mu	ltiple a	ccess	techn	iques
for satellite	links: Multiple acce	ess, frequen	ncy division	multiple acces	s, time divis	sion multiple a	access, demand a	ccess m	ultiple	acces	ss, rand	dom ac	cess, c	code d	ivision	multip	le acce	ess				0	Haur
Network ar radio: C-ba TV antenna	chitectures, access and and Ku-band ho as, satellite radio bi	s control pro ome satellite roadcasting	otocol, basi e TV, DBS	c techniques, sa modulation, digi	i <mark>t ea</mark> rth sta tal DBS-TV	tion engineeri /, DBS-TV sys	ng, calculation of tem design, DBS	link marı -TV link l	gins fo oudget	r VSA t, erroi	T star	networ ol in dig	k, syst ital DB	em de S-TV,	sign pr mastei	ocedu r contr	res. Di ol stati	rect br on and	oadcas uplink,	t satell estab	ite (DE lishme	BS) T ent of I	/ and DBS–
		0																			-		

# Unit-5 – Satellite Navigation and Global Positioning System (GPS)

Radio and satellite navigation, GPS position location principles, GPS receivers and codes, satellite signal acquisition, GPS navigation message, GPS signal levels, timing accuracy, GPS receiver operation, case study – IRNSS/NAVIC, case study – GAGAN (GPS Aided GEO Augmented Navigation) Satellite packet communication: Message transmission by FDMA, message transmission by TDMA, pure Aloha-satellite packet switching, slotted Aloha, packet reservation

	1. D.Roddy, "SatelliteCommunications", McGraw Hill Education, 4 <sup>th</sup> Edition, 2017.	G. D. Gordon and W. L. Morgan, "Communications Satellite Ha	ndbook", Wiley, 2010.
Learning	2. T.Pratt, C.Bostian and J.Allnutt, "Satellite Communications", Wiley, 2 <sup>nd</sup> Edition, 2013.	L. J. Ippolito Jr, "Satellite Communications Systems Engineerin	g: Atmospheric Effects,
Resources	3. W. L. Pritchart, H. G. Suyderhoud and R. A. Nelson, "Satellite Communication Systems	Satellite Link Design and System Performance", John Wiley & S	Sons, 2nd Edition, 2017.
	Engineering", Pearson Education, 2 <sup>nd</sup> Edition, 2012.	M.Richharia, "Satellite Communication Systems: Design Princip	es",Macmillan, 2 <sup>nd</sup> Edition, 2003.

Learning Assessmer	nt									
	Bloom's Level of Thinking	Form CLA-1 Averag (50	Continuous Learning ative ge of unit test %)	Assessment (CLA) Life-Long CL (10	g Learning A-2 0%)	Summative Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	20%		20%		20%	-			
Level 2	Understand	25%		25%		<mark>25</mark> %	-			
Level 3	Apply	35%	HOLD CRAPT VO	35%		<mark>35</mark> %	-			
Level 4	Analyze	20%		20%		<mark>20</mark> %	-			
Level 5	Evaluate			THE REAL			-			
Level 6	Create					-	-			
Total		100	)%	10	0 %	100 %				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Plan	1. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai	1 Dr. Sachin Kum <mark>ar, SRMI</mark> ST



B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

Course Code	21ECE224T Co	ourse ame	CRYPT	OGRAPHY AN	D NETWORK SECURITY	Cou Cate	irse gory	E			PROF	ESSIC	)NAL E	ELECT	IVE			L T 3 0	P 0	C 3
Pre-requ Cours	uisite N	1	Co- r Coi	requisite urse <mark>s</mark>	Nil		Progres Cours	ssive ses						Nil	1					
Course	Offering Department		ECE		Data Book / Codes / St	tandards							Nil							
Course L	earning Rationale (CLR	): The pu	urpo <mark>se of lea</mark> r	rning this cour	se is to:		1		2.1	Progr	am Ou	utcome	es (PO	)				Pr	rogra	m
CLR-1:	Recognize classical a	nd moder <mark>n</mark> s	ymmetric encr	yption standard	S	1	2	3	4	5	6	7	8	9	10	11	12		pecifi itcom	c es
CLR-2:	Analyze different publi	c key crypto	graphy algorith	hms	1 march and	0		4	of	34	ety			¥		-				
CLR-3:	Interpret the various te	chniques in	authentication	schemes		leda	)	ent o	tions	e	soci			Moi		ance	5			
CLR-4:	Study the concepts in	network sec	urity	0		Mon	lysis	opme	stiga	Usaç	and	~~		eam	и	š Fin	urning			
CLR-5:	Identify the effect of va	arious <mark>malwa</mark>	ares and count	er measures		neering k	em Ana	jn/devel	uct inve lex prob	ern Tool	engineer	onment ainabilit <mark>v</mark>	s	dual & T	nunicati	ct Mgt. 8	ong Lea	<del>.</del>	5	ę
Course C	Outcomes (CO):	At the	e end of this c	ourse, learner	s will be able to:	Engir	Probl	Desig		Mode	The e	Envir Susta	Ethic	ndivi	Comr	<sup>2</sup> roje	_ife L	OSc	-OSc	ÖS
CO-1:	Examine the methods	of <mark>classical</mark> a	and modern E	ncryption	ALLO BURN	2	3	-	-		1	-	-	-	-	-	-	-	-	-
CO-2:	Apply the concepts of	Nu <mark>mber th</mark> ea	or <mark>y</mark> in key gene	eration and enci	yption standards	2	3	12	-	-	-		-	-	-	-	-	-	-	-
CO-3:	Discuss about the auti	ne <mark>ntication</mark> a	and digital signa	ature schemes	1.25	3	1	2		-	-	-	-		-	-	-	-	-	-
CO-4:	Gain knowledge in the	va <mark>rious fo</mark> rn	n <mark>s</mark> of network :	security		3		2					-	-	-	-	-	-	-	-
CO-5:	Analyse the effects of	intr <mark>usion, vi</mark> r	uses, firewalls	and various lev	els of system security	3		2	-	-	-	-	-	-	-	-	-	-	-	-
Unit 1 (	Conventional and Made	n Enorumtia	n forme Play	ak Cinhara			102				c	<u>.</u>		_						Hour
Security	Services Mechanisms A	ttacks Netw	on camp; вюс vork Security I	Sk Cipners. Model: Cryptogr	aphy and Cryptanalysis Conve	ntional Encr	ntion 1	Technio	ues Di	S and	t its S	ecurity	Stren	ath Bl	lock Ci	nher Iv	lodes (	of One	ration	Kev
Distributio	on Centre, Overview of Al	ES, ID <mark>EA, B</mark>	l <mark>owf</mark> ish, RC5, <i>e</i>	and CAST-128,	Characteristics of Advanced Syn	nmetric Bloc	k Ciphe	rs, Ste	ganogra	phy	1 110 0	oounty	ou on	jan, Dr	oon on	<i><i><i><i></i></i></i></i>	00000	n Opol	lation	, 100
Unit-2 - F	Public Key Encryption			12.0	-2 - 2 / 2 /				10	1									9	Hour
Number 1	Theory, Public Key Crypto	systems, <mark>RS</mark>	<mark>SA Algorithm</mark> , F	Public Key Mana	agement, Public Key Certificate	Generation a	nd Veri	fication	, X. 509	) Certii	ficates	, Diffie-	Hellm	an Key	/ Excha	inge, E	Iliptic (	Curve		
cyptograp	ohy.									2	-									
Unit-3- A	uthentication Protocols	, Hash & MA	AC Algorithms	S		Oten de ed e					4.41	11 4					Kaulaa		9	Hour
Message	Authentication, DAC, CN	AC, Hash Fl ity and Woh	unctions, MDD,	, SHA-T and SH	IA-512, HMAC, Digital Signature	Standard ar	ia Algol	<i>nınm</i> , C	one way	and N	lutual	User A	utneni	ication	Techr	liques,	Kerbe	ros	0	Hour
Email sec	urity. Overview of PGP a	nd S/MIMF	IP Security W	leb Security Se	cure Socket Laver, Transport La	ver Security	Secure	e Flectr	onic Tr	ansact	ion								3	ioui
Unit-5- S	vstem Security	na ominie,				yer coounty,	Coourt		onio m	anouot	ion								9	Hour
Intrusion	Detection Techniques. Pa	ssword Man	nagement, Mal	icious software.	Viruses, Worms, and Zombies.	Introduction	to Firev	vall Typ	es and	Confic	uratio	ns. Tru	sted S	svstem	. Port §	Scannir	ng and	Knock	ing.	

Learning Resources	1. 2.	William Stallings, "Cryptography & Network Security",6th ed., Pearson, 2014 BehrouzA.Forouzan, Debdeep Mukhopadhyay,"Cryptography and Network Security", 2nd ed., Tata McGraw Hill, 2010	3. 4.	Bruce Schneier, "Applied Cryptography", 2nd ed., 2015 Bernard Menezes, "Network Security and Cryptography", Cengage Learning, 2010	
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Learning Assessm	lent		177 N 17 N	6.20							
		-	Continuous Learning	Assessment (CLA)		Summativa					
	Bloom's Level of Thinking	Form CLA-1 Avera (50	ative ge of unit test %)	Life-Long CL (10	) Learning A-2 )%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%		15%		15%	-				
Level 2	Understand	25%	1 1 1 1 1 C	20%		25%	-				
Level 3	Apply	30%	States Service	25%		30%	-				
Level 4	Analyze	30%		25%		30%	-				
Level 5	Evaluate	- W	-	10%			-				
Level 6	Create	1	A Station	5%		-	-				
	Total	100	)%	- 10	0 %	100 %					

Course Designers							
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts					
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Mrs.A. Vinnarasi, SRMIST					
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@ici.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	2. Dr. B. Ramachandran, SRMIST.					



Course Code	21ECE225T	Course Name	OPT	ICAL SYSTE	MS AND NETWORKS	Course Category			Е	PROFESSIONAL ELECTIVE									P 0	C 3	
Pre-requ Course	isite es	Nil	Co- re Cou	equisite rse <mark>s</mark>	Nil		Pro C	ogres ours	sive es						Nil						
Course	Offering Departme	ent	ECE		Data Book / Codes / Sta	andards								Nil							
Course La	amina Dationala			ine this say	and the second sec		-	1	1		Due au			- (DO)					Pr	roara	m
Course Le	earning Rationale		purpose of learn	ing this cou	rse is to:	-					Progra		tcome	s (PU)		1.0		Specific			ic
								2	3	4	5	6	1	8	9	10	11	12	Ou	tcom	es
CLR-2: Identify the different Modulation, detection and Link design for Optical systems									of	ls of	10	ciety			ork		e				ĺ
CLR-3:	-3: Investigate the Recent Optical Communication Technologie								Tent	atior	age	d so			۲		nan	و			
CLR-4:	-4: Explore the concept of Optical Networks						Kno	alysi	lopn	estig	Usé	r an	×,		Tear	ion	& Fi	arnir			
CLR-5:	Interpret and corr	relate the <mark>Switc</mark>	hing and Routing	Networks			ring	Ana	deve	t inve	Tool	inee	ment		8	nicat	Mgt.	g Le			
				11		1.00	inee	olem	ign/c	duct	ern	eng	ironi taina	cs	vidua	nmr	ect I	Lon	-	-2	-3
Course O	utcomes (CO):	Att	<mark>the</mark> end of this co	ourse, learne	rs will be able to:	370	Eng	Prot	Des	Con	Moc	The	Env Sus	Ethi	Indiv	Con	Proj	Life	PSC	PSC	PSC
CO-1:	Interpret the cond	cepts of <mark>Optical</mark>	fiber Communica	tions and its o	haracteristics	4	3	÷.	- 1	3	I	4	-	-	-	-	-	_	-	-	-
CO-2:	Explore the signif	ficance <mark>of syste</mark>	om design for Anal	og and Digita	I Optical systems		3	( e.)	3	-	-	- 2	-	-	-	-	-		-	-	-
CO-3:	Describe and Ana	alyze th <mark>e Recer</mark>	<mark>nt</mark> Optical Commu	nication Tech	nologies	1	2.		2	-	-	- 10	-	-		-	-		-	-	3
CO-4:	Illustrate the cond	cept of Optical I	Networks	1000		100	L-	2	-	-	-	-	-	-	3	-	-	-	-		-
CO-5:	Categorize and c applications	onclude the Ph	otonic Packet Swi	tching and W	avelength Routing Networks with i	ts	-	-	űZ.	2	-	2	-		3	-	-	_	-	-	-
Unit-1 – 0	ptical Fiber Comn	nunications										-	.,							9	Hour
Historical (	development, The g fibers Graded ind	eneral system, ex fibers Single	Advantages of op	tical fiber com	nmunication, Optical fiber wave gui h Mode field diameter, effective re	des: Ray fractive i	theor ndex	y tran Fihe	ismissi r Mate	on, Mo rials Pl	aes in p notonic	orvst	guide, i al fibers	Phase	and g	roup ve urces a	elocity, and Def	cylinan ectors	ICAI IID Chara	)er: M acteris	odes, stics
Unit-2 - S	ystem Design	ox nooro, onigio		on wavelengt		maouvon	nuox.	1 100	i mato	100,11	10101110	01 y 01		, opu			na Dol	001010	onara	9	Hour
Intensity m	nodulation/ direct de	tection: Source	limitations, equali	zation, desigr	n considerations, digital systems, re	egenerati	/e rep	peater	r, digita	al optica	l receiv	ver, bi	error ra	ate (BE	ER), ey	∕e diag	ram, lir	ık desiç	gn-pov	ver bu	ıdget,
rise time b	udget, analog syste	ems, direct inter	nsity modulation, s	subcarrier inte	ensity modulation, distribution syste	ems. Cas	e stuc	dy-Vic	leo Tra	ansmiss	ion ov	en fibe	er optic	links							Haur
Free space	e optical communic	ation system: 1	Transmission para	meters Sour	ces, and detectors for ESO, effect	of atmos	spher	ic atte	enuatio	on and	turbule	nce o	n ESO	terres	strial s	vstem	Ontica	l Code	Divisi	ion Mi	ultiple
Accesses	(OCDMA): performa	ance of synchro	onous OCDMA, op	otical encoder	s and decoders, Sub carrier multip	lexing sy	stems	s. Cas	se stud	ly-Simu	lation o	of Mod	leling T	echnic	ques fo	or Optic	al Con	nmunic	ation \$	Syster	ms.
Unit-4 - In	troduction to Opti	cal Networks																		9	Hour
First gener	ration optical netwo	rks, multiplexin	g techniques, sec	ond generatio	n optical networks, virtual circuit s	ervices al	nd da	tagra	ms, tra	inspare	ncy of	regen bdonc	erators,	Broad	dcast a	and Sel	ect Ne	tworks:	Торо	logies	; for
Unit-5 - Pl	hotonic Packet Sw	itching and mesh	lavelength Routi	na Networks		1, alulla c	inu si	olleu	aluria,	lesiber	15, Idili	Duarre	il, TallID	uw an	u stari	iei.				9	Hour
Optical tim	ne domain multiplex	ring (OTDM), m	nethods of multiple	exing and der	nultiplexing, broadcast OTDM net	works. Cl	assifi	catior	n of lig	ht path:	s, The	Optica	al layer,	Wave	elengtł	n Cross	Conn	ects (V	VXC) ı	wavele	ength
reuse, Sta	tic and reconfigurat	ole network and	l its applications. (	Case Study: N	IBM - Emp <mark>owering Di</mark> gital India wit	h Fiber N	letwoi	rk.													

	1.	J.M. Senior, "Optical fibre communications, Principles & Practice", (PHI), 3/e, 2009	5.	R. Ramaswami and K. N. Sivarajan, "Optical Networks", Morgan Kaufmann Publishers, 3/e, 2010
Learning	2.	G. P. Agrawal, "Fiber-optic communication systems", John Wiley & sons, Inc. 5/e, 2010.	6.	C. S. R. Murthy and M. Gurusamy, "WDM Optical Networks", Prentice Hall, 2002.
Resources	3.	Gerd keiser "optical fiber communication" 5th edition, mcgraw-hill,2017	7.	Le Nguyen Binh, "Optical Fiber Communication Systems with MATLAB and Simulink Models",
	4.	J.E. Midwinter, "Photonics in Switching" Academic Press, 1993.		Second Edition CRC Press, 2014

			Continuous Learning	Assessment (CLA)		Summative Final Examination (40% weightage)				
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native oge of unit test 0%)	Life-Lon Cl (1	g Learning LA-2 0%)					
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	30%		20%	1 1 A 2 A	30%	-			
Level 2	Understand	40%		25%		40%	-			
Level 3	Apply	30%	A Section Sector	35%		30%	-			
Level 4	Analyze			20%			-			
Level 5	Evaluate				1	- 15 I	-			
Level 6	Create		Sec. Sector	17		-	-			
	Total	10	0%	- 10	00 %	10	0%			

Course Designers		2
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Mr. Saivineeth, ML Accelerator Architect @ Google	1. Dr T. Rama Rao, SRMIST
		2. Dr.C.T. Manimegalai, SRMIST



Course Code	21ECE320T	Course Name		SOFTWARE	E DEFINED NETWO	ORKS	Co Cat	ourse egory		E	PROFESSIONAL ELECTIVE									- T 3 0	P 0	C 3
Pre-requ Cours	iisite es	Nil		Co- requisite Courses		Nil		Prog Co	ress urse	sive s						Nil	1					
Course	Offering Departme	ent		ECE	Data B	Book / Codes / Sta	andards	1.0							Nil							· · · · · · · · · · · · · · · · · · ·
-																						
Course Learning Rationale (CLR): The purpose of learning this course is to: Program Outcomes (PO)										- 5	rogra	m ic										
CLR-1:	Understanding th	e evolution o	of SDN		002			1 :	2	3	4	5	6	7	8	9	10	11	12	Oi.	utcom	ies
CLR-2:	Familiarize with the	he SDN Devi	rices and Cor	trollers	1 A			je	1	of	s of	3	iety			¥		0				
CLR-3:	CLR-3: Analyze the basics of open flow and NFV							viedç		ent o	ations	ge	soc			oW د		Jance	b			
CLR-4:	Create insights to	o various use	e case of SDI	J		22 23			IJSIS	mdo	stig: lem	Usa	and	∞ .		ean	u	Ξ	arnin			
CLR-5:	Understand the c	oncepts of S	SDN op <mark>e</mark> n sol	irce and Software	Defined Mobile Net	tworks		eering i	em Ana	n/devel	uct inve lex prob	m Tool	ngineer	onment inability		dual & T	nunicati	ct Mgt. 8	ong Lea	-	5	
Course O	utcomes (CO):	A	At the end of	this course, lea	rners will be able to	o:			Proble	Desig	Cond	Mode	The e	Envire Susta	Ethics	Indivi	Comr	Proje	Life L	-OS4	PSO-	-OS4
CO-1:	Express the SDN	l archite <mark>cture</mark>	e and its bene	fits		ALC: NO	1.29	3	-	-	-	1.		-	-	-	-	-	-	3	-	-
CO-2:	Analyze SDN cor	ntrollers <mark>and</mark>	Devices fund	tionality	and the second second	Server.		3	-	$\mathcal{C}$	-	-	1	-	-	-	-	-	-	2	-	-
CO-3:	Interpret the oper	n flow te <mark>chno</mark>	ology and Ne	work Virtualizatio	n	24. 2		3	-	1	-	-	-	-	-		-	-	-	2	-	-
CO-4:	Discuss about SL	DN Appl <mark>icatio</mark>	on and Use C	ase	1255115			3	-	6	-	-		-	-	-	-	-	-	-	2	-
CO-5:	Gain knowledge t	towards SDN	<mark>V Imp</mark> lementa	tion in 5G Mobile	Networks			3	-	14	-	-	1	-	-	-	-	-	-	-	-	1
Unit 1 D	laging of SDN		-	24	Carlan Ser			16					-									Hour
Introductio	on to SDN- Evolutio	n of Switche	es and Contro	ol Planes, Cost, S	SDN Implications for	Research and In	novation.	Need o	of SI	DN- D	ata Ce	nter In	novat	ion. Dai	ta Cer	nter Ne	eds. T	The Co	ntrol P	lane. I	<b>y</b> Data F	Plane.
Moving In	formation Between	Planes, Sepa	aration Impor	tance, Technical	Landscape, Hybrid A	Approaches Ships	in the Nig	ht, Dua	al Fu	Inctio	n Switc	hes		, = .			, -					,
Unit-2 - S	DN Devices and C	ontroller		1 2 3		1.80						2									9	Hour
How SDN	Works- Fundament	tal Character	ristics of SDI	I, SDN Operation	, SDN Devices, SDN	N Controller, SDN	Applicatio	ons, Alt	terna	ate SL	N Met	hods,	VMwa	re/Nicira	a, Ope	n⊢low	-Relate	əd, Min	inet ,N	OX/PO	JX , I	rema,
Unit-3 – C	Doen Flow and Net	work Virtual	lization		Sec. 1. 3.77	A sector	1.1.1.			-		10	-								9	Hour
OpenFlow	Overview- The Op	enFlow Swit	tch, The Ope	nFlow Controller,	The OpenFlow Pro	otocol, OpenFlow	1.0 and O	penFlo	w B	asics	Ports	and P	ort Qu	eues, F	low T	able, I	Packet	Match	ing, Ac	tions	and F	acket
Forwardin	g, Messaging Betw	een Controll	ler and Switc	<mark>h, OpenFl</mark> ow 1.3	Additions and Oper	nFlow Limitations,	OpenFlow	v Prog	rami	ming,	Netwo	rk virti	<mark>laliz</mark> at	ion - Cl	halleng	ges, Ai	rchitec	ture, Br	uilding	Block	s, Exa	ample
system, M	licro segmentation	d llea Caea																			0	Hour
SDN in the	e Data Center - Data	a Center Defi	finition. Data	Center Demands.	Tunneling Technolo	ogies for the Data	Center. Pa	ath Tec	hnol	loaies	in the	Data C	Center	Switchi	ng Fal	brics. 7	Fraffic I	Enaine	erina fa	or WAI	N. Sot	ftware
Defined W	AN, Access Netwo	rks - SD - PC	ON, SD- RAN		, in the second second	Julia Die Data									<u>.</u>	, .					, 20.	

# Unit-5 - SDN Implementation in 5G Mobile Networks

SDN Open Source-Chapter-Specific Terminology, Open Source Licensing Issues, Profiles of SDN Open Source Users, OpenFlow Source Code, Switch Implementations, Controller Implementations, SDN Applications, Simulation, Testing, and Tools, OpenStack, SDN Futures-Current State of Affairs, Potential Novel Applications of Open SDN, LTE Architecture Integration with SDN - Restructuring mobile networks to SDN, SDN and LTE integration Benefits, Controller Placement - Performance objectives, Controller Placement problem

	1.	Paul Goransson and Chuck Black, "Software Defined Networks: A Comprehensive	4.	Madhusanka. Liyanage et.al, "Software Defined Mobile Networks, Beyond LTE Network
		Approach," Morgan Kaufmann Publications, 2014.		Architecture," Wiley, 2015.
Learning	2.	Thomas D.Nadeau & Ken Gray, "SDN - Software Defined Networks, "O'Reilly, 2013.	5.	Arsany Basta; Andreas Blenk; Klaus Hoffmann; Hans Jochen Morper; Marco Hoffmann; Wolfgang
Resources	3.	Larry. L. Peterson, Carmelo Cascone, et.al, " Software-Defined Networks: A Systems		Kellerer, "Towards a Cost Optimal Design for a 5G Mobile Core Network Based on SDN and
		Approach, Systems Approach LLC, 2021.		NFV",,IEEE Transactions on Network and Service Management, 2017, Volume: 14, Issue: 4 Pages:
				1061 - 1075

Learning Assessm	nent de la companya d		100 State 1								
			Continuous Learnir	Sum	mativa						
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test )%)	Life-Long CL (10	Learning A-2 0%)	Final Examination (40% weightage)					
	-	Theory	Practice	Theory	Practice	<u>The</u> ory	Practice				
Level 1	Remember	25%	Sec. Astronomy Sec.	15%		25%	-				
Level 2	Understand	30%		20%	200	<mark>30</mark> %	-				
Level 3	Apply	30%	St. 1752 Mar	40%		<u>30</u> %	-				
Level 4	Analyze	15%		25%	-	15%	-				
Level 5	Evaluate		-	12 10 10 10 10	10 M	-	-				
Level 6	Create		-			-	-				
	Total	10	0%	100	0 %	100 %					

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Mr. Raji Kumar, Sr. Manager Core Corporation (Airtel)	1. Dr. V. Nithya <mark>, SRMIST</mark>
		2. Dr. P. Vija <mark>yakumar, S</mark> RMIST



Course Code	21ECE321T	Course Name	9	RF AND MICROWAVE SEMICONDUCTOR DEVICES			C	Cours atego	e ory	E			PROF	ESSIO	NAL E	ELECT	IVE		L 3	- T 3 0	P 0	C 3
Pre-requis Courses	site 21	ECC201	Γ	Co- requisite Courses		Nil		Pro	ogres Cours	sive es						Nil	1					
Course C	offering Departme	nt		ECE		Data Book / Codes / Star	ndards	11-14							Nil							
Course Lea	arning Rationale (	CLR):	The purp	os <mark>e of learnin</mark> g this	course is	to:		-	đ	A.		Progr	am Ou	itcome	s (PO	)				P	ogra	m
CLR-1:	Gain knowledge o components unde	n microwa r microwa	ave semico ave sign <mark>al</mark>	nductor materials and	d to unders	tand the fundamental of electr	onic	1	2	3	4	5	6	7	8	9	10	11	12	S Ou	pecifi tcom	c es
CLR-2:	Attain knowledge communication sy	Attain knowledge of microwave components and devices that are used in modern microwave radar and communication systems					and	ge		of	s of		ciety			ł		e				I
CLR-3:	Analyze the characteristics and operation of microwave transistors.				10	vled		ent	s	ge	soc			۱ Vo		Janc	б			r		
CLR-4:	Familiarize the fur	ndamenta	ntals of RF power transistors and challenges			2	Knov	alysis	ign/developme tions	estiga	I Usa	er and	t &		Tean	tion	& Fir	arnin			I	
CLR-5:	Acquire deep und	erstandin	andin <mark>g of deve</mark> lopment of RF and modern semiconductor devices			_	heering	em Ani		luct inv olex pro	ern Too	enginee	onmen ainabilit	s	dual &	nunica	ct Mgt.	ong Le	ŕ.	-2	ကိ	
Course Out	tcomes (CO):		At the en	e end of this course, learners will be able to:			1.0	Engir	Probl	Desig	Cond	Mode	The e	Envir Susta	Ethic	Indivi	Com	Proje	LifeL	-OS	PSO.	PSO SO
CO-1:	Explain the proper	rties of <mark>Se</mark>	emiconduct	or Junction Diodes u	nder micro	wave signals		3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Analyze the devel	opmen <mark>t o</mark>	<mark>f nega</mark> tive i	resistance characteri	stics in tun	nel diode and transit time dev	rices	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	Characterize the r	nicrow <mark>av</mark>	<mark>e com</mark> pone	nts and circuits in ter	ms of their	performance parameters	- 5	3	2		-	-		-	-	-	-	-	-	2	1	-
CO-4:	Express the chara	octeristi <mark>cs</mark>	of <mark>RF</mark> pow	er transistors	1.15		101	3	2	1		-		-	-	-	-	-	-	2	-	-
CO-5:	Evaluate the conc	epts of <mark>R</mark>	F and semi	iconductor devices a	nd apply in	the design of electronic syste	ems.	3	1	2	-	-	-	-	-	-	-	-	-	2	-	1
Unit-1 - Ser	niconductor P-N	Junction		plan 1								-	-		-						9	Hour
Review of p Varactor Die	roperties of semico ode, Schottky effec	onductors t. Schottk	, Transient vy barrier di	and ac behavior of p ode, Hetero junction	-n junction s. Construc	s, Effect of doping pr <mark>ofile on t</mark> tion andoperation of microwa	the cap ve PIN	acitan diode	ice of e. App	p-n jur licatior	nctions, ns.	Noise	in p-n	junctio	ns, Va	ractor	diode,	Consti	ruction	and C	perat	on of
Unit-2 - Neg	gative Resistance	and Tra	nsit <mark>Time L</mark>	Devices	1				, 11			1									9	Hour
Negative Re	esistance Devices,	Tunnel L	Diode, <mark>Tunı</mark>	<mark>neling</mark> process in p-n	junction, l	MIS tunnel diodes, Backward	Diode,	Tran	sferre	d Elec	tron De	evices,	IMPA	TT, Sm	<mark>all-</mark> sig	nal an	alysis	of IMP,	ATT di	odes,	TRAP	ATT-
Power output	ut and efficiency, B	ARITT D	iodes, Two	-valley model of com	pound serr	iconductors, vd-E characteris	tics, G	inn Ei	ffect, r	nodes	of oper	ration,	small-	signal a	analys	is of G	unn dia	ode, Po	wer-fre	equen	cy limi	<u>t</u>
Unit-3 - Mic	9 Hour																					
MICrowave Proportion c	Wicrowave Transistor, might nequency initiations of BJ1, Microwave bipolar transistors – operation, here of punction bipolar transistors – operation, nik energy negatives, might negative to peration, nik energy negatives of MISEET.																					
Hoperties C	MT Transistors ar	nd RF Po	wor Trans	istor	mology, M	ESFET MOUEIING, I-V Charact	ensucs	, nigi	rnequ	iency p	enonn	ance,	IVIISE	1-1110	uucuo	n, Ope	aung	ciiaiac	lensuc	S OI IVI	<u>3751</u>	Hour
Introduction	to HEMT, Short c	hannel ei	ffects, Devi	ice operation, Device	e design, S	caling issues, Material Syste	ms for	НЕМТ	T Devi	ces, G	aAs H	EMT, I	nP HE	EMT, Te	chnol	ogy co	mparis	ons, Ir	ntroduc	tion o	ΓRF μ	ower
transistor, F	igure of Merit for R	Preserver 25 Power	Transistor,	Common RF power	devices, M	aterial properties, State-of-the	e-art-wi	de ba	ndgap	o micro	wave ti	ransist	or data	a, Chall	enges	to pro	ductior	1				
Unit-5 - RF	Package Design a	and Deve	elopment	Machanizal Davi	Dealers	la duia da la duia du dui dui dui dui dui dui dui dui dui	Mard 1		!			lada at 1	- 4 1'			4			4	-1.1.4	9	Hour
Thermal mo	то к⊢ Раскаде, П <u>deling, Thermal</u> an	iermai Ma <u>ialysis o</u> f	anagement <u>resistanc</u> e	, mecnanical Design, <u>networks, Introdu</u> ctio	Раскаде е <u>n to com</u> pl	electrical and electromagnetic iter aided design, Benefits, lir	nitation	ng, De <mark>s and</mark>	esign applie	cations	ation, M s of CAL	aterial D	s testi	ng, Keli	ability	testing	j, comp	outer in	tegrate	a Mar	uracti	uring,

Learning	Golio, M., "RF and Microwave Semiconductor Devices Handbook", CRC Press,(2002)     Simon M. Sze, Yiming Li, Kwok K. Ng, "Physics of Semiconductor	<ol> <li>Glover, I.A., Pennoek, S.R. and Shepherd P.R., "Microwave Devices, Circuits and Sub-Systems", 4th Ed., John Wiley &amp; Sons (2005)</li> </ol>
Resources	3. Devices", 4th Ed., Wiley (2021).	<ol><li>Liao, S.Y., "Microwave Devices and Circuits", 4th Ed., Pearson Education (2002).</li></ol>

Learning Assessm	ient		Continuous Loornin	Accomment (CLA)						
	Bloom's Level of Thinking	Forr CLA-1 Avera (5	native nge of unit test 0%)	Life-Long CL (1	g Learning LA-2 0%)	- Summative Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%	and the second second	15%		15%	-			
Level 2	Understand	25%		25%		25%	-			
Level 3	Apply	30%		30%		30%	-			
Level 4	Analyze	30%	and the second second	30%		30%	-			
Level 5	Evaluate	STATISTICS FOR	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1				-			
Level 6	Create			San States		-	-			
	Total	10	0%	10	0%	10	0%			

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
	1. Mr. Saivineeth, ML Accelerator Architect @ Google	1. Dr.S. Bashyam, SRMI <mark>ST</mark>	
		2. Dr.J. Manjula, SRMIST,	



Course Code	21ECE322T	21ECE322T Course DATA ANALYTICS USING R			Course Catego	e ry	Е			PROF	ESSIC	NAL E	ELECT	IVE		;	L T 3 0	P 0	C 3
Pre-requis	site s	Nil	Co- requisite Courses	Nil	Progressive Nil														
Course C	Offering Departme	ent	ECE	Data Book / Codes / Stand	ards			-				Nil							
Course Lea	arning Rationale (	(CLR): The purp	os <mark>e of learning</mark> this course	is to:	1	1			Progra	am Ou	itcome	s (PO	)				P	rogra	m
CLR-1:	<b>CLR-1:</b> Identify usage of R programming for various data types an data structures					2	3	4	5	6	7	8	9	10	11	12	S Oı	pecifi utcom	ic ies
CLR-2:	Understand contr	ol statements , f <mark>unct</mark>	ions and exception handling	in R	e		of	s of	1	iety			¥		0				
CLR-3:	Interpret the R language basic statistical and probability concepts						ento	ations	ge	soc			oW r		ance	b			
CLR-4:	Explore R programming tool for statistical testing					lysis	mdo	stiga	Usa	r and	ઝ્		Γearr	u	& Fir	arnin			
CLR-5:	Select different gr	raphical re <mark>presenta</mark> ti	ons to recognize patterns an	d trends in data.	eering	eering l em Ana n/devel		ict inve ex prot	m Too	Iginee	nment		ual & T	unicati	t Mgt.	ong Lea			~
Course Ou	tcomes (CO):	At the er	nd of this course, learners	will be able to:	Engine	Proble	Design	Condu	Moder	The er	Enviro Sustai	Ethics	ndivic	Comm	Projec	Life Lo	,-OSc	-OSc	S-OSc
CO-1:	Enumerate data S	Structur <mark>es in R su</mark> ch	as Vector, List, Matrix, Array	& Data Frame		3	-	-	2	1	-	-	-	-	-	-	3	-	-
CO-2:	Write R programm	ning co <mark>des usin</mark> g cor	ntrol statements, functions a	nd exception handling.		-	3	- 1	2	-0		-	-	-	-	-	3	-	-
CO-3:	Demonstrate stat	istical a <mark>nalysis a</mark> nd te	echnologies on data to find t	rends and solve problems using R		3		-	2	- 10	-	-	-	-	-	-	3	-	-
CO-4:	Apply the differen	t distrib <mark>utions an</mark> d st	atistical testing using R	Service of the		-	3	-	2	-	-	-	-	-	-	-	-	-	3
CO-5:	Construct data vis	sualizati <mark>on using</mark> vari	ious types of graphs and plo	ts in R			3	-	2	2	-	-	-	-	-	-	-	-	3
Unit-1 - Da	ta Types and Stru	ictures in R Langua	age						1	£	<u>.</u>							9	Hour
Numerics, Defining a l Lists of Obj Out Data Fi	Arithmetic, Assignr Matrix, Row and Co ects, Data Frames, iles and Plots	nent, and Vectors-R olumn Bindings, Mat , Basic Plotting, Usin	for Basic Math, Assigning O trix Dimensions, Subsetting, g plot with Coordinate Vecto	bjects, Creating a Vector, Sequer Matrix Operations and Algebra, M. rs, Graphical Parameters, The ggplo	nces , Repo ultidimensio ot2 Packago	etitio onal J e, Re	n, Sorti Arrays, eading a	ing, and Non-nu and Wri	Leng Imeric ting Fil	gths, S value les, R-	Subsett s, Logic Ready	ing an cal Val Data S	d Elei lues, C Sets, F	ment E. Charact Reading	xtractic ers, Li g in Ext	on, Mai ists and ernal E	trices a d Data Data Fi	and Al a Fra iles, N	rrays, ames, Vriting
Unit-2 - Co	ntrol Statements,	Functions and Exc	ception Handling in R		1				15							_		9	Hour
Calling Fun Command,	ctions- Scoping, A Arguments, Specia	rgument Matching, C alized Functions, Re	Conditions and Loops- if State cursive Functions, Exceptior	ements, Coding Loops, for Loops, was s, Timings, and Visibility -Exception	vhile Loops, n Handling,	Oth Prog	er Con gress a	trol Flov nd Timi	v Mecl ng, Me	hanisn easurii	ns-The ng Com	repea pletior	t State n Time	ment, \ , Mask	Writing ing,	Functi	ons, T	he fur	nction

### Unit-3 - Statistics and Probability

Elementary Statistics- Describing Raw Data, Numeric Variables, Numeric Variables, Univariate and Multivariate Data, Summary Statistics- Mean, Median, Mode, Counts, Percentages, and Proportions, Quantiles, Percentiles, Variance, Standard Deviation, and the Interquartile Range, Covariance and Correlation, Outliers, Probability-Events and Probability, Random Variables and Probability Distributions, Common Probability Distribution-Bernoulli Distribution, Binomial Distribution, Poisson Distribution, Common Probability Functions - Uniform, Normal, Student's t-distribution, Exponential.

### Unit-4 - Statistical Testing and Modeling

9 Hour

9 Hour

Sampling Distributions and Confidence - Distribution for a Sample Mean, Distribution for a Sample Proportion, Confidence Intervals, Hypothesis Testing- Hypotheses, p-value, Significance Level, Testing Means, Testing Proportions, Testing Categorical Variables, Hypothesis Test Errors, Type I Errors, Type II Errors, Analysis of Variance - One-Way ANOVA, One-Way ANOVA Table Construction, Simple Linear Regression-Definition of the Model, Estimating the Intercept and Slope Parameters, Fitting Linear Models with Im, Illustrating Residuals, Prediction, Plotting Intervals, Interpolation vs. Extrapolation, Linear Model Selection and Diagnostics

### Unit-5 - Data Visualization

Exploring Data - Creating a Scatter Plot, Line Graph, Bar Graph, Histogram, Box Plot, Plotting a Function Curve, Bar Graphs-Basic Bar Graph, Grouping Bars Together, Bar Graph of Counts, Using Colors in a Bar Graph, Stacked Bar Graph, Basic Line Graph - Adding Points to a Line Graph, a Line Graph with Multiple Lines, Changing the Appearance of Lines and points, Graph with a Shaded Area, Stacked Area Graph, Adding a Confidence Region, Scatter Plots-Basic Scatter Plot, Grouping Data Points by a Variable Using Shape or Color, Using Different Point Shapes, Mapping a Continuous Variable to Color or Size, Summarized Data Distributions-Basic Histogram, Multiple Histograms from Grouped Data, Density Curve, Violin Plot, Density Plot of Two-Dimensional Data, Annotations, Axes, Legends,

Loarning	1.	Tilman M. Davies," The Book of R, A First Course in Programming and Statistics",	3.	James G, Witten D, Hastie T, Tibshirani R "Introduction to Statistical Learning", Springer, 2013.
Learning		No Starch Press, Inc. 2016	4.	Norman Matloff, "The Art of R Programming, A Tour of Statistical Software Design", No Starch
Resources	2.	Winston Chang, "R Graphics Cookbook", O'Reilly Media, Inc.,2013		Press, Inc., 2011

			Continuous Learning	Assessment (CLA)					
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (10	ן Learning A-2 גער אין				
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice		
Level 1	Remember	15%		15%	- Parent	15%	-		
Level 2	Understand	25%		20%		25%	-		
Level 3	Apply	30%		25%		30%	-		
Level 4	Analyze	30%	1	25%		<mark>3</mark> 0%	-		
Level 5	Evaluate	and the second		10%	1 - C - C - C - C - C - C - C - C - C -	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	-		
Level 6	Create	1.00		5%			-		
	Total	10	0%	10	0%	100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Mr. Raji Kumar, Sr. Manager Core Corporation (Airtel)	1. Dr.J. Subhashini, SRMIST
	Entrance in the second se	2. Dr. <mark>P. Vijayakum</mark> ar, SRMIST

Course Code	rse 21ECE323T Course CYBER SECURITY			Cour Categ	se ory	E			PROF	ESSIC	NAL E	ELECT	IVE		l	- T 3 0	P 0	C 3		
Pre-requi Course	site s	Nil	Co- requisite Course <mark>s</mark>	-	Nil	Pr	ogres Cours	sive ses						Nil	1					
Course (	Offering Departme	ent	ECE	Data Bo	ok / Codes / Standar	rds							Nil							
Course Le	arning Rationale	(CLR):	The purpose of learning this c	ourse is to:	11-11	Program Outcomes (PO)									Program		m			
CLR-1:	Learn the securit	y concepts	, standards and protocols of cyb	er security		1	2	3	4	5	6	7	8	9	10	11	12	S Ou	pecifi utcom	.c es
CLR-2:	Familiarize variou	us types of	cyber-attacks and cyber-crimes			e		Ŧ	of	20	ety			¥		0				
CLR-3:	R: Analyze security and privacy th <mark>reats in co</mark> mputer networks			vledg		ient o	ations	ge	soci		-	No No		Jance	6					
CLR-4:	Develop deep understanding on cyber-crime issues and forensics				<b>Von</b>	ysis	opu	stig	Usa	and	∞.		ear	и	& Fil	arnir			1	
CLR-5:	Discuss the improvement in cyber security on hardware and software			ering h	n Anal	n/develo	ct inve	n Tool	Igineer	nment nability		ual & T	unicati	t Mgt. 8	ng Lea					
Course Ou	Course Outcomes (CO): At the end of this course, learners will be able to:			Engine	Proble	Design	Condu	Moder	The er	Enviro Sustai	Ethics	Individ	Comm	Projec	Life Lc	PSO-1	PSO-2	PSO-3		
CO-1:	Identify the desig	n secur <mark>e s</mark>	ystems using digital security star	ndards	S	115	3	-	1	1	1	-	-	-	-	-	-	3	-	-
CO-2:	Design different p	oractical di	gital encrypted systems with min	imal supervision	and a second	- 1		3	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Implementation of	of the ha <mark>rdv</mark>	vare and software's for designing	cyber physical syste	em	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-4:	Discussing the cy	/ber-crime	issues and investigations	1000		-	-	3	-	-		-	-	-	-	-	-	3	-	-
CO-5:	Analyze the impr	ovemen <mark>t in</mark>	cyber security	1		(C)	-	3	-	-		- 10	-	-	-	-	-	3	-	-
<b>Unit-1 - Di</b> Digital Prive Security Sc	<b>gital Security</b> acy- Privacy Laws- olutions-Antivirus-F	· Types of ( irewalls-Pa	Cyber Attacks- Computer Securit	y Risks-Online Trackin	ing-Malware -Hacking	- Pharm urity - IC	ing - I	Phishir	ng - Ran case stu	somwa dv: Pro	are-vin	us- Wi-l	Fi Eave	esdrop	ping -	Social	Engine	ering a	<b>9</b> attack	Hour type-
Unit-2 - Or	line Anonymity	nowano r c		Cooure Will I Couling	ge cloud clolage cool	unty ic	// 000	Juny	000 010	<i>ay.11</i>	1001 0	maron	or mino						9	Hour
Anonymity- Search End	Anonymous Netwo aine-Web Browser	orks-TOR I Privacv Co	Netw <mark>orks -I2P</mark> Network- Freenet onfiguration-Anonymous Paymer	- Darknet-Anonymou t- case study: Payme	is OS–Secure File Sh ent Security Measures	aring- V	'PN-P	roxy S	ervers-	Conne	ection	Leak Te	esting-	Check	for DN	VS Lea	k-Fix D	ONS L	eak-Se	ecure
Unit-3 - Se	cure Communica	tion		1.	Assilution	1.1	-		10.00	1.50									9	Hour
Introduction Multi Task Counterme	n to Encryption & C Encryption Tools- asures Against Cr	Cryptograpl Securing D yptography	hy- Crypto <mark>graphic Fun</mark> ctions-Typ lata In Transi <mark>t -Cloud Storage</mark> En v Attac	es-Cryptographic Trus cryption-Encrypt DNS	st Models-Cryptograp S Traffic-Email Comm	hic Key unicatio	Pair-L n-Atta	Disk er cking (	cryptior Cryptogi	n using raphic	windo Syster	<mark>ows bitlo</mark> ns- Typ	ocker - les of a	Disk I attackii	Encrypt ng cryp	tion Us otograp	ing Op hic sys	en-So tems-	urce T case s	<sup>-</sup> ools- study:
Unit-4 - Cy	ber Crime Issues	& Challer	nges																9	Hour
Cyber Crin browsina-B	ne-Classifications-I Luving Online-Wire	Kinds of C less Secur	yber Crime-cyber fo <mark>rensic-comp</mark> itv-Email-social media marketing	outer_forensics-Digital security-smart_phone	I Forensics-Password e securitv-Challenges	l manag in smari	er- W devid	/indow :es	s Firew	all with	n Adva	anced S	Securit	у- Сог	nectio	n Secu	urity Ru	ules-sa	afe int	ternet
Unit-5 - Ad	Ivances in Cyber	Security	,,,	, p.	ly i i inger														9	Hour
Introduction systems ag	n to cyber security ainst cyber-attack	today-DDC s	Ds-Strategies for improving cyber	security-Bastion hard	dware-software securi	ty archit	ecture	-Trust	ed platfo	orm ma	odule-l	Mitigatir	ng Haro	dware	inform	ation le	aks-De	efendii	ng sofi	tware

Learning	<ol> <li>Nihad Hassan, Rami Hijazi, "Digital Privacy and Security Using Windows: A Practical Guide"1st Edition, Apress Publications, 2017</li> </ol>	<ol> <li>D.Frank Hsu, Dorothy Marinucci, "Advances in Cyber Security; Technology, Operations and Experiences"1st Edition, Fordham University Press, New York 2013</li> </ol>
Resources		3. Nina Godbole & Sunit Belapure "Cyber Security", Wiley India, 2012

			Continuous Learning	Assessment (CLA)		Summative Final Examination (40% weightage)			
	Bloom's Level of Thi <mark>n</mark> king	Forn CLA-1 Avera (50	native ge of unit test )%)	Life-Lon Cl (1	g Learning LA-2 0%)				
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	20%		20%		20%	-		
Level 2	Understand	20%		20%		20%	-		
Level 3	Apply	20%		20%		20%	-		
Level 4	Analyze	20%	and the second second	20%		20%	-		
Level 5	Evaluate	10%	100 A 100 A	10%	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	10%	-		
Level 6	Create	10%		10%		10%	-		
	Total	10	100 %		0%	100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Athif Shah, Chairman, Abe Semicondutor, abechennai@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Dr.R. Dayana, SRMIST
2. Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI, Imadank@amail.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	



Course Code	21ECE324T	Course Name	ADVANCED MOBILE COMMUNICATION SYSTEMS	Cou Cateç	rse Jory	E		F	PROF	ESSIO	NAL E	LECT	IVE		:	- T 3 0	P 0	C 3
Pre-requi Course	isite es	Nil	Co- requisite Courses	P	rogres Cours	sive ses						Nil	1					
Course (	Offering Departme	ent	ECE Data Book / Codes / S	tandards							Nil							
						_			_		(7.0)							
Course Le	arning Rationale (	CLR): Th	e purpose of learning this course is to:			44	-	Progra	m Ou	tcome	s (PO)	) T	T	<b></b>		- S	pecif	ic
CLR-1:	Introducing recent	t advanceme	nts and growing trends in mobile telecommunications	1	2	3	4	5	6	7	8	9	10	11	12	Ou	itcom	ies
CLR-2:	Figure out the me	thods to impr	ove the Data Rates in mobile communication	ge		of	s of	10	iety			rk		đ				
CLR-3:	Inferring technical	l requirem <mark>ent</mark>	s for 5G, network architecture	vledç		ento	ation	ge	soc			oW r		anci	g			
CLR-4:	Acquire the know	ledge of Netv	vork Planning and Deployment techniques.	Anov	lysis	mdo	stiga	Usa	and	~~		earr	uo	Ĕ	urnin			
CLR-5:	Analyzing security	y techniques	and Applications of Advanced Mobile communication system	Sering 1	m Ana	n/devel	ct inve ex prob	n Tool	gineer	nment		ual & T	unicati	t Mgt. 8	ong Lea			
Course Ou	utcomes (CO):	A	t the end of this course, learners will be able to:	Engine	Proble	Design	Condu	Moder	The er	Enviro Sustai	Ethics	Individ	Comm	Projec	Life Lc	PSO-1	PSO-2	PSO-3
CO-1:	Examine the deve	əlopmen <mark>t ,ch</mark> ə	Illenges and requirements of mobile communications	3	2	-	-	I	-	-		-	-	-	-	-	- 1	-
CO-2:	Interpret the meth	ods to <mark>impro</mark>	ve the data rate	3		2	-	-	-0	<u> </u>	-	-	-	-	-	-	-	-
CO-3:	Connect the layer	rs of co <mark>mmun</mark>	ication systems		10.7		3	-	- 10	-	-		-	-	-	-	2	-
CO-4:	Analyze the techn	niques o <mark>f Plar</mark>	ning and deployment of communication network	100	-		2	-	-	-	-	3	-	-	-	-	-	-
CO-5:	Summarize the se	əcurity, <mark>servic</mark>	es and applications of Next generation communication techniques	š. –	2	1.1	- 1	-	2	-	-	-	-	-	3	-	-	-
Unit-1 - In	traduction		C. Kida		100				5								0	Hour
Overview -	-What Is 5G? -Back	around -Res	earch and Challenges for Electronics -Expected 5G in Practice - f	G and Secur	itv -Mo	tivation	s -5G S	tandaro	dizatio	on and	Regula	ation -	Global	Standa	ardizat	ion in !	5G Fr	a 5G
Requireme Case Stud	ents Based on ITU-	The Technica Operators an	al Specifications of 3GPP-The 5 G Security. d Mobile Device Manufacturers in India	C and Cooun	ty mot	aration		tandare		in and i	rioguit		Ciobai	otando	and 2 dd	011 111 0	, o E.	u. 00
Unit-2 - De	ata Rates in Mobile	e Communic	ation	A		-	-	1									9	Hour
Fundament	tal Constraints in ac	hieving High	Data Rates Noise-limited scenarios Interference-limited scenarios I	Higher-order N	Nodula	tion, M	ulti carri	er modu	ulatio	n Wider	<mark>r ba</mark> ndv	width, S	Spectru	ım Con	npositi	on Lov	v freqi	Jency
spectrum, o	capacity and covera	age, spectrun	1 for 5GNR, unlicensed mm waves bands, Terahertz spectrum, sp	ectrum requir	ements	s for 6G	6: SUB-	ö.										Hour
Radio acce	ess technology-Orth	hogonal Freg	uency Division Multiplexing- Channel estimation and equalization-	Multiple-Inpr	ıt Multi:	ple-Ou	tout Tec	hnique	s-Adv	/anced	МІМО	-Radic	o netwo	ork arch	nitectu	re and	Interi	hour faces
Case Stud	ly: The Role of 5G a	and beyond in	i the Cyber-World		e maiaj		.put roc	miquo	0 7 10 1	anoou		riadio	notho	in aron	ntootai	o una	mitori	u000.
Unit-4 - Ne	etwork Planning ar	nd Deployme	en e														9	Hour
Core and T	Fransmission Netwo	ork Dimension	ing- Radio Network Planning- Core and Radio Network Deploymer	nt Scenarios-	Standa	ilone ar	nd Non-	Standal	lone [	Deployn	nent S	cenario	os- Net	twork Ir	nterfac	es and	l Elerr	ients-
Case Stud	<b>Iv</b> : Security Opport	unities for Sta	akeholders															

 
 Unit-5 - Security Services and Applications
 9 Hour

 Security Threats and Challenges- Security Implications in 5G Environments and Use Cases - Security Layers- Device Security- Security between Network Entities, Vehicle Communications- Machine Learning and
 Artificial Intelligence .

Case Study: The concept and vision of 6G Massive IoT

l earning	1.	5G explained: security and deployment of advanced mobile communications by Jyrki	3. 4	Rappaport.T.S.," Wireless Communications: Principles and Practice", 2nd Edition, Pearson, 2011 Chiller "Mobile Communications" Pearson Education Asia Ltd. Reprint 2012
Resources	2.	6G wireless communications and mobile networking by xianzhong Xie, Bo Rong, Wichel Kadoch Bentham book		

Learning Assessme	nt									
			Continuous Learning	Assessment (CLA)		Sum	mativo			
	Bloom's Level of Thinking	Form CLA-1 Avera (50	ative ge of unit test %)	Life-Long CL (10	g Learning .A-2 0%)	Final Examination (40% weightage)				
	2	Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		20%		30%	-			
Level 2	Understand	30%		25%		<mark>4</mark> 0%	-			
Level 3	Apply	40%	HOR Crast VO	35%		30%	-			
Level 4	Analyze	30%		20%		-	-			
Level 5	Evaluate			11-11-2-14			-			
Level 6	Create	( NA - 0 - 1			-	- 11	-			
	Total	100	)%	10	0 %	10	0 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	Plan III	1 Dr.C.T. Manimegalai, SRMIST



Course Code	21ECE420T Course INFORMATION THEORY AND CODING						C	Cours atego	se ory	E	PROFESSIONAL ELECTIVE							P 0	C 3			
Pre-requ Course	isite es	Nil		Co- requisite Course <mark>s</mark>		Nil		Pr (	ogres Cours	sive es						Nil						
Course	Offering Departme	ent		ECE		Data Book / Codes / Sta	ndards								Nil							
Course Le	earning Rationale	(CLR): <i>TI</i>	he purpose	of learning this o	course is t	0:		-	đ	1		Progra	am Ou	Itcome	s (PO	)				P	rogra	m
CLR-1:	Introduce the sig	nificance of th	the quantitativ	e measure of info	ormation in	the communications system	าร	1	2	3	4	5	6	7	8	9	10	11	12	S Oı	pecifi utcom	ic Ies
CLR-2:	Impart the fundar	mentals of eri	rror c <mark>ontrol co</mark>	ding techniques a	and their a	oplications		e		+	of	3	ety			¥						
CLR-3:	Analyze the fixed	l and variable	e l <mark>ength cod</mark> e	S			16	vledg		ent o	ations	ge	soci			IOW L		Jance	б			
CLR-4:	Assess the perfo	rmance of co	o <mark>nvolution</mark> al c	oding schemes in	n different p	practical	1 × 1	<nov< td=""><td>lysis</td><td>mdo</td><td>stige</td><td>Usa</td><td>anc</td><td><u>م</u></td><td></td><td>ean</td><td>uo</td><td>ž.</td><td>arnin</td><td></td><td></td><td></td></nov<>	lysis	mdo	stige	Usa	anc	<u>م</u>		ean	uo	ž.	arnin			
CLR-5:	Estimate the cha	nnel capacity	<mark>y and its</mark> type:	6			2	eering I	em Ana	n/devel	uct inve ex prob	rn Tool	ngineer	onment inability		dual & T	nunicati	st Mgt. 8	ong Lea	-	~	~
Course O	ourse Outcomes (CO): At the end of this course, learners will be able to:				17	Engin	Proble	Desig	Condu	Mode	The e	Envirc Susta	Ethics	Individ	Comn	Projec	Life Lo	-OS4	PSO-S	PSO-3		
CO-1:	Identify the basic	s of info <mark>rmati</mark>	t <mark>ion a</mark> nd codin	g methodology		to bus W	4.11	127	3	-		-	-	-	-	-	-	-	-	-	2	-
CO-2:	Develop various	codes a <mark>nd e</mark> r	rror checksun	1	a start	Server .		-	1	3	-	-		-	-	-	-	-	-	-	2	-
CO-3:	Apply variable le	ngth cod <mark>es fo</mark>	o <mark>r so</mark> urce cod	ing, Comprehend	l various so	ource coding schemes		3	3		-	-	- 10	-	-		-	-	-	-	2	-
CO-4:	Implementation of	of convol <mark>ution</mark>	<mark>n co</mark> des for er	ror detection and	l correction		100	1	-	3	-	-	1	-	-	-	-	-	-	-	2	-
CO-5:	Analyze any type	e of chan <mark>nel a</mark>	and select co	ding techniques to	o improve	channel performance	1		1	3	-	-	-	-	-	-	-	-	-	-	2	-
Unit_1 _ S	ourco Codina		-		C. M. LA		90		62				5								0	Hour
Model of s	ignaling system - N	lathematical i	models for in	formation sources	s – Encodi	ng a source alphabet- Code	Forma	tion fo	or an ii	nforma	tion -R	adix r d	code -	source	e codir	ng with	differe	nt radi.	x- Misc	cellane	ous c	odes-
Simple par	rity checks – CRC o	codes – Sin <mark>gl</mark>	<mark>ile / Doub</mark> le pa	arity checks - Len	npel–Ziv C	oding-case study: Relationsh	hip of in	forma	tion th	neory to	o other	fields										
Unit-2 - El	rror Detection / Co	orrection & C	Codes Ainimum dioto	noo doooding Ha	omming og	daa Linaar black oodoo (	Cuplic	odoo	Curro.	drama	aalaula	tion [	Dioaka	noodo	ro and	Deeee	lara				9	Hour
Hamming	weignt – Hamming pripble-Length Co	distance – M	Annimum dista	nce decoding- Ha	amming co	des – Linear Diock codes – C	Cyclic c	oues	– Syrie	arome	calcula	uon –e	SIOCK E	encoaei	rs and	Decou	iers				0	Hour
Unique de	coding – Instantan	eous codes a	and its constr	uction – The Kra	off's inequa	lity – Shortened block codes	s – The	МсМ	illan's	Inequa	alitv — F	luffma	n code	es and	its spe	ecial ca	ises –	Fxtens	ions o	f a cor	1e – R	adix-r
Huffman c	odes				iit o iitoquu					moque		. ann an		lo ana i								aant i
Unit-4 - C	onvolutional Code	es			1				1.11												9	Hour
Encoding	of Convolutional Co	odes-Propertie	ies- Maximun	<mark>i likelihood de</mark> cod	ding -Viterb	i decoding-sequential decod	ling-Tre	ellis-Tu	irbo co	odes												Harris
Entropy: m	ntropy & Cnannel	Lipint and re	alativo ontroni	es- Mutual inform	nation_infor	mation rate- channel capacit	v_rodur	ndanci	vand	officier	cy of c	hannel	s- Dise	rata ch	nannel	s_Tvn	as_Sh	annon	theore	m_She	<b>9</b>	Fano
coding		, joint, and le	Janve end Opi				y iouur	luant	y and t	CIIICIGI			5. DISC			з-тур	03- 011		I I E U E I	-011a		1 0110

	1.	Thomas M. Cover and Joy A. Thomas, "Elements of Information Theory", second edition,	3.	Hamming, Richard W, "Coding and Information Theory", Prentice Hall Inc., NJ, 1986.
Learning		Wiley, 2012	4.	Proakis J. G., "Digital Communications", McGraw Hill Inc., 4th Edition, NY, 2001.
Resources	2.	Shu Lin and Daniel J Costello, "Error Control coding fundamentals and applications", 2nd	5.	R. Togneri, C.J.S deSilva, Fundamentals of Information Theory and Coding Design, Taylor and
		edition, Pearson Education, Inc, Prentice Hall,2011		Francis, 2011

			Continuous Learning A	Assessment (CLA)		Summative Final Examination (40% weightage)				
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (1)	a Learning A-2 0%)					
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	10%		10%		10%	-			
Level 2	Understand	20%	10.5 C	20%		20%	-			
Level 3	Apply	30%	A State Server	30%		30%	-			
Level 4	Analyze	20%	1	20%		20%	-			
Level 5	Evaluate	15%		15%	1.	15%	-			
Level 6	Create	5%	and the second	5%		5%	-			
	Total	10	0%	10	0%	10	0%			

Course Designers	A STREET REPORT OF A STREET REPORT	2
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Dr.R. Dayana, SRMIST
<ol> <li>Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@ici.com</li> </ol>	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	



Course Code	21ECE421T	Cours Name	e e	WIRELESS C	OMMUNIC	ATION NETWORKS	Cou Cate	rse Jory	E			PROF	ESSIC	)NAL E	ELECT	IVE		l	L T 3 0	P 0	C 3
Pre-requ Course	isite es	Nil		Co- requisit Courses	e	Nil	F	rogres Cours	ssive ses						Nil	1					
Course	Offering Departme	ent		ECE		Data Book / Codes / Sta	indards							Nil							
Course Le	earning Rationale		The nurr	ose <mark>of learning</mark> th	is course i	is to:		1	1.0		Progr	am Qi	Itcome	s (PO	)				P	rogra	m
	Idontify the difference	ont types	of wiroloss	communication not	works		1	2	3	4	5	6	7	8	, 	10	11	12	S	pecifi	ic
CLR-1.		ent types	UI WIIEless		WUIKS			2	3	4	5	0	'	0	9	10		12	01	<u>itcom</u>	es
CLR-2:	Define large scale	e fading i	n mobile ra	dio wave propagatio	on	Contraction of the second s	ge		of	o su	10	ciet			ork		8				
CLR-3:	Demonstrate sma	all scale f	ading <mark>in mo</mark>	<mark>obile</mark> radio wave pro	pagation	100000000000000000000000000000000000000	wled	S	lent	atio	age	d so			א ג		nan	Б			
CLR-4:	Investigate the co	oncepts <mark>o</mark>	f c <mark>apacity a</mark>	and diversity to impr	ove wireles	s network link performance	Kno	Ilysi	lopn	estig	Us	r an	∞ _		Tear	ion	& E	amir			
CLR-5:	Evaluate different types of wireles		wireless co	ommunication netwo	orks and st	andards	eering	em Ane	n/deve	ons uct inve lex prol	rn Tool	nginee	onment		dual & <sup>-</sup>	nunicat	ct Mgt.	ong Le:	-	5	8
Course O	utcomes (CO):		At the e	nd of this course, I	earners w	ill be able to:	Engin	Proble	Desig	Cond	Mode	The e	Envire Susta	Ethics	Indivi	Comr	Proje	Life L	-OS4	PSO-	PSO-
CO-1:	Interpret the cond	epts of <mark>v</mark>	vireless con	nmunication and net	works	Siles Sure W	3	2	-		-	-	-	-	-	-	-	-	3	-	-
CO-2:	Analyze different	radio w <mark>a</mark>	ve propaga	tion models for wire	less comm	unications	-	3	G	2	-	1.	<u>.</u>	-	-	-	-	-	2	-	-
CO-3:	Apply different m	ultipath <mark>p</mark>	ropagation	channel models		19 - 19 - A -		3	2	-	1	- 10	-	-		-	-	-	2	-	-
CO-4:	Illustrate the link	perform <mark>a</mark>	<mark>nce im</mark> prov	ement techniques	100		12	3	16	-		1	2	-	-	-	-	-	-	-	3
CO-5:	Summarize differ	ent wire <mark>le</mark>	ess commu	nication standards t	o construct	wireless networks			2	2	-	-	-	-	-	-	-	-	-	2	-
Unit-1 - In	troduction to Wire	less Cor	nmunicati	ons and Networks	C.A.	1.1	9					÷								9	Hour
Introductio	n to wireless com	nunicatio	n and mob	ile radio communic	ation class	sification of wireless communi	cations/netv	vorks -	simp	lex half	duplex	c full	duplex	pagin	and	cordle	ss svs	tems (	cellula	r teler	hone
systems, t	iming diagram - lan	dline to	mobile, tim	ing diagram - mobil	e to mobile	e, frequency reuse, sectored a	nd omni-dir	ectiona	al ante	ennas, c	hannel	assig	nment s	strateg	gies, ha	andoff	and its	types,	interf	erenc	e and
system ca	pacity, cell splitting	and sect	oring, micro	ocell zone concepts,	umbrella d	ells, introduction to telecommu	inication ne	tworkin	ıg: trui	nking an	d grad	e of se	ervice								
Unit-2 - La	arge Scale Fading						1.1				1							<u> </u>	<u> </u>	9	Hour
Introductio	on to radio wave pro	pagation	, large scal	e, and small-scale fa	ading, Friis I Walfich	transmission equation - free s	pace propa	gation I	model	- pathlo	SS MO	del, tw	o ray m	odel, s	simplifi	ed pati	hloss n dowing	10del, e	empirio	cal mo	)del –
coverage a	empirical model –O area	kumura i		em, empirical mode	1 - VValliSII	anu benom mouer, piecewise i	inear moue	- 10g 11	onnai	mouer,	Silauon	wing, c	OMDINE	u pau	11055 d	110 5118	uowing	, outay	je proi	Janiii	y, cen
Unit-3 - S	mall Scale Fading				-			1.1		100										9	Hour
Introductio	on Small scale multi	path prop	agation, in	npuls <mark>e response</mark> mo	del of mult	ipath channel, impulse respon	se model of	multip	ath ch	annel, s	mall so	ale m	ultipath	meas	ureme	nts - di	rect pu	lse me	asure	ment,	small
scale mult	ipath measurement	s - slidin	g correlato	r measurement, sm	<mark>all scale n</mark>	nultipath measurements - swe	pt frequenc	y meas	surem	ent, par	ameter	s of m	obile n	nultipa	th cha	nnels -	time o	dispers	ion an	id coh	erent
bandwidth	, parameters of mob	nie multip	oatn channe	eis - doppler <mark>spread</mark> a	and cohere	nt time, types of fading: flat and	1 trequency	selectiv	ve tadi	ng, type	s of fac	nng: fa	ist and a	siow ta	adıng, i	icean (	iistribu	tion, ra	yieigh	distrit	Jution

Unit-4 - Improvement in Link Performance	9 Hour
Improvement in link performance/ communication networks - introduction to diversity, equalization and capacity, space diversity, scanning diversity, maximal ratio combiner, equal gain diversity, rak	e receiver,
MIMO/diversity, massive MIMO (elementary level), equalizer and its mode, adaptive equalizer block diagram, types of equalizers - elementary level only, Shannon capacity equation and throughput	
Unit-5 - Wireless Networks and Standards	9 Hour
Evolution of various wireless standards GSM system architecture and its interfaces GSM frame structure CDMA transmitter network architecture. CDMA receiver network architecture. OEDM bloc	k diagram

Evolution of various wireless standards, GSM system architecture and its interfaces, GSM frame structure, CDMA transmitter network architecture, CDMA receiver network architecture, OFDM block diagram, importance of cyclic prefix, introduction to 4G and 5G communications (frequency allocations and data rates), case study – 4G LTE architecture, case study – 5G architecture

	1.	Rappaport.T. S, "Wireless Communications: Principles and Practice", Second Edition, Pearson	4.	John D Kraus, Ronald J Marhefka, Ahmed S Khan "Antenna and wave propagation" 4th
Looming		Education, Reprint 2011.		Edition 2010.
Deseuress	2.	Andreas. F. Molisch., "Wireless Communications", Wiley Publications, Second Edition-2005,	5.	Jochen Schiller, "Mobile Communications", Pearson Education Asia Ltd., Reprint 2012.
Resources		Reprint-2014.	6.	Lee W.C.Y., " Mobile Communications Engineering: Theory and Applications", McGraw
	3.	Andrea Goldsmith, "Wireless Communications", Cambridge University Press, Aug 2005.		Hill, New York, 2nd Edition, 1998.

			Continuous Learning	Assessment (CLA)		Cummotive.				
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ige of unit test 0%)	Life-Long CL (1)	g Learning _A-2 0%)	Final Examination (40% weightage)				
	1. State 1.	Theory	Practice	Theory	Practice	<u>The</u> ory	Practice			
Level 1	Remember	20%		20%		20%	-			
Level 2	Understand	25%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	25%	-	25%	-			
Level 3	Apply	35%	2 S 10 10 10 10 10	35%		35%	-			
Level 4	Analyze	20%		20%		20%	-			
Level 5	Evaluate	1000		CHEVE AND	-	-	-			
Level 6	Create		-	A Party of the second		-	-			
	Total	10	0%	10	0%	100 %				

Course Designers	New Million and	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr. Sachin Kumar, SRMIST

Course Code	21ECE240T	Course Name	WAVELETS ANI	D SIGNAL PROCESSING	C	Course ategor	e Ty	E			PRO	ESSIO	NAL E	ELECT	IVE		1	L T 3 0	P 0	C 3
Pre-requ Cours	isite es	Nil	Co- requisite Cour <mark>ses</mark>	Nil		Pro	gres ours	sive es						Nil						
Course	Offering Departme	ent	ECE	Data Book / Codes / S	Standards	1							Nil							
Course L	earning Rationale	(CLR): The	purpose of learning this co	ourse is to:		-	đ		21	Progr	am Oi	itcome	s (PO)	)	_	-		P	rogra	m
CLR-1:	Summarize multi	resolution anal	lysis a <mark>nd wavele</mark> t signal proce	ssing		1	2	3	4	5	6	7	8	9	10	11	12	0	utcom	les
CLR-2:	Identify the famili	es of wavelets	re <mark>quired to ap</mark> ply the transform	mation to various real time applicat	ions	ge		of	s of	2.	ciety			rk		ē				
CLR-3:	Discuss about dis	screte systems	that employs wavelet transfor	rmation	100	vled		ent	ation	ge	soc			۶ ۸		anc	b			
CLR-4:	Analyze various r	real time applic	ations using filter banks		24	Knov	alysis	lopm	estiga	Usa	r and	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		Tean	ion	& Fir	arnin			
CLR-5:	Acquire knowledg	ge on wav <mark>elet t</mark> i	ransforms, types and applicat	ions of multiresolution analysis		eering	em Ana	in/deve	uct inve lex prol	rn Tool	nginee	onment	(0)	dual & .	nunicat	ct Mgt.	ong Le	-	2	е
Course O	utcomes (CO):	Att	the end of this course, learn	ers will be able to:		Engin	Probl	Desig	Cond	Mode	The e	Envire Susta	Ethics	Indivi	Comr	Proje	Life L	PSO-	PSO-	PSO-
CO-1:	Compare the mul	lti resolu <mark>tion an</mark>	alysis for discrete signals	The same in	54121	3	2		-	-		-	-	-	-	-	-	1	-	-
CO-2:	Summarize the fa	amilies o <mark>f wave</mark>	lets for compression	All and a second second		1		2	-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	Apply Discrete wa	avelet tr <mark>ansform</mark>	n to signals	11-252 0.02 2		1	-	3		-	-	-	-	-	-	-	-	-	-	2
CO-4:	Design filter bank	and its structu	re	2.2	200	3	-	2		-	-	-	-	-	-	-	-	-	-	1
CO-5:	Apply wavelet tra	nsforma <mark>tions fo</mark>	or varied applications	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-				2	1	-	-	-	-	-	-	-	-	-	-	3
linit d M	lultirocolution Ano	lucia		and the second															0	Hour
Introductio	on to multi resolution	n/ multi_scale_a	analysis- Time-frequency and	alvsis and wavelets- Piecewise cou	nstant anr	roxima	ation	Haar	wavele	t- Ruil	dina i	n the c	oncen	t of dy	adic. N	Aultires	olution	Anal	ysis (N	ARA)-
Relating o	yadic MRA to filter l	banks-A review	of discrete signal processing	-Elements of multi rate systems - 1	wo-band	filter ba	ank a	lesign	for dya	dic way	velets		oncop		aaro n	raitii 00	oration	, areary		noy
Unit-2 - F	amilies of Wavelet	s							10	12									9	Hour
Orthogona	al -Biorthogonal wa	velets-Daubecl	hies' family of wavelets-Conj	ugate Quadrature Filter Banks -	and their	design	-Dat	a Con	pressio	on-Fing	gerprir	t comp	ressio	n stan	dards-	JPEG-	2000 s	standa	rds-So	olving
Unit-3 - D	iscroto Wavalat Tr	ansform		1. 1. N. 11 N		_	-	-			-								0	Hour
Discretiza	tion in steps-Discre	tization of scale	e -Generalized filter bank-Dis	cretization of translation -Generaliz	zed outpu	t samp	lina-l	Discre	tization	of time	e/ spa	ce (inde	epende	ent var	iable)-	Goina	from pi	iecewi	ise line	ear to
piecewise	polynomial-The cla	ss of spline wa	velets-A case for infinite impu	lse response (IIR) filter banks											,					
Unit-4 - F	ilter Banks							_	-										9	Hour
Introductio	on to Variants of th	e wavelet tran	sform-Imple <mark>mentational stru</mark> c	tures-The wave packet transform-	-Computat	ional e	efficie	ency ir	n realizi	ng filte	er ban	ks -Pol	yphas	e com	ponent	ts-The	lattice	struct	ure-So	olving
Problems	inne illung scheme ianal Processina I	Applications						-											٥	Hour
Transient Applicatio	analysis-Singularity ns to the solution of	Detection-Bior	medical signal processing app ial equations-Solving Problem	olications-Efficient signal design ar	nd realizat using Scil	ion-Wa ab	avele	t base	d modu	lation	and d	emodula	ation-A	Applica	tions i	n math	ematic	al app	roxim	ation-

g.			Continuous Learning	Assessment (CLA)		Cum	mativa			
	Bloom's Level of Thinking	Forr CLA-1 Avera (5	native age of unit test 0%)	Life-Loi C (	ng Learn <mark>ing</mark> CLA-2 10%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		15%		15%	-			
Level 2	Understand	25%		25%		25%	-			
Level 3	Apply	30%		30%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	30%	-			
Level 4	Analyze	30%		30%		30%	-			
Level 5	Evaluate			100 C		-	-			
Level 6	Create			Sector Sector		-	-			
	Total	10	0 %	1	00 %	10	0%			
			1. S. 1. 2. 1981	distant 200	53- A -					

Cοι	ırse Designers		
Ex	perts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.	Mr. Anuj Kumar, Bombardier Tr <mark>ansporta</mark> tion,	1. Dr. Meenakshi, Professor of ECE, CEG, Anna	1. Dr.C. Vimala, SRMIST
	Ahmedabad, kumaranuj.anii@g <mark>mail.com</mark>	University, meena68@annauniv.edu	
2.	Mr. Hariharasudhan - Johnson Controls, Pune,	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai,	2. Dr.S. Dhanalakshmi, SRMIST
	hariharasudhan.v@jci.com	venkat@niot.res.in	



Course Code	21ECE241J	Course Name	e	AUDIO AND	SPEECH	H PROCESSING		Co Cate	urse egory	E		PROFESSIONAL ELECTIVE							C 3				
Pre-requis Course	site 27	1ECC204	T	Co- requisite Course <mark>s</mark>		Nil			Progre Cour	ssiv ses	e						Ni	1					
Course C	Offering Departme	ent		ECE		Data Book / 0	Codes / Stand	lards							_	Nil							
Course Le	arning Rationale	(CLR):	The purpos	e <mark>of learnin</mark> g this o	course is	s to:	101		- 2-	U	6	11	Progr	am Ol	<mark>itcom</mark> e	es (PO	)				P	rogra	m
CLR-1:	Knowledge on au	dio proce	essing and cha	racteristics of spee	ch signa	1		1	2		3	4	5	6	7	8	9	10	11	12	01	itcom	es
CLR-2:	Know the speech	signal an	nalysis i <mark>n time</mark>	domain	N	de la compañía de la		-		5		-	2.										
CLR-3:	CLR-3: Identify frequency characteristics of speech signal and know the linear predictive analysis of sp signal								2	of	5	s of		ciety	inability		Ł		e				
CLR-4: Acquire the fundamental knowledge on acoustic theory of speech production and construct the dig model of speech signal							ital permot	Sis	pment		tigation	Isage	and soc	k Susta		eam Wo	c	Financ	ning				
CLR-5: Identify the ethical issues of elements of music and know about the sound vibrations –pure tones							nd K	n Analy	/develo	JS S	ct inves ex proble	J Tool L	gineer	ment 8		Jal & Te	unicatio	: Mgt. &	ng Lear				
Course Ou	tcomes (CO):		At the end	of this course, lea	rners wi	II be able to:	314	Encine	Probler	Desian	solution	Conduc	Moderr	The en	Enviror	Ethics	Individu	Commi	Project	Life Lo	PSO-1	PSO-2	PSO-3
CO-1:	Acquire the basic	s of audic	o processing a	nd characteristics c	of speech	1		3	1.1		-	-	3	- 16	-	-	-	-	-	-	-	-	-
CO-2:	Analyze the func characteristics	tion of <mark>fe</mark>	eature extraction	on in speech and	audio si	gnal processing u	sing time dor	nain 3	-		2	- 1	-		-	-	-	-	-	-	-	-	2
CO-3:	Demonstrate the	frequen <mark>cy</mark>	<mark>y chara</mark> cteristic	cs of speech signal	and the	linear predictive ar	nalysis of spe	ech 3			2	-	-		-	-	-	-	-	-	-	-	2
CO-4:	Apply appropriate	e digital <mark>m</mark>	<mark>iodels fo</mark> r spee	ech signal		1000		3	2		-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Interpret the time	elements	s <mark>of music</mark>	120			1.1.1	-	-		2	-	- 1	1	1	-	-	-	-	-	-	-	-
Unit-1 - Fu	ndamentals in Au	idio Proc	essina	-			-Hete					-	-	-								12	Hour
Introduction Speech pro <b>Practice</b> : E	n to Digital audio, ( oduction mechanis Basic operations or	Capturing m-Charac n speech	and convertin cteristics of Sp signals, Fourie	g sound, Sampling eech, Speech Unde <mark>er tra</mark> nsform and ma	of sound erstandir agnitude	l wave, Audio hand ng spectrum of speec	lling, Normaliz ch signal, Cep	ation, A strum sr	udio pro nootheo	ocess I mag	sing, gnitu	. Segm ide spe	entati ectrum	on, An 1	alysis	of wind	low siz	ing, Vi	sualiza	tion, Se	ound g	enera	tion,
Unit-2 - Sp	eech Signal Anal	<b>ysis in Ti</b> domain n	ime Domain promotore of c	pooch signal Math	odo for c	wtracting the para	motora Short	timo En	aray St	ort	timo	Avora	ao Ma	anitud	la Sha	rt Time	Zoro	orocoir	a Doto	(700)	Tho	12 obort	Hour Time
Autocorrela	ation Function, Sile	nce Discri	imination usin	g ZCR and energy,	Pitch Pe	eriod Estimation us	ing Autocorre	lation Fu	inction	1011 -1	ume	Avela	ye ma	griituu	e, 3110	it inne	Zeio	6103511	y Rale	(206)	, me	511011	IIIIe
Practice: S	Short-term energy of	of a speed	ch signal, Spee	ech analysis using z	zero cros	ssing detector, Spe	ech analysis	using au	tocorre	lation	n and	d Shor	t-time	Fourie	r trans	form s	pectrui	n.					
Unit-3 - Sp	eech Signal analy	/sis in Fr	equency Don	nain Iomorporphia opeac	ah analu	aia. Llamamampia	Customa for	Convolu	tion T	ha (	<b>1</b> 0 ma m	law C	o otru	m of C		The	110 00 0		. 1/2	dar F		12	Hour
Estimation, Solution for <b>Practice:</b> I	Linear Predictive the Autocorrelatio	analysis c n Equatio nagnitude	of speech -Inti ofs. spectrum, Est	roduction, Basic Pri timation of formant	frequenc	of Linear Predictive	e analysis of s e diction, Estin	peech, in the second se	Autocor Autocor pitch p	relat relat	ion i d usi	methoo ing Sin	d, Cov	arianc Inver	e meth se Filte	, The lod, So er Trac	hornon olution king A	of LPC	c voco c equat m (SIF1	ions D () and	urbin's harmo	nic pr	rsive oduct
spectrum																							

### Unit-4 - Digital Models for Speech Signal

Introduction to Acoustic Phonetics, Acoustic theory of speech production-Sound propagation - uniform lossless tube, Effect of losses in the vocal tract, Effect of radiation at the lips, Vocal tract transfer function ofvowels, Effect of nasal coupling, Excitation of sound in vocal tract, Digital models for speech Signals **Practice:** Phoneme-level segmentation of speech, Estimation of sound in vocal tract, Sound vibrations

### Unit-5 - Time Elements in Music

Sound vibrations – Pure tones and perception of pitch, Auditory coding in the nervous system, Subjective pitch and role of nervous system, Sound Waves, Acoustic Energy, and the Perception of Loudness- The Loudness Perception Mechanism and Related Processes, Perception of Pitch and Timbre of Musical Tones Practice: Feature extraction of speech signal, Speech production mechanism, Study of feature extraction and SVM classifier

	1.	Ian McLaughlin, Applied Speech, and audio processing, with MATLAB examples, 1st	4.	Lawrence Rabiner, B.H. Juang, Fundamentals of Speech Recognition, 2 <sup>nd</sup> edition.
Loomina		edition Cambridge University Press, 2009.		Prentice-hall, 1993
Descurees	2.	Ben Gold, Nelson Morgan, Dan Ellis, Wiley, Speech, and Audio Signal Processing:	5.	A.R. Jayan, Speech and Audio Signal Processing, PHI Learning Pvt. Ltd, 2016.
Resources		Processing and Perception of Speech and Music, 2nd edition. John Wiley & Sons 2011.	6.	Juan G. Roederer, The Physics and Psychophysics of music, An Introduction
	3.	Ken Pohlmann, Principles of Digital Audio, 6th edition., McGraw-Hill, 2007	1,24	4th edition, Springer, 2008

Learning Assessn	nent			207512						
			Continuous Learning	Assessment (CLA)		0				
	Bloom's Level of Thinking	Forn CLA-1 Avera (4)	native ge of unit test 5%)	Life-Lon CL (1	g Learning "A-2 5%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		1-3 - 4 - 1 / 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1	15%	15%	-			
Level 2	Understand	25%		STREET, NO.	25%	25%	-			
Level 3	Apply	30%		A CONTRACTOR	30%	<mark>3</mark> 0%	-			
Level 4	Analyze	30%			30%	<mark>3</mark> 0%	-			
Level 5	Evaluate			-		-	-			
Level 6	Create			-			-			
	Total	10	0%	10	0 %	10	0 %			

Course Designers	ALL CONTRACTOR OF THE OWNER OWNER OF THE OWNER OWNE	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
<ol> <li>Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranui anii@gmail.com</li> </ol>	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Mrs.Suganthi Brindha G, SRMIST
<ol> <li>Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@ici.com</li> </ol>	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	2. Dr.S. Dhanalakshmi, SRMIST

12 Hour

Course Code	21ECE242J	Course Name	PATTERN RECOO	SNITION AN	ID NEURAL NETWORKS	C Ca	ourse itegory	,	E		Ρ	ROF	ESSIO	NAL E	LECT	IVE			- T 2 0	P 2	C 3
Pre-requis	site s	Nil	Co- requisit Courses	e	Nil		Prog	ress urse	sive es						Nil						
Course (	Offering Departme	ent	ECE		Data Book / Codes / Sta	ndards	100		_					Nil							
Course Le	arning Rationale (	(CLR): 7	The purpos <mark>e of learnin</mark> g th	is course i	s to:		-	1	1	P	rogran	n Out	tcome	s (PO)	)				P	rograi	m
CLR-1:	Have an insight o	n pattern re	ecognition	1.0			1	2	3	4	5	6	7	8	9	10	11	12	่ S 0เ	pecifi Itcom	c es
CLR-2:	Analyze few para	meter estim	nation methods for pattern re	cognition	Concernance and		e		f	s of	10	ety			¥		0		l l		
CLR-3:	Acquire knowledg	ge on the fu	nda <mark>mental ne</mark> ural networks	1	-	16	ledc		ent o	tions	a	soc		-	Wo		ance	5			
CLR-4:	Apply the neural i	network rec	urrence for pattern recogniti	on studies	West and		Non	lysis	opme	stiga	Usaç	and	æ		eam	u	š Fin	Ining			
CLR-5:	Know the practica	al applicatio	ns of neural networks in pat	tern recogni	tion		ering F	ר Ana	devel	t inve x prob	Tool	gineer	ment ability		al & T	nicati	Mgt. 8	ig Lea			
-						-	gine	blen	sign/	nduc nple;	dern	e enc	viron stain	ics	ividu	mm	ject	e Lor	<u>-</u>	0-7	0-3
Course Ou	tcomes (CO):		At the end of this course,	learners wi	Il be able to:		ы́.	E E	De	8 8	Mo	Ĕ	Su: Su:	击	pul	රි	Pro	Life	R	R	PS
CO-1:	To outline the fun	dament <mark>als</mark> o	<mark>of rec</mark> ognition of patterns , re	egularities in	n data and classifiers	41	1	-	-	3	-	-	-	-	-	-	-	-	-	-	2
CO-2:	Understand the estimation and tra	basic is <mark>sue</mark> aining-s <mark>et er</mark>	e <mark>s in</mark> classification of error rror estimation	estimation,	such as definitions, test-set	error	2	1		3	-	-		-	-	-	-	-	-	-	3
CO-3:	Acquire knowledg	ge on th <mark>e ba</mark>	<mark>asics</mark> of neuron model and fu	ndamentals	s on learning algorithms		- 1	-	3		3	-	-	-	-	-	-	-	-	-	-
CO-4:	Realize the error	model a <mark>nd o</mark>	calculate the deviation with i	back propag	ation networks			-	2	3	-		-	-	-	-	-	-	-	2	-
CO-5:	Identifying the ap	plication <mark>s o</mark> i	<mark>f neur</mark> al networks in the area	of pattern	recognition	11	-hi	-	2	3	3	-	-	-	-	-	-	-	-	2	-
<b>Unit-1 - Int</b> Introduction Classifiers	roduction to Patte to Pattern Recog	ern Recogn nition- Ove	nition rview of Pattern Classifiers	Bayesian	decision making - Bayes Clas.	sifier - B	Bayes (	Class	sifier fo	or minim	izing R	isk-E	stimati	ing Ba	yes Er	rror; M	inimax	and N	eymai	<b>12</b> 1n-Pea	<b>Hour</b> arson
Practice of	n Digitization of and	alog signals	s, e <mark>xtract info</mark> rmation from in	age, analys	sis of a data set with classifiers	<u>.</u>			_	-	1										
Unit-2 - Lir Məximum li	lear Basis Function	on wodels	equential learning - The Bias	Varianco D	ecomposition - Bayesian Lines	ar Roaro	ssion -	Dara	motor	distribut	ion - Pr	dict	ivo dist	ributio	n - Rai	Incian	Model	Comp	arison	-Evalı	HOUR Intion
of the evide	ence function - Max	imizing the	evidence functions- Limitati	ons of Fixed	Basis Functions.	ar Negre	331011-1	ara	meter	นเรแามนเ	1011 - 1 11	Juici		Indutio	n - Day	1031011	MOUCI	Compe	113011	Lvaiu	auon
Practice of	n Bayesian regress	sion, selection	on of pre <mark>dictive featur</mark> es and	l clustering	methods		1	1	1.1												<del></del>
Unit-3 - Int	roduction to Neur	ral Network	(S	Unounory	and rainforced Pasia los	rning ru	loo of	1 1/1/1	Food	forward	Notwo	k Eu	notion	o 14/o	iaht or	200 0	mmot	rian M	otwork	12 /	Hour
Perceptron Practice of	theory- Parameter function descripti	optimizatio	n -Local quadratic approxim Culloh pitt. Hebb and Prece	ation - Use	of gradient information -Gradie	ent desce	ent opt	imiza	ation	iorwaru	Networ	k Fu		s - we	iyin-sp		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	162 -14	JIWUIK	IIdili	nıg –
Unit-4 - AN	IN for Classificati	on and Reg	ression																	12	Hour
Hop-field r backpropag <b>Practice o</b>	etworks, Recurrer <sub>J</sub> ation - Annealing - <b>n</b> Back propagation	nt and bi-di -Travelling n networks,	irectional associative mem salesman problem. Hopfield networks and me	ories, Boltz mory assoc	mann machine - Back propa iations	agation I	networ	(S –	Error	Backpi	opagat.	on-	Evalua	ation o	f erro	r-functi	ion de	rivative	s - E	fficien	cy of
																					07

# Unit-5 - ANN for Organization and Recognition

Self-organizing map - learning algorithm – feature selection -feature map classifier – applications - Architecture of Adaptive Resonance Theory – Pattern matching in ART network - Hand written digit recognitioncharacter recognition networks

Practice on orthogonality, character recognition and a mini project

Learning	1. 2	Laurene Fausett, "Fundamentals of Neural Networks: Architecture, Algorithms and Applications", Pearson Education, (reprint) 2006. Martin T Hagan, "Neural network design", Cangage publications, 2010.	4. 5.	R.O.Duda, P.E.Hart and D.G.Stork, "Pattern Classification", John Wiley, 2002 Freeman J.A. and Skapura B.M., "Neural Networks, Algorithms Applications and Programming Techniques" Addison-Wesely, 1991
Resources	3.	C.M.Bishop, "Neural Networks and Pattern Recognition", Oxford University Press (Indian Edition), 2003.	6.	Kosko B, "Neural Networks and Fuzzy Systems: A dynamical system approach to machine intelligence", Prentice Hall of India, 2009

Learning Assessn	nent	N 2 1							
		/	Continuous Learning	Assessment (CLA)		Sum	mativo		
	Bloom's Level of Thinking	Forn CLA-1 Avera (45	native ge of unit test 5%)	Life-Long CL (1-	g Learning A-2 5%)	Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%		1000	15%	15%	-		
Level 2	Understand	25%	How Store Vo	41.4	20%	25%	-		
Level 3	Apply	30%	100	1000	25%	30%	-		
Level 4	Analyze	30%	1	あるとなる	25%	<mark>30</mark> %	-		
Level 5	Evaluate	1 1 2 2 3			15%	-	-		
Level 6	Create	No. Anna		100 Mar 100 Co		-	-		
	Total	10	)%	10	0%	10	0%		
				A state of the	1000				

Course Designers		A CONTRACT OF A
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Mr. Anuj Kumar, Program Delivery Manager, Nagarro Software's Pvt Ltd.	1. Dr.A. Ruha <mark>n Bevi, SR</mark> MIST



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Course Code	21ECE340J	Cou Categ	rse Jory	E			PROF	ESSIC	)nal e	ELECT	IVE			L T 2 0	P 2	C 3			
Pre-requ Cours	isite es	Nil	Co- requisite Courses	Nil	P	rogres Cours	ssive ses						Nil	1					
Course	Offering Departme	ent	ECE	Data Book / Codes / St	tandards							Nil							
Course L	earning Rationale	CLR): The p	urpose <mark>of learnin</mark> g this o	course is to:		1	1		Progra	am Ou	utcome	s (PO	)				P	rogra	m
CLR-1:	Impart knowledge	on the basic ima	age processing technique	S	1	2	3	4	5	6	7	8	9	10	11	12	<ul> <li>Specific</li> <li>Outcomes</li> </ul>		
CLR-2:	Identify image fre	quency level filt <mark>e</mark> l	Ð		+	of	2.	ety			¥		-						
CLR-3:	Gain knowledge o	n Image Seg <mark>me</mark> l	/ledg		ent o	tions	ge	soci			Wo		ance	0					
CLR-4:	Educate the basic	s of video proces	ssing	West and	Anow	lysis	opme	stiga	Usaç	and	∞		eam	uo	& Fin	arnin			
CLR-5:	Describe video sa	ampling, storage a	and communication proce	dures	leering h	em Ana	In/devel	uct inve lex prob	rn Tool	ngineer	onment	6	dual & T	nunicati	ct Mgt. 8	ong Lea	-	2	3
Course O	utcomes (CO):	At the	e end of this course, lea	rners will be able to:		Proble	Desig	Cond	Mode	The e	Envire	Ethics	ndivi	Comr	Proje	-ife L	-OSc	-OSc	-OSc
CO-1:	Acquire the funda	mentals of Image	Processing	Alter Sure M	3	-	2	-	-	1	-	-	-	-	-	-	3	-	-
CO-2:	Describe the imag	ge frequ <mark>ency do</mark> n	nain filtering, restoration a	nd reconstruction	-	2		3	-		-	-	-	-	-	-	-	2	1
CO-3:	Construct image	segmen <mark>tation m</mark> o	d <mark>el</mark> s and know about des	criptors extraction	2	3	1		-	- 30	-	-		-	-	-	-	3	-
CO-4:	Interpret the video	o compr <mark>ession a</mark> r	d sampling standards		3	-	2		-		-	-	-	-	-	-	3	-	-
CO-5:	Evaluate video sa	mpling <mark>and stor</mark> a	ge techniques	A CONTRACTOR		2	3	-	-		-	-	-	-	-	-	2	-	1
Unit-1 - F	undamentals of Im	age Proc <mark>essing</mark>	1	Color of the	2	1.62			1	-								12	Hour
Elements Sharpenin Practice	of visual perception, og filters Image sampling and	Image sensing a	nd acquisition, Image san	npling and quantization, Relationship b s in image. Histogram equalization	between pixe	ls, Ima	ge Tran	nsforms,	Trans	forma	tion fun	ctions	, Histo	gram F	Process	ing, Sp	oatial-	Smoo	thing,
Unit-2 - In	nage Filtering and	Reconstruction			1.000				1									12	Hour
Filtering ir frequency <b>Practice</b> :	n frequency domain domain filtering, Inv Frequency domain i	- Sampling, Fo <mark>ur</mark> erse, Wiener, Le iltering, Image Re	<mark>ier trans</mark> form of sampled a <mark>st Square,</mark> Geometric Fi econstruction, Matching F	functions, Discrete Fourier Transform Itering ;ilters	n, Properties,	Image	Restor	ration ai	nd Rec	constru	uction -	Noise	mode	l, Spat	ial Filte	ering, r	ioise re	educti	on by
Unit-3 - In	nage Segmentation	n <u><u></u></u>	,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,,			1.1												12	Hour
Point, Line <b>Practice</b> :	e, Edge Detection, T Image Segmentatio	hresholding, Reg n, Region descrip	ion based segmentation, otors detection, Extraction	Morphological Watersheds, Motion in of Principal Components	n image segr	entatio	on, Bou	ndary, I	Region	desc	riptors,	Use o	f princi	ipal coi	npone	nts			
Unit-4 - B	asics of Video Pro	cessing											<u>.</u>					12	Hour
Video bas	ics, Time-varying In Split video into fram	age formation Me	odels, Spatio Temporal <mark>S</mark> eo signal, Video Compres	ampling, Optical flow, General metho ssion	dologies, Ov	erview	of codi	ng syste	ems, V	ideo C	Compre	ssion	Standa	ards, O	bject b	ased v	ideo co	oding	

Unit-5 - Video Sampling and Storage Video Sampling and Interpolation, Video Rendering and Assessment, Perceptual criteria for Image Quality Evaluation, Video Storage, Retrieval and Communication Practice: Content based image retrieval, Video quality evaluation, video communication networks

Learning	<ol> <li>Gonzalez.R.C &amp; Woods, "Digital Image Processing", R.E., 3/e, Pearson Education, 2008.</li> <li>Bovik, "Handbook of Image &amp; Video Processing", Academic Press, 2000.</li> <li>Yao Wang, Jorn Ostermann and Ya Qin Zhang, "Video Processing and Cmmunications",</li></ol>	<ol> <li>Thanki, Rohit M., Kothari, Ashish M, "Digital Image Processing using SCILAB", Springer</li> <li>Mohammad Atique, Amol Bhagat, "Introduction to Digital Signal Processing - Using Matlab</li></ol>
Resources	Prentice Hall Publishers, 2002	and Scilab", Vikas Publishing

	Bloom's Level of T <mark>hinking</mark>	Bloom's     CLA-1 Average of unit test     CLA-2       Level of Thinking     (45%)     (15%)							
	1.0	Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%			15%	15%	-		
Level 2	Understand	25%	1	10/01/2010	20%	25%	-		
Level 3	Apply	30%	100 C 20 100		25%	30%	-		
Level 4	Analyze	30%	No Cast Vi		25%	30%	-		
Level 5	Evaluate		10 10 10 10 10 10 10 10 10 10 10 10 10 1	1.000	10%	-	-		
Level 6	Create	Contraction of the second		1411400	5%	- H	-		
Total		10	0%	10	0%	10	0%		

Course Designers					~				
Experts from Industry	1	Ex	perts from Higher Technical Institutions	Internal Experts					
1. Athif Shah, CTO, Abe	Technologie <mark>s, Chenn</mark> ai	1.	Dr.V. Masilamani, Associate Professor, Computational Engineering, IIIT D&M, Kancheepuram	1.	Dr.S. Dhanalakshmi, SRM IST				
2. Mr.A. Vishwanath, Res	earch and Innovation Scientist,	2.	Dr.V. Sathiesh Kumar, Assistant Professor, Electronics Department,	2.	Dr.S.Latha,As <mark>sistant, S</mark> RM IST				
Genet.IO.Hyderabad			MIT, Chennai	in the second					



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Course Code	21ECE341J	Course Name	TEM DESIGN	Cour Categ	se ory	E			PROF	ESSIC	)NAL E	ELECT	IVE		Ĺ	<u> </u>	P 2	C 3		
Pre-requi Course	site s	Nil	Co- requisite Courses	Nil	P	rogres Cours	sive es						Nil	1						
Course	Offering Departme	ent	ECE	Data Book / Codes / Stan	ndards							Nil								
Course Le	arning Rationale	(CLR): Th	ne purpo <mark>se of learnin</mark> g this cour	se is to:		1	1	1.1	Progra	am Ou	itcome	s (PO)	)				Pr	Program		
CLR-1:	Summarize the co	1	2	3	4	5	6	7	8	9	10	11	12	SI Ou	tcom	c es				
CLR-2:	Analyze multirate	signal proce	ssing	and the second s	e e		of	s of	2	iety			¥		a)					
CLR-3:	Explain the archit	ecture of TM	S <mark>320C54X</mark>	1000	vledç		ento	ations	ge	soc			oW r		ance	D				
CLR-4:	Gain knowledge o	on DSP archi	itecture and instruction sets of TM	S320C6X	Knov	lysis	mdo	stiga	Usa	and	৵		Team	u	& Fir	arnin				
CLR-5:	Design DSP syste	em for real tir	ne applications.			em Ana	jn/devel	uct inve lex prot	ern Tool	engineer	onment ainability	S	dual & J	nunicati	ct Mgt.	ong Lea	5	ç	ç	
Course Or	utcomes (CO):	A	t the end of this course, learner	s will be able to:	Engir	Probl	Desig	Cond	Mode	The e	Envin Susta	Ethics	ndivi	Comr	Proje	life L	-OSc	-OSc	-OSc	
CO-1:	Illustrate the effect	ct of fini <mark>te wo</mark>	rd length and structure realization	A December of the	1	3	-	-		1	-	-	-	-	-	   -	-	-	2	
CO-2:	Apply concepts o	f multira <mark>te si</mark> g	gnal processing	the second second	-	2	3		-	-	-	-	-	-	-	-	-	-	1	
CO-3:	Summarize TMS	320C54 <mark>x arcl</mark>	hitecture	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		2	3	-	-	- 20	-	-		-	-	-	-	-	3	
CO-4:	Acquire in-depth	knowled <mark>ge o</mark> l	n DSP architecture and instructior	sets of TMS320C6X	1	-	3	2	-	-	-	-	-	-	-	-	-	-	3	
CO-5:	Infer Knowledge	on DSP <mark>syste</mark>	em based design and application	States and	1 C	2	1.	3	-	-	-	I	-	-	-	-	-	-	1	
Unit-1 - Fi Basic Elen and roundi Practice: (	nite Word Length nents of DSP, Adva ng off, Realization Generation of seque	Effect and S ntages and a of digital filter ences (function	tructure Realization applications of DSP, Sampling of s - Direct form I realization, Cano onal & random), Correlation, Linea	analog signals Sampling theorem, A nical structure Realization ar convolution, circular convolution	Aliasing and	l Quan	tization	of con	tinuous	s ampl	litude s	ignal,	Quanti	ization	noise,	Errors	due to	12 trunc	Hour ation	
Unit-2 - M	ultirate Signal Pro	cessing							1					_				12	Hour	
Introduction using z tra Application <b>Practice</b> : I	n to Multirate signa nsform, Polyphase is of multirate DSP, nterpolation. effect	l processing, structure of Sub band co of interpolation	decimation, interpolation, antia-li interpolator, Polyphase interpolati oding of speech signals, filter bani on in frequency domain, decimatio	asing filter, anti-imaging filter, Samp on using z transform, Advantage ar < on, effect of decimation in frequency	oling rate conditional application of the second seco	onversi ons of desian	ion by a multira of antia	a ration te DSF a-liasin	al facto , interfa a filter. <mark>.</mark>	or I/D, acing desiar	Polyph of digit	i <mark>ase</mark> st al sysi i-imag	ructure tems v ina filte	e of de⊧ vith diff er	cimatoi erent s	, Polyp amplin	hase g rates	decim s, Pra	ation ctical	
Unit-3 - TI	IS320C54x Archit	ecture				Ŭ				9		5	0					12	Hour	
Harvard Ar of TMS320	chitecture and Von C54x, Addressing	- Neuman Ar Modes of TM	chitecture, Tex <mark>as Instruments</mark> TM IS320C, Introductio <mark>n to code com</mark>	S320 Family, TMS320C54x DSP Fu poser studio and Procedure to work	unctional B on ccs usi	lock Di ng targ	agram et	and Ex	olanatio	on, Mi	AC Uni	t, Pipe	ling an	nd Para	llel Pro	cessin	g, Inst	ructio	า Set	

Practice: : Design of digital FIR Low, High, Band Pass filters using different windows, Design of digital filters using Impulse invariance method, Design of digital filters Bilinear transformation

## Unit-4 - TMS320C6X Architecture

Architecture of TMS320C6X, Pipeline CPU, Functional Units, Addressing modes, TMS320C6X Instruction Sets, TMS320C6X Assembly Language Operations, Individual Instruction Descriptions, Arithmayic and logical operations, Memory data operations, Conditional Operations

# Practice: study of architectural digital signal processor, Arithmetic operations using processor (Addition, Subtraction, Multiplication) - Assembly and C language

## Unit-5 - DSP Applications

Dual tone Multi-Frequency (DTMF) Signaling, Software Defined Radio (SDR), QAM Transmitter and QAM Receiver, u-Law for Speech Companding, Acoustic Direction Tracker, Multirate Filter, Neural Network for Signal Recognition, PID Controller, Four-Channel Multiplexer for Fast Data Acquisition, Video Line Rate Analysis, MP3 Player, DSP Automotive application **Practice**: Linear and circular convolution using DSP processor, waveform generation using DSP processor.

		1.	B Venkataramani, M Bhaskar, "Digital Signal Processors: Architecture, Programming and	4.	RulphChassaing - "DSP Applications Using C and the TMS320C6x DSK"	
			Applications", TMH Publishers, 2nd edition, 2017		John Wiley & Sons, Inc. 2002.	
Learnin	g	2.	Paulo S. R. DinizEduardo A. B. da Silva and Sergio L. Netto, "Digital Signal Processing System	5.	Nasser Kehtarnavaz, "Real-Time Digital Signal ProcessingBased on the	
Resour	ces		Analysis and Design", Cambridge University Press, 2nd Edition.2010		TMS320C6000", Newnes, 2005.	
		З.	John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing, Principles, Algorithms and			
			Applications", Pearson Education, 4th edition, 2007			

Learning Assessm	nent			Same and the second							
		1 St.	Continuous Learning	g Assessment (CLA)		Cum	motivo				
	Bloom's Level of Thinking	Form CLA-1 Avera (45	native ge of unit test 5%)	Life-Long CL (15	1 Learning A-2 5%)	Final Examination (40% weightage)					
	and the second se	Theory	Practice	Theory	Practice	<u>The</u> ory	Practice				
Level 1	Remember	15%	A Contract March	and the second second	15%	15%	-				
Level 2	Understand	25%	a literative states in the		20%	25%	-				
Level 3	Apply	30%			25%	<mark>3</mark> 0%	-				
Level 4	Analyze	30%			25%	<mark>3</mark> 0%	-				
Level 5	Evaluate				15%	-	-				
Level 6	Create		- 1/14-	-	-	-	-				
	Total	10	0 %	100	0 %	10	0 %				

Соі	ourse Designers												
Ex	perts from Industry	Experts from Higher Technical Institutions Internal Experts											
1.	Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna     1. Dr. Damodar Panigrahy, SRMIST       University, meena68@annauniv.edu     1. Dr. Damodar Panigrahy, SRMIST											
2.	Mr. Hariharasudhan - Johnson Controls, Pune,	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in											

12 Hour

Course Code	Course Code         21ECE440T         Course Name         ADAPTIVE SIGNAL PROCESSING								Cour Categ	se ory	E			PROF	ESSIO	NAL E	ELECT	IVE			- T 3 0	P 0	C 3
Pre-requis Course	site s	21ECC204	4T	Co- Co	requisite urses		Nil		P	rogres Cours	sive es					2	1ECE	241J					
Course C	Offering Departi	ment		ECI			Data Book /	Codes / Standa	rds							Nil							
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Course Le	arning Rational	e (CLR):	I ne purp	bose of lea	rning this co	ourse is	t0:	_				-	Progr	am Ol	Itcome	S (PU	Specific						
CLR-1:	Acquire knowle	edge about	the random	n processes		1	1		1	2	3	4	5	6	7	8	9	10	11	12	Ou	tcom	es
CLR-2: Describe the various applications of adaptive filters.											of	s of		siety			¥		ġ				
CLR-3:	CLR-3: Analyze the variants of Least Mean Square algorithm.										ent	ation	ge	soc			۲ Wc		Janc	b			
CLR-4:	Gain knowledg	e on data <mark>s</mark>	ele <mark>ctive ada</mark>	aptive filter	ing and its ty	rpes.	112-1		<b>Von</b>	lysis	mdo	stig:	Usa	and	∞ .		ean	u	Ē	arnin			
CLR-5:	Compile the typ	pes of perio	dogram for	spectral a	nalysis.		1.63.9	1. 1.	ing	Ana	evel	inve	00	neer	hent bility		<u>م</u>	icati	lgt. å	Lea			
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Course Ou	tcomes (CO):		At the er	nd of this o	course, learn	ners will	be able to:	A Decore	Engi	Prob	Desi	Conc	Mode	The	Envi	i <del>i</del>	ndiv	Com	<sup>2</sup> roje	_ife	SC	So	SO
CO-1:	Identify the diffe	erent rand <mark>o</mark>	o <mark>m proce</mark> sse	es.		154	12-6-65	. N. V. S.	3	2		-	-	1		-	-	-	-	-	-	1	-
CO-2:	Construct adap	tive filters <mark>:</mark>	<mark>for vario</mark> us a	applications	6.	de de		신문 문	-	3	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	Analyze the val	riants of L <mark>e</mark>	<mark>ast Me</mark> an S	Square algo	rithm.		22. U	1.8.4		2	3		-	- 10	-	-		-	-	-	-	2	-
CO-4:	Describe the da	ata selecti <mark>v</mark>	<mark>e adapt</mark> ive i	filtering and	l its types.	2.5		100	1.14	2	3		-		-	-	-	-	-	-	-	-	1
CO-5:	Illustrate Spect	ral analys <mark>is</mark>	<mark>s using p</mark> erio	odogram.			10.00	2	163	2	3	- 1	-	1	-	-	-	-	-	-	-	-	1
11-14 4 1-4	maderations to De			1		27.9								-									
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Central Lim	it theorem, Rand	lom proces	ses, Wide-S	Sense Stati	onary proces	sses, Aut	ocorrelation and	autocovariance f	unctions	s, Spec	ctral rep	present	ation o	f rando	om sign	als, W	liener l	Khinch	in theor	em, Pr	opertie	es of p	ower
spectral de	nsity, Gaussian	Process an	d White noi	<mark>is</mark> e process	s, Linear Syst	tem with	random input, S	Spectral factorizati	on theo	rem ar	nd its in	nportar	ice, Ini	novatio	on proce	ess an	d white	ening f	ilter, Ra	andom	signal	mode	lling:
MA(q), AR(	<u>p) , ARMA(p,q) ı</u> Iantiva <b>Filt</b> ars	nodels				-	-		_		-	-	1										Hour
Principle ar	application. S	teepest de	scent algori	ithm, Conv	ergence char	racteristi	cs, LMS algorith	m, Convergence,	Excess	Mean	n Squai	re Erroi	: Leak	V LMS	algorit	hm, A	pplicat	ion of	adaptiv	e filter	s. RLS	algor	ithm.
Matrix inve	rsion Lemma, Ini	itialization,	Tracking of	<sup>r</sup> nonstation	arity,	£1			Ρ.		54			,	Ū				,			U	,
Case Stud	y- Applications o	of adaptive	signal proce	es <mark>sing:</mark> Noi	<mark>se Cancellati</mark>	ion	_		_	direction of the													
Unit-3 - Le	ast inean Squar hm in real-time a	e Algorith	m and its v	Sign Rog	essor Sign F	Error and	I Sian Sian I MS	Normalized I MS	algorith	m Ble	ockIM	S - FET	hasor	imple	montati	on of	tha hla	ckIM	S Algor	ithm V	ariahlı	9 I	Sizo
(VSS) LMS	and NLMS algo	rithm, Self-	correcting L	LMS algorit	hm, Affine Pr	rojection	algorithm vs LM	IS algorithm,	aiyonti	пп, ыс		0=111	Daset	imple	mentati				JAIYUI	<i>um,</i> v	anabit	; olep	0120
Case study	y-application usi	ng VSS alg	orithm					0															
Unit-4 - Da	ta Selective Ad	aptive Filt	ering	ot momber	hin hinormal	lined LM	Computations	l complexity Der	iol unde	to ode	ntivo f	iltora										9	Hour
Case Stud	v: Application of	data selec	µ n∟iviS, S€ tive filters fo	er mennbers or system ic	lentification	iiseu L <mark>M.</mark> echo cai	s, computationa	a complexity, Pan	iai upda	ile ada	apuve fi	ners,											
						25.10 501																	

# Unit-5 - Spectral Analysis

Estimated autocorrelation function, Periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Blackman, and Tukey method of smoothing periodogram, Parametric method, AR(p) spectral estimation and detection of Harmonic signals.

Case Study: Applications of adaptive signal processing: System identification, channel equalization

	1. S. Haykin, "Adaptive Filter Theory", Prentice-Hall, 4-th edition, 2001.	4. B. Widrow, S. Stearns, "Adaptive Signal Processing", Prentice-Hall, 1985
Learning	2. Ali H. Sayed, "Fundamentals of Adaptive Filtering", Jo10hn Wiley, 2003.	5. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", Edition: 1st, 2008
Resources	3. D. Manolakis, V. Ingle, S. Kogan, "Statistical and Adaptive Signal Processing: Spec	stral
	Estimation, Signal Modeling, Adaptive Filtering and Array Processing", McGraw Hill, 1999.	

Learning Assessm	ient										
		N 1 1	Continuous Learning	Assessment (CLA)		Summativa					
	Bloom's Level of Thinking	Forma CLA-1 Averag (505	g Learning _A-2 0%)	Final Ex (40% w	native amination eightage)						
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	20%		20%		20%	-				
Level 2	Understand	30%		20%		20%	-				
Level 3	Apply	30%	Contraction of	20%		<mark>25</mark> %	-				
Level 4	Analyze	20%		20%		<mark>25</mark> %	-				
Level 5	Evaluate			20%		10%	-				
Level 6	Create			1.1		-	-				
	Total	100	%	10	0 %	10	0%				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Athif Shah, CTO, Abe Technologies, Chennai	1. Dr.V.Masilamani, Associate Professor, Computational Engineering, IIIT D&M, Kancheepuram	1. Dr.S. Dhanalakshmi, SRMIST
2. Mr.A. Vishwanath, Research and Innovation Scientist, Genet.IO.Hyderabad	2. Dr.V.Sathiesh Kumar, Assistant Professor, Electronics Department, MIT, Chennai	2. Mrs. S. Hannah Pauline, SRMIST

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course Code	21ECE441T	ON WITH COGNITION	C	ategory E PROFESSIONAL ELECTIVE								1	_ T 3 0	C 3							
Pre-requ Cours	isite es	Nil	Co- requis Cours <mark>es</mark>	ite	Nil		Pro	ogres Cours	sive es						Nil	1					
Course	Offering Departme	ent	ECE		Data Book / Codes / S	tandards								Nil							
Course L	earning Rationale	(CLR):	The purpo <mark>se of learnin</mark> g t	his course	is to:			4	1		Progr	am Ou	utcome:	s (PO	)				P	rogra	m
CLR-1:	Understand the c	oncepts o	of image pr <mark>ocessing a</mark> nd colo	r fundamer	itals		1	2	3	4	5	6	7	8	9	10	11	12	0 0	pecifi itcom	c es
CLR-2:	Gain Knowledge	on the va	rious m <mark>achine perc</mark> eption col	ncepts	1 march and		e		4	of	20	ety			¥						
CLR-3:	Acquire knowledg	ge on filter	r text <mark>ure analys</mark> is of an image	e	1.152.65	10	vledg		ent o	ations	ge	soci			IOW L		ance	D			ĺ
CLR-4:	Learn the relation	n between	th <mark>e templat</mark> es to match the i	image requ	irements	25-1	Knov	lysis	mdo	stige	Usa	anc	৵		ean	и	& Fir	arnin			ĺ
CLR-5:	Describe the prac	ctical appl	i <mark>cations of</mark> computer vision ir	n images ur	nderstanding		ering	i Ana	devel	t inve	Tool	ineer	ment		al & J	nicati	Mgt. 8	g Lea			ĺ
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Course O	utcomes (CO):		At the end of this course	, learners	will be able to:	1.22	Enç	Pro	Des	Cor	Moc	The	Env	E	Indi	Š	Pro	Life	PS(	PS(	PS(
CO-1:	Demonstrate the	fundam <mark>er</mark>	<mark>ntals of</mark> image and color mod	lels	ALC: CLERK N.	4.1	3	2	-	-	- L	-	-	-	-	-	-	-	-	-	-
CO-2:	Acquire the basic	machin <mark>e</mark>	perception concepts				3	2	1	-	-	-	<b>D</b> -	-	-	-	-	-	2	-	-
CO-3:	Analyze the vario	us textu <mark>re</mark>	es for image synthesis	1000	1995 - 1997 - 27		1	2		3	-	1	-	-	-	-	-	-	-	3	-
CO-4:	Explain the objec	ts base <mark>d (</mark>	on template relations	10		1	1	2	3		-		-	-	-	-	-	-	2	-	-
CO-5:	Apply the concep	t of ima <mark>ge</mark>	e recognition	1.10		123	2		3	-	1	1	-	-	-	-	-	-	2	I	-
l Init-1 - Ir	nade Formation an	d Imana	Models	- Cir				62				-								٥	Hour
The huma	n Eye - Introduction	to image	formation- Image models- Ca	ameras- Pir	nhole camera, Camera with len	ises- Cam	era m	nodels	- Sam	ole prog	grams	for rea	ding im	ages,	unders	standin	g pixel	- Shade	ows ar	nd sha	iding-
Color -Hu	man color perceptio	n, Repres	enting color	N																	
Unit-2 - N	lachine Perception	wing Ob	iont recognition and Scone a	nalvoia Co	poont formation Machine por	contion (	onco	n obi	ioot Vi	ouol m	ohino	noroo	ntion A	lachin	o Und	oroton	dina Cr		duan	9	Hour
and transi	parency problem- SI	hape clas	ses- Perceptual operators- T	he Basic 3	D obiect classes	ception- 3	senso	ry obj	eci, vi	sual ma	acrime	perce		acriin	e onu	erstari	ung-Ca	ase siu	uy on	comp	letion
Unit-3 - F	iltering and Textur	e Analys	is Techniques	700	LARA ADD	12.1				1.1	1									9	Hour
Linear filte	ers and convolution-	Sampling	and Aliasing-Filters as Terr	plates- No	malized correlation and findin	g patterns	s-Gau	issian	pyram	nid- Det	ecting	edges	s- Using	i Lapla	acian te	o deteo	ct edge	s, Gra	dient k	based	edge
detection-	Representing textu	re-Analys	is using Laplacian pyramid- twoon Tomplates	Synthesizin	g textures for rendering-Shape	e from Tex	cture				-									0	Hour
Findina te	molates Using class	sifiers- Me	thods for building classifiers	-Buildina cla	assifiers from class Histogram-	-Feature s	electi	ion- Fi	indina	obiects	by Vo	tina or	n relatio	ns bet	ween t	templa	tes- Re	lationa	l reas	<b>9</b> Onina	usina
probabilis	tic models and sear	ch- Using	classifiers to prune search-	Hidden Mai	kov Models- case study on fin	ding peop	le wit	h Hido	den Ma	arkov M	odel	9 -									
Unit-5 - R	ecognition						_				-	,					01			9	Hour
Object De and occlu	tection- Face Reco sions	gnition- In	istance recognition- Categor	y rec <mark>ognitio</mark>	on- 3D shape models of face s	surveilland	ce Foi	regrou	und se	paratio	n- Bac	кgroui	nd sepa	ration	- Partio	cie filte	r- Cha	mper n	natchii	ng, tra	cking

	1.	E. R. Davies, "Computer & Machine Vision", Fourth Edition, Academic Press, 2012
	Ζ.	Zbigniew Les, Magdalena Les, "Machine Understanding:Machine Perception and Machine
Learning		Perception MU", Springer, 2020
Resources	З.	Szeliski, Richard, "Computer vision: algorithms and applications", Springer Nature, 2022.
	4.	Solem, Jan Erik, "Programming Computer Vision with Python: Tools and algorithms for
		analyzing images", O'Reilly Media, In <mark>c., 2012.</mark>

5.	Mark Nixon and Alberto S. Aquado, "Feature Extraction & Image Processing for Computer
	Vision", Third Edition, Academic Press, 2012

 D. L. Baggio et al., "Mastering OpenCV with Practical Computer Vision Projects", Packt Publishing, 2012

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	Bloom's Level of Thin <mark>king</mark>	Form CLA-1 Avera (5)	native age of unit test 0%)	Life-Lon Cl (1	g Learning LA-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%	John Street Call	15%		15%	-			
Level 2	Understand	25%		20%		25%	-			
Level 3	Apply 📃	30%		25%		30%	-			
Level 4	Analyze	30%		25%		30%	-			
Level 5	Evaluate			10%		-	-			
Level 6	Create		10 20 5 W	5%		-	-			
	Total	10	0%	10	0 %	10	0 %			

Co	urse Designers									
Ex	perts from Industry	Ex	perts from Higher Technical Institutions	Internal Experts						
1.	Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	1.	Dr. Meenakshi, Professor, CEG, Anna University, meena68@annauniv.edu	1.	Dr.S. Vasanthadev Suryakala, SRMIST					
2.	Mr. Hariharasudhan, Johnson Controls, Pune,	2.	Dr. Venkatesan, Sr. Scientist, NIOT, Chennai,	2.	Dr. S. Dhanalakshmi, Professor, SRMIST					
	hariharasudhan.v@jci.com		venkat@niot.res.in							



Course Code	21ECE442T	QUES	Co Cat	Course ategory         E         PROFESSIONAL ELECTIVE         L         T									P 0	C 3									
Pre-requi Course	site es	Nil		Co- requi Courses	site	N	lil		Progr Cou	ress urse	sive es						Ni	1					
Course	Offering Departme	ent		ECE		Data Book	<pre>/ Codes / Stan</pre>	dards								Nil							
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Course Le	arning Rationale	(CLR): T	The purpose	e of learning	this course	is to:						11	Progr	am Ou	utcome	s (PO	)	1			- P	rogra	m ic
CLR-1:	Summarize on pr	robability mo	odels and int	troducing the e	elements of	coding			1 2	2	3	4	5	6	7	8	9	10	11	12	01	itcom	es
CLR-2:	LR-2: Implement lossless compression										÷	s of		iety			논		0				I
CLR-3:	CLR-3: Discover various types of lossy data compression								Medo		ent c	ations	ge	soc			oW ۲		Jance	б			
CLR-4:	Apply the vector	quantization	n <mark>techniqu</mark> es	~					Knov	iysis	mdo	stiga	Usa	r anc	જ		Tean	.u	& Fir	arnin			
CLR-5:	LR-5: Carry out the transform coding and incorporate it in various standards								v no	Alia	devel	inve	Tool	ineel	ment		al & _	nicati	Mgt.	g Le:			
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Course Ou	utcomes (CO):	A	<mark>At the</mark> end o	of this course	e, learners v	will be able to:	Augor		Eng	Ы Ц	Des solu	Con	Mod	The	Env	Ethi	Indiv	Con	Proj	Life	PSC	PSC	PSC
CO-1:	Express the princ	ciples of <mark>com</mark>	<mark>mpres</mark> sion lu	cidly		ALC: N	<b>GR</b> (154		3 2	2	-3		-	-	-	-	-	-	-	-	-	-	-
CO-2:	Evaluate the diffe	erent typ <mark>es o</mark>	of los <mark>sless c</mark>	ompression			1997 - E		3 2	2	3	-	-	1		-	-	-	-	-	2	-	-
CO-3:	Apply the various	s techniq <mark>ues</mark>	<mark>s tow</mark> ards los	sy image con	pression		8.84		- 2	2	-	3	-	- 30	-	-		-	-	-	-	3	-
CO-4:	Analyze the meth	nods ava <mark>ilabl</mark>	ble in vector	quantization	14.24		1	2	- 2	2	3	-	-			-	-	-	-	-	2	-	-
CO-5:	Examine transfor	m codin <mark>g for</mark>	o <mark>r data</mark> comp	ression and a	pplications	120.2		10	2 -	-	3	-	-	-	-	-	-	-	-	-	2	-	-
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Mathemati	cal preliminaries fo	r lossless co	om <mark>pression,</mark>	Huffman cod	ing, Optimal	ity of Huffman co	des, Extended F	luffman	coding	<u>д</u> , А	daptive	e Huffn	nan co	ding, J	Arithme	tic co	ding, A	daptive	e arithn	netic c	oding,	Run l	əngth
coding, Dic	tionary techniques	, Application	ns L <mark>empel-</mark> 2	Ziv coding, Pre	edictive codi	ng, Burrows Whee	eler transform,						1	-									
Unit-3 - Lo	ssy Compression	<u> </u>	(				<u> </u>			-	0				-							9	Hour
Rate Disto	rtion (RD) function Trellis coded quan	, Properties	s of RD, Calo	culation of RD	for the bina	ary source and the	e Gaussian soul	rce, RD kov con	theore	em,	Conve	erse of	the R	D theo ntizati	orem, Q	uantiz	ation p	oroblen	n, Scal	ar qua	ntizatio	on- Un	Iform
Unit-4 - Ve	ctor Quantization	12au011 u aris 1	Sioinis, Aud			morm quantization	in, Dynamic Man	NUV CUII	ipiessi	ΟΠ,	Linuop	ly coue	u yua	nuzau								9	Hour
Vector Qua	antization (VQ), LB	G algorithm,	, Tree struct	ured VQ, Stru	ctured VQ, V	ariations of VQ, C	Gain shape VQ, I	Mean re	emovea	I VG	), Clas	sified \	/Q, Mi	ultistag	je VQ, J	Adapti	ve VQ,	Basic	algoritl	hm, Pre	edictio	n in D	PCM,
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Unit-5 -Tra	ansform Coding a	nd Standard	rds	( D'											,			,			101	9	Hour
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	1.	Khalid Sayood, "Introduction to Data Compression", Fifth edition, Morgan Kaufmann	4.	Yun-Qing Shi, Huifang Sun, "Image and Video Compression for Multimedia Engineering
		Publishers, 2017		Fundamentals, Algorithms, and Standards", Third edition, CRC Press, 2021.
Learning	2.	N. Jayant and P. Noll, "Digital Coding of Waveforms: Principles and Applications to Speech	5.	D. Salomon, "Handbook of Data Compression", Fifth Edition, Springer-Verlag London Limited
Resources		and Video", Prentice Hall, USA, 1984.		2010
	З.	Ze. Nian Li and M. S. Drew, "Fundamentals of Multimedia", Second edition, Pearson	6.	M. Rabbani: "Digital image compression techniques", First Edition, SPIE Press Book, 1991
		Education (Asia) Pvt. Ltd., 2004.	1	

		5	Continuous Learning	g Assessment (CLA)	A	Sum	mativo		
	Bloom's Level of Thin <mark>king</mark>	Forr CLA-1 Avera (5	native age of unit test 0%)	Life-Lon Cl (1	g Learning "A-2 0%)	Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%	A State State	15%	1.1	15%	-		
Level 2	Understand	25%		25%		25%	-		
Level 3	Apply 📃	30%		30%		30%	-		
Level 4	Analyze	30%	12	30%		30%	-		
Level 5	Evaluate	-					-		
Level 6	Create		20 345 W				-		
	Total	10	0%	10	0%	100 %			

Course Designers			
Experts from Industry		Experts from Higher Technical Institutions	Internal Experts
	1	1. Mr. Anuj Kumar, Program Delivery Manager,	1. Dr. Diwakar R. Marur, SRMIST
	1 m / 1	Nagarro Software's Pvt Ltd.	



# ACADEMIC CURRICULA

# UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES (With exit option of Diploma)

(Choice Based Flexible Credit System)

**Regulations 2021** 

Volume - 14B (Syllabi for Electronic and Communication Engineering w/s in Cyber Physical System Programme Courses)



## SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

# ACADEMIC CURRICULA

**Professional Elective Courses** 

**Regulations 2021** 



### SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

### (Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	Course Code         21ECE250J         Course Name         SENSORS AND ACTUATORS FOR CYBER PHYSICALSYSTEMS											PROF	ESSIC	)NAL E	ELECT	IVE			- T 2 0	P 2	C 3
Pre-requis Courses	site s	Nil		Co- requisite Course <mark>s</mark>		Nil	1	Progres Cours	ssive ses						Nil	1					
Course C	Offering Departme	nt		ECE	1	Data Book / Codes / Standa	rds							Nil							
						State 11			1.00												
Course Lea	arning Rationale (	CLR):	The purpo	ose of learning this	course is to:				100		Progr	am Ou	utcome	s (PO	)			1	- S	rograr	m ic
CLR-1:	Learn sensor basi	c workin	g		100		1	2	3	4	5	6	7	8	9	10	11	12	0	itcom	es
CLR-2:	Understand senso	r design	for embedd	led applications	2	In section where the section of the	e		of	s of	1.	iety			¥		a)				
CLR-3:	Design optimal rea	al time m	odel <mark>s and le</mark>	earn the uncertainties	3	1000	vledo	·	ento	ition	ge	soc			oW r		ance	D			
CLR-4:	Understand the In	terface c	of S <mark>ensor Sy</mark>	stem Design And Im	plementation		Anov	lysis	mdo	stige	Usa	and	৵		ean	и	& Fir	arnin			
CLR-5:	Understand the fu	nctions o	of actuators				biu	Ana	evel	inve	0	neer	hent		န	licati	Agt. 8	) Lea			ĺ
				and the second s			neel	em	gn/d		- Lue	engi	ronn aina	s	idua	mur	ect N	-ouć	-	5	က္
Course Ou	tcomes (CO):		At the en	d of this course, lea	arners will be	able to:	Engi	Prob	Desi	Conc	Mode	The	Envi	Ethio	Indiv	Com	Proje	Life I	PSO	PSO	PSO
CO-1:	Explain the overal	l senso <mark>r</mark>	characterist	tics required to make	energy conver	sions	3	-	-	-	-	-	2	-	-	-	-	2	3	-	-
CO-2:	Summarize the fur	nctiona <mark>lit</mark>	<mark>ties of v</mark> ariou	us Optical Sensors	<b>HEAR</b>		3	1	10	-	-	-	_	-	-	-	-	2	-	3	-
CO-3:	Implement security	y, surv <mark>ei</mark>	llance, energ	gy management syst	ems with minin	nal supervision	12	2	3	-	3	-	-	-	-	-	-	-	-	-	2
CO-4:	Explore the varion applications	ous ch <mark>e</mark> i	mical senso	ors and sensing sys	stems for min	iaturized systems for mob	ile _	3		3	-			-	-	-	-	-	-	3	2
CO-5:	Explain the function	onalities	<mark>of variou</mark> s ty	pes of actuators			3	1	-	-	-		2	-	-	-	-	2	3	-	-
11						11/22					1	*								40	
Doto Acqui	nsor Basic Blocks	anolo o	nd Sustama	Sonsor Classifian	tion Units of	Magguramanta Transfor	Supotio	no M	othom	tical N	Indolo	Euro	otional	Annro	vimoti	000	incor	Dograd	nion	<u>12</u>	Hour
Approximat	ions - Piecewise Lii	near An	proximations	- Spline Interpolation	n. Multidimensi	ional TransferFunctions - Ca	libratior	Com	outation	of Par	amete	rs – Ite	erative (		itation	of Stin	nulus	Negres	51011,	FOIYI	Unia
Unit-2 - Op	tical Sensing	iou ripp					nor acror	.,	, atation			0 /10	, all ro	2011.pd	itution.	0. 00				12	Hour
Optical Uni	ts - Effects of Optic	al Radia	tions - Phot	to Conducting Senso	rs, Photoelectr	ic Sensors - Optical Positior	Senso	r - Cha	rge Co	upled L	Device	(CCD	) <mark>Sens</mark> c	ors and	d Deteo	ctors -	Therm	opile P	IR - P	yro el	ectric
sensors - A	ctive Far Infrared (A	AFIR) Se	ensors		Sec. Se	A STATE															
Unit-3 - Hu	man Detectors				A (1 -	MAX ANT - PARTO	-													12	Hour
Ultrasonic L	<u> Detectors - Microwa</u>	ive Motic	on Detectors	s - Capacitive Occupa	ancy Detectors	- Triboelectric Detectors - P	ressure	-Gradie	ent Sen	sors –	Gestur	esensi	<mark>ng –</mark> Ta	actile s	ensors	3					<del></del>
Unit-4 - Ch	emical and Biolog	ical Ser	isors		the share is all O	Detentionetria Ora		11-1-10	) da O			(1100				0-1-	- Oh			12	Hour
Chemical S	ongue	acteristic	s – Bio Che	mical S <mark>ensors – Ele</mark> c	ctrocnemical S	ensors – Potentiometric Sen	sors – I	Metal C	Ixiae S	emicor	auctor	IMOS	)Cnem	ical Se	ensors	- 000	r Chan	ige ser	sors -	- Elect	ronic
Unit-5 - Ac	tuators																			12	Hour
Basic elem	ents of Sensor- Ac	tuator sy	/stem – Cla	ssification of Actuato	ors and other o	lassification methods - Cap	acitive .	Actuato	ors – U	Itrason	c Sens	sors a	nd Actu	ators	- Magi	netostr	ictive S	Sensors	s and	Actual	tors -
Radiation S	Sensors and Actuato	ors: Ante	nna as an A	Actuators											-						

Learning	1. Phillip A. Laplante, "Handbook of Modern Sensors – Physics Design and Applications",	2. Nathan Ida, "Sensors, Actuators, and their Interfaces - A Multidisciplinary Introduction," 1st Edition,
Resources	5th Edition, Springer Publication, 2015.	SciTech Publishing, Edison, NJ

Learning Assessm	ient										
			Continuous Learning	Assessment (CLA)		Summativo					
	Bloom's Level of Thinking	Form CLA-1 Averag (45	ative ge of unit test %)	Life-Long CL (1)	) Learn <mark>ing</mark> A-2 5%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	25%	the second		15%	15%	-				
Level 2	Understand	25%			20%	25%	-				
Level 3	Apply	30%		1. 1. 1. 1.	25%	30%	-				
Level 4	Analyze	20%			25%	30%	-				
Level 5	Evaluate	State 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1			10%		-				
Level 6	Create			Sector Sector	5%	-	-				
	Total	100	)%	10	0 %	10	0 %				

1.	Mr. Athif Shah Chairman, Abe, Semicondutor,	1.	Dr. Meenakshi, Professor of ECE, CEG, Anna University,	1.	Dr. M. Sangeetha, SRMIST
	abechennai@gmail.com		meena68@annauniv.edu		
2.	Dr. S. A. Akbar, Director-CPS, Rtd. CSIR- CEERI, Pilani.	2.	Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	2.	Dr. P. Vijayakumar <mark>, Profess</mark> or, SRMIST
	saakbar158@gmail.com				



Course Code	21ECE251T	Course Name	EMBEI	DDED ANI	) implan	TED DE SYSTI	VICES FOR CYBEF	R PHYSICAL	Cou Cate	irse gory	E			PRO	FESSIC	)NAL I	ELECT	IVE			L T 3 0	P 0	C 3
Pre-requ Course	isite 2	1EES101T		Co- Cou	equisite Irses		Nil		1	Progre Cour	ssive ses						Ni	I					
Course	Offering Departme	ent		ECE			Data Book / C	odes / Stand	ards							Nil							
						_	a bart of		100														
Course Le	earning Rationale	(CLR): 7	The purpo	se of lear	ning this (	course i	is to:						Prog	ram O	utcome	es (PO	)				P	rogra	m
CLR-1:	Understand the v	various emb	edded pro	ocessors a	nd memor	ry archite	ecture		1	2	3	4	5	6	7	8	9	10	11	12	- S 01	pecifi itcom	ic ies
CLR-2:	Identify suitable I	hardware ar	าd so <mark>ftwar</mark>	<mark>e avail</mark> able	e to develo	op a CPS	S	-	de	,	of	s of	1	ciety			ork		ę				
CLR-3:	Study the multita	sking and ti	hre <mark>ading t</mark>	echniques	for embed	dded pro	ocessors	Sec. and	vled		ent	tior	ge o	soc		-	Ň		and	0		ĺ	
CLR-4:	Analyze the impl	ementation	s <mark>cheme</mark> c	of implanta	ble CPS fo	or health	care application	1000	Knov	alvsis	lopm	estige	Usa	r and	~		Tean	ion	& Fir	arnin			
CLR-5:	Use CPS for ene	ergy manage	əment and	l design a	CPS fram	e work f	or real time applicat	tion	heering	em Ana	gn/deve	ions uct inve	ern Tool	enginee	onment	S	idual &	nunicat	ct Mgt.	-ong Le	-	-2	ę
Course O	utcomes (CO):		At the end	d of this c	ourse, lea	irners w	ill be able to:	A GOINT	Engir	Probl	Desi	Cond	Mode	The e	Envir Susta	Ethic	Indivi	Com	Proje	Life L	PSO	PSO	PSO
CO-1:	Identify suitable e	embedd <mark>ed p</mark>	o <mark>roces</mark> sor a	and memo	ry for cybe	r physic	al system applicatio	ns	1	2	3		-	-	-	-	-	-	-	-	-	-	3
CO-2:	Select optimal ha	rdware <mark>and</mark>	software i	for cyber p	hysical sys	stem mo	del	1000	1	2	3	-	-	1		-	-	-	-	-	-	-	3
CO-3:	Efficiently use the	e embed <mark>dea</mark>	<mark>l proc</mark> esso	r resource	S		225.244	3.4	1	2	3		- 1	-30	-	-		-	-	-	-	-	3
CO-4:	Develop implanta	able CP <mark>S mo</mark>	<mark>odel f</mark> or he	alth care a	pplication	12.20		1	1	2	3	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Develop implanta	ible CP <mark>S mo</mark>	<mark>odel f</mark> or va	rious real-	world prob	olems.	1.00		1	2	3	- 1	2	2	-	1	2	-	-	2	-	-	3
linit-1 - E	mbaddad Bracass	ore		4		Cont.		4.0.1		16.				4								0	Hour
Types of F	Processors - Micro	controllers	DSP Proc	essors Gr	anhics Pro	ocessors	Parallelism- Paral	lelism vs Con	currency	/ Pine	linina	Instruc	tion-Le	vel Par	allelism	n Mult	ticore /	Archite	ctures	Memo	rv Arc	hitect	ures -
Memory T	echnologies. Memo	rv Hierarch	v. Memory	Models.	apinoo i re	10000010	, i aranonom i aran		carronoj	, 1 100	ning,	moado		vor r ur	anonom	i, man		ii ornico.	<i>otal</i> 00,	monito	.,	moon	
Unit-2 - In	put and Output Ha	ardware an	d Softwar	e	12.11								1									9	Hour
I/O Hardw	are - Pulse Width I	Modulation,	G <mark>eneral-I</mark>	Purpose D	igital I/O,	Serial In	terfaces, Parallel In	terfaces, and	Buses,	Seque	ntial S	oftware	in a (	Concur	rent Wo	orld- Ir	nterrup	ts and	Excep	tions, 7	Timers	, Ator	nicity,
Interrupt C	ontrollers, Modellin	g Interrupts	•		and the second second	_			-				105	-									
Unit-3 - M	ultitasking and Sc	heduling									-										<del></del>	9	Hour
Multitaskin	ig - Threads, Creatil	ng Threads,	, Implem <mark>er</mark>	nting Three	ads, Mutua	al Exclus	ion, Deadlock, Men	nory Consiste	ncy Mod	lels, 11	ne Pro	blem w	ith Thr	eads, F	rocess	es an	d Mess	sage P	assing,	Schec	Juling	- Basi	cs Of
Scheduling	, Scheduling Deck	sions, Task	models, C	Companing	Schedule	rs, imple	ementation OFA Sc	meduler, Rale	e Monolo		neaui	ng, Ea	nest D	eauime	e First,	Schet	iuning a	ana ivit	iluai e.	KCIUSIO	n, mu	uproc	essor
Unit-4 - In	/ nplanted Cyber-Ph	vsical Syst	tems																			9	Hour
Medical C	yber-Physical Syste	ems - Syster	m Descrip	tion and O	perational	Scenarie	os, Key Design Driv	ers and Quali	ty Attribu	ites- Ti	ends.	Quality	Attribu	tes an	d Challe	enges	of The	MCPS	S Doma	iin, On	-Dema	and M	edical
Devices a	nd Assured Safety,	Smart Alarr	ns and Cli	inical Deci	sion Suppo	ort Syste	ms, Closed-Loop S	ystem, Energy	Cyber-I	Physic	al Syst	ems -	System	Descr	ption a	nd Op	eration	al Sce	narios,	Key D	esign	Driver	s and
Quality Att	ributes , Cyber Para	adigm for Si	ustainable	SEES, Pr	actitioners	' Implica	tions.																

 Unit-5 - Human-in-The-Loop Cyberphysical Systems
 9 Hour

 Theory Of HiTLCPSS - Data Acquisition, Humans as Sets of Sensors, Humans as Communication Nodes, State Inference- Human nature, Humans as Processing Nodes, Actuation, Technologies for Supporting
 9 Hour

 HITLCPS, HITL In Healthcare, Social Networking.
 9 Hour
 9 Hour

	1.	E. A. Lee And S. A. Seshia, Introduction To Embedded Systems - A Cyber-Physical Systems	5.	Raj Kamal, Internet of Things, Mcgraw Hill Education; First Edition, 2017.
		Approach, Second Edition, Mit Press <mark>, 2017.</mark>	6.	Edward Ashford Lee, Sanjit Arunkumar Seshia, Introduction To Embedded Systems - A
	2.	Houbing Song Danda Rawat Sabina Jeschke Christian Brecher, Cyber-Physical Systems		Cyber Physical Systems Approach - Second Edition, Lulu Enterprises Incorporated, 2014
Learning		Foundations, Principles And Applications, , 1st Edition, Academic Press, 2016	7.	Hamid R. Arabnia, Leonidas Deligiannidis, Fernando G. Tinetti, Embedded Systems, Cyber-
Resources	З.	Raj Rajkumar, Dionisio De Niz, Mark Klein, Cyber-Physical Systems, Pearson Education,		Physical Systems, And Applications, The 2017 Worldcomp International Conference
		Inc.2017,		Proceedings, Csrea, 2018
	4.	David Nunes, Jorge Sá Silva, Fernando Boavida, A Practical Introduction To Human-In-The-		
		Loop Cyber-Physical Systems, Johnwiley & Sons Ltd, 2018.		

			Continuous Learning	Assessment (CLA)		Sum	motivo
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (10	g Learning "A-2 0%)	Final Ex (40% w	amination eightage)
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice
Level 1	Remember	20%		20%	· / · /	20%	-
Level 2	Understand	20%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	20%		20%	-
Level 3	Apply	30%		30%		30%	-
Level 4	Analyze	30%		30%		30%	-
Level 5	Evaluate	the second second		in the second		-	-
Level 6	Create			A Party of			-
	Total	10	0%	10	0%	10	0%

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
	1. Dr. S. A. Akbar, Chief Scientist, CEERI Pilani	1. Dr.M. Sangeetha, SRMIST	
		2. Mr. Saminathan, SRMIST	



Course Code	21ECE252J	Course Name	CYBER	PHYSICAL C	ONTROL SYSTEM		Cours Catego	se ory	E			PROF	ESSIC	)nal e	ELECT	IVE			L T 2 0	P 2	C 3
Pre-requ Course	isite Con	trol Systems	Co- requ Course	isite s	Nil		Pr	ogres Cours	sive es						Nil						
Course	Offering Departme	ent	ECE		Data Book / Code	es / Standar	ds						_	Nil							
Course La	arning Potionala			this course	in to:		1		100		Drogs	am ()	Itoomo	o (DO)	\				Pr	oara	n
					13 10.	_	1	0			FIOG			з (FU		10	11	10	S	pecifi	c
CLR-1:	Learn the basics	and advanced c	oncepts of control sy	/stems				2	3	4	Э	0	/	0	9	10	11	12	Ou	tcom	es
CLR-2:	Impart knowledge	e about the indus	s <mark>trial contro</mark> llers proc	ess and their	instrumentation	1.00	dge		of	o su	10	ociet			/ork		ee				
CLR-3:	Comprehend bas	ic symbology an	d process control el	ements and te	echniques	2010	wlee	s	nent	jatio	age	d so			∕ E		inan	бu			
CLR-4:	Know about Indu	strial standa <mark>rds a</mark>	<mark>and m</mark> ethods for cali	bration and co	ontroller tuning.	1.1.1	Knc	alysi	alopr	estic	IUs	er an	۲ &		Tea	tion	&F	ami			
CLR-5:	Acquire knowledg	ge on Control sy	stems networking				eering	em An:	in/deve	uct inv	rn Too	nginee	onmen	6	dual &	nunica	ct Mgt.	ong Le	-	2	33
Course O	utcomes (CO):	At th	e end of this cours	se, learners w	vill be able to:	Sec. 2	Engin	robl	Desig		Mode	The e	Envire	Ethics	ndivi	Comr	Proje	-ife L	-OSc	-OSc	-OSc
CO-1:	Interpret mathem	atical equations	of control systems a	and their stabil	iity	N.541	10	3	2	-		-	-	-	-	-	-	-	-	-	-
CO-2:	Analyze instrume	ntation process	control instrumentat	ion and variou	is control flow		3		12	-	-	-		-	-	-	-	-	-	-	-
CO-3:	Illustrate optimal	process <mark> control</mark>	methods		1997	1	3	2		-	-	- 10	-	-		-	-	-	-	-	-
CO-4:	Evaluate Industria	al stand <mark>ards and</mark>	methods for calibra	tion of industr	ial instrumentation	1.0		3	2		1	-	- 1	-	-	-	-	-	-	-	-
CO-5:	Explore Industrial	l networ <mark>king HA</mark> I	RT protocols.		1.		3		2	-	-	2	-	-	-	-	-	-	-	-	-
			1000	and the set				67				-	1							- 10	
Unit-1 - In	troduction to Con	trol System	Eaglback Control	Foodforward	control Transfor functio	n for SISO			votom	noloo	and zo	ros of	o trono	for fun	otion	Impulo		2000.01	ad ator	12	Hour
Controller system, Th	operation: control r nermometer, Pneun <b>ly</b> - An arbitrary inp	nodes, ON-OFF naticsystem. ut time response	of Control system,	al control of h	eating system, Proporti os Map of a system	onal integral	control	Time	e propo	ortionin	g conti	rol, Tin	ne prop	ortion	ing cire	cuit, Th	ermal	systen	ns: Hea	at Tra	nse, nsfer
Unit-2 - In	dustrial Process T	echniques and	Instrumentation	Dropper	an Control Deguiremen	to Magauran	nont Do	1000	Conor		nomio	Statio	Food	book I	oon In	torfooo	Inotru	monto	Dlook	12 diogra	Hour
Batch Prod	cesses-Batch Proce	esses Control Re m-Transmitters	equirementsContin	iuous Process itorina Instrum	es Control Requiremen	Recorders.	Maninu	/ICES ( lation	Senso	rs): Dy	namic, Final	Static	- Feeal	ack L	oop ini he Soli	ertace	INStrui /alve l	nents DC an	-BIOCK	alagra Intors	im of The
Control Va	lve-Instrumentation	Symbology-Ge	neral Instrument Syr	nbols-Tag Nul	mbers Line Symbols-Va	lve and Actu	ator Syl	nbols-	-Readi	ng a S	ingle L	pop-Int	formatic	on Bloc	ck.	cholu	uive, i	<i>50 un</i>	170 1	101013	me
Case Stud	<b>ly-</b> Closed loop con	trol system syst	em, Del <mark>ay time, Rise</mark>	<mark>e time</mark> , Peak ti	me and Peak overshoot	of Control s	ystem			0	U	'									
Unit-3 - Pi	rocess-Control Me	thods	add and Original Da	Dehavi	an Oalaatinaa a Oantaalla				0	un face of the			Ma da la		Mada	Dent	-	1l 1	A ./	12	Hour
Technique Systems (I	ontrollers-Open-Lo s-Cascade Control- DCS). <b>hv</b> - SISO system m	op Control-Clos Feed-Forward	ea-Loop Control-Pro Control-Ratio Contr trol system	ol- Adaptive (	Control-Pneumatic Controlle	r-On-Off Co. rollers- Pane	ntroi-Co el-Mouni	ntinuc ed Co	ontrolle	ntroi, i ers-Per	sonal (	ionai i Compu	vioae-ir iters-Pr	itegrai ogram	mable	, Deriv Logic	Contro	noae-A llers-D	istribut	ed Co ed Co	ontrol ontrol
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#### Unit-4 - Industrial Standards and Methods for Calibration and Controller Tuning

Instrument Calibration and Controller Tuning-Reasons for Performing Calibrations-Calibration Preparation-Standard Calibration Procedure-Five-Point Calibration Procedure-Process Calibrators-Sensor Calibration-Transmitter Calibration-Tuning the Controller-Trial-and-Error Tuning Method-Ziegler-Nichols Tuning Methods-Ziegler-Nichols Continuous-Cycling Method-Ziegler-Nichols Reaction-Curve Tuning Method-Controller Autotuning.

Case Study- DC motor control using PIDcontroller, Tuning a PID Controller Using the Ziegler-Nichols Method

### Unit-5 - Industrial Networking

Hierarchy of Industrial Networks, Network Topologies, Network Backbones: Hubs, Switches, Bridges, Gateways. Network Communication Standards- Fieldbus Networks: Modbus, HART. Case Study- Tuning system controller using Simulink

	1.	Industrial Automated Systems: Instrumentation and Motion Control, Terry Bartelt,	4.	Frank Petruzella. D, "Programmable Logic Controllers", Tata McGraw Hill Third Edition, 2010
Learning		ISBN-13: 978-1-4354-8 <mark>888-5</mark>	5.	Bolton. W, "Progra ble Logic Controllers mma" Fifth Edition, Elsevier Newnes, 2009.
Resources	2.	Nagrath I.J and Gopal M, "Control Systems Engineering", New Age Publishers, 5 <sup>th</sup> ed 2009	6.	Michael Lucas, "Distributed Control Systems", Van Nostrand Reinhold Co., 1986.
	3.	S. Hasan Saeed, "Automatic Control Systems", s k kataria and sons, 2013 edition		

			Continuous Learning	Assessment (CLA)		Cum	mativa			
	Bloom's Level of Thinking	Form CLA-1 Avera (45	native ge of unit test 5%)	Life-Long CL (1)	g Learning "A-2 5%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	25%	the present states	1	20%	15%	-			
Level 2	Understand	20%	A CONTRACT		15%	20%	-			
Level 3	Apply	15%		and the second second	25%	25%	-			
Level 4	Analyze	20%			25%	20%	-			
Level 5	Evaluate	10%	-	A CONTRACTOR OF	10%	10%	-			
Level 6	Create	10%			5%	<mark>1</mark> 0%	-			
	Total	100	0%	10	0 %	10	0%			

Course Designers		19 C
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Dr. S. A. Akbar, Chief Scientist, CEERI Pilani	1. Dr. K. Va <mark>divukkaras</mark> i, SRMIST

12 Hour

Course Code	21ECE350T	Course Name	REAL	TIME CYBE	R PHYSICAL SYSTEM	Co Cat	ourse egory	E			PROF	ESSIO	NAL E	LECT	IVE		1	- T 3 0	P 0	C 3
Pre-requi	site s	Nil	Co- rec Cours	quisite	Nil		Progre Cour	ssive ses						Nil						
Course (	Offering Departm	ent	ECE		Data Book / Codes / Sta	Indards	100						Nil							
						1	1.													
Course Le	arning Rationale	(CLR):	The purpo <mark>se of learni</mark>	ng this cou	rse is to:		. <	1	1.1	Progr	am Ou	utcome	s (PO)					Pr	ograr	n
CLR-1:	Understand the p	process, ma	odel and <mark>composition</mark> s o	f real time cy	ber physical systems		1 2	3	4	5	6	7	8	9	10	11	12	00	tcom	c es
CLR-2:	Identify the softw	are archite	ctures <mark>and design</mark> comp	onents of rea	al time cyber physical systems		de	of	Is of	2.	ciety			ork		e				1
CLR-3:	Create insights to	o the senso	or ne <mark>tworking</mark> technologi	es with real t	ime cyber physical systems			lent	ation	ge	l soc			Ми		Janc	ð			
CLR-4:	Analyze the cond	cepts of Ub	iq <mark>uitous C</mark> omputing in c	yber physica	l systems		alysis	lopr	estig	Usa	r and	ઝ		Tear	ion	& Fii	amir			
CLR-5:	Use Cyber physi	cal system:	<mark>s for furth</mark> er new applica	tion and dev	elopments		lem Ana	gn/deve	duct inve	ern Tool	enginee	ronment ainability	s	idual & <sup>-</sup>	municat	ect Mgt.	Long Le:	-	5	ကို
Course Ou	itcomes (CO):		At the end of this cou	ırse, learnei	rs will be able to:		Prob	Desi	Con	Mod	The	Envi	Ethic	Indiv	Com	Proj	Life	PSO	PSO	PSO
CO-1:	Implement real ti	ime cybe <mark>r p</mark>	<mark>hysica</mark> l system for engi	n <mark>eering appl</mark> i	cations	4.21	- 6-	-	-	-	-	3	-	-	-	-	2	-	3	-
CO-2:	Design software	architec <mark>tur</mark>	<mark>es an</mark> d schedulers for re	eal time cybe	r physical model			3	-	-	-	<u> </u>	-	-	-	-	-	-	3	-
CO-3:	Analyze sensor i	networki <mark>ng</mark>	<mark>techn</mark> ologies for real tin	ne cyber phy	sical systems			3	-	-	- 100	-	-	1	-	-	-	-	-	-
CO-4:	Apply the CPS n	nodel to <mark>rep</mark>	<mark>blace o</mark> lder existing tech	nology mode	ls	12	-	10	-	-	-	3	-	-	-	-	-	-	-	-
CO-5:	Incorporate the o	concepts <mark>of</mark>	<mark>cyber</mark> physical systems	in real time	applications		10	3	-	-		-	-	-	-	-	-	-	3	-
Unit-1 - Int	roduction to Rea	l Time Svs	tems	1		-	1.6.7			-	÷	<u>.</u>		_					9	Hour
Overview C	Of Embedded Syst	ems, Exam	ples Of Embedded Syst	tems, Soft Re	eal-Time Systems, Hard Real-Time	e Systems	, Spectri	ım Of	Real-Ti	ne Sys	tems,	Exampl	es Of I	Real T	ime Sy	stems,	Case	Study	Real	Time
Systems, Ir	ntroduction To Cro	ss-Platforn	n <mark>Developm</mark> ent, Hardwa	re Architectu	re, SoftwareDevelopment: Softwa	re Design,	System	Progr	amming	, Langu	lage C	/C++, E	B <mark>uild Ta</mark>	arget li	mages	, Build	Target	Image	₹S,	
Case Stud	y: Building A QNX	(Image, Tr	ansfer Executable File (	Object To Ta	rget, Integrated Testing On Target,	, System F	Productio	on		1 A										
Unit-2 - So	tware Architecti	ures for Re	eal Time Systems, Rea	I Time Sche	duling and Sharing	ima Cabar	duling: C	look D	rivon A	nraad	h Doo	Time	Cohodi	dina: [	Data M	anatan	io Ann	rooch	9	Hour
Scheduling	' Sporadic Server	Resource	Sharing: Shared Variah	les Shared	Memory Semaphore Mutex Cond	dition Varia	ahle	OCK-D	IIVEII A	proaci	I, Rea	- mile c	Scheut	лшу. г	Tale-IVI	01101011	iic App	Udun,	Real-	, iiiie
Unit-3 - CF	PS Architectural L	Design. Da	ta Management and R	outing with	WSN Technologies			12.7		1									9	Hour
Wireless S	ensor Networks, D	Distinguishii	ng WSN, MANET, M2M	and CPS, (	Cyber-Physical System Design cha	llenges, C	Cyber-Ph	ysical	System	s archi	tecture	, The ro	ole of I	NSN te	echnol	ogies ii	n CPSs	s, Tow	ards a	a new
CPS Archit	ecture, Data mana	agement: V	VSN Vs. WSN-CPS, Da	<mark>ta manage</mark> m	ent Activities, Cyber-Physical Cloud	ud Compu	iting: Op	portun	ities an	d Chall	enges	Desigr	n chall	enges	and is	sues fo	or routil	ng in V	VSN v	vithin
the context	Of CPS,Routing	protocols in	WSNs for CPSs, Future	e directions o	of routing protocols in WSN for CP.	S,														
Case Stud	y: WSN-CPS App	lications	Cubor Physical System																	Hour
Ubiquitous	Computing Fundam	v to Date 1	Ibiquitous Computing F	undamentals	Smart Devices: Components and	Services	Taggin	a Sen	sina A	nd Con	trollino	Auton	omous	Syste	ms in	Ubiavit	ous Co	mnuti	na	noui
Case Stud	y: Robot Manipula	tor, Introdu	ction to Systems Engine	ering, Introd	uction to Software Engineering, V-	Model, Ag	ile Softw	are De	velopn	ent Me	thodol	ogy, Co	mparis	son Of	The V	-Model	And T	he Agi	le Sof	tware
Developme	ent Methodology, F	Requiremer	nts in Software Design ir	n Cyber-Phys	sical Systems, Maritime Area Case	e Studies														
																				110

#### Unit-5 - Real Time CPS Applications and Case Studies

Cyber-Physical Systems Applications: Communication, Consumer Interaction, Energy, Infrastructure, Health Care, Manufacturing, Military, Robotics, Transportation, Smart Cities and the Internet of Everything, Medical Cyber-Physical Systems: Introduction, Background and Related Works, Technical Components, Towards Cognitive Prostheses, Challenges And Opportunities, Mobile WSN-CPS Applications, Smart Space Systems, Emergency Response Systems, Human Activity Inference, Smart Factory,

Case Study: Cyber-Physical Vehicle Tracking System

	1.	Kuodi Jain-Real Time Sysytems , 1st edition, Intech Open Publshing, 2015	3.	Sherali Zeadally and Nafaa <sup>*</sup> Jabeur- Cyber-Physical System Design with Sensor Networking
Learning	2.	Xiaocong Fan- Real-Time Embedded Systems Design Principles and Engineering	6.4	Technologies, 1st Edition, IEEE Design & Test, 2017
Resources		Practices, 1 st Edition, Newnes Publications, 2016	4.	Dietmar P.F. Moller- Guide to Computing Fundamentals in Cyber-Physical Systems, 2nd edition,
				Springer Publications, 2016.

and the second second

			Continuous Learning	Assessment (CLA)		0				
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ige of unit test 0%)	Life-Long CL (10	g Learning A-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	25%	10 10 10 10 10 10 10 10 10 10 10 10 10 1	15%		15%	-			
Level 2	Understand	25%	the state of the	20%		<mark>25</mark> %	-			
Level 3	Apply	30%	10 10 10 10 10 10 10 10 10 10 10 10 10 1	25%		30%	-			
Level 4	Analyze	20%		25%	-	<u>30%</u>	-			
Level 5	Evaluate	1 2 2 2 3		10%		-	-			
Level 6	Create	No. of Concession		5%		-	-			
	Total	10	0%	10	0%	10	0%			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Athif Shah, Chairman, Abe Semicondutor,	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University,	1. Dr. M. Sangeetha, SRMIST
abechennai@gmail.com	meena68@annauniv.edu	1 11 1
2. Dr. S. A. Akbar, Director-CPS, Rtd. CSIR- CEERI, Pilani.	2 Dr. Venkatesan, Sr. Scientist, NIOT, Chennai,	2. V. Padmajothi, Asst. SRMIST
saakbar158@gmail.com	venkat@niot.res.in	

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Course Code	21ECE351T	Course Name	UNSUPI	ERVISED INTELL	IGENCE	IN CYBER PHYSICAL SYS	STEM	Cour Categ	se ory	E			PROF	ESSIC	)NAL E	ELECT	IVE		Ĺ	- T 3 0	P 0	C 3
Pre-requis	site s	Nil		Co- requisite Courses	,	Nil		Pr	ogres Cours	sive es						Nil	1					
Course C	Offering Departm	lent		ECE		Data Book / Codes /	Standard	S							Nil							
		(a) => =						1		1.0		_										
Course Lea	arning Rationale	(CLR): T	The purpos	e of learning this	s course	is to:				1		Progr	am Ou	Itcome	s (PO	)	1	1		- S	ograi pecifi	n C
CLR-1:	Learning of unsu	pervised inte	elligence al <mark>g</mark>	<mark>gorithms</mark> in cyber	physical	system		1	2	3	4	5	6	7	8	9	10	11	12	Ou	tcom	es
CLR-2:	Understand the	working of mo	odel <mark>based</mark>	<mark>reinfo</mark> rcement lea	arning	1 under			5	1	of	10	ty									
CLR-3:	Learn with case	study about r	rei <mark>nforceme</mark>	nt learning	2		2016	ədge		nt of	ons (	0	ocie			Nork		nce				
CLR-4:	Use of python p	rogramming <mark>f</mark>	fo <mark>r reinfor</mark> ce	ment learning	1			owle	SI.	mer	gati	sage	s pu			am /	_	Fina	ing			
CLR-5:	Unsupervised le cyber intelligent	arning using systems for r	<mark>SCIKIT</mark> lea	nrner, tensor flow	and KEF	RAS, Gain overall understa	nd of the	ering Kn	n Analys	/develop	ot investi x proble	1 Tool U	gineer a	Iment &		ual & Tea	unicatior	Mgt. & I	ng Learr			
Course Ou	tcomes (CO):	4	At the end	of this course, le	arners v	vill be able to:	N	Engine	Probler	Design	Conduc	Moderr	The en	Enviror Sustair	Ethics	Individu	Comm	Project	Life Lo	PSO-1	PSO-2	PSO-3
CO-1:	Ability to unders	tand rein <mark>force</mark>	ement learn	ing and its use fo	r intellige	ence	1221	1-1	3	-	÷ -		3	-	-	-	-	-	-	-	-	- 1
CO-2:	Able to design ir	ntelligent <mark>syst</mark> e	tems using	cyber security sta	ndards		6.5		-	2	-		3		-		-	-	-		-	-
CO-3:	Implement differ	ent pract <mark>ical</mark> :	self learning	g systems with mi	inimal su	pervision			-	2	3	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Develop deep re	einforcem <mark>ent l</mark>	learning for	designing cyber	physical	system	-	-	-	1	3	-	3	-	-	-	-	-	-	-	-	-
CO-5:	Come up with c implement real t	ost effecti <mark>ve,</mark> ime systems	, reliable, ro and addres	bust and feasible s the problems a	) designs nd limitat	for real world problems, D ions	esign and	1	2	2	3	-			-	-	-	-	-	-	-	-
IInit-1 - Ro	inforcement I ea	rning and C	PS	- Marine			-					<u> </u>	-		_						<u> </u>	Hour
overview of reinforceme systems, cy	reinforcement Lea ent learning, histo ber security-intro	arning, compa ry of reinforce duction, cybe	arison of di cement learn er security e	ferent reinforcem ning, simulation to xamples, cyber s	ent learn ool kits fo ecurity s	ing methods, examples of d r reinforcement learning, sin tandards, reinforcement lean	lifferent rein mulation to rning probl	nforcei ol kit f ems, r	ment le or rein nulti ai	earning forcen rmed b	g metho nent lea andit p	ods, ap arning, roblem	oplication overvit n, conte	ons of o iew of o extual b	lifferer yber p andit j	nt reinf hysica problei	orceme al syste m, rein	ent lear em, exa force le	ning m Imples	ethods of cyb proble	s, histo er phy em	ory of ysical
Unit-2 - Mo	del Based Reinf	orcement Le	earning			1						125								·	9	Hour
Model base	d reinforcement	earning intro	oduction, mo	del free reinforce	ment lea	rning, model based reinford	ement lea	rning p	princip	les, wo	orking &	applic	ations,	dynam	nic pro	gramn	ning, dy	ynamic	progra	ımminç	g prind	ciples
& applicatio	ns,partially obser	vable Markov	v decision p	rocess, partially of	bservable	e Markov decision process –	- architectu	re, pai	tially c	bserva	able Ma	arkov d	ecisior t loorn	n proces	SS – Wo	orking	& appli	ications	;, contir	1UOUS (	obser	vable
algorithm e	xamples_reinforc	ement learnin	na advance	d algorithm applic	ations	icalion analysis, reiniorceni	entiearnin	y com	orme	unous,	reinion	Jemen	lieain	ing auv	anceu	aiyun	, re	IIIOICE	mentie	annng	l auva	nceu
Unit-3 - De	ep Reinforceme	nt Learning a	& Case Stu	idy	ationio									-							9	Hour
Deep reinfo	prcement learning	introduction,	, deep reinf	prcement learning	<mark>j exampl</mark> i	es, deep reinforcement lear	ning workii	ng prir	ciples	, deep	reinfor	cemen	t learn	ing ma	thema	tical m	odellin	g, deep	o reinfo	rceme	nt lea	rning
value funct reinforceme in smart gri	ion, deep reinford ent learning for cy d –introduction ar	cement learni ber security – nd application	ning value fu – architectur n, case stud	inction tools, dee res, reinforcement y: online cyber at	<mark>p reinfor</mark> t learning tack dete	cement learning value polic for cyber security – archited action in smart grid –system	cy tools, re ctures, rein <mark>design, ca</mark>	einforc forcen se stu	ement nent le dy: on	learni earning line cy	ng for for cyb ber atta	cyber : er sec ack del	securit urity – tection	y, reinf system in sma	orcem functi rt grid	ent lea on, ca: –work	arning se stud ing prii	for cyb ly: onlin nciple, (	er secu 1e cybe case st	urity – r attac tudy: o	exam k dete nline	ıples, ection cyber
attack deter	ction in smart grid	–system mo	odel, case s	tudy: online cyber	attack d	etection in smart grid -state	estimation	1														

#### Unit-4 - Python Programming for Reinforcement Learning

introduction to reinforcement learning using python, introduction to reinforcement learning libraries used, introduction to reinforcement learning set up of tools, elements of reinforcement learning, agent environment interface, types of reinforcement environment, reinforcement environment platforms, reinforcement environment platform call function, getting started with openai and TensorFlow, setting up your machine for open ai and tensor flow, openai gym, openai universe, TensorFlow, the Markov chain and Markov process, Markov decision process, the bellman equation, optimality, solving the bellman equation.

#### Unit-5 - Unsupervised Learning Using Scikit-Learner, Tensorflow and Keras

9 Hour

9 Hour

Unsupervised learning using scikit-learn, dimensionality reduction, the motivation for dimensionality reduction, dimensionality reduction algorithms, principal component analysis, singular value decomposition, dictionary learning, independent component analysis, unsupervised learning using tensor flow, Keras- auto encoders, auto encoder: the encoder and the decoder, under complete auto encoder, over complete auto encoders, dense vs. sparse autoencoders, denoising autoencoder, variational autoencoder, hands-on with autoencoder, hands-on with autoencoder

	1. Chong Li, Meikang Qiu, Reinforcement Learning for Cyber-Physical Systems and	З.	Sudharsan Ravichandiran, Hands-On Reinforcement Learning with Python, 2nd Edition, Packet
Learning Resources	Cybersecurity Case Studies, 1st Edition, CRC Press.	1	Publishing, 2018.
Resources		ŕ	March 2019

			Summotivo							
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test %)	Life-Long CL (10	g Learning A-2 0%)	Final Examination (40% weightage)				
	-	Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	20%	the state of the state	10%		20%	-			
Level 2	Understand	30%		10%		30%	-			
Level 3	Apply	30%		40%		30%	-			
Level 4	Analyze	20%		40%		20%	-			
Level 5	Evaluate	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1				-	-			
Level 6	Create	and the second second				1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	-			
	Total	100	)%	10	0%	100 %				

Course Designers		1.13	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
	1. Dr. S. A. Akbar, Chief Scientist, CEERI Pilani	1. Dr.P. Vija <mark>yakumar, S</mark> RMIST	

Course Code	21ECE352T	Cours Nam	se HIGH e	I PERFORMANCE COMPUTING FC	OR CYBER PHYSICAL	Cou Cate	irse gory	E			PROF	ESSIC	NAL E	ELECT	IVE			- T 3 0	P 0	C 3
Pre-r	equisite Courses		Nil	Co- requisite Courses	Nil		Progre	essive	Cours	es					Nil					
Course	Offering Departme	nt		ECE Da	ta Book / Codes / Standa	irds							Nil							
Course Le	arning Rationale (	CLR):	The purpo	se of learning this course is to:	CHEN	1		i e		Progr	am Ou	itcome	s (PO	)				P	rogra	m
CLR-1:	Understanding the	e role of	supercomput	e <mark>rs</mark>		1	2	3	4	5	6	7	8	9	10	11	12	S Ou	pecifi Itcom	c ies
CLR-2:	Implementing the	HPC Ap	oplication <mark>s on</mark>	Grid and cloud Infrastructures					of	-	ţ									
CLR-3:	JGRIM Simplifies	the proc	cess of <mark>porting</mark>	g applications	39.50	edge		nt of	ons (		ocie			Nork		nce				
CLR-4:	Learning on Sche	duled A	lgorith <mark>m</mark>			hor	sis.	omer	igati	sage	and s			am /	E	Fina	ning			
CLR-5:	Real –world Infra customization des	structure sign	es-Research a	area, Big Data challenge and Applica	ations in cloud environmer	t leering Kr	em Analy	In/develo	uct invest lex proble	rn Tool U	ingineer a	onment & inability	(0	dual & Te	nunicatio	ct Mgt. &	ong Lear	1	2	3
Course Or	utcomes (CO):	-	At the end	l of this course, learners will be ab	ole to:	Engin	Probl	Desig	Cond	Mode	The e	Envire Susta	Ethics	Indivi	Comr	Proje	Life L	PSO-	PSO-	PSO-
CO-1:	Improve products	reduce	<mark>the time</mark> taker	n for develop new products-HPC			3		1		-	-	-	-	-	-	-	-	-	-
CO-2:	Reduce the produ	iction c <mark>o</mark>	st			-	3		-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	High performance	compu <mark>n</mark>	<mark>ting sys</mark> tems o	can be highly useful to analyze the d	ata	113	1 -	2	3	-	2	-	-	-	-	-	-	-	-	-
CO-4:	Big data as our al	oility to <mark>g</mark>	<mark>ather th</mark> e info	ormation	States and the	1	-	2	3	_	2	-	-	-	-	-	-	-	-	-
CO-5:	Ability to learn the	e Algorit <mark>l</mark>	<mark>hm, HPC</mark> mair	n advantage learning here (Processir	ng speed super computer)			2	3	-	1	-	-	-	-	-	-	-	-	-

#### Unit-1 - Introduction to Super Computers

Introduction of super computers and grids, grids and supercomputers, grids do support supercomputing, grids cannot replace supercomputers, the role of supercomputers in grids, a public-private supercomputing grid partnership prerequisites and problems, mode of operation, the public-private grid, discussion of results, conclusion, introduction to porting HPC applications to grids and clouds -applications and the grid infrastructure, applications and resource management, applications

#### Unit-2 - Scheduling Architectures

Introduction to scheduling- mouldable job allocation for handling resource fragmentation in computational grid, computational grid model and experimental setting, mouldable job allocation on homogeneous parallel computer, moldable job allocation in heterogeneous grid, comparison with multi-site co-allocation and conclusion, introduction to speculative scheduling of parameter sweep application using job behaviour descriptions, architecture overview, job behaviour description, simple, complex description, generating simple job descriptions, generating complex job descriptions, complex descriptions with mutation, scheduling strategies, static data feeder strategy, dynamic data feeder strategy, implementation, scheduler, description generator, description repository service, simulation results, summary and conclusion

#### Unit-3 - Privacy & Security Framework

Introduction to security, a policy based security framework for privacy-enhancing data access and usage control in grids, privacy management in large scale distributed systems, managing initial data access, controlling data usage, grids and their requirements for privacy management, architecture of a policy based security framework for privacy-enhancing data access and usage control in grids, application of the security framework to a XACML-based privacy management architecture, integration of the security framework's privacy management components on the service provider side, summery, adaptive control of redundant task execution for dependable volunteer computing-instruction, related work, statistical resource availability characterizing, root cause analysis of failures, fitting distribution to empirical availability data, availability prediction, a heuristics- based failure probability estimation, life cycle of a volunteer peer, failure probability estimation, least, failure probability dispatch policy, an enhanced workflow management mechanism, the task selection, evaluation results, baseline policies, time dependent Schrodinger's wave equation, performance evaluation, comparison with the simple redundant task dispatch policy, comparison with the greedy dispatch, effects of window size on the process time, improvement of the performance by identifying worker types

9 Hour

9 Hour

#### Unit-4 - Data Execution Models

Big data architectures, dataflow model for cloud computing frameworks in big data, introduction, cloud computing frameworks, batch, iterative, incremental processing frameworks, streaming processing frameworks, general dataflow frameworks, application examples, controllable data execution model, design of a processor core customized stencil computation – introduction, related work-customizable design and processors, micro architecture, stencil computation, customization design, flow, array padding and loop tiling, BWOptimizations, SIMD, DMA stencil computation and others, implementation, test results, introduction to electro migration alleviation techniques

#### Unit-5 - Emerging Applications

Introduction to emerging big data, matrix factorization for drug target interaction prediction, classification based methods, neighbourhood regularization logistic matrix – problem formation, logistic matrix factorization, neighbourhood regularization, combined model, neighbourhood smoothing, experimental settings, comparison, benefits, parameter sensitive analysis, predicting novel interactions, overview of neural network accelerators, architectures of hardware accelerators – ASIC, GPU, FPGA, modern storage accelerator, parallel programming models, middleware of neural networks, latest developments

Learning	1.	Emmanuel Udoh, Cloud, grid and High performance computing Emerging Applications,	2.	Chao Wang, High performance computing for Big Data Methodologies and Applications, 1st Edition,
Resources		1st Edition, IGI Global, 2011		Chapman & Hall Press Publications, 2020.

Learning Assessm	nent	No. 1		the second						
			Continuous Learni	ng Assessment (CLA)		Summativa				
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native nge of unit test 0%)	Life-Long CL (10	g Learning A-2 0%)	Final Ex (40% w	amination eightage)			
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice			
Level 1	Remember	20%		10%		25%	-			
Level 2	Understand	20%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	20%		<mark>25</mark> %	-			
Level 3	Apply	30%	CONTRACTOR OF	30%	-	30%	-			
Level 4	Analyze	30%		40%		20%	-			
Level 5	Evaluate			CHECK PARTY	-	-	-			
Level 6	Create			A Part of		-	-			
	Total	10	0%	10	0 %	10	0 %			

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
E. 19	1. Dr. S. A. Akbar, Chief Scientist, CEERI Pilani	1. Dr.P. Vijavakumar, SRMIST	



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9 Hour

Course Code	21ECE450T	Course Name		DESIGN OF	CYBE	R PHYSICAL SYSTEMS		Cour: Catego	se ory	E			PROF	ESSIC	)nal e	ELECT	IVE			L T 3 0	P 0	C 3
Pre-requ Course	isite es	Nil		Co- requisit Course <mark>s</mark>	e	Nil		Pr	ogres Cours	sive es						Nil						
Course	Offering Departme	ent	1	ECE		Data Book / Cor	des / Standard	ls							Nil							
						and the second second			1	1.00												
Course Le	earning Rationale	(CLR): T	The purpo <mark>s</mark>	e <mark>of learnin</mark> g th	is col	ırse is to:			6	0.0	1.1	Progr	am Ou	<mark>itco</mark> me	es (PO	)				P	rogra	am file
CLR-1:	Able to understar	nd the design	ın of huma <mark>n</mark>	in the loop cybe	ər phy:	sical systems		1	2	3	4	5	6	7	8	9	10	11	12	01 01	utcon	nes
CLR-2:	Design knowledg	e of energy o	cybe <mark>r phys</mark>	<mark>ical s</mark> ystems	5	1.000	-	ge		of	s of	2	iety			ork		е				
CLR-3:	Learn how Symb	olic synthesi	is f <mark>or cyber</mark>	physical system	is wor	ks	1000	vled		ent o	ation	ge	l soc			NC NC		Jano	Ð			
CLR-4:	Design principles	of Intelligen	n <mark>t wireles</mark> s s	sensor networks	in cyt	per physical systems	1.2	Kno	alysis	lopm	estig: blem	Usa	r and	~		Tear	ion	& Fi	arnir			
CLR-5:	Through simple h	ands on exe	ercise learn	and implement	huma	ns in the loop software		neering	em Ana	gn/deve	luct inve olex pro	ern Tool	enginee	onment	<mark>v</mark>	idual & .	municat	ect Mgt.	-ong Le	-	-2	ę
Course O	utcomes (CO):	A	At the end	of this course,	learne	ers will be able to:	1000 27	Engi	Prob	Desig	Conc	Mode	The (	Envir	Ethic	Indiv	Com	Proje	Life I	PSO	PSO	PSO
CO-1:	Design the Cyber	r Physic <mark>al sy</mark>	y <mark>stem</mark> s with	Industry 4.0 star	ndards	5	233412	3	2	3	-	-		-	-	-	-	-	-	3	-	-
CO-2:	Explain the mode	ling an <mark>d con</mark>	ntrol of Ene	rgy CPS		Alexandre alexand	8. E.	3		100	-	-	-	-	-	-	-	-	-	-	3	-
CO-3:	Implement synthe	esis mo <mark>dels</mark> f	for real time	e CPS			1		2	3	-	-	-	-	-	-	-	-	-	-	-	2
CO-4:	Deploy Wireless	Sensor <mark>Netw</mark>	works using	intelligent metho	ods	1000	1000	-	3	-	3			-	-	-	-	-	-	-	-	2
CO-5:	Experience the H	luman in the	<mark>e Loop</mark> CPS	through app's	Π.	1 - Table - State		3	-	1.1	-	3		-	-	-	-	-	-	3	-	-
11		0. t Dh		(0.0.0)	-72	interior and the	14.5.5						-									
Evolution	of CPS – Humans a	s Flomonts	in CPS - H	ems (CPS)	And V	irtual Communities - Taxon	omies For Hun	ion In	Thol	oon CE	S - Hu	mane	As Sot	Of So	nsors	Hum	ne Ae	Comm	unicat	ion Nr	y ydos -	State
Inference	And Human Nature	– Humans a	as processi	na nodes – Actu	ation i	n CPS –Robots as actuato	rs – Technoloa	ies for	SUDDO	rtina H	uman i	1 Loop	CPS	- Applic	cations	of Hu	man in	Loops	unicali	UII NO	Jues -	olale
Unit-2 - El	nergy CPS			<u></u>			<u> </u>			<u>-</u>			•. •								9	Hour
System De	escription and Oper	rational Scen	na <mark>rios - Ke</mark> j	<mark>y Des</mark> ign Drivers	and (	Operational Scenarios - Ar	chitectural Des	ign - P	hysics	Based	l Com	ositior	1 of Cł	PS for a	an Soo	cio Ecc	logical	Energ	ıy Syst	ems –	Inter	raction
variable ba	ased Automated mo	odeling and c	contr <mark>ol – D</mark> i	<mark>stributed Optimiz</mark>	zation							125										
Unit-3 - S	mbolic Synthesis	for CPS			200	1 1 A 16 A 10	SILL'L	1.	-		100	1									9	) Hour
Symbolic S	Synthesis- its techni	iques – Probl	blem Definiti	on and Solving t	he Sy	nthesis problem - Asynchro	nous Design P	rimitive	s – Co	onstruc	tion of	Symbo	lic mo	dels - A	dvanc	ed Teo	hnique	es for C	Constru	ction (	Of Syr	mbolic
Models - (	Continuous Time C	ontrollers An	nd Software	Tools – Control	)ller Ti	iming and Control Design	For Resource	Efficier	icy - 0	Compu	tationa	comp	lexity	and tin	ne red	uction	– Cont	roller S	Softwar	re Stru	ıcture	s and
Snaring of	resources – Analys	sis and Simula	tworks in C	PODACK CONTROLS	system	1																Hour
Denlovme	nt of Wireless Sens	or Networks	In Cyher P	hysical Systems	- Info	rmation Security and Cyber	Physical Syste	ms - A	ttacks	and V	Inerat	ilities i	n Cybe	or Phys	ical S	/stem -	Attack	Resili	ent De	sian _	Annli	ication
in Intellige	nce Level – Smart (	Grid – Smart	t Field Mon	itoring – Variant	Smart	ness	1 11931001 09310	110 - 1	auno		annordu		n Cybe				7111000			sign =	, uppii	oation

#### Unit-5 - Humans in the Loop –Simple Hands on

A Sample Behavior change intervention application - Architecture – The Android App and Server Set up – Enhancing the sample app with Human in the loop Emotion Awareness – Choosing a Machine Learning Technique – Implementing Emotion Awareness – Installing the Android studio – Cloning the android project – Deploying the server protocols - Installing the Software and Cloning the Server's Project – Setting up the database and deploying the server on Tomcat – Handling emotions on the server – Creating the web interface – Creating the servers background thread – Processing incoming emotions– Handling new emotion interfaces – Providing Positive reinforcement – Creating a motivational dialog box.

-				
	1.	David Nunes, Jorge SA Silva, And Fernando Boavida, a Practical Introduction to Human-	3.	Rai Raikumar, Dionisio De Niz, And Mark Klein, "Cyber Physical Systems", 1st Edition, Addison
Learning		In-The-Loop Cyber Physical Systems, 1st Edition, Wiley & IEEE PRESS, 2018.		Wesley Publishers, 2017
	~			
Resources	2.	Sherali Zeadally and Nataa Jabeur, "Cyber Physical System Design with Sensor		
		Networking Technologies, 1st Edition IET Press, London, 2016.		

			Continuous Learnin	a Assessment (CLA)		_				
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (1)	g Learning A-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	25%	100 - 10 - 10 - 10 - 10 - 10 - 10 - 10	15%		15%	-			
Level 2	Understand	25%	the base is	20%		25%	-			
Level 3	Apply	30%	2002	25%		30%	-			
Level 4	Analyze	20%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	25%		<mark>30%</mark>	-			
Level 5	Evaluate	1 2 2 2 3		10%		-	-			
Level 6	Create	No. Alar		5%		-	-			
	Total	10	0%	10	0%	10	0 %			

Co	urse Designers	10			
Ex	perts from Industry	Exp	erts from Higher Technical Institutions	Int	ernal Experts
1.	Mr.Athif Shah, Chairman, AbeSemicondutor,	1.	Dr. Meenakshi, Professor of ECE, CEG, Anna University,	1.	Dr. M. Sangeet <mark>ha, SRMI</mark> ST
	abechennai@gmail.com		meena68@annauniv.edu		
2.	Dr. S. A. Akbar, Director-CPS, Rtd. CSIR- CEERI, Pilani.	2.	Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	2.	Dr. P. Vijayakumar, SRMIST
	saakbar158@gmail.com				

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Course Code	21ECE4511		Course Name	(	CYBER I	PHYSICAL	. INTERF	ACE AND A	AU <mark>TOMATIC</mark>	ON	C	Cours atego	e ry	Е			PROF	ESSIO	NAL E	ELECT	IVE			L T 3 0	P 0	C 3
Pre-requi Course	site s	21E	CE251T		Co- Co	requisite urse <mark>s</mark>			Nil			Pro	ogres Cours	sive es						Nil						
Course	Offering Depar	men	t		EC	E		Data	Book / Cod	les / Stan	dards	100							Nil							
Course Le	arning Rationa	le (C	:LR): 7	he purpo	se of lea	<mark>rnin</mark> g this	course i	is to:					đ			Progr	am Ou	itcome	s (PO	)	1	1	1	P	rogra	m
CLR-1:	Study the cybe	er phy	ysical syst	ems built-c	on Wirele	ss sensor	networks	1				1	2	3	4	5	6	7	8	9	10	11	12	01	itcom	es
CLR-2:	Learn the data	man	nagement f	for c <mark>yber p</mark>	<mark>hysica</mark> l s	ystems				-		ge		of	s of	24	iety			¥		a				
CLR-3:	Gain knowled	je on	routing in	WSN for a	cyber ph	sical syste	əms		-	0.34		/led		ent o	tion	ge	soc			Wo		anci	0			
CLR-4:	Analyze the se	curit	y issu <mark>e</mark> s in	cyber phy	sical sys	tems				1.35		Vou	lysis	mdo	stiga	Usa	and	æ		earr	uo	& Fin	ini			
CLR-5:	Enhance the s	cient	ific compu	ting skills o	on media	al cyber pł	hysical s <mark>y</mark> :	stems				eering h	em Ana	jn/devel	uct inve lex prob	im Tool	engineer	onment ainabilit <mark>y</mark>	S	dual & T	nunicati	ct Mgt. 8	ong Lea	<del></del>	5	ņ
Course Ou	tcomes (CO):		/	At the end	l of this	course, le	arners w	ill be able	to:	a dine	17	Engir	Probl	Desig	Cond	Mode	The e	Envir Susta	Ethic	ndivi	Comr	Proje	life L	-OSC	-OSc	-OSC
CO-1:	Integrate wire	ess s	senso <mark>r net</mark>	works with	CPS		1	100	Cart	2434	12	1	3	-	-	1	-	-	-	1	1	-	3	-	-	-
CO-2:	Apply data ma	nage	ement <mark>conc</mark>	cepts in Cl	PS	1.000	1.000	in Second	100	67. I		2	3	1	-	1	-	_	-	2	1	-	3	-	-	-
CO-3:	Implement rou	ting p	protoc <mark>ol fo</mark>	r CPS	Sec.	184	10.00	1997	0.02	100		2	3	2	-	1		-	-	2	1	-	3	-	-	-
CO-4:	Design a resil	ent C	PS			1	1225	and all	1100	1	- 51	2	3	2		1	-		-	2	1	-	3	-	- 1	-
CO-5:	Develop Cybe	r phy	rsical s <mark>yste</mark>	e <mark>ms f</mark> or inte	erfacing	and autom	ation	1	2			3	3	3	-	1	2	-	-	1	1	-	3	-	-	-
Unit-1 - Int	tegrating Wirel	ess S	Sensor Ne	tworks ar	nd Cybe	r-Physical	Systems	3								<del>,</del>	-	-							9	Hour
Wireless se	ensor networks,	Cybe	er-physica	<mark>l syste</mark> ms,	role of V	VSN techno	ologies in	CPS, CPS	6 design ch <mark>a</mark>	allenges, V	VSN-C	CPS a	rchite	cture, I	NSN-C	PS ch	allenge	es and	c <mark>har</mark> ad	<mark>cter</mark> istic	cs, Op	oortunii	ties			
Unit-2 - Da	nta Managemer	t in (	CPS with	WSN		6													_						9	Hour
Data mana	gement: WSN	/s. N	/SN-CPS,	Constrain	ts of dat	a manager	ment, Dat	ta manager	ment activiti	ties- Mobil	e data	colle	ection,	Data	oroces	sing, L	Data st	orage,	Data d	queryin	ng, Dat	a com	pressio	on, Da	ta ana	ılysis;
Unit-3 - Ro	sical cloud comp	for C	ps	iilies allu (	Jianeny	es, rteal un	ne, biy ba	ala, Dala III	iiiiiiy, Dala	Integratio	II, LUa	u Dale	ancing	/		10									0	Hour
Desian cha	allenges and iss	ues i	for routina	in WSN.	Routina	protocols i	in WSN fc	or CPS. Lo	cation-base	ed routina	protoc	ols. E	Data-c	entric	routina	proto	cols. H	lierarch	ical ro	outina ı	protoco	ls. Fut	ure dir	ection	s of ro	outina
protocols in	WSN for CPS			,			100		N		,	, -					,					,				
Unit-4 - Re	esilient WSN fo	r CP	S			1.1							1.24												9	Hour
Objectives	of WSN for CF	S, In	formation-	security g	oals, Att	acks again	ist sensor	rs-Types of	f attacks an	nd vulnera	bilities	in CF	PS; N	otion o	f attac	k resili	ence-	Securit	y and	resilie	nce, R	andom	failure	es and	inten	tional
attacks, Ch	allenges; Appro	ache	es for attac	k resilienc	e		_							_	-	-										Haur
Introduction	n System Desc	rintio	n and One	is Irational Si	conarios	-Virtual Ma	odical Der	vices Clini	cal Sconaric	ns Kov Da	osian I	Trivor	s and	Quality	. Attrib	utos 7	Trands	Qualit	/ Δttril	hutass	nd Ch	allonac	s of th		00 25	moin
High-Confi MCPS Dev	dence Developri veloper Perspec	ipilo ient d tive, l	of MCPS, ( MCPS Adr	On-Demar ninistrator	nd Medic Perspec	al Devices tive, MCPS	and Assu	red Safety, erspective,	, Smart Alari Patient Pers	ms and Cl spective, I	inical I MCPS	Decisi Regu	ion Su ilatory	pport S	System ective,	s ; Clo Sumn	sed-Lo nary ar	op Sys	tem, A n Chal	issurar Ilenges	nce Ca	ses, Pr	actition	ners' Ir	nplicat	tions-

Learning	1.	Sherali Zeadally, Nafaa <sup>^</sup> Jabeur. "Cyber-Physical System Design with Sensor	3.	Edward D Lamie, "Computing Fundamentals Of Cyber Physical Systems," 2nd Edition, Newnes
Desources		Networking Technologies," Institution of Engineering and Technology, 2016.		Elsevier Publication.
Resources	2.	Raj Rajkumar, "Cyber Physical Systems," 2nd Edition, Elsevier, 2015.	4.	Rajeev Alur, "Principles of Cyber Physical Systems," 1st Edition, MIT Press, 2015.

Learning Assessme	ent			2-200 A			
			Continuous Learning	g Assessment (CLA)		Sum	motivo
	Bloom's Level of Th <mark>inking</mark>	For CLA-1 Aver (:	rmative rage of unit test 50%)	Life-Loi C (	ng Learn <mark>ing</mark> CLA-2 10%)	Final Ex (40% w	mative amination eightage)
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	and the second sec	20%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	20%	-
Level 2	Understand	30%		20%	1242	20%	-
Level 3	Apply	20%		30%		30%	-
Level 4	Analyze	20%	and the second second	30%		30%	-
Level 5	Evaluate				1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		-
Level 6	Create	- W		1	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	-	-
	Total	1	00 %	1	100 %	10	0%
					Contra la		

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Athif Shah, Chairman, AbeSemicondutor,	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University,	1. Dr. Lavanya A., SRMIST
abechennai@gmail.com	meena68@annauniv.edu	
2. Dr. S. A. Akbar, Director-CPS, Rtd, CSIR- CEERI, Pilani.	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	
saakbar158@gmail.com		



Course Code	21ECE452T	CAL	Cours Catego	se ory	Е			PROF	ESSIC	)nal e	ELECT	IVE		!	- T 3 0	P 0	C 3					
Pre-requi Course	site s	Nil		Co- requisite Course <mark>s</mark>		Nil		Pr	ogres Cours	sive es						Nil	1					
Course (	Offering Departme	ent		ECE		Data Book / Codes /	Standard	s					-		Nil							
Course Le	arning Rationale (	CLR): T	The purpo <mark>se</mark>	<mark>of learnin</mark> g this co	ourse is to:	Ser.			1		2.1	Progr	am Ou	utcome	s (PO	)				Pr	ograr	n
CLR-1:	Design architectu	re of a clou	ıd based distr	ibuted system	100			1	2	3	4	5	6	7	8	9	10	11	12	Ou	tcom	es
CLR-2:	Understand proce	ess of desig	gning <mark>fault-tole</mark>	erant cloud based	distributed	systems		e		f	s of	1	iety			¥		0				
CLR-3:	Understand and o	lesign distri	ibu <mark>ted real-t</mark> in	ne system computil	ing challeng	es	100	vledç		ento	tions	ge	soc			Wo		ance	5			
CLR-4:	Understand distri	buted secur	r <mark>e comput</mark> ing	system and design	ning securit	/ models		Von	lysis	mdo	stiga	Usa	and	<b>∞</b> ठ		earr	u	ž Fin	inin			
CLR-5:	Understand funda	amental con	ncepts of dist	ributed system ma	anagement			leering h	em Ana	In/devel	uct inve lex prob	rn Tool	engineer	onment inability	6	dual & T	nunicati	ct Mgt. 8	ong Lea	Ţ	5	e.
Course Ou	itcomes (CO):	-	At the end of	this course, learr	ners will be	able to:	1. SY	Engir	Probl	Desig		Aode	The e	Envir	Ethics	ndivi	Comr	Proje	-ife L	-OS	-OS	-OSc
CO-1:	Design architectu	re of a <mark>cloud</mark>	d based distri	buted system	100	No. AL	141.	3	-	2	-	-	2	-	-	-	-	-	-	-	-	-
CO-2:	Explain various fa	ults in <mark>cloud</mark>	d based distri	buted systems and	how to des	ign a fault tolerant sys	tem.	-	3	3	-	-	-	<u> </u>	-	-	-	-	-	-	-	-
CO-3:	Design a distribut	ed real <mark>-time</mark>	e system		1.162			3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Design security m	nodels f <mark>or a</mark> :	secure distrib	uted cyber physica	al system	and the second second	200	1	3	3		-	2	-	-	-	-	-	-	-	-	-
CO-5:	Understand key n	nanage <mark>ment</mark>	<mark>it issu</mark> es in dis	tributed cyber phys	sical system			1	3	2	-	ł	1	-	-	-	-	2	-	-	-	-
				201.0	Contract of																	
Distributed	oud Based Distrib	uted System res Strategi	ins for Distrib	uted Systems Sole	octina a Sor	vice Platform Asynchi	ronous Ma	dale (	Synchi	ronous	Model	Dist	ributeo	l Sharoi	d Mor	on G	roun (	ommu	nicatio	n Dist	9 I ributo	Hour d Filo
Systems, D	Distribution of Data	Repositories	s, Distributed	File System Acces	ss, Strategy	for Scaling, Data Shar	ding, Thre	ading,	Queu	ieing, l	Strateg	for R	esilien	CV.		10 <i>1 y</i> , 0	noup C	ommu	ncalio	1, DISU	innier	11110
Unit-2 - Fa	ult-Tolerant Comp	outing	,							<u>0</u> ;		1		-							9	Hour
system, Fa	ult-tolerant Consen	sus, Replica	ati <mark>on Manag</mark> e	ment in Partition-fr	ree and Par	titionable Networks, Cl	lasses of F	ailure	Sema	ntics,	Basic F	ault to	leranc	e Frame	eworks	s, Faul	t Toler	ance S	trategi	əs, Faı	lt-Tol	erant
Client-Serv	er Database, Fault	Tolerance of	of Lo <mark>cal Serve</mark>	ers, Distributed Fau	ult-Tolerant	Systems, Cluster archi	tectures,					2	_									
Unit-3 - Re	al-lime Networks				- K	Or start and Orthodalia	011-0					- De a	LTime	Analaita	- 4				24		91	Hour
Concertion	Specifications, Timi The Event-triagere	ng Fallure D d and Time-	Jetection, Rea	ar-Time Communica	Databases	Control and Schedulin	ig, Clock 3 onstraints	Jimo	onizat Servic	ion, Di	stribute	a Real	the Int	Archite	ectures	s ana F tion of	ramev the Inc	/OFKS, 3 Iustrial	Svster	les tor ms	Real-	ıme
Unit-4 - Se	curity and Privacy	/ in CPS's			Databases,	Operating Systems co	Jiisti anno,	TIME	Jeivic	,co, ne					negra			นอแานเ	Uyster	113	9	Hour
Security an	d Privacy Issues in	CPSs, Sec	cureNetworks	, Internet-Wide Sec	cure Comm	unication, Security and	d Privacy i	or Clo	ud- Int	tercon	nected	CPSs,	Key N	lanagei	ment i	n CPS	s, CPS	Key N	lanage	ment (	Challe	nges
and Open I	Research Issues, S	ecure Regis	stration and R	emote Attestation of	of IoT Devid	es Joining the Cloud,	Stack4Ťhi	ngs Ar	chitec	ture, S	Secure I	letwor	k Codi	ing, Šec	cure D	istribut	ted Arc	, hitectu	res, Vu	ılnerab	ility, A	ttack
and Intrusio	on, Fault Tolerance	and Securi	rity, Mean time	e between failure (l	(MTBF) in D	istributed Systems, Tr	usted Cor	nputin	g Base	e (TCE	3), Secu	re Cor	nmuni	ication a	and Di	stribut	ed Pro	cessin	g, Intra	nets a	nd Fir	ewall
Systems, A	uthentication and A	Authorization	n Services, Da	ata Encryption Stan	ndard, Symi	netric and asymmetric	cryptogra	ohy, Di	iffie-He	ellman	and RS	A enc	ryptior	n, Lightv	veight	Crypto	o and S	ecurity	, Light	weight	Symn	netric
anu Asymn	neuric Cipriers Imple	ementations	5																			

#### Unit-5 - Management Information Base

Management Functions, ManagementFrameworks, Strategies for Distributed Systems Management, Generic Management Model, Centralized and Decentralized Management Model, OSI Management Model, Management and Configuration Tools, Distributed Management Environment, Managing Security on the Internet, Disaster Preparedness

Learning Resources	1. 2. 3.	Security and Privacy in Cyber-Physical Systems Foundations, Principles, and Applications" by Glenn A. Fink and Sabina Jeschke, IEEE Press Wiley, 2018 Distributed Systems for system architects, Paulo Verissimo and Luis Rodrigues,2001	4.	Designing and Operating Large Distributed Systems Volume 2, by Thomas A. Limoncelli, Strata R. Chalup and Christina J. Hogan, Addison Wiely, 2014

		1. 1. 1.	Continuous Learning	g Assessment (CLA)	11	Sum	motivo		
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (1	g Learning "A-2 0%)	Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%		15%		15%	-		
Level 2	Understand	30%		20%		25%	-		
Level 3	Apply	30%		25%		30%	-		
Level 4	Analyze	25%		25%		30%	-		
Level 5	Evaluate		10 245 W	10%		-	-		
Level 6	Create	1. al (1977)		5%		-	-		
	Total	10	0%	10	0%	10	0%		

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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abechennai@gmail.com	meena68@annauniv.edu	
2. Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI,	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	2. Dr. M. Sangeetha, SRMIST
Imadank@gmail.com	West States	



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Course Code	21ECE453T	Cour Nam	rse ne	MOBILE CYBER PHYSICAL SYSTEM					se ory	E			PROF	ESSIO	NAL E	ELECT	IVE		[ (	- T 3 0	P 0	C 3
Pre-requ Course	isite 2	1ECE25	50T	Co- requisite Courses		Nil		Pro	ogres Cours	sive es						Nil	1					
Course	Offering Departm	ent		ECE		Data Book / Codes / S	tandards								Nil							
Course Le	earning Rationale	(CLR):	The purpose of	F learning this co	ourse is to:	-			1		11	Progr	am Ou	utcome	s (PO)	)				P	rogra	m
CLR-1:	Outline the conte	ext of the	e mobile cyber- phys	sical system				1	2	3	4	5	6	7	8	9	10	11	12	01	itcom	ies
CLR-2:	Identify different	applicati	ions of co <mark>mmunity s</mark>	ensing	1	and the second		e		+	of	3.	ety			¥				i I		
CLR-3:	Understand the s	security i	issues <mark>of CPS in</mark> the	e Smart grid appli	cation	4.525	10	vledg		ent o	ations	ge	soci			Wor ר		Jance	D			
CLR-4:	<b>LR-4:</b> Develop a deep understanding of CPS automation in Transportation application							<b>Voux</b>	lysis	mqo	stig: lem	Usa	and	∞ .		ean	и	Υ	arnin		l <sup> </sup>	
CLR-5:	Design mobile m	edical cy	yber-physical system	m				eering I	em Ana	jn/devel	uct inve lex prob	ern Tool	engineer	onment ainabilit <mark>v</mark>	S	dual & T	nunicati	ct Mgt. 8	ong Lea	<del>.</del>	-2	က္
Course O	utcomes (CO):		At the end of t	his course, learn	ners will be	able to:	. 27	Engir	robl	Desig	Sond Song	Aode	he	Envir	Ithic	ndivi	Comr	roje	ife L	SO	SO	SO
CO-1:	Appreciate the fe	atures o	o <mark>f the mo</mark> bile cyber-	physical system	1993	Serie of	94.24	1	-	-	-	-		-	-	-	-	-	-	-	-	-
CO-2:	Apply CPS conc	ept in co	mmunity sensing a	oplications	120-2	100 C		2	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Analyze security	issues i	in smart grid CPS		1.1.1.1			2	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Design CPS for	Transpor	rtation application		200		10	3	2	3	-	-			-	-	-	-	-	-	-	-
CO-5:	Implement CPS	in mobile	e Health care	-01 E			1	3	2	3	-	-	1	-	-	-	-	-	-	-	-	-
Unit 1 M	ahila CDS				200								9									Hour
Mohile CP	S-Vehicular CPS	Iohile Si	unervision System	Smart Grid CPS	Cognitive R	adio Network for Mobile	CPS Cor	nmun	nicatio	n Mode	L Coar	nition (	Vole	Commu	inicatio	on Prot	tocols	Quality	of Ser	vice A	<b>y</b> rchite	cture
Methods to	Enhance System	Efficiend	cy, Challenges-Sec	urity, Survivability	/.		01 0, 001	mnan	noution	mout	n, oogi	naon e	<i>y</i> 010,	oomina	mound		00010,	Quality	01 001	1007	onico	otaro,
Unit-2 - Co	ommunity Sensin	g		14 J 2 11		2.2.2.2						1									9	Hour
Devices a	nd Programs Invo	ved in C	Commu <mark>nity Sens</mark> ing	- Mobile Phones	s, platform f	or remote sensing usir	ng smartpl	hones	s, Dev	vice Co	ontrol, I	Nirele	ss Coi	nmunity	y Netw	vorks,	Applica	ations	of Con	าmunit	y Ser	nsing-
Environme	ental Applications,	Air Trans	sportation, Earthqua	ake Detection		1111						125	-									
Unit-3 - Ci	PS for Smart Grid	Applica	ations	Creart Crid Day i	ing Ingung A	latuarling laguage Drive			and out a	Crid F		Linform	motion	Drives							9	Hour
Communic	ations in Smart Gr	ia, Cybei tion Ani	Prsecurity issues on	Smart Grid- Devid	ce issues, i	ietworking issues, Priva	acy issues	s on S	mart	Gria- P	ersona	i intori	nation	, Privac	cy Con	cerns					0	Hour
Networker	Automotive Cyber	-Physica	al Systems Arterial	Traffic Condition F	Estimation.	Traffic Model Assumptio	ons Grant	nical N	Model	CarM	leraina	Assist	ant- M	eraina l	001100	Mora	ina Asc	sistant	for Mix	od Tra	ffic · Δ	rtorial
Traffic Pre	diction. Road Traff	ic Delav	Estimation.		Lounduon		5113, <b>O</b> rapi	ncarn	nouci,	Our W	lorging	733131		ciging i	55005,	morgi	ng Ass	Jotunti		Ju mu	110, AI	tonui
Unit-5 - He	ealth Care Cyber-	Physica	l System																		9	Hour
Basics of	Implementing Cyb	er-Physic	cal Medication Sys	tems, Medical De	evice Coord	ination and Integration,	Medical	Devic	e Coc	ordinat	ion Fra	mewol	rk, Me	dical D	evice I	Integra	ation O	ptions-	Plug i	and Pi	ay me	edical
devices, S	afe Interoperability	of Media	ical Devices in the E	Event of Failure		-										-			-			

	1.	Fei Hu, "Cyber-Physical Systems: Integrated Computing and Engineering Design,"	3. Christophe Tricaud, YangQuan Chen, "Optimal Mobile Sensing and Actuation Policies in Cyber-
Learning		CRC Press (2013)	physical Systems," Springer 2015.
Resources	2.	Rawat, D.B., Rodrigues, J.J.P.C., & Stojmenovic, I, "Cyber-Physical Systems: From	4. Dietmar P.F. Moller, "Computing Fundamentals In Cyber Physical Systems," 1st Edition, Springer
		Theory to Practice," CRC Press (2015).	2015.

		-	Continuous Learning A	ssessment (CLA)		Sum	motivo		
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native lige of unit test 0%)	Life-Long CL (10	Learning A-2 %)	Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	30%		20%		20%	-		
Level 2	Understand	30%		20%		20%	-		
Level 3	Apply	20%	States and	30%		30%	-		
Level 4	Analyze	20%		30%		30%	-		
Level 5	Evaluate			1		L. 1.200 1.1-	-		
Level 6	Create		Section 1			1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	-		
	Total	10	0%	100	)%	10	0 %		

Course Designers	ALL AND						
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts					
1. Mr.Athif Shah, Chairman, AbeSemicondutor, abechennai@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Dr. Lavanya A, SRMIST					
2. Dr. S. A. Akbar, Director-CPS, Rtd, CSIR- saakbar158@gmail.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	X					



# ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES (With exit option of Diploma)

(Choice Based Flexible Credit System)

**Regulations 2021** 

Volume - 14C (Syllabi for Electronics and Communication Engineering w/s in Data Science Programme Courses)



### SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India



Course Code	21ECE270T	FOR DATA SCIENCE	(	Cours Catego	e ory	Е			PROF	ESSIO	NAL E	LECT	IVE		l	- T 3 0	P 0	C 3			
Pre-requi Course	isite es	Nil	Co- Coi	requisite Irse <mark>s</mark>	Nil		Pr	ogres: Course	sive es						Nil						
Course	Offering Departme	ent	ECE		Data Book / C	odes / Standard	S							Nil							
Course Le	arning Rationale (	(CLR): <i>TI</i>	he purpose of lear	nina this co	ourse is to:		-	1	1		Progr	am Ou	Itcome	s (PO	)				P	ogra	m
CLR-1:	Learn about prob	ability theory	and random variat	oles.			1	2	3	4	5	6	7	8	9	10	11	12	S	pecifi	C
CI R-2'	Describe the rand	nom process	es and Markov cha	in			0			of	1	ity			~				00	tcom	62
CLR-3:	Know to analyse	descriptive s	statistics		A 103		ledge		nt of	ions	Ð	socie			Wor		ance				
CLR-4:	Educate about Ba	avesian statis	stics and hypothesis	s testina			now	ysis	pme	stigat	Jsag	and	~*		eam	E	Fina	ming			
CLR-5:	LR-5:       Gain knowledge on linear regression and its models.								evelo	inves	00	leer	ient 8 oility		& T	icatio	gt. 8	Lea			
	g						neer	lem	gn/d	duct	E me	engii	ronm ainal	s	idua	unu	ect M	-ong	-	Ņ	က္
Course Or	utcomes (CO):	A	At the end of this c	ourse, learı	ners will be able to:	A. 100 10 10 10	Engi	Prob	Desi	Conc	Mod	The	Envi	Ethio	Indiv	Com	Proje	Life	PSO	PSO	PSO
CO-1:	Identify the function	ons in p <mark>roba</mark>	<mark>bility</mark> and random va	ariables.	a literation	× 1.54	3	2	-	-	<u> </u>		-	-	-	-	-	-	-	-	-
CO-2:	Construct random	n proces <mark>ses</mark> i	<mark>usin</mark> g statistical fun	ctions.	<b>持法</b> 他	11		3	6	-	-		-	-	-	-	-	1	-	-	-
CO-3:	Evaluate the desc	criptive <mark>and</mark> f	f <mark>requ</mark> entist statistics	100	0.000	3.4		3		-		-	-	-		-	-	1	-	-	-
CO-4:	Analyse Bayesiar	n statisti <mark>cs a</mark> r	<mark>nd h</mark> ypothesis testin	g models.		5	1	2	3	-	-		-	-	-	-	-	-	-	-	-
CO-5:	Describe the diffe	erent lin <mark>ear re</mark>	<mark>egres</mark> sion models.				2	3	1.1	-	-		-	-	-	-	-	-	-	-	-
<b>Unit-1 - Pr</b> Probability	robability Theory a	and Random al probability	1 Variables y, Discrete and Co	ntinuous ra	ndom variables, Functions	s of random vari	ables,	gener	rating I	random	varia	bles, J	Joint di	stribut	ions o	f discr	ete an	d conti	nuous	<b>9</b> varia	<b>Hour</b> ables,
Unit-2 - Ra	andom Processes			aung muluva	nale random vanables, EX	uecialion operalo	i, iviea	ii allu	Vallall	LE, CON	ananc	e, coi	IUILIUITA	rexpe	ClaliOI	1				9	Hour
Definition,	Mean and autocova	ariance funct	io <mark>ns, Indepen</mark> dent i	dentically-dis	stributed sequences, Gauss	sian process, Pois	son pi	rocess	s, Conv	ergenc	e of Ra	andom	Proces	sses: 7	ypes o	of conv	ergenc	e, Cen	tral lim	it theo	orem,
Monte Car	lo simulation, Marko escriptive Statistic	ov Chains: T	ime-homogeneous	discrete-tim	e Markov chains, Recurren	ce, Periodicity, C	onverg	ence	-	-		-	-		_					9	Hour
Histogram,	Sample mean and	variance, Oi	rder statistics, Sam	ole covarian	ce, Sample covariance mat	rix, Independent i	dentic	ally-dis	stribute	d samp	oling, F	reque	ntist sta	atistics	: samp	ling, m	ean sq	uare e	rror, co	onsist	ency,
confidence	intervals, parameti	ric and non-p	parametri <mark>c model es</mark>	stimation	1		_	K.01	ine di		0.					0.					
Unit-4 - Ba	ayesian Statistics	and Hypoth	rior Bayesian esting	nators The	hypothesis-testing framew	ork Parametric te	stina	Nonna	aramot	ric test	ina: Th		nutatio	n tost	Multir	le testi	ina Ga	nucciar	mixtu	<b>9</b>	Hour
multinomia	al mixture models	conjugato pi	nor, Dayesian esan				,sung,	Nonpe	aramet		ng. m		natatioi	11001,	munup	10 1031	ng, oc	ussiun	mixtu		ucis,
Unit-5 - Li	near Regression							"		_		,			,				,	9	Hour
Linear mod	tels, Least-squares models, Poisson re	estimation, earession	Prediction, Residua	nis, Bases ar	nd <mark>residuals Overfitting, No</mark>	n-linear regressio	on: Nor	n-linea	r least	square	s, tran	storma	ation to	linear	mode	– Gen	eralize	d linea	r mod	eís: lo	gistic
																					-

	1.	Michael Mitzenmacher and Eli Upfal; Probability and Computing, 2ed, Cambridge	3.	Course notes of Carlos Fernandez-Granda, DS-GA 1002: Probability and Statistics for Data
Learning		University Press, 2017		Sciencehttps://cims.nyu.edu/~cfgranda/pages/DSGA1002_fall17/index.html
Resources	2.	Robert V Hogg, Joseph W McKean and Allen T Cralg; Introduction to Mathematical	4.	Sheldon M Ross; A First Course in Probability, 10ed, Pearson, 2018
		Statistics, 8 <sup>th</sup> ed, Pearson, 2018		

			Continuous Learning	Assessment (CLA)		Summative				
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (10	Learning A-2 )%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	20%		20%			-			
Level 2	Understand	20%	0.53 C	20%			-			
Level 3	Apply	10%	A Carton Same	10%			-			
Level 4	Analyze	20%		20%			-			
Level 5	Evaluate	20%		20%	1		-			
Level 6	Create	10%	the state of the s	10%			-			
	Total	10	0%	100	)%	100 %				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Baraneedhara Karthikeyan, Director,	1. Dr. Bhuvaneshwari, Professor, MIT, Anna University, Chennai	1. Mrs. S. Hannah Pauline, SRMIST
Skylim Infotech Pyt Ptd		



Course Code	21ECE271T	Course Name	REG	RESSION AND N	IULTIVARIATE DATA ANALYSIS	C	Course ategor	e ry	Е			PROF	ESSIO	NAL E	LECT	IVE		L 3	. T 3 0	P 0	C 3
Pre-requ Cours	iisite es	Nil		Co- requisite Courses	Nil		Pro	gress ourse	sive es						Nil						
Course	Offering Departme	ent		ECE	Data Book / Codes / S	Standards	1							Nil							
Course L	earning Rationale	(CLR): 7	The purpose o	o <mark>f learnin</mark> g this c	ourse is to:		-	1		12.1	Progra	am Ou	utcome	s (PO	)				Pi	rogra	m
CLR-1:	Learn about diffe	rent regress	sion technique	<mark>s and</mark> their limitati	ons		1	2	3	4	5	6	7	8	9	10	11	12	Ou	pecifi itcom	c es
CLR-2:	Describe the diag	gnostics, trar	nsformations a	and graphical plot	s for multivariate regression		Ð		f	s of	1	ety			논						
CLR-3:	Know to analyse	variance and	nd l <mark>ogistic reg</mark> r	ession	1 1150	100	/ledg		ent o	tions	ge	soci			Mo		ance	0			
CLR-4:	Educate about th	e interdeper	n <mark>dence te</mark> chni	ques of multivaria	te data analysis	24.7	<ul><li>Anow</li></ul>	lysis	mdo	stiga	Usa	and	∞ .		earr	uo	& Fin	arnin			
CLR-5:	Gain knowledge	on the deper	endence multi	variate data analy	sis methods		eering I	em Ana	n/devel	uct inve lex prob	rn Tool	ngineer	onment inability		dual & T	nunicati	ot Mgt. 8	ong Lea	-	2	
Course O	utcomes (CO):	4	At the end of	this course, lear	ners will be able to:	. 197	Engin	Proble	Desig	Condi	Mode	The e	Enviro	Ethics	ndivid	Comn	Projec	-ife L	-OSc	-OSc	So
CO-1:	Identify the regre	ssion m <mark>etho</mark>	ods and visual	ize efficiently	a decision of the	41.4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Construct graphs	, identif <mark>y and</mark>	<mark>id re</mark> present re	gression for multi	variate data		-	3	$\langle \hat{\mathcal{C}} \rangle$	-	-	-	-	-	-	-	-	1	-	-	-
CO-3:	Evaluate regress	ion para <mark>me</mark> te	<mark>ters a</mark> nd test it	s exploratory app	lications	1.0	3.4	3	-		-	-	-	-		-	-	1	-	-	-
CO-4:	Analyse multi-din	nension <mark>al m</mark> u	<mark>ulti v</mark> ariate dat	a		12	-	-	3	-	2	-	-	-	-	-	-	-	-	-	-
CO-5:	Describe logistic	regress <mark>ion a</mark>	<mark>and tr</mark> ee based	l methods analys	s				1.1	- 1	2	1	-	-	-	-	-	-	-	-	-
Unit 1 S	imple and Multiple	Bogracoio		<u> </u>								-								0	Hour
Bivariate	Correlation and Reg	ression, Da	ata visualizatio	n, exploration, an	d assumptions, Categorical or Nom	inal Indep	endent	t Vari	ables,	Quanti	tative S	Scales	, Curvil	inear l	Relatic	onships	and T	ransfor	matio	ns, De	agree
of Relatio	nship, Parameter E	stimates, Lin	mitations to Re	gression Analysis	, Standard, Sequential and Statistica	al regressio	on														<del></del>
Outliers, I	egression Diagno: nfluential points. Gr	stics, Trans raphical diao	stormations, anostics. Rem	edies. Weighted	sentation Least Squares, Transformations in	rearessior	. Pred	licting	i total	movie (	arosse	s aftei	one w	eek N	lodellir	na Low	e's sal	es. Sca	atter p	91 lot. Sc	Hour catter
plot matrix	, Coplots and Trellis	s Graphics, F	Prob <mark>ability Plo</mark>	ts		- g	,									- <u></u>		,		,	
Unit-3 - A	nalysis of Varianc	e and Cova	ariance	1	$1 \times 1$ Alt A $1 \times 1$	R. LT														91	Hour
chi square	e analysis, outliers, ins. Homogeneity of	normality, li fvariance R	linearity and h Regression Si	iomoscedasticity, ims of square cr	Effects of covariates, Limitations to oss products, Significance test and	o analysis Effect siz	of cov	variar osina	ice – Fval	absenc uation c	e of ou	utliers, ariates	multic Test t	ollinea for hor	rity an noaen	nd Sing eitv of	jularity, Reares	Norma	ality o	f Sam	pling
Unit-4 - N	lultivariate Data Al	nalysis – Ini	iterdependen	ce Methods		Encot of	o, ono	oomg	, <b>_</b> ran			anatoc	, 10001	01 1101	nogon	ony or	riogroc	01011		9 /	Hour
Basic mul	tivariate statistics–n Typos Limitations	nean, varian	nce, covarianc	e, correlation, line	ar combination of variables, data ap	opropriate	for mu	ltivan	iate sta	atistics,	geom	etric c	oncepts	s, dista	nces,	Princip	oal Con	nponen	t Anal	ysis, f	actor
Unit-5 - N	iultivariate Data Δι	nalvsis – De	ependence M	lethods. I ogistic	Regression	ence and	y 313, 11	uitiül	1101130	Silal SC	anny, I	iypour	৬১০১ টে	sung						9	Hour
Multiple re (MANOVA	egression models, lo \), Canonical Correl	ogistic regres	ession canonic sis	al correlation, dis	criminant analysis, Multivariate Norr	nal Distrib	ution, l	Discri	iminan	t Analy:	sis, Cla	assific	ation, R	egres	sion tr	ees, M	ultivari	ate Ana	ilysis c	of Vari	ance

Learning Resources	1. 2. 3.	Trevor Hastie, Robert Tibshirani, Jerome Friedman (2017) the Elements of Statistical Learning - Data Mining, Inference, and Prediction, Second Edition. Tabachnick, B. G., & Fidell, L. S. (2012). Using Multivariate Statistics, 6th Edition. Pearson. Craig A. Mertler, Rachel A. Vannatta, Kristina N. LaVenia (2022) Advanced and Multivariate Statistical Methods, Practical Application and Interpretation, 7th Edition.	4. 5.	Afifi A., May S. and Clark V.A. (2012) Practical Multivariate Analysis, CRC Press, Taylor & Francis, Boca Raton. Johnson R.A. and Wichern D.W. (2002) Applied Multivariate Statistical Analysis, Prentice Hall of India Pvt Ltd., New Delhi.

Learning Assessm	nent			and the second	the second s						
		1	Continuous Learning	Assessment (CLA)		Sum	motivo				
	Bloom's Level of Thinki <mark>ng</mark>	Form CLA-1 Avera (50	native ge of unit test 1%)	Life-Long CL (1	g Learning LA-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	20%		20%		-	-				
Level 2	Understand	20%	Strate Land	20%		-	-				
Level 3	Apply	10%	1.1.1.1.1.1	10%			-				
Level 4	Analyze	20%		20%			-				
Level 5	Evaluate	20%	and the second	20%		-	-				
Level 6	Create	10%		10%	1 - 1 - 1 - 1		-				
	Total	10	0%	10	00%	10	00%				

Course Designers	W1.1312 002 01 W5 65 22 0	Press .
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Baraneedhara Karthikeyan, Director, Skylim Infotech Pvt Ptd	1. Dr. Bhuvaneshwari, Professor, MIT, Anna University, Chennai	1. Dr.S. Latha, SRMIST



Course Code	urse ode 21ECE272T Course Name DATA ANALYTICS USING SAS							se ory	E	PROFESSIONAL ELECTIVE											C 3
Pre-requ Cours	lisite es	Nil	Co- requisi Course <mark>s</mark>	te	Nil		Pr (	ogres Cours	sive es						Nil	1					
Course	Offering Departme	ent	ECE		Data Book / Codes	/ Standards		-		-			_	Nil							
Course L	earning Rationale	(CLR): The	purpose of learning th	nis course	is to:			1			Progr	am Ou	utcome	s (PO	)				P	rogra	m
CLR-1:	Understand basic	syntax of SAS		10	2.2		1	2	3	4	5	6	7	8	9	10	11	12	S Or	ipecifi utcom	ic Ies
CLR-2:	Demonstrate data	a with statistical	g <mark>raph using</mark> SAS/GRA	PH	1 million		e		-	of	2.	ety			논		0				
CLR-3:	Explain statistical	l analysis and re	egression model.	1		1000	ledg		ento	tions	e	soci	4		Mo		ance	5			
CLR-4:	describe variance		Know	lysis	bmdo	stiga	Usa	and	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		eam	ы	Ein	nin							
CLR-5:	Gain knowledge	on Mixed <mark>effect</mark> s	s model				eering h	em Anal	jn/devel	uct inve	ern Tool	angineer	onment ainability	s	dual & T	nunicati	ct Mgt. 8	ong Lea	<u>.</u>	5	ę
Course C	utcomes (CO):	Att	<mark>he</mark> end of this course,	learners w	vill be able to:	are 27	Engir	Probl	Desig		Mode	The e	Envir	Ethic	ndivi	Com	Proje	_ife L	0Sc	SO	0Sc
CO-1:	Express SAS pro	grammi <mark>ng langi</mark>	uage		ALC: CLASS	(34			1	-	3	1	-	-	-	-	-	-	2	-	-
CO-2:	Evaluate different	t statisti <mark>cal grap</mark>	<mark>h</mark> for data analysis usin	g SAS			-	1	3	-	-	-	<u> </u>	-	-	-	-	-	-	2	-
CO-3:	Apply SAS for sta	atistical <mark>analysis</mark>	and regression model	100				3		-	2	-	-	-		-	-	-	2	-	-
CO-4:	Analyze data usir	ng varia <mark>nce mod</mark>	del	1.20		1000	1	3	2	-	-		-	-	-	-	-	-	2	-	-
CO-5:	Demonstrate mix	ed effec <mark>t model</mark>	and the second se					-	2	-	2		-	-	-	-	-	-	1	-	-
Unit-1 - A	Brief Introduction	to SAS		Gia		1.5		62			1	£								9	Hour
Basic Lan	guage: Rules and S	Syntax, Cre <mark>atin</mark> g	SAS Data Sets, The IN	IPUT Stater	ment, SAS Data Step Prog	gramming St	ateme	ents ar	nd The	ir Uses	, Data	StepP	rocessi	n <mark>g,</mark> Th	i <mark>e p</mark> roc	step,	SAS G	raphics	<i>.</i>		
Unit-2 - S	tatistical Graphics	Using SAS/GF	RAPH	DU Ourset	lle Dista Francisiani Oranti	la Ouartila D	1-1- F	)	Dista					. T	Dime		10#			9	Hour
SAS proc Matrices.	eaure for computing	statistics, An Ir	itroduction to SAS/GRA	PH, Quanti	te Plots, Empirical Quantil	ie-Quantile P	iots, f	ronie	PIOTS	of Mear	is or in	teracti	ion Plot	s, Two	)-Dime	ensiona	I Scatt	er Plots	; and ;	Scatte	r Pioi
Unit-3 - S	tatistical Analysis	of Regression	Models	-							15									9	Hour
An Introdu	uction to Simple Line	ear Regression	model using PROC RE	G and PRC	C ANOVA, An Introductic	on to multiple	regre	ssion	analys	sis usin	g PRO	C REC	G, case	statist	ics and	d resid	ual ana	alysis, <sup>•</sup>	Types	of Su	ms of
Squares (	Computed in PROC	REG and PRO	C GLM.	C.A.W.	The second second	10.1		1.1	20												
Unit-4 - A	nalysis of Variance	e Models					-										. ,			9	Hour
One-Way	Classification-use F	ROC ANOVA &	and PROC GLM, , One-	Way Analys	sis of Covariance using Pl	ROC GLM, A	I wo-	-Way I	-actor	al in a	Compl	etely F	Random	ized L	)esign,	, Analy	sis of a	i two-w	ay fac	ctorial	using
Unit-5 - A	nalvsis of Variance	e-Random and	Mixed Effects Models												-					9	Нош
Introductio	on, One-Way Rando	om Effects Mode	el, Using PROC GLM to	analyze or	ne-way random effects mo	odels, Using	PROC		ED to a	analyze	one-v	vay rai	ndom ei	fects	models	s, Two-	-Way C	Crossec	I Rand	dom E	ffects
Model. Us	sing PROC GLM and	d PROC MIXED	to analyze two-way cro	ssed rando	om effects models.	. 0															

Loorning	1.	Mervyn G. Marasinghe, William J. Kennedy, SAS for DataAnalysis Intermediate Statistical	3.	Lawrence S. Meyers, Glenn Gamst, A. J. Guarino, Data Analysis UsingSAS Enterprise Guide,
Desources		Methods, Springer, 2020.		Cambridge University press, 2009
Resources	2.	Geoff Der, Brian S. Everitt, A Handbook of Statistical Analysesusing SAS, CRC press, 2002.		

Learning Assessm	ient		Continuous Learning	a Assessment (CLA)						
	Bloom's Level of Thinking	Forr CLA-1 Avera (5	native age of unit test 0%)	Life-Lon Cl (1	g Learning LA-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%	the second second	15%		15%	-			
Level 2	Understand	25%		25%		25%	-			
Level 3	Apply	35%		35%		35%	-			
Level 4	Analyze	25%	A REAL PORT	25%		25%	-			
Level 5	Evaluate	STATE	1.2.2				-			
Level 6	Create		-	San States		-	-			
	Total	10	0%	10	0 %	10	0 %			

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mr. Athif Shah, Chairman, Abe Semicondutor,	1. Dr. Meenakshi, Professor of ECE, CEG, Anna	1. Dr. Damodar Panigrahy, SRMIST	
abechennai@gmail.com	University,meena68@annauniv.edu		



Course Code	21ECE2731		Course PYTHON FOR DATA SCIENCES Name			Cours Catego	e ory	E	PROFESSIONAL ELECTIVE							- T 3 0	P 0	C 3							
Pre-requisite         Nil         Co- requisite         Nil           Courses         Nil         Courses         Nil						Pr	ogres Cours	sive es	Nil																
Course Offering Department ECE Data Book / Codes / Standar								ds						_	Nil										
Course Lea	Learning Rationale (CLR): The purpose of learning this course is to: Program Outcomes (PO)									P	Program														
CLR-1: Understand the basic concept of variables, text, numericals, and list and control statements.								1	2	3	4	4 5 6 7 8 9 10 11 12 Outco						pecit	ic Ies						
CLR-2:	Familiarize the	stuc	dents with	h the p <mark>ython</mark>	dictionary <sup>*</sup>	s,lists,fund	ctions, file	ə handling	and exception	on handling		sis	ment of	igations of ms	2.	N.									
CLR-3:	Understanding	ı Dat	a analysis	is us <mark>ing Data</mark>	a wrangling	method	1		1	100	edge				ms sage	ociet			Vork		Finance				
CLR-4:	Using matplot	ib, se	eaborn an	nd <mark>pandas</mark> fo	or Data Vis	ualization					lowle					s pu			am /	_		ing			
CLR-5:	Provide funda classifier	men	tals on M	Machine Lea	arning, K I	Vearest N	leighbors,	, linear re	gression, N	laive Bayes	eering Kr	eering Kn sm Analys		uct invest	n Tool U	ngineer a	onment & inability		dual & Te	nunicatio	ct Mgt. &	ong Lean	-	2	~
Course Ou	Course Outcomes (CO): At the end of this course, learners will be able to:				Ingin	roble	)esig	Condi	lodel	he el	Enviro	Ethics	ndivid	Comn	rojec	ife Lo	OS	20-2	S-OS						
CO-1:	Apply python	orogr	rammi <mark>ng t</mark>	to solve prol	blems			1.0	245	1024	2		-	-	3		-	-	-	-	-	-	-	-	-
CO-2:	Write python o	ode	with Dictio	ionaries, Fur	nctions, Cla	asses, files	s, and exu	ception ha	ndling to sol	ve problem:	-	-	-	-	3	- 10	. ·	-		-	-	-	-	-	-
CO-3:	Demonstrate I	Data	wrang <mark>ling</mark>	g for effectiv	e Data ana	lysis		546.8		10	2	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-4:	Analyze data	visua	ally usi <mark>ng r</mark>	<mark>matpl</mark> otlib, p	andas, sea	aborn visu	alization i	tools		1			-	2	3		-	-	-	-	-	-	-	-	-
CO-5:	Develop machine learning model using K Nearest neighbours, linear regression, and Naive Bayes for given dataset					ve Bayes fo	r _			2	3	-	-		-	-	-	-	-	-	-				
IInit-1 - Pv	thon and Prog	rami	mina Fun	ndamentals	- pla	<u></u>				16					1	-									Hour
Introduction when worki	to Python Proging with Lists, A	gram void	iming, Val	ariables and on errors, Tu	simple Dat ples, Cont	a types, S rol statem	Strings, nu nents, lf st	umbers, In tatements	troducing Li	ists, Changi nent - if stat	ng, Add ements	ng an with lis	d rem sts	oving e	lement	ts, orga	anizing	a List,	Loopi	ing thro	ough lis	ts, Avo	oiding	index	errors
Unit-2 - Alg	Unit-2 - Algorithms, Data Structures and Performance Analysis 9 Hour																								
Dictionaries - Working with dictionaries, looping through a Dictionary, Nesting, User Input function, while loop with lists and dictionaries, Functions- Passing Arguments, Return Values, Passing a list, Passing an arbitrary number of arguments and storing functions in modules, Classes - Creating and using a class, Working with classes and instances, Inheritance - importing classes, Files and exceptions - Reading from a file, Writing to a file.																									
Unit-3 - Da	ta Analysis					-	122		_		_	1.00												ç	Hour
Data wrangling introduction, Subsetting a dataset, Generating and seeding random numbers, generating random numbers using probability distributions, Grouping the data aggression, Filtering, Transformation, Random sampling - introduction, Method: Customer chum model, Method: using sklearn, Method: using shuffle function, Concatenating, and appending data. Merging/Joining datasets																									
Unit-4 - Data Visualization 9 Hour																									
An introduc plots, Boots	ction to matplotli strap plots, Sea	b, Ba born	asics, plot - advance	t component ed plotting, l	ts, plotting Distribution	with pand , Faceting	las, Relati g, Formati	ionship be <u>ting - Title</u>	tween varial <mark>and axes, C</mark>	bles, Distrib Customizing	utions, ( <mark>visualiz</mark>	Counts ations	s and f – Add	requen ing refe	<mark>cies</mark> , F erence	Pandas lines,	- subp shading	ackage i regio	es - sc ns, An	atter m notatio	atrix, L ns, col	ag plo ors	ts, Aut	tocorr	elation

#### Unit-5 - Python for Machine Learning

Introduction to machine learning- Problems Machine Learning Can Solve, Classifying Iris Species, meet the Data, Measuring Success: Training and Testing Data, Building Your First Model: k-Nearest Neighbors, Making Predictions, Evaluating the Model, classification and regression, K neighbours classification, analysing K neighbours classifier, K neighbors regression, Analyzing K neighbors regressor, linear regression, linear model for classification, Naïve bayes classifier

	1.	Eric Matthes, Python Crash Course, No starch Press, 2nd Edition 2019. Kirthi Raman, Ashish	3.	Andreas C. Muller and Sarah Guido, Introduction to Machine Learning with Python, O'Reilly
Learning		Kumar, Martin Czygan, Phuong Vo.T.H., Python: Data Analytics and Visualization", Packt		Media, Inc.,2018
Resources		Publishing, 2017.	4.	Joel Grus, Data Science from Scratch, O'Reilly Media, Inc, 2019.
	2.	Stefanie Molin, Hands on Data Analysis with Pandas, Packt Publishing, 2019.		

Learning Assessment									
		Summative							
	Bloom's Level of Thinking	Form CLA-1 Avera (50	ative ge of unit test %)	Life-Long CL (10	ı Learning A-2 )%)	Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	<u>Th</u> eory	Practice		
Level 1	Remember	15%		15%		15%	-		
Level 2	Understand	30%		30%		<mark>30</mark> %	-		
Level 3	Apply	35%	LO CAR NO	35%		<mark>35</mark> %	-		
Level 4	Analyze	20%	10 10 10 10 10 10 10 10 10 10 10 10 10 1	20%		<mark>20</mark> %	-		
Level 5	Evaluate	0%		0%	-	0%	-		
Level 6	Create	0%		0%	-	0%	-		
	Total	100	0%	10	0 %	100	%		

Co	urse Designers							
Experts from Industry			erts from Higher Technical Institutions	Internal Experts				
1.	Mr. Athif Shah, Chairman, Abe Semicondutor,	1.	Dr. Meenakshi, Professor of ECE, CEG, Anna University,	1.	Mr. P. Muthukrishnan, SRMIST			
	abechennai@gmail.com		meena68@annauniv.edu					
2.	Dr. Madan Kumar Lakshmanan, Senior Scientist, CEERI,	2.	Dr. Venkatesan, Sr. Scientist, NIOT, Chennai,	2.	Dr.S. Krithiga <mark>, SRMIST</mark>			
	Imadank@gmail.com		venkat@niot.res.in					

B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy
Course Code	rse 21ECE274T Course MACHINE LEARNING FOR DATA ANALYTICS Ca				Cour Categ	se ory	E			PROF	ESSIO	NAL E	LECT	IVE		l	- T 3 0	P 0	C 3
Pre-requisite Nil Co- requisite Nil Nil							sive es						Nil						
Course Offering Department ECE Data Book / Codes / Standards Nil																			
Course Le		1			Progr	am Ou	itcome	s (PO)		1			Pr	ograr	n c				
CLR-1:	Understand the Ba	asic Concepts of I	Data	124	1	2	3	4	5	6	7	8	9	10	11	12	Ou	tcom	es
CLR-2:	Learn the Basic co	oncepts of Clas <mark>sif</mark>	ication Techniques	2 martine	ge		of	s of		iety			ork		е				
CLR-3:	Explore the Advance methods in Classification Techniques						lent o	ation	ge	d soc			n Wo		Janc	b			
CLR-4:	4: Analyse and understand the Clustering Techniques						lopm	estig	Usa	r and	~		Tear	ion	& Fii	arnir			
CLR-5:	Create insights to	the conc <mark>ept of Re</mark>	einforcement Learning		eering	em Ana	In/deve	uct inve lex prol	rn Tool	nginee	onment	(0)	dual & <sup>-</sup>	nunicat	ct Mgt.	ong Le:	-	2	е
Course Ou	utcomes (CO):	At the	end of this course, learners w	vill be able to:	Engin	Probl	Desig	Cond	Mode	The e	Envire Susta	Ethics	Indivi	Comr	Proje	Life L	-OS4	PSO-	PSO-
CO-1:	Explain the basic Transformation ar	concep <mark>ts of Data</mark> nd Discr <mark>etization</mark>	, Statistical description of Data,	Data cleaning, Data reduction, Da	ta 3	2	1	-	54	1	-	-	-	-	-	-	-	-	-
CO-2:	Discuss the Basic and Techniques to	level D <mark>ecision</mark> Tre 5 impro <mark>ve class</mark> ific	ee, Bayes Classification, Rule B cation Accuracy	ased Classification, Model Evaluati	on -	2	3	-	-	2		-		-	-	-	-	-	-
CO-3:	0-3: Apply the advance methods- Bayesian Network, Backpropagation, Support vector Machine, Frequent pattern classification, Lazy learns for classification problem				nt _	2	3				-	-	I	-	-	I	-	-	-
CO-4:	<b>:0-4:</b> Analyse the clustering techniques- Partitioning Methods, Hierarchical Methods, Density-Based Methods and Grid-Based Methods				S, -	2	3	-			-		-	-		-	-	-	-
CO-5:	CO-5: Explore the concept of Reinforcement learning and its applications					2	3	-	-		1	-	-	-	-	-	-	-	-
	-			1.1.1											-				

#### Unit-1 - Data Objects and Attribute Types

9 Hour

9 Hour

Nominal Attributes, Binary Attributes, Ordinal Attributes, Numeric Attributes, Discrete versus Continuous Attributes - **Basic Statistical Descriptions of Data-** Measuring the Central Tendency: Mean, Median, and Mode, Measuring the Dispersion of Data: Range, Quartiles, Variance, Standard Deviation, and Interquartile Range, Graphic Displays of Basic Statistical Descriptions of Data - **Data Pre-processing**. Data Quality: Why Pre-process the Data, Major Tasks in Data Pre-processing, **Data Cleaning-** Missing Values, Noisy Data, Data Cleaning as a Process, **Data Integration-** Entity Identification Problem, Redundancy and Correlation Analysis, Tuple Duplication, Data Value Conflict Detection and Reso lution, **Data Reduction-** Overview of Data Cube Aggregation, **Data Transformation and Data Discretization-** Data Transformation Strategies, Wavelet Transformation and **Data Discretization-** Data Transformation Strategies Overview, Data Transformation by Normalization, Discretization by Binning, Discretization by Histogram Analysis, Discretization by Cluster, Decision Tree, and Correlation, Concept Hierarchy Generation for Nominal Data

### Unit-2 - Classification: Basic Concepts

What Is Classification?, General Approach to Classification, Decision Tree Induction - Decision Tree Induction, Attribute Selection Measures, Tree Pruning, Scalability and Decision Tree Induction, Visual Mining for Decision Tree Induction, Bayes Classification Methods- Bayes' Theorem, Naive Bayesian Classification, Rule-Based Classification- Using IF-THEN Rules for Classification, Rule Extraction from a Decision Tree, Rule Induction Using a Sequential Covering Algorithm, Model Evaluation and Selection- Metrics for Evaluating Classifier Performance, Holdout Method and Random Subsampling, Cross-Validation, Bootstrap, Model Selection Using Statistical Tests of Significance, Comparing Classifiers Based on Cost-Benefit and ROC Curves, Techniques to Improve Classification Accuracy- Introducing Ensemble Methods, Bagging, Boosting and AdaBoost, Random Forests, Improving Classification Accuracy of Class-Imbalanced Data.

#### Unit-3 - Classification: Advanced Methods - Bayesian Belief Networks

Concepts and Mechanisms, Training Bayesian Belief Networks, Classification by Backpropagation - A Multilayer Feed-Forward Neural Network, Defining a Network Topology, Backpropagation, Inside the Black Box: Backpropagation and Interpretability, Support Vector Machines- The Case When the Data Are Linearly Separable, The Case When the Data Are Linearly Inseparable, Classification Using Frequent Patterns - Associative Classification, Discriminative Frequent Pattern– Based Classification, Lazy Learners (or Learning from Your Neighbours) - k-Nearest-Neighbour Classifiers, Case-Based Reasoning, Other Classification Methods - Genetic Algorithms, Rough Set Approach, Fuzzy Set Approaches, Additional Topics Regarding Classification - Multiclass Classification, Semi-Supervised Classification, Active Learning, Transfer Learning

#### Unit-4 - Cluster Analysis: Basic Concepts and Methods

Requirements for Cluster Analysis, Overview of Basic Clustering Methods, Partitioning Methods- k-Means: A Centroid-Based Technique, k-Medoids: A Representative Object-Based Technique, Hierarchical Methods- Agglomerative versus Divisive Hierarchical Clustering, Distance Measures in Algorithmic Methods, BIRCH: Multiphase Hierarchical Clustering Using Clustering Feature Trees, Chameleon: Multiphase Hierarchical Clustering Using Dynamic Modelling, Probabilistic Hierarchical Clustering, Density-Based Methods- DBSCAN: Density-Based Clustering Based on Connected Regions with High Density, OPTICS: Ordering Points to Identify the Clustering Structure. DENCLUE: Clustering Based on Density Distribution Functions, Grid-Based Methods- STING: Statistical Information Grid, CLIQUE: An Apriori-like Subspace Clustering Method, Evaluation of Clustering-Assessing Clustering Tendency, Determining the Number of Clusters, Measuring Clustering Quality 9 Hour

### Unit-5 - Reinforcement learning

Basics, Important terms: Agent, Environment, Reward, state, Policy, value etc., Reinforcement Learning Algorithms- Value Based, Policy Based, Model Based learning, Reinforcement Learning Characteristics, Features of Reinforcement learning, Types of Reinforcement Learning - Positive, Negative, Learning Models of Reinforcement - Markov Decision Process, Q-Learning, Applications of Reinforcement learning, Challenges of Reinforcement learning

	1.	Data Mining Concepts and Techniques, Jiawei Han, Micheline Kamber, Jian Pei, 3rd	3.	Hands-On Machine Learning with Scikit-Learn, Keras, and Tensor Flow: Concepts, Tools,
		edition, Elsevier <mark>, ISBN: 9</mark> 78-0-12-381479-1		and Techniques to Build Intelligent Systems 2nd Edition, by Aurélien Géron, ISBN-13: 978-
Learning	2.	Reinforcement Learning with Open AI, Tensor flow and keros using python., Abhishek Nandy	27	1492032649., ISBN-10: 1492032646
Resources		Manisha Biswas Kolkata, West Bengal, India North 24 Parganas, West Bengal, India ISBN-	4.	Hands-on Scikit-Learn for Machine Learning Applications: Data Science Fundamentals with
		13 (pbk): 978-1 <mark>-4842-3</mark> 284-2 ISBN-13 (electronic): 978-1-4842-3285-9		Python David Paper Logan, UT, USA ISBN-13 (pbk): 978-1- 4842-5372-4 ISBN-13
				(alactronic): 078 1 4842 5272 1

Learning Assessm	ient			PLACE N					
			Continuous Learning	g Assessment (CLA)	)	Summ	activo		
	Bloom's Level of Thinking	Forr CLA-1 Avera (5	mative age of unit test 10%)	Life-Long CL (1)	g Learning _A-2 0%)	Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%		10%	- 1	15%	-		
Level 2	Understand	15%		10%		15%	-		
Level 3	Apply	20%	A10 - 510	20%		20%	-		
Level 4	Analyze	20%	Contraction of the	20%		20%	-		
Level 5	Evaluate	15%		20%		15%	-		
Level 6	Create	15%	-	20%		15%	-		
	Total		00 %	10	0%	100 %			

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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abechennai@gmail.com	University,meena68@annauniv.edu	

B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

9 Hour

Course Code	21ECE275T	75T Course TABLEAU FOR BUSINESS INTELLIGENCE			Cou Categ	rse Jory	E			PROF	ESSIC	NAL E	ELECT	IVE			L T 3 0	P 0	C 3
Pre-requi Course	site s	Nil	Co- requisite Course <mark>s</mark>	Nil	P	rogres Cours	sive es						Nil	1					
Course (	Offering Departme	ent	ECE	Data Book / Codes / S	tandards							Nil							
Course Learning Rationale (CLR): The purpose of learning this course is to:						-	-		Progra	am Ou	Itcome	s (PO)	)	1			Specific		in ic
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CLR-2:	Discuss the data	visualization an	nd its parameters	Section and the section of the secti	e		of	s of		iety			rk		Ð				
CLR-3:	Inculcate Busines	ss intelligence <mark>u</mark>	sing Tableau		ledç		ento	tion	ge	soc			Wo		ance	5			
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Course Ou	tcomes (CO):	Att	<mark>he</mark> end of this course, lea	rners will be able to:	Engi	Prob	Desi	Conc	Mod	The	Envi	Ethic	ndiv	Com	Proje	Life	PSO	SO	SO
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CO-2:	Implement the gra	aphs an <mark>d charts</mark>	s using Tableau for data vis	ualization	3	1.0	3	-	-		-	-	-	-	-	-	2	-	-
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CO-4:	Apply the Geo sp	atial an <mark>alytics u</mark>	ising Tableau		100	-	3	-	2			-	-	-	-	-	-	-	3
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Unit-2 – Vi	sualization							1	1									9	Hour
Type Conv	ersion, Parameters	, Filtering Cond	litions, Filtering Measures, H	listograms, Sorting, Grouping, Sets,	Tree maps, w	ord clo	uds and	d bubbl	e chart	s, Par	eto Cha	arts, W	aterfal	ll Chart	s, Bum	p Chai	ts, Fui	าnel C	;harts,
Bollinger B	ands, Visual Analy	tics – Trends, C	Clustering, Distribution and I	-orecasting. Advanced visualization.			_			-									Harri
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	1. Joshua N.Milligan, Learning Tableau 2020, Fourth Edition, Packt Publishing Ltd. 2020	3.	Shankar Arul, Tableau for Business users, Apress Berkeley, CA,2021 .ISBN-13 (Electronic):
Learning	2. Marleen Meier and David Baldwin, Mastering Tableau 2021, Third Edition, Packt Publishing		978-1-4842-7786-7.
Resources	Ltd.2021	4.	Alexander Loth, Visual, Analytics with Tableau, Wiley, 2019.
		5.	Joshua Milligan, Learning Tableau 10, 2nd Edition, Pakt Publishing,2016

Learning Assessm	ient		Continuous Loorning	Appagament (CLA)						
	Bloom's Level of Thinking	Form CLA-1 Averag (50	ative ge of unit test %)	Life-Long CL (10	I Learning A-2 0%)	- Summative Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		15%		15%	-			
Level 2	Understand	25%		20%		25%	-			
Level 3	Apply	30%	and the second second	25%		30%	-			
Level 4	Analyze	30%		25%		30%	-			
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Level 6	Create			5%		-	-			
	Total	0%	10	0%						
	-		S 242.34	and the factor of the	·					

Course Designers	and the second second second second		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mr. Athif Shah, Chairman, Abe Semicondutor,	1. Dr. Meenakshi, Professor of ECE, CEG, Anna	1. K. Harisudha, SR <mark>MIS</mark> T	
abechennai@gmail.com	University,meena68@annauniv.edu	Charles and the second s	



Course Code	e         21ECE370T         Course Name         BLOCK CHAIN IN DATA ANALYTICS         Course Category         E         PROFESSIONA						NAL E	L ELECTIVE					P 0	C 3								
Pre-requ Course	isite es	Nil		Co- requisite Courses		Nil		Pro	ogres Cours	sive es						Nil						
Course	Offering Departm	lent		ECE		Data Book / Codes /	Standards						-		Nil							
			_		1	the state of the s		-	-	-	_		_	_								
Course Learning Rationale (CLR): The purpose of learning this course is to:											Progr	am Ou	itcome	s (PO	)		1		Program		m ic	
CLR-1: Provide basic knowledge on blockchain technology							1	2	3	4	5	6	7	8	9	10	11	12	Oi.	utcom	ies	
CLR-2:	Understand the	principles of	f data <mark>analytic</mark>	<mark>s in b</mark> lobkchain	2			e		f	s of	2	ety			ž		0				
CLR-3:	Develop knowledge on blockchain analytics ecosystem						25.76	ledç		ent o	tions	ge	soc	4		Ŵ		ance	5			
CLR-4:	Explore the benefits of visualization of blockchain data							Non	lysis	opme	stiga	Usaç	and	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		eam	ы	k Fin	min			
CLR-5:	R-5:         Analyze the blockchain data analysis models							ering h	i Ana	devel	t inve	Tool	jineer	ment ability		al & T	nicati	Mgt. 8	g Lea			
							1000	jinee	blen	sign/	uduc npley	dern	enç	iron	S	vidu	nmu	ject	Lon		0-2	0-3
Course O	utcomes (CO):		At the end o	of this course, lea	arners will <mark>k</mark>	be able to:	10.27	Enc	Pro	Des	Cor	Moc	The	Env	Ethi	Indi	Co	Pro.	Life	PS(	PS(	PS(
CO-1:	Express the fund	damental <mark>s of</mark>	<mark>f block</mark> chain t	echnology			34.4	3	(e)	- 1			-	-	-	-	-	-	-	3	-	-
CO-2:	Apply data analy	/tics mec <mark>han</mark>	nism in blocko	chain		第二 通外に		3	2	3	-	-	-		-	-	-	-	-	3	-	-
CO-3:	Compile blockch	nain ecos <mark>yste</mark>	<mark>em fo</mark> r data a	nalysis	10.00	25.2 116. 8		3	2		-	3	-	-	-		-	-	-	-	3	-
CO-4:	Analyse and visu	ualize blo <mark>ckc</mark>	<mark>chain</mark> analysis	s data	12.55		200	1	2			3	-	-	-	-	-	-	-	-	3	-
CO-5:	Incorporate the u	usage of <mark>pop</mark>	<mark>pular m</mark> odels	for block chain da	ata analysis		123	3		14	-	2		-	-	-	-	-	-	-	3	-
l Init-1 - In	traduction To Blo	ockchain Te	chnology	Z	Contra				62				-									Hour
What is blo	ockchain – Central	ized vs. Dec	centralized Sv	stems - Lavers -	Importance	– Uses – Properties of I	blockchain -	- Bloc	kchaii	n trans	actions	- Bloc	kchair	n applic	ations	- Bitco	in bloc	kchain	- Fthe	reum	netwo	rk?
Unit-2 - Da	ata Anavtics and	Blockchain	) 		inip of tarroo			2.00				2.00		. appno		2.100					g	Hour
Deriving v	alue from data - P	Predicting fut	ture outcome	with data - Explo	oring blockch	nain landscape - <mark>Block</mark> c	hain types	- Exp	loring	blockc	hain d	ata - C	Catego	rizin <mark>g c</mark>	ommo	n data	in a b	lockch	ain - E	xamin	ing ty	pes of
blockchain	i data for value - Al	ligning block	kcha <mark>in data w</mark>	ith real world proc	cesses.		100					1									• •	
Unit-3 - B	lockchain Analyti	cs Ecosyste	tem				100	-	-			125	1								9	Hour
Aligning ar	nalytics with busine	ess goals - S	Surveying opt	ons for analytics	Lab - Installa	ation of blockchain envir	onment (Se	lf stud	ly) - E	xplorin	g the B	lockch	nain Ar	alytics	Ecosy	stem -	Fetchi	ng bloo	ckchair	ı client	t Com	paring
on-chain a	nd external analys	is options, In	ntegrating ex	ternal data, Identi	fying feature	s building an analysis d	lataset		1.1	100												
Unit-4 - Al	nalyzing and Visu	ializing Bloc	CKCNAIN ANA	Iysis Data	ata Classifi	instian of blackshain da	to Analyzi	o of de	ata ala	noifing	tion up	ing no	nulor r	nodolo	Drod	iation (		o uoina	roaro	oolon	4 00/	Hour
time series	uata ciustering usi s data using nonula	ng popular n ar models	models - asso	clauon rules in a	ala - Classili	cation of Diockchain dat	la - Analysis	s 01 08	ala cia	issilica	uon us	ing po	pular r	noaeis	- Prea	CUON	or rutur	e using	regre	551011 -	· Anar	ysis oi
Unit-5 - B	lockchain Data Ar	nalysis Mod	dels																		g	Hour
Interaction	with blockchain -	Connection	to a blockch	ain - examining l	blockchain c	lient languages - Asses	ssing blockd	chain	needs	: - cho	osing ti	he bes	st fit -	manage	ement	of bloc	ckchair	n proje	ct - To	ols for	deve	loping
blockchain	analytics models.																	-				

	1.	Bikramaditya Singhal, Gautam Dhameja, and Priyansu Sekhar Panda, Beginning	4.	Brojo Kishore Mishra, Sanjay Kumar Kuanar, Sheng-Lung Peng, andDaniel D. Dasig Jr, eds,
		Blockchain: A Beginner's guide to building Blockchain solutions, First Edition, Apress, 2018.		Handbook of IoT and Blockchain: Methods, Solutions, and Recent Advancements, First
Learning	2.	Michael G. Solomon, Blockchain data analytics for dummies, First edition, Wiley, 2020.		Edition, CRC Press, 2020. 5. Manav Gupta, Blockchain for dummies, Second edition, Wiley,
Resources	3.	Ganesh Prasad Kumble, Practical Artificial Intelligence and Blockchain: A guide to		2018.
		converging blockchain and AI to buildsmart applications for new economies, First Edition,	5.	Pedro Franco, Understanding Bitcoin: Cryptography, engineering and economics, First Edition,
		Packt Publishing Ltd, 2020.		Wiley, 2015.

		111	Continuous Learning	Assessment (CLA)		Sum	motivo		
	Bloom's Level of Thi <mark>nking</mark>	Form CLA-1 Avera (50	native ge of unit test 0%)	Life-Long L CLA- (10%	earning 2 .)	Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%	And I am the	15%		15%	-		
Level 2	Understand	25%		25%		25%	-		
Level 3	Apply 📃	30%		30%		30%	-		
Level 4	Analyze	30%		30%		30%	-		
Level 5	Evaluate	-				-	-		
Level 6	Create		2012/10	ter and the second	-	-	-		
	Total 100 %		0%	100 9	6	100 %			

Course Designers							
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts					
1. Mr. Athif Shah, Chairman, Abe Semicondutor,	1. Dr. Meenakshi, Professor of ECE, CEG, Anna	1. Dr. R. Jansi, SRMI <mark>ST</mark>					
abechennai@gmail.com	University,meena68@annauniv.edu						



Course Code         21ECE371T         Course Name         DATABASE MANAGEMENT SYSTEMS				Ca	ourse	e ry	E			PROF	ESSIC	onal e	ELECT	IVE			L T 3 0	P 0	C 3	
Pre-requ Cours	iisite es	Nil	Co- requisite Cour <mark>ses</mark>	Nil	-	Pro C	gres ours	sive es						Nil	1					
Course	Offering Departm	ent	ECE	Data Book / Codes / Sta	ndards								Nil							
Course L	earning Rationale	(CLR):	The purpos <mark>e of learnin</mark> g this co	urse is to:			+		1	Progr	am Oi	utcome	es (PO	)				P	rogra	m
CLR-1:	Understand the f	undament	als of Database Management Syst	ems, Architecture and Languages		1	2	3	4	5	6	7	8	9	10	11	12	S	pecifi	iC 195
CLR-2:	Conceive the dat	abase des	sign process through ER Model and	Relational Model			-			1		ity								
CLR-3:	Design Logical D Language Featu	Database S res	Schema and mapping it to implem	entation level schema through Datal	base	edge		nt of	ons of	6	ociety	tainabil		Nork		nce				
CLR-4:	Understand the recovery	practical	problems of concurrency control	and gain knowledge about failures	and	Knowle	alysis	lopmer	estigati blems	I Usage	er and s	t & Sus		Team \	tion	& Fina	arning			
CLR-5:	Explore the data	base imple	ementation mechanism	1	100	ering	m An	/deve	ex pro	n Too	ginee	nmen		ual &	iunica	t Mgt.	ng Le			~
Course O	utcomes (CO):		At the end of this course, learn	ers will be able to:	91	Engine	Proble	Design	Condu	Moder	The er	Enviro	Ethics	Individ	Comm	Projec	Life Lo	PSO-1	PSO-2	PSO-3
CO-1:	Define the variou	ıs eleme <mark>nt</mark>	<mark>s of Da</mark> tabase Management Syster	ns		3	2		-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	Apply E-R diagra	am for da <mark>ta</mark>	base design and normalization			2	3		-	3	-	-	-	-	-	-	-	-	-	-
CO-3:	Express databas	e progra <mark>m</mark>	using Relational Algebra and Rela	tional Calculus		2	3	-	-	-		-	-	-	-	-	-	3	-	-
CO-4:	Evaluate the con	cepts of tr	ansaction, concurrency control, and	d recovery mechanism in database		2	2	112	-	3	2	- 1	-	-	-	-	-	-	2	-
CO-5:	Compile databas	e impleme	entation mechanism	20140 TO 10 10 10 10 10 10 10 10 10 10 10 10 10		2	1	-	-	3	-	N	-	-	-	-	-	-	-	-
			the second second													·				
Unit-1 - D	atabase Systems	m Annlic	ations Purpose of Database Syste	ams View of Data, Database Langu	ages D	ata St	oran	o and	Quervii	na Tr	ansact	ion Ma	nanom	ont D	Jatahar	Arch	nitoctur	<u>n SOI</u>	9 Con	) Hour
Basics of functions,	SQL, DDL,DML,DC set operations, sub	CL, structu o-queries, c	re – creation, alteration, defining correlated sub-gueries, join, Exist, /	constraints – Primary key, foreign ke Any, All , view and its types., transact	ey, uniqu tion cont	ue, no rol col	oragi ot nul mmai	l, cheo nds	ck, IN o	perato	or, agg	iregate	functio	ons, B	uilt-in f	unction	is –nui	meric,	date,	string
Unit-2 - D	atabase Design			and the second second second				-		152	<b>.</b>								ç	) Hou
Entity-Rel	ationship model - E	-R Diagrai	ms - Enhanced-ER Model - ER-to-	Relational Mapping - Functional Dep	endenci	es - N	on-lo	ss De	compos	ition -	First,	Secon	d, Thirc	d Norm	al Fori	ms, De	pender	ncy Pr	eserv	ation
Unit-3 - R	elational Algebra	นแ-งลเนยน		Form - Join Dependencies and Finn	nomai	FUIII			-		-	-							ç	) Hou
Relational	Algebra and Calcu	ılus: Relati	ional algebra: introduction, Selectic	n, and projection, set operations, rer	naming,	Joins,	Divi	sion, s	yntax, s	seman	tics. O	perato	rs, gro	uping a	and ung	groupir	ıg, rela	itional	comp	arisoi
Calculus:	Tuple relational cal	culus, Don ement	nain relational Calculu <mark>s, calculus</mark> v	algebra, computational capabilities																Hou
Transactio	on processing - Con	currency c	control - ACID property - Serializabi	ity of scheduling - Locking and timest	amn-ha	sed so	hedu	ilers - i	multi-ve	rsion a	and op	timistic	Conci	Irrency	Contr	ol sche	mes -[	Databa	ase re	cover

## Unit-5 - Implementation Technique

Redundant Array of Independent Disks (RAID) - File Organization - Organization of Records in Files - Indexing and Hashing - Ordered Indices - B+ tree Index Files - B tree Index Files - Static Hashing - Dynamic Hashing - Query Processing Overview - Algorithms for SELECT and JOIN operations - Query optimization using Heuristics and Cost Estimation

	1	Data base Management Systems Raghu Ramakrishnan Johannes Gehrke McGraw Hill	4	Database Systems Design Implementation and Management Peter Rob& Carlos Coronel
		Education (India) Private Limited, 3rd Edition, 2003		7th Ed., 2011.
Learning	2.	Fundamental of Database Systems, Ramez Elmasri, Shamkant B.Navathe, Pearson	5.	Principles of Distributed Database Systems, Ozsu, Pearson Publication, 2011
Resources		Education, 6th edition, 2011	6.	Distributed Database Mangement Systems, Rahimi & Haug, Wiley, 2010
	З.	Data base System Concepts, A. Silberschatz, and Henry. F. Korth, S.Sudarshan, McGraw		
		Hill Education(India) Private Limited I, 6thedition, 2011		

Learning Assessm	ent internet	N. 1									
		135 M	Continuous Learnin	g Assessment (CLA)		Sum	mativa				
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ige of unit test 0%)	Life-Long CL (10	g Learning _A-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	<u>Th</u> eory	Practice				
Level 1	Remember	15%		15%		15%	-				
Level 2	Understand	25%	to bars of	20%		<mark>25</mark> %	-				
Level 3	Apply	30%		25%		<u>30</u> %	-				
Level 4	Analyze	30%		25%		<mark>30</mark> %	-				
Level 5	Evaluate			10%		-	-				
Level 6	Create	and the second		5%		-	-				
	Total	10	0%	10	0 %	100 %					

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mr. Athif Shah, Chairman, Abe Semicondutor,	1. Dr. Meenakshi, Professor of ECE, CEG, Anna	1. Dr.B. Muruganandam, SRMIST	
abechennai@gmail.com	University, meena68@annauniv.edu		
		2. Dr. Elizer, SRMIST	

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Course Code	21ECE372T	ECE372T Course DEEP LEARNING FOR DATA ANALYTICS								S		Cours Catego	se ory	Course Category         E         PROFESSIONAL ELECTIVE         L         T           3         0         0         0         0         0								<u> </u>	P 0	C 3		
Pre-requis Course	site s	Nil		C	Co- requ Course	uisite es			Nil			Pr	ogres Cours	sive es						Nil						
Course C	Offering Departme	ent		E	ECE			Da	ata Book / (	Codes / S	Standard	ls							Nil							
<b></b>				_	_	_	_	-				-	1.0	1.00												
Course Lea	arning Rationale (	(CLR): 7	The purpo	)se of I	learnin	g this c	course	e is to:	-				1	1	1.1	Progr	am Ou	<b>itco</b> me	s (PO)	)	<b></b>			- PI	rogra	m ic
CLR-1:	Understand the c	oncepts of L	Data Scien	nce and	<mark>d D</mark> eep	Learnin	ng	10 2				1	2	3	4	5	6	7	8	9	10	11	12	01	utcom	les
CLR-2:	Implement Deep	Learning me	nethod <mark>ologi</mark> e	i <mark>es f</mark> or	data an	nalysis		1			-	ge		of	s of	2.	tiety		1	ork		e				
CLR-3:	Study deep learni	ing techniqu	ues <mark> for ima</mark> g	<mark>age</mark> ana	alysis a	nd its a <sub>l</sub>	pplicati	tions		1		vled		ento	ution	ge	soc			Ň		anc	5			
CLR-4:	Learn deep learni	ing technigu	ues for vide	eo ana	alysis	201			10-20			Nov	ysis	udc	stiga	Usa	and	<u>م</u>		earr	Ц	ΞĽ	min			
CLR-5:	Demonstrate the	concepts of	of deep lean	rnina ir	n multirr	nedia da	ata ana	alvsis and	l its applicat	tions		ing k	Anal	evelo	inve	8	neer	hent -		R T	icatio	lgt. 8	Lea			
												leer	em	p/ug	uct olex	Lue	engi	onmaina	s	dua	unu	ct⊳	-ong	<u> </u>	5	က္
Course Ou	tcomes (CO):	1	At the end	d of th	is cour	rse, lear	rners v	will be ab	ble to:	CREAT		Engi	Prob	Desig	Conc	Vode	he	Envir Susta	Ethic	ndiv	Com	Proje	-ife [	SO	SOS	SO
CO-1:	Apply basic conce	epts in Deep	p Learning	g for pr	rocessin	ng high c	dimens	sional data	ta	200	Y4.,	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-2:	Incorporate deep	learnin <mark>g me</mark>	nethods for a	data a	analysis			100	- 10 M	0.62			3	12	-	3	-	-	-	-	-	-	-	-	-	-
CO-3:	Develop Compute	er Proc <mark>essin</mark>	ing of an im	nage u:	ising De	ep Neu	Iral Net	etwork				1.3		3		3	- 10	-	-	-	-	-	-	-	3	-
CO-4:	Analyze various t	ypes of vide	eo data usii	ing De	ep Lear	rning tee	chnique	ues	120		100	10	3	-	-	3		-	-	-	-	-	-	-	-	3
CO-5:	Implement Deep	Learnin <mark>g in l</mark>	n multimedia	ia data	analysi	is		5.00	1.5			62.5	-	1.1	3	3	1	-	-	-	-	-	-	-	3	-
				17				1.4.1													1	1	<u> </u>	· · · · ·		
Unit-1 - Int	roduction to Deep	b Learning	<mark>in Data Sc</mark>	cience	e																<u> </u>			<u></u>	9	Hour
Data Analy	tics Basics, Enterp	orise Data S	Science, Pro	redictiv	ve Analy	ysis, Sc	alabilit	ity of deep	p learning n	nethods, hellongoo	Statistic	al learr	ning to	r minir	ng and	analys	is of b	igdata,	Comp	utatior	ial Inte	lligenc	e Meth	odolo	gy for	Data
Init-2 - Do	en Learning Meth		for Data A		jes, ma sis	nageme		lallenges,	Process Ci	nallenges	; 			-	-	1				-					- 0	Hour
Optimizatio	n for deep learning	- model stru	ructure optin	imizati	on larg	e-scale	optimiz	ization hy	vper-param	eter optim	nization	Feature	e selec	tion us	sina dee	en lear	nina. N	lovel m	ethodo	logies	usina	deen le	arning	for cla	assific	ation
detection a	nd segmentation,	Non linear F	Feature Ex	xtractic	on for E	Big Data	a Analy	lytics, Sing	gle layer cc	onvolution	al neura	al netwo	ork for	cardia	ac dise	ase cla	ssifica	ation us	ing ele	ectro c	ardiog	ram sig	gnals, l	Deep I	learnii	ng on
information	retrieval and its ap	oplications				U. I.				as IU	10.1								Ű		Ŭ	C				Ū
Unit-3 - De	ep Learning in Im	age Analys	vsis			100	11.8	1.4			11 A A		1	22	1										9	Hour
Computer I	Processing of an In	nage: An Int	ntroduction,	i, Case	e Studie	s- Apple	e Leaf	f Identifica	ation based	on Optim	nized De	ер Neu	iral Ne	etwork,	Perfor	mance	Analy	r <mark>sis o</mark> f V	/GG19	) Deep	Learn	ing Ne	twork t	ase E	3rain l	mage
Fusion, Dee	ep learning based t	amil vowels	ls prediction	n using	<mark>j segme</mark>	entation	and U-	J-Net Arch	nitecture, Pe	erformanc	ce analy:	sis of G	AN arc	chitect	ure for	effectiv	e facia	al expre	ssion s	synthe	sis, De	ep CN	N for O	bject (	classif	iction
Unit-4 - De	ep Learning in Vi	deo Data Al	Analysis 📕																						9	Hour
Introduction	n to video data ana	lysis, Uniqu	ueness of v	video a	data, <mark>lim</mark>	nitations	s of vide	deo data, c	conducting	video dat	ta analys	sis, Vid	eo dat	a anal	sis an	d comp	uter v	ision, T	he futu	ire of	video d	lata in :	social s	science	e rese	arch,
Case study	- Discrete action s	equences u	using deep	) emoti	ional int	elligenc	)e																			11
Enoturo Ex	traction from Pig M	ultimodia D	Search Data Ponra	roconto	ation loc	orning o	n largo	o and smr	all data Co	ncont has	od and	ovont k	based	vidoc	oarch	Footu	ro ovtr	action t	acina	volum	0 100	city yr	rioty I	arac	<b>y</b>	nour
multimedia	analysis, Data stor	rage and ma	nanagement	nt for B	Big Multi	media,	Applica	cations of I	large scale	multimed	lia searc	h - Ima	ge tag	ging w	ith Dee	p Lear	ning: I	Fine gra	acing ained V	isual /	Analys	is is	nety, L	arye s	scale 3	soundi

	1.	Himansu Das, Chattaranjan Pradhan, Nilanjan Dey, "Deep Learning for Data	4.	Anne Nassauer, Nicolas M. Legewie, "Video Data Analysis", Sage Publications, March 2022
		Analytics",Elsevier, May 2020.	5.	Debi Prasanna Acharjya, Anirban Mitra, Noor Zaman, "Deep Learningin Data Analytics",
Loorning	2.	Arun K. Somani Ganesh Chandra Deka " Big Data Analytics Tools and Technology for		Springer, 2022.
Becourooo		Effective Planning ", CRC Press, 2018	6.	Stefanos Vrochidis, Benoit Huet, Edward Y. Chang, IoannisKompatsiaris, "Big Data Analytics
Resources	З.	Alex Noel Joseph Raj, Vijayalakshmi G. V. Mahesh and RubanNersisson, "Handbook of		for Large Scale Multimedia Search", WILEY, 2019
		Research on Deep Learning-Based Image Analysis Under Constrained and Unconstrained	7.	N. D. Lewis, "Deep Learning Step by Step with Python: A Very GentleIntroduction to Deep
		Environments", IGI Global, Dec 2020		Neural Networks for Practical Data Science, 2016

			Continuous Learning	Assessment (CLA)		Sum	mative			
	Bloom's Level of Th <mark>inking</mark>	Forr CLA-1 Avera (5	native age of unit test 0%)	Life-Long CL (1	g Learning _A-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		15%		15%	-			
Level 2	Understand	25%		20%		20%	-			
Level 3	Apply	30%	1	25%		20%	-			
Level 4	Analyze	30%	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	25%		30%	-			
Level 5	Evaluate		10 Cars NO	10%		10%	-			
Level 6	Create		10 M 10 M 10	5%		<mark>5%</mark>	-			
	Total	10	0 %	10	0 %	10	0%			

Course Designers	The second se	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
<ol> <li>Mr. Athif Shah, Chairman, Abe Semicondutor, abechennai@gmail.com</li> </ol>	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University,meena68@annauniv.edu	1. Mrs. V. Padmajothi, SRMIST



Course Code	21ECE373T Course JULIA FOR DATA SCIENCE							C	Cours atego	e ory	E			PROF	ESSIO	NAL E	LECT	IVE		l	- T 3 0	P 0	C 3	
Pre-requ Course	isite es	Nil		Co- requis Courses	site	-	N	11	-	Pro	ogres Cours	sive es						Nil						
Course	Offering Departme	ent		ECE			Data Book	/ Codes / Sta	Indards								Nil							
Course Le	earning Rationale (	CLR): 7	The purpose	of learning	this cour	rse is to:				Program Outcomes (PO)												P	rogra	m
CLR-1:	CLR-1: Describe the various data types and data structures in Julia programming.									1	2	3	4	5	6	7	8	9	10	11	12	S Or	pecifi utcom	C es
CLR-2:	Organise the cont	trol flow usi	ing Ju <mark>lia prog</mark>	ramming.	1	1		-		e		-	of	3.	ety			¥						
CLR-3:	To compile data f	rames oper	rations with J	ulia programi	ming.	1			16	ledg		ent o	tions	ge	soci			Mo		ance	5			
CLR-4:	Define statistics a	nd its visua	ali <mark>zation in</mark> Ju	lia programm	ning.		177-7			Von	lysis	opme	stiga	Usaç	and	~~		eam	ы	k Fin	Ining			
CLR-5:	Understand the m	achine lear	rning models	and Principa	al Compor	nent Anal	ysis.			leering h	em Ana	in/devel	uct inve lex prob	rn Tool	engineer	onment	(0)	dual & T	nunicati	ct Mgt. 8	ong Lea	5	5	ę
Course O	utcomes (CO):		At the end o	of this cours	e, learnei	rs will be	able to:	Anone	127	Engir	Probl	Desig	Cond	Mode	The e	Envin	Ethics	ndivi	Comr	Proje	_ife L	-OSc	-OSc	-OSc
CO-1:	Define the various	s data t <mark>ypes</mark>	<mark>s and</mark> data str	ructures in Ju	ulia progra	amming.	1-0-15			3	2	-	-	-		-	-	-	-	-	-	2	-	-
CO-2:	Express the contr	ol flow <mark>state</mark>	<mark>emen</mark> ts for pr	rogramming i	n Julia pro	ogrammir	ng.	10 S.		-	3	2	-	-		-	-	-	-	-	-	-	2	-
CO-3:	Analyse the data	frames <mark>and</mark>	<mark>I the </mark> operatio	ns using Julia	a program	nming.	Sec. 9.	1. 1. 1			2	3	-	1	-	-	-		-	-	-	1	-	-
CO-4:	Apply Julia progra	amming for	statistics and	its visualiza	tion mode	els.	10.5	100	100	1	2	3	-	1		-	-	-	-	-	-	-	2	-
CO-5:	Implement the ma	achine l <mark>earn</mark>	<mark>ning m</mark> odels f	or data scien	ice using	Julia prog	gramming.				2	3	-	1		-	-	-	-	-	-	-	2	-
				221	10	1									-									
Unit-1 - D	ata Types and Data	a Structure	s in Julia	mboro Arith	motio and	d Logical	anaratara (	Vachroia opora	tiona (	Stringe	Arro			d diati	non	oto Va	otor o	nd mo	triv pro		a Don	domn	<u>9</u>	Hour
Introductio	ontrol Elow in Date		using Julia	mbers, Anum	metic anu	LOgical C	perators, A	Ngebraic opera	alions, c	sunge	s, Alla	ys, ru	oles all		Diary :	sels, ve		iu mai	μιχ ριο	cessin	y, ran	Join p	ackay	es. Hour
Decision n	nakina Loopina Co	nditional ev	valuation. Rel	peated evalu	ation Exc	ception h	andling. Vai	riables and fun	nctions i	n Julia	a Ano	ทงฑดม	s funct	ions F	unctio	ns with	araum	ents t	vne as	sertion	for fur	nction :	araum	ents
Varargs fu	inctions, User define	d functions	s, Methods ar	nd constructo	ors.						.,			,.				, ,	,,					,
Unit-3 - O	perations in Data I	rames wit	h Julia						100					124								·	9	Hour
Data frames: Reading and writing, Filtering and sorting, Row and column operations, Replacing and changing entries Split-Array-Combine Strategy, Time series and dates in Julia, Time array: Accessin										ssing	data,													
applying conditions, combining methods, Case study: E-commerce in data analysis																								
Unit-4 - St	tatistics and Data \	/isualizatio	on in Julia				D 1 1	11 0	" 0		<i>c</i>		D'				<b>D</b> (	· ,		<u> </u>			9	Hour
Interpolation	on, Macros and me nctions, line and sca	taprogramn atter plots. H	ning with data Histogram	a frames, De	escriptive	statistics	, Deviation	metrics, Samp	pling, C	orrela	tion a	nalysis	, Dime	nsiona	lity re	duction,	Data	visuali	ization	: Plottii	ng of b	asic a	rrays,	data
Unit-5 - M	achine Learning M	odels in Ju	ulia																				9	Hour
Simple Linear regression, Multiple Linear regression, Logistic Regression, Polynomial Regression, Clustering, K-means clustering, unsupervised learning, Principal Component Analysis, Real										al Tim	e case	study	with											
in depth a	depth analysis of code														-									

Learning	1. Logan Kilpatrick, Nolan Fortman. Julia Crash Course: Learn the world's fastest	3. Paul D. McNicholas and Peter Tait. Data Science with Julia. Chapman and Hall/CRC, January 2019.
Resources	growing programming language, December 2022 Zacharias Voulgaris, Julia for Machine Learning, Technics Publications, June 2020	4. Sambit Kumar Dash. Hands-on Julia Programming, Bpb Publications, October 2021.

			Continuous Learning	Assessment (CLA)		Sum	motivo			
	Bloom's Level of Thi <mark>nking</mark>	Forn CLA-1 Avera (50	native ge of unit test %)	Life-Long CL (1	g Learn <mark>ing</mark> _A-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	20%		20%		20%	-			
Level 2	Understand	30%		20%	112	20%	-			
Level 3	Apply	30%	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	30%		30%	-			
Level 4	Analyze	20%	and the second second	30%		30%	-			
Level 5	Evaluate		1. S.		and the second second	- 19	-			
Level 6	Create			and the second	1 m	-	-			
	Total	10	0%	10	00 %	10	0%			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Athif Shah, Chairman, Abe Semicondutor,	1. Dr. Meenakshi, Professor of ECE, CEG, Anna	1. Dr.P. Vijayakumar, SRMIST
abechennai@gmail.com	University, meena68@annauniv.edu	
		2 Mrs S Hannah Pauline SRMIST



Course Code	21ECE374T	Course Name		DATA PATTER	RN AND VI	SUALIZATION		Cours Catego	se ory	E			PROF	ESSIO	NAL E	LECT	IVE		L 3	- T 3 0	P 0	C 3
Pre-requi Course	site es	Nil		Co- requisite Course <mark>s</mark>		Nil	-	Pr	ogres Cours	sive es						Nil						
Course	Offering Departm	ent		ECE		Data Book / Coo	des / Standard	ls							Nil							
Course Le	arning Rationale	(CLR): 7	The purpose	<mark>of learnin</mark> g this c	ourse is to	):		r -	4	1	11	Progra	am Ou	itcome	s (PO	)				Pi	ograi	m
CLR-1:	Obtain knowledg	e in distribut	tion and shap	e of the data	100	20		1	2	3	4 5 6 7 8 9 10 11 12						12	S Ou	pecifi Itcom	c es		
CLR-2:	Identify various o	lata sources	s and <mark>dealing v</mark>	with messy data	1			ge		of	s of	2	iety			ĸ		a				
CLR-3:	Explore the art of visualization							vledo		ento	ation:	ge	soc			٥٧ ر		lance	D			
CLR-4:	Knowing the data layout for v <mark>isual effec</mark> ts						1	Knov	Ilysis	mdo	stiga	Usa	r and	~~~		Tean	U	& Fir	arnin			
CLR-5:	: Familiarize with concepts on geometric modelling and virtual environments for visualization		neering	lem Ana	gn/deve ions	duct inve olex prol	ern Tool	enginee	ronment ainability	s	idual & <sup>-</sup>	municat	ect Mgt.	-ong Le	<u>-</u>	-2	φ					
Course Ou	utcomes (CO):		At the end of	this course, lear	rners will b	e able to:	1000 27	Engi	Prob	Desi	Conc	Mode	The	Envii Sust	Ethic	Indiv	Com	Proj€	Life I	PSO	PSO	PSO
CO-1:	Analyze univaria	te and m <mark>ultiv</mark>	variate data	1		the black	- N.S.4	2	3	-	-	1		-	-	-	-	-	-	-	-	-
CO-2:	Implement variou	us metho <mark>ds t</mark>	<mark>to ha</mark> ndle mes	sy data			45. E	-		2	3	-		<u> </u>	-	-	-	-	-	2	-	-
CO-3:	Incorporate appr	ropriate d <mark>ata</mark>	visualization	technique	1.1.1		3.44	-		2	-	3	-	-	-		-	-	-	2	-	-
CO-4:	Develop customi	ized layo <mark>uts</mark>	<mark>by su</mark> itable vi	sual encoding tech	nniques		100			2	-	3	-	- 1	-	-	-	-	-	2	-	-
CO-5:	Apply the concep	ots of ge <mark>ome</mark>	etric modelling	and virtual enviro	nments to e	enhance data visu	alization	2	-	2	-	3	-	-	-	-	-	-	-	2	-	-
Unit-1 - Da	ata Shape Analys	is	-		CO-LEN	ALC: NO	172		02			-	-								9	Hour
Univariate continuous tale of two Unit-2 - Re	data, Frequency d variable, Relation interpretations, Sa atational Database	listributions, aships betwe ampling from es	Measures of e een two catego distributions	central tendency, S prical variables, R Binomial distribu	Spread, Po elationship tion, Proble	pulation, sampling between two cont ems in binomial dis	and estimation tinuous variabl stribution, Norn	n, Prob es, Cov nal dist	ability varianc ributio	distribu ce, Cori n, Prot	itions, relatior plems i	Multiva coeffi n norn	ariate d icients nal dis	lata: Re , Comp stributio	elation aring n, Thi	ships t multipl ee sig	betwee le corre ma rul	n single elations e and	e categ , Prob using .	gorical ability z table	and s : Basi <del>)</del> S <b>9</b>	ingle cs, A
Data sourc data: Comp Stochastic unlikely da	es, Relational data olete case analysis regression imputa ta, Other messing	abases, SQL, s, Pairwise de ation, Multipl ess	., JS <mark>ON, XML,</mark> eletion, Unsop le imputation,	Other data format histicated method Analysis with san	ts, Handling Is for dealing hitized data	data from online r g missing data: Me , Checking for out	epositories, De ean substitution t of bounds ar	ealing n , Hot d nd data	eck im type	data, A. putatio , Chec	nalysis n, Unso cking f	with m ophistic or une	cated i expected	data: Ty method ed cate	vpes, L s for d gories	Insoph ealing s, outli	nisticate missin iers, ty	ed metl g data: pograp	nods fo Regre phical	r deali ssion errors,	ng mi imputa Che	ssing ation, cking
Unit-3 - Da	ata Visualization (	Consideratio	ons					_													9	Hour
Classificati Creation of redundant in designir	on of visualization <sup>f</sup> visualization for o encoding, Default ng	: complexity, ther people, s vs innovati	, Infographics Contextual co ive formats, F	vs data visualizati nsiderations, Con Readers context, C	ion, Explora text of use, Compatibility	ation vs explanati The goal and supp with reality, Patt	on, Information porting data, Ki erns and cons	vs per nowled istency	suasiv ge befo v, Sele	re vs vi ore stru ecting s	isualari ucture, structui	, Look Choos es: Co	ing da ing ap ompar	ta as de propria isons, l	esigne te visu bad S	r, Role Ial enc tructur	of des odings res, Ab	signer, i : naturi oused :	Lookin al orde structu	g data r, disti re anc	as re nct va 1 sim	ader, Iues, olicity

Unit-4 - Data Layouts	9 Hour
Positioning: layout, Positioning: axes, Placement and proximity: Semantic distance and relative proximity, absolute placeme	nt, Representation of physical space, Logical and physical relationships, Patterns and
grouped objects, Patterns of organizations: Graphs, Iayouts, Axis styles, Using circles and circular layouts, Applying encodings	: Color, Leverage Common color, Cognitive interference and Stroop test, Color theory,

Sizes: Conveying size, Size: Comparing size, Text and typography, Shapes and lines, Keys Vs direct labeling of data points

### Unit-5 - Geometric Modeling and Virtual Environments for Visualization

3D Mesh compression- corner table representation, Geometry compression, connectivity compression, edge compression, other approaches, Retiling, Direct manipulation in virtual reality for scientific visualizations, The Data analysis pipeline, Advantages of direct manipulation in virtual environment, How scientific visualization differs from other VR applications, Basics of direct manipulation, system architecture issues, Distributed implementation, Time critical techniques

Learning Resources	<ol> <li>Tony Fischetti, Data Analysis with R, second edition, Packt publishing, 2018.</li> <li>Noab Iliinsky, Julie Steele, Designing data visualizations, O' Reilly publishers, 2011</li> </ol>	<ol> <li>Trevor Hastie, Robery Tibshirani, Jerome Friesman, The Elements of Statistical</li> <li>Learning, Data mining, Inference and prediction, Springer, 2013.</li> <li>Charles D. Hansen and Chris R. Johnson, Visualization Handbook, Academic Press, 2011</li> </ol>								

			Continuous Learning	Assessment (CLA)		Cum	mativa			
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (1)	Learning A-2 )%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice			
Level 1	Remember	15%		15%		15%	-			
Level 2	Understand	25%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	20%		<mark>25%</mark>	-			
Level 3	Apply	30%	20 S 10 S 10 S 10	25%		30%	-			
Level 4	Analyze	30%		25%		30%	-			
Level 5	Evaluate	ALC: NO DECISION		10%	-	-	-			
Level 6	Create			5%		-	-			
	Total	10	0%	10	0 %	10	0%			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Baraneedhara Karthikeyan, Director,	1. Dr. Bhuvaneshwari, Professor, MIT, Anna University, Chennai	1. Dr. Revathi Venkataraman, SRMIST
Skylim Infotech Pvt Ptd		
		2 Dr S Krithiga SRMIST

Course Code	21ECE375T	Course Name	DATA SCIENC	E FOR COMM	UNICATION NETWORKS	Cour Categ	se ory	Е			PROF	ESSIO	NAL E	ELECT	IVE		l	. T 3 0	P 0	C 3
Pre-requis Course	site s	Nil	Co- required Co- required Course	uisite	Nil	P	rogres Cours	sive						Nil						
Course C	Offering Departme	nt	ECE		Data Book / Codes / Stand	lards							Nil							
Course Lea	arning Rationale (	CLR):	The purpose of learnin	g this course is	s to:		Program Outcomes (PO)										Pr	ograi	n	
CLR-1:	Provide basic con	cepts of D	oata Scienc <mark>e</mark>	- 0	12	1	2	3	4	5	6	7	8	9	10	11	12	SI Ou	tcom	es S
CLR-2:	Provide knowledg	e on differ	rent da <mark>ta sources</mark> for vari	ous communica	ion networks	е		-	s of	3	ety	1.4		×		0				
CLR-3:	Emphasis on data visualization and different learning paradigms for communication networks							ient o	ations	ge	l soci	4	-	n Wo		Jance	b			
CLR-4:	Handle the various data science problems in wireless communication networks				Kno	Ilysis	lopm	estig: olem	Usa	r and	ø ,		Tean	ion	& Fir	arnin				
CLR-5:	Examiliarize with the applications of data science in Telecom Industry		leering	em Ana	gn/deve	luct inve olex prol	ern Tool	enginee	onment ainability	S	idual & <sup>-</sup>	nunicat	ct Mgt.	-ong Le	-	-2	ę			
Course Ou	tcomes (CO):	-	At the end of this cour	se, learners wi	Il be able to:	Engir	Probl	Desig	Cond	Mode	The e	Envir Susta	Ethic	ndivi	Com	Proje	Life L	-OS-	ŌSd	0S <sup>d</sup>
CO-1:	Express the conce	epts of <mark>dat</mark>	t <mark>a scie</mark> nce in different cor	nmunication net	work	3	2	-	-	4	-	-	-	-	-	-	-	3	-	-
CO-2:	Plan the appropria	ate data so	<mark>ources</mark> needed in commu	nication networ	ſS	3	2		-	-		-	-	-	-	-	-	3	-	-
CO-3:	Apply data visuali	zation <mark>and</mark>	<mark>l differ</mark> ent learning paradi	gms necessary	for different applications	3	3		-	-	-	-	-	-	-	-	-	3	-	-
CO-4:	Analyze various d	ata sci <mark>enc</mark>	<mark>ce pro</mark> blems in communic	ation networks		3	3	-	-	-	1	-	-	-	-	-	-	3	-	-
CO-5:	Implement the dat	a scien <mark>ce</mark>	in Telecom Industry		and the second second	3	3	11.24	-	2	1	-		-	-	-	-	3	-	-
<b>Unit-1 - Int</b> Introductior Visualizing Sampling S	roduction to Data n to Data Science: C Numerical Distribu Sizes; Technical ele	<b>Science</b> Causality a tions, Ove ments of t	nd Experiments; Data Pro erlaid Graphs, plots, Sun he Data Science, Analyti	eprocessing: Da nmary statistics cs Toolkit, Com	ta cleaning, Data reduction, Data of exploratory data analysis, Ra ponents of the analytics toolkit, A	transform andomnes Application	ation, s Prob s of Da	Data di ability.i ata Scie	scretiza Introdu ence	ation; \ ction to	/isualiz Stati	ation a stics: :	nd Gra Learn	aphing. ing Cu	: Visual rve, Sa	lizing C ampling	ategor g, Sam	ical Di: pling r	<b>9</b> stribut neans	<b>Hour</b> ions, and
Unit-2 - Da	ta Source and Neo	cessities	for Large Scale Commu	inication Netwo	orks					~							o /		9	Hour
Data Sources of Internet Service Providers: Telephony call record details, IP traffic flow records generated by routers, Protocol transitions; Data Sources of Mobile Communication Networks: Subscriber-related data, Network-related data, and Application data. Vehicular networks: Traffic Flow data, Public safety/security data, Vehicular safety warning messages, Ride quality monitoring information, Location-aware social network information Mobile Social Networks: Service Provider-related data, User related data. Security and Privacy Concerns of data – Security in data acquisition, privacy and security in data storage, Data Privacy and Challenges of data – Security in data acquisition, privacy and security in data storage, Data Privacy and Challenges of data privacy: Privacy in data analytics. Data policies for maintaining the privacy of data																				
Unit-3 - Da	ta Visualization ar	nd Learni	ng Paradigms				,								-				9 /	Hour
Data Visual Science; Da	Interpretation: Design principles for data visualization, Human perception of data, Effective interpretation with data, Modern visualization tools and techniques. Overview of Types of Learning Paradigms for Data Science; Data Mining vs. Machine Learning; Supervised vs. Unsupervised vs. Semi- Supervised Learning; Offline vs. Online vs. Active Learning																			

Introduction to various data science problem in wireless networks; Introduction to Regression - Linear Regression, Non-linear Regression, Logistics Regression, Classification – Neural Networks, Deep Learning, Support Vector Machine (SVM) k-Nearest Neighbour (k-NN), Clustering, Anomaly Detection Summarization

### Unit-5 - Application of Data Science in Telecom Industry

9 Hour

9 Hour

ISP Network: Structure of large ISP Networks, Measuring the ISP network, Challenges of ISP data analysis, Traffic Flow Management, Application of data science in Telecommunication – Personalized Services -Customer Behaviour, Customer Demographics Network Management and Optimization, Social Media and Sentiment Analysis; Location-Based Initiatives, Customer Churn Prevention. Application of data science in Telecom Industry - Customer Experience, Customer Segmentation, Product Development, Real-time Analytics, Customer Sentiment Analysis., Fraud detection, Predictive analytics, Lifetime Value Prediction, Product Development, Price Optimization, Capacity management, Data integrity management, Propensity profiling management, offer performance management.

		1.	Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MITPress, 2012.	4.	Adi Adhikari and John DeNero, "Computational and Inferential Thinking: The Foundations of
	Loorning	2.	Ethem Alpaydin, "Introduction to Machine Learning", Prentice Hall ofIndia, 2005		Data Science", GitBook, 2019
	Deseurees	З.	Larry L Peterson & Bruce S Davie, "Computer Networks – A SystemsApproach", Morgan	5.	Srinivasa, K.G., G M, Siddesh, H., Srinidhi, "Network Data Analytics: A Hands-On Approach
ľ	Resources		Koufmann (5th Edition)		for Application Development", Springer, 2018
				6.	Kolaczyk, Eric D., "Statistical Analysis of Network Data: Methods and Models", Springer, 2009

			Continuous Learning	Assessment (CLA)		Sum	motivo		
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (10	y Learning A-2 0%)	Final Examination (40% weightage)			
	- 7	Theory	Practice	Theory	Practice	<u>The</u> ory	Practice		
Level 1	Remember	15%		15%	A COLORADO	- <mark>15</mark> %	-		
Level 2	Understand	25%		20%		25%	-		
Level 3	Apply	30%		25%		30%	-		
Level 4	Analyze	30%	1	25%		<mark>3</mark> 0%	-		
Level 5	Evaluate	and the second		10%	1		-		
Level 6	Create	1.1		5%			-		
	Total	10	0%	10	0%	100 %			

Course Designers		1
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Baraneedhara Karthikevan, Director, Skylim Infotech Pvt Ptd	1. Dr. Bhuvaneshwari. Professor. MIT. Anna University. Chennai	1. Dr. M. Susila, SRMIST

Course Code	21ECE376T	Course Name		BUSINES	S DATA AN	IALYTICS		Cours Catego	se ory	Е			PROF	ESSIO	NAL E	LECT	IVE		L 3	- T 3 0	P 0	C 3
Pre-requ Course	isite es	Nil		Co- requisite Courses		Nil		Pr	ogres Cours	sive es						Nil						
Course	Offering Departm	ent		ECE		Data Book / Code	s / Standard	s							Nil							
						- Late			1	100	-	_	-		(DO)					D	roara	m
Course Le	earning Rationale	(CLR): 1	he purpose o	f learning this c	ourse is to	):										S	pecifi	ic				
CLR-1:	Understand the o	concept of bu	usiness analyti	<mark>c me</mark> thods and m	odelling.	A.		1	2	3	4	5	6	7	8	9	10	11	12	Ou	tcom	es
CLR-2:	Familiarize abou	t the supervis	ised l <mark>earning fo</mark>	r forecasting			-	ge		f	s of	24	iety			논		Ð				
CLR-3:	Understand about	Understand about the optimizati <mark>on models</mark> and their analysis								ento	ation	ge	soc			N N		anc	b			
CLR-4:	Inculcate the sta	nculcate the statistics and pr <mark>obability fo</mark> r data analytics						Von	lysis	mdo	stige	Usa	and	ø		ean	u	ËFir	urnin			
CLR-5:	Discuss about the latest data warehousing						ering h	n Ana	/devel	ct inve	n Tool	gineer	nment ability		ual & T	unicati	Mgt. 8	ng Lea				
Course O	Course Outcomes (CO): At the end of this course, learners will be able to:							Engine	Proble	Design	Condu	Modern	The en	Envirol Sustair	Ethics	Individ	Comm	Project	Life Lo	PSO-1	PSO-2	PSO-3
CO-1:	Understand the l	business <mark> ana</mark>	alytical models	and Data Dashbo	oards u <mark>sing</mark>	Excel.	134.2	1	-					-	-	-	-	-	-	3	-	-
CO-2:	Design of superv	vised lea <mark>rnin</mark> g	<mark>g mo</mark> dels for fo	recasting	Harry .	Sec. 10.12	E	1	-	12	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Understand linea	ar optimi <mark>zatio</mark>	on models usin	g spreadsheet.	20.05	1. S.	2.4	3	1		2	-	-	-	-	-	-	-	-	3	-	-
CO-4:	Apply various sta	atistical t <mark>echn</mark>	niques for busi	ness analytics	1.25	The second second	1000		-		3	3	-	-	-	-	-	-	-	1	-	3
CO-5:	Analyze data wa	rehouse <mark>tools</mark>	<mark>ls and</mark> mechan	'sm		1.1.1		Ċ.	-	19	3	3		-	1	-	-	-	-	2	-	2
l Init-1 - In	troduction To Bu	siness Analı	vtic Using Ex	ral	679222		105		62				-								0	Hour
Decision N	laking – Business	Analytics De	efined – Catego	prization of Analy	/tical Methc	ods and Models – Bi	g Data – Bus	iness .	Analyt	ics in F	Practice	– Des	scriptiv	e Stati	stics –	Types	s of Da	ta – M	odifyind	g Data	in Ex	cel –
Creating D	istributions from D	ata – Measu	res of Location	– Measures of V	/ariability –	Analysing Distribution	o <mark>ns –</mark> Measur	es of A	Associ	ation b	etween	Two	Variab	es.		21			, (	<i>.</i>		
Unit-2 - R	egression & Fore	casting						_				- 1									9	Hour
Linear and Moving Av	Logistic Regressi erages and Expon	on & Forecas	sting – Simple	Linear Regression	on Model –	Least Square Meth	iod – Multiple	Regre	ession	Model	– Infei	ence a	and Re	egressio	on – 1	ime Se	eries P	atterns	– Fore	ecast A	Accura	асу –
Unit-3 - O	ntimization Model	enilai Sinooli Is	inening – Negr	SSION Analysis IC	JITUIECasi	.iriy.	TI TO I			-		18									9	Hour
Spreadshe	et Models & Linea	r Optimizatio	on Models – Bu	uilding Good Spre	eadsheet M	lodels – What-If Ana	alysis – Usefu	I Exce	l Func	tions f	or Mod	elling -	- Linea	ar Optin	nizatio	n Mod	els – S	imple I	Maximi	zation	Prob	lem –
Simple Mir	nimization Problem	– Sensitivity	/ Analysis.		1				1.11			Ű										
Unit-4 - St	atistics and Prob	ability		1011 0000	<u> </u>	" D ( 5" 0		.,					01			<u> </u>					9	Hour
Manipulati measure o intervals, ł	a Study - Preparin ng the Data - Che f spread, five points hypothesis testing,	g a Codeboo cking the Re s' summary, F F-test, Z-test	ok - Getting to I eliability of a S Probability Dist t, t-test, ANOV	cnow IBM SPSS cale - Choosing a ributions, Probab A, chi-square tes	- Preparing the Right S illity in Busir t.	the Data File - Crea Statistic - Statistical ness Analytics, Binor	ating a Data F Techniques t mial distributio	o Expl Din, Poi	ore Re sson d	ring Da elation listribut	ships a tion, Ba	scripti mong yes the	ve Sta Variat eorem,	ustics - les. De central	Using escripti I limit t	Graph ve and heoren	is to D alysis - n, Corr	escribe Measi elation,	e and E ure of ( covari	xpiore central iance,	the L tend confic	vata - ency, lence

## Unit-5 - Data Warehousing

Data Warehousing: Identify purpose of data warehousing - Identify between key components of a data warehouse - Distinguish between data warehouses and data lakes - Determine the role of different warehousing techniques - Data Warehousing Tools: Differentiate between utility of Relational DW, cubes, and in-memory scenarios - Compare techniques for data integration with regards to warehousing - Use warehousing tools - Use integration tools for warehousing.

	1	Anil Maheswari - "Data Analytics"- McGraw Hill Education (India) Private Ltd, Kindle Edition, 2021.	5	James (JD) Long – "R Cookbook" - O'Reilly Media Inc 2nd Edition– 2019
	2	Tim Costello, Lori Blackshear – "Prepare Your Data For Tableau: A Practical Guide To The Tableau	6	Andy Field - "Discovering Statistics Using IBM SPSS Statistics" - Sage
Loorning		Data Prep Tool" – Apress – 1stEdition – 2020		Publications Ltd - 5th Edition – 2018
Desources	3	Brian Larson - "Data Analysis with Microsoft Power BI" - McGraw-Hill Education - 1st Edition – 2020	7	Gowrishankar S, Veena A - "Introduction to Python Programming" - Chapman and
Resources	4	Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W.Ohlmann, David R.		Hall/CRC – 1st Edition – 2018.
		Anderson, Dennis J. Sweeney, Thomas A. Williams – "Business Analytics" – Cengage – 3rd Edition	8	SandipRakshit - "R Programming for Beginners" - McGraw Hill Education - 1st edition
		- 2019		21 July 2017.

		Cum	motivo							
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ige of unit test 0%)	Life-Lonı CL (1	g Learning "A-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		15%		15%	-			
Level 2	Understand	25%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	20%		<mark>25</mark> %	-			
Level 3	Apply	30%		25%		30%	-			
Level 4	Analyze	30%	10.5	25%		30%	-			
Level 5	Evaluate			10%		-	-			
Level 6	Create			5%			-			
	Total	10	0%	10	0%	100 %				

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mr.Baraneedhara Karthikeyan, Director,	1 Dr. Bhuvaneshwari, Professor, MIT, Anna University, Chenn	ai 1 K. Harisudha <mark>, SRMIST</mark>	
Skylim Infotech Pvt Ptd			

B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

Code     21ECE377T     BIG DATA ANALYTICS STRATEGIES FOR THE SMART GRID     Category     E     PROFESSIONAL ELECTIVE	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$
Pre-requisite Courses     Nil     Co- requisite Courses     Nil     Progressive Courses     Nil	
Course Offering Department         ECE         Data Book / Codes / Standards         Nil	
Course Learning Rationale (CLR): The purpose of learning this course is to: Program Outcomes (PO)	Program
CLR-1: Understand the basics of smart grid	Specific Outcomes
CLR-2: Design architecture of smart grid	
CL R-3:     Summarize WAMS architecture	
Course Outcomes (CO): At the end of this course, learners will be able to:	
CO-1:     Express the basics of smart grid	2
CO-2: Compile architecture of smart grid	2
<b>CO-3</b> : Implement phasor measurement units	2
CO-4: develop big data analytic framework in smart grid	2
CO-5: Apply data management in smart grid applications 1 3	2
Unit-1 - Introduction to Smart Grid and Communication Technologies in Smart Grid	9 Hou
Basics of power systems, definition of smart grid, need for smart grid, smart grid domain, enablers of smart grid, smart grid, smart grid priority areas, regulatory challenges, and smart-grid activities in Indi Technologies in Smart Grid: Introduction to Communication Technology. Two Way Digital Communications Paradigm. Synchro- Phasor Measurement Units (PMUs) – Wide Area Measurement	a. Communication Systems (WAMS)
Introduction to Internet of things (IoT)- Applications of IoT in Smart Grid	systems (mine)
Unit-2 - Smart Grid Architecture	9 Hou
Smart grid architecture, standards-policies, smart-grid control layer and elements, network architectures, IP-based systems, power line communications, supervisory control and data acquisition	system, advanced
Instantion, Distribution Automation, Renewable Integration	0 Hou
Importance of PMUs Phasor Measurement Units and Phasor Data Concentrators Wide Area Monitoring: WAMS concent data collection WAMS architecture. Monitoring systems placement	nt Advanced dat
processing. Time-frequency representation: Hilbert–Huang analysis, Wavelet analysis, Dynamic harmonic regression, Multivariant multi scale analysis; Multi-signal Prony analysis, Data fusion prin	ciples
Unit-4 - Application of Big Data Analytics in Smart Grid	9 Hou
Big data characteristics in smart grid, Data sources in smart grids, Data analysis techniques, Procedures of data Mining in Smart Grids, Big data analytics in smart grid-Fault detection, Predictive main	tenance/condition
based maintenance, Transient stability analysis, Electric device state estimation/health monitoring, Power quality monitoring, Topology identification, Renewable energy forecasting, load forecasting	g, load profiling
Unit-5 - Smart Grid Data Management and Applications	<u>9 Hour</u>
Uverview of Deep Learning, artificial neural network, Pricing and energy forecasting in Demand Response, case study on Energy Forecast, Smart Meter Data Management -PHEVs: Internet of Buildings	t vehicles - Smar

	1.	Smart Grids, Infrastructure, Technology and Solutions, S. Borlase, CRC Press, 2013,	6.	Introduction to Machine Learning with Python, Andreas C. Mueller and Sarah Guido,
		1stEdition.		O'Reilly Media, Inc.
	2.	Renewable and Efficient Electric Power System, G. Masters, Wiley-IEEE Press, 2013, 2nd	7.	Smart Grid Technology: A Cloud Computing and Data Management Approach, S. Misra
Loarning		Edition.		and S. Bera, Cambridge University Press, 2018, 1st Edition.
Desources	З.	Wide Area Monitoring of Interconnected Power Systems, R. Messina, IET publisher, 2015, 1st	8.	Smart Grid Communication Infrastructure: Big Data, Cloud Computing and Security, F.
Resources		Edition		Ye, Y. Qian and R.Q. Hu, Wiley IEEE Press, 2018, 1 <sup>st</sup> Edition.
	4.	Interconnected Power Systems Wide-Area Dynamic Monitoring and Control Applications, Yong	9.	Zhang, Y., Huang, T. & Bompard, E.F. Big data analytics in smart grids: a review. Energy
		Li, D. Yang, Fang Liu, Y. Cao, Springer-Verlag Berlin Heidelberg, 2016, 1st Edition		Inform 1, 8 (2018). https://doi.org/10.1186/s42162-018-0007-5
	5.	Power System Stability and Control, Prabha Kundur, McGraw Hill Education, 2006, 1 <sup>st</sup> Edition.		

			Continuous Learnin	g Assessment (CLA)		0				
	Bloom's Level of Thinking	Forma CLA-1 Average (50%	tive e of unit test 6)	Life-Long CL (1)	g Learning _A-2 0%)	Final Examination (40% weightage)				
	1	Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		15%		15%	-			
Level 2	Understand	25%	1. 1. 1. 1. 1.	25%	1	<mark>25%</mark>	-			
Level 3	Apply	35%		35%		35%	-			
Level 4	Analyze	25%		25%		25%	-			
Level 5	Evaluate			100.000	-	-	-			
Level 6	Create			1000	-	-	-			
	Total	100	%	10	0%	10	0 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Baraneedhara Karthikeyan, Director, Skylim Infotech Pvt Ptd	1. Dr. Bhuvaneshwari, Professor, MIT, Anna University, Chennai	1. Dr. Damodar Panigrahy, SRMIST



Course Code	21ECE470T	Course Name	CLOUD A	AND DISTRIBUTED CC	MPUTING FOR DATA ANALYTICS	Cor Cate	irse gory	E			PROF	ESSIO	NAL E	LECT	IVE		L 3	L T P C 3 0 0 3			
Pre-requis	site s	Nil		Co- requisite Courses	Nil		Progre Cours	ssive ses						Nil							
Course C	Offering Departme	ent		ECE	Data Book / Codes / Stan	dards							Nil								
Course Le	arning Rationale (	(CLR):	The purpose	e <mark>of learnin</mark> g this cour	se is to:		2	A		Progr	am Ou	itcome	s (PO)	)				Pr	ogra	m	
CLR-1:	its 1	2	3	4	5	6	7	8	9	10	11	12	S Ou	Specific Outcomes							
CLR-2:	To learn about AV	NS IoT Ana	e		of	s of	15	iety			rk		a								
CLR-3:	Understand the fu	vlede		ent o	ation	ge	soc			n Wo		nano	Ð								
CLR-4:	Explore distribute	Knov	lysis	mdo	stige	Usa	anc	৵		Tean	on	& Fir	arnin								
CLR-5:	To learn about pa	eering	em Ana	jn/devel	uct inve lex prot	ern Tool	Ingineer	onment inability	S	dual & <sup>-</sup>	nunicat	ct Mgt.	Long Le	5	2	ņ					
Course Ou	tcomes (CO):		At the end o	- Dair	Probl	Desig	Cond	Mode	The	Envir Susta	Ethic	ivipu	Comi	Proje	_ife L	-OSc	-OSc	-OSc			
CO-1:	Explain the funda	mental <mark>idea</mark>	eas behind clo	oud computing, cloud m	odels and current trends.	3	3	-	2			-	-	-	-	-	-	-	-	-	
CO-2:			-	Z		3	3	1	2	-	-	-	-	-	-	-	-	-	-	-	
CO-3:				Ser Steril		3	3	-	2	_		-	-	-	-	-	-	2	-	3	
CO-4:	Apply distributed	system <mark>mo</mark>	odel and unde	erstand the design princ	iples of computer clusters	3	-	3	1.1	2	1	-	-	-	-	-	-	2	3	-	
CO-5:	Illustrate the fund	amenta <mark>l co</mark>	oncepts parall	lel processing		3	3	3	-	2		-	-	-	-	-	-	-	3	-	
Unit-1 - Int Introduction Goals and I (AWS), Goo Unit-2 - AV What Is AM	roduction to Clou to Cloud Comput Benefits-Risks and ogle Clouds, Micro. VS IoT Analytics VS IoT Analytics? -	d Comput ing: Why C Challenge soft Azure	ting Clouds? What es-Roles and I Cloud-SLA M	t is a Cloud? What's ne Boundaries Cloud Cha lanagement in Cloud C	w in today'sClouds? - Evolution of o racteristics- Cloud Service Models-C omputing: A Service Providers Pers VS IoT Analytics -AWS IoT Analytic	cloud cor Cloud Dep pective	nputing oloymer	-1 Clou at Mode	d Comp els-Clou	outing: d Serv s- Get	Basic ice Pro	Concept oviders	ots and and th	d Term e Clou /S IoT	ninolog Id Ecos Analvt	y-Netw system ics-Pip	ork-Ce -Amaz eline A	entric ( on We	9 Compu b Ser 9 s -Pir	Hour uting- vices Hour	
Activities -A	Automating Your W	orkflow -SC	QL Support -	Visualizing AWS IoT An	alytics Data with QuickSight-Loggin	g AWS lo	T Anal	tics Al	PI Calls	with C	loudTr	ail ail		0 101	, marya	00 T Ip	0		0 1 10	/0///10	
Unit-3 - AV	VS IoT Analytics (	Commands	ls	the Observation Operation	to the state of th	-4- D' 1'					- 4 4	Dalata	Datas	- 10		-1-4-0	- 4 4	- 0-/	9	Hour	
BatchPutMessage-CancelPipeline Reprocessing -CreateChannel -CreateDatasetContent -CreateDatastore -CreatePipeline -DeleteChannel -DeleteDataset-DeleteDatasetContent -DeleteDatasetContent -ListDatasetContent -DeleteDatasetContent -DeleteDatasetContent -ListDatasetContent -ListDatasetConte																					
Unit-4 - Distributed Cloud Computing 9 Hour																					
System Mo Service Ori Cluster Des	System Models for Distributed and Cloud Computing: Clusters of Cooperative computers-Grid Computing Infrastructures-Peer-to-Peer Network families- Software Environments for Distributed Systems and clouds: Service Oriented Architecture(SOA)-Trends towards distributed operating systems-Parallel and distributed programming models-Cluster Development trends-Design Objectives of Computer Clusters, Fundamental Cluster Design Issues-n Design Principles of Computer Clusters Single System Image featuresHigh availability through redundancy, fault tolerant cluster configurations																				

## Unit-5 - Technologies and Techniques

9 Hour Load balancing techniques for Data Intensive computing – Resource Management for Data Intensive Clouds – SALT - Parallel Processing, Multiprocessors and Virtualization in Data intensive Computing - Challenges in Data Intensive Analysis and Visualization - Large-Scale Data Analytics Using Ensemble Clustering - Ensemble Feature Ranking Methods for Data Intensive Computing Application - Record Linkage Methodology and Applications- Semantic Wrapper

	1	Dan C. Marinescu, Cloud Computing Theory and Practice, 2nd Edition, Elsevier Inc., 2018	4	Rajkumar Buyya, James Broberg, Andrzej Go scinski, Cloud Computing Principles and
Learning	2	Hwang, K., Dongarra, J. and Fox, G.C., 2013. Distributed and cloud computing: from parallel		Paradigms, Wiley Publications, 2017.
Resources		processing to the internet of things. Morgan ufmann.	5	Bahga, A. and Madisetti, V., 2013. Cloud computing: A hands-on approach. CreateSpace
	3	Furht, Borko, Escalante, Armando, "Handbook of Data Intensive Computing", Springer 2011	-	Independent Publishing Platform.AWS IoT Analytics AWS IoT Analytics User Guide

Learning Assessm	nent	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1								
			Continuous Learning	Sum	mativo					
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test )%)	Life-Long CL (10	n Learning A-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		15%		15%	-			
Level 2	Understand	25%		20%		25%	-			
Level 3	Apply	30%	to bush he	25%		<mark>3</mark> 0%	-			
Level 4	Analyze	30%		25%		<mark>3</mark> 0%	-			
Level 5	Evaluate			10%	-		-			
Level 6	Create			5%	-	-	-			
	Total	100	0 %	10	0 %	10	0 %			

Course Designers		
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1 Mr. Baraneedhara Karthikeyan, Director, Skylim Infotech Pvt Ptd	1. Dr. Bhuvaneshwari, Professor, MIT, Anna University, Chennai	1. Mr. Maria Dominic Savio.M. SRMIST



Course Code	21ECE4	71T	Cour: Nam	se e				DATA	MINING	3 TEC	CHNIQU	UES			C	Cours Catego	e ory	E			F	PROF	ESSI	ONAL	- ELF	ECTI	VE		:	- T 3 0	P 0	C 3
Pre-requ Course	isite es		Nil				Co- re Cour	quisite ses	e			N	Vil			Pro	ogres Cours	sive es								Nil						
Course	Offering De	oartme	ent				ECE				Data	a Book	k / Cod	les / Star	ndard	3								N	il							
Course Le	arning Rati	onale (	(CLR):	T	he purpo	ose of	learn	ing thi	is cours	se is t	to:	-	-			Program Outcomes (PO) Pro											rogra	m				
CLR-1: Identify data, patterns and applications suitable for data mining											1	2	3	4		5	6	7	8		9	10	11	12	S Oı	pecif itcom	ic Ies					
CLR-2:	2: Forecast trends to make informed decisions using data mining											e		f	s of			iety				¥	 	-								
CLR-3:	Understan	l vario	us class	ifica	tio <mark>n algor</mark> i	ithms		-	27	-		1	1	0.34		vledç		ent c	ations	S	ge	soc				oW r		ance	D			
CLR-4:	Group data	with s	similar p <mark>r</mark>	ope	r <mark>ties usin</mark> g	g clus	stering	2	1		- 57	R			-	Knov	lysis	mdo	stige	lem	Usa	and	ø			Fean	ы	& Fir	arnin			
CLR-5:	Separate o	Separate contaminated data from data set									neering	lem Ana	gn/devel	duct inve	olex prot	ern Tool	enginee	ronment	S	2	idual & 7	municati	ect Mgt.	-ong Lee	5	-2	-3					
Course O	Dutcomes (CO): At the end of this course, learners will be able to:											1	Engi	Prob	Desi	Conc	com	Mode	The	Envii	Ethic		Indiv	Com	Proje	Life I	PSO	PSO	PSO			
CO-1:	Express th	e basio	c conce <mark>p</mark>	ts o	<mark>f Dat</mark> a Mir	ning	<b>P</b> 21	1				1.6	Safe.	200	1	3	2	-			1	-	-	-		-	- 1	-	-	3	-	-
CO-2:	Compile va	rious p	oatterns	of D	<mark>ata M</mark> inin	ig Tec	:hnique	əs		Try.	1		199	£		÷	3	1	-		2	1		-		-	- 1	-	-	-	1	-
CO-3:	Analyze da	ta usir	ng class <mark>i</mark>	ficat	<mark>ion </mark> algori	thms	57	E.		12	22.5		1	84		2	1	2	3		1	- 200	-	-	-	-	-	-	-	3	-	-
CO-4:	Produce di	stinct g	groups w	r <mark>ith</mark> ir	<mark>n dat</mark> aset	using	cluste	ring al	gorithm		10	1.5	1		1	1	1	3	-		2	1	-	-		-	-	-	-	2	-	-
CO-5:	Implement	metho	d of out <mark>l</mark>	i <mark>er</mark> a	l <mark>ata d</mark> etec	ction t	echniq	ues	6	1			-			2	1	1	3		-	-	-	-		-	-	-	-	3	-	-
Unit-1 - C	oncepts of L	ata M	inina			-	-	-	- 60		100		-	10-2	-		ee.					÷.			-	_					9	Hour
Why Data Statistical	mining? What descriptions	at is Da of data	ata minii - Need	ng? for c	<mark>- Kind</mark> s oi lata pre-p	f data proces	mean ssing a	nt <mark>for</mark> m and dat	nining - I a quality	Kinds y - Dai	i of pat Ita clea	tterns th aning -D	that can Data int	n be mine tegration	ed - A - Data	oplicat reduc	ions s tion -	suitable Data i	e for d transf	data orma	minir ation -	ng - Is - Data	sues i cub <mark>e</mark>	in Da and I	ta m its นะ	<mark>nining</mark> sage.	i - Dati	a objec	cts and	l Attrib	oute ty	pes -
Unit-2 - Da	ata Mining T	echnic	ques									01 1									2										9	Hour
frequent it	quent pattern em sets - Im on of pattern	s: Basi proviną evaluai	ic conce g efficiei tion mea	ots - ncy sure	- Market E of Apriori es.	Baske	t Analy ttern g	/sis - F rowth	requent approac	t item . ch - M	sets, C Aining f	Closed I frequen	item se nt item	ets - Ass sets usii	ociatio ng Vei	n rule: tical o	s-Intro lata fo	oductic ormat -	n - Aj Stro	ng ru	algo. ules v	rithm- /S. We	theore	etical les -	appr Assc	roach ociati	i - Ger on and	ierating alysis t	j Asso o Corr	ciation elation	n rules n anal	strom ysis -
Unit-3- Cl	Unit-3- Classification Algorithms 9 Hour																															
Classification: Basic concepts - General approach to Classification - Decision tree induction - Algorithm for Decision tree induction - Numerical example for Decision tree induction - Attribute selection measure - Tree pruning - Scalability and Decision tree induction - Bayes' Theorem - Naïve Bayesian Classification - IF-THEN rules for classification - Rule extraction from a decision tree - Metrics for evaluating classifier performance - Cross validation - Bootstrap - Ensemble methods- Introduction - Bagoing and Boosting - Random Forest: Introduction.																																
Unit-4 - C	luster Analy	sis						J	<u> </u>																	·					9	Hour
Introductio	Introduction - Requirements and overview of different categories - Partitioning method: Introduction - k-means - k-medoids - Hierarchical method: Introduction - Distance measures in algorithmic methods- Distance																															
measures	in algorithmi	c meth	ods - Bl	RCH	l techniqu	le - D	BSCA	N tech	nique - l	STINC	G techr	nique -	CLIQU	JE techni	ique - I	Evalua	ntion c	of clust	ering	tech	nique	əs.										

## Unit-5 - Outlier Analysis Techniques

Outliers: Introduction - Challenges of outlier detection - Outlier detection methods: Introduction - Supervised and Semi-supervised methods -Unsupervised methods - Statistical and Proximity based methods - Statistical approaches - Statistical data mining - Data mining and recommender systems - Data mining for financial data analysis - Data mining for Intrusion detection.

Learning Resources	1. 2.	Jiawei Han and Micheline Kamber, "Data Mining: Concepts and Techniques", 3rd Edition, Morgan Kauffman Publishe <mark>rs, 2011.</mark> Charu C. Aggarwal, "Data Mining the Textbook", Springer, 2015.	3. Mohammed J. Zak and Wagner Meira Jr., Data Mining And Analysis, "Fundamental Concepts And Algorithms", Cambridge University Press, 2014.

Learning Assessme	ent		1		2							
			Continuous Learnin	g Assessment (CLA)	9	Summativa						
	Bloom's Level of T <mark>hinking</mark>	Forma CLA-1 Average (50%	tive e of unit test 6)	Life-Lon CL (1	g Learning _A-2 0%)	Final Examination (40% weightage)						
		Theory	Practice	Theory	Practice	Theory	Practice					
Level 1	Remember	15%		15%		15%	-					
Level 2	Understand	25%		20%		25%	-					
Level 3	Apply	30%	Sec. Sectors	25%		30%	-					
Level 4	Analyze	30%	1000 00000	25%	2 - A - K-	30%	-					
Level 5	Evaluate	the second second		10%	· · · · ·		-					
Level 6	Create		1	5%			-					
	Total	100	%	- 10	0 %	10	0%					
		and the second	A STATE OF A	and the second								

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1 Mr Baraneedhara Karthikevan, Director, Skylim Infotech Pyt Ptd	1 Dr. Bhuvaneshwari, Professor, MIT, Anna University, Chennai	1 Mr. A. Joshua Jafferson, SRMIST



B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

Course Code	21ECE472T	Course Name	SOCIAL MEDIA DATA ANALYTICS			C	Cours atego	se ory	E			PROF	ESSIO	NAL E	ELECT	IVE		l	- T 3 0	P 0	C 3		
Pre-requi Course	isite es	Nil		Co- requisite Courses		1	Nil		Pro	ogres Cours	sive es						Nil						
Course	Offering Departme	ent		ECE		Data Boo	k / Codes / Star	ndards	1000							Nil							
						- <u></u>		1		1.0	1												
Course Le	arning Rationale (	CLR): Th	he purpose	<mark>of learnin</mark> g this	course is	; to:				6	1	1.1	Progr	am Ou	Itcome	s (PO	)				P	rogra	m
CLR-1:	Identify the variou	is concepts fo	for data iden	tification	100	1200			1	2	3	4	5	6	7	8	9	10	11	12	0ı	itcom	ies
CLR-2:	Familiarize the lea	arners with va	vario <mark>us analy</mark>	rsis tools	2	6			ge		of	s of	1	iety			rk		e				
CLR-3:	Enable the learne	ers to develop	p <mark>skills requ</mark> i	red for informatio	on interpre	tation	1.20	16	vled		ent o	ation	ge	lsoc			N NG		Janc	Ð			
CLR-4:	Acquire the know	ledge o <mark>f socia</mark>	<mark>ial influen</mark> ce	parameter of the	system	146	1 1 1 2 2		Kno	lysis	mdo	stige	Usa	anc	ઝ્		[ean	u	& Fir	arnin			
CLR-5:	Outline the behav	rior analy <mark>sis c</mark>	<mark>of grou</mark> p and	l individual			25.5		ring	Ana	level	inve	Tool	inee	ment		<u>م</u>	nicat	Mgt.	g Le:			
				State of the second sec				-	inee	lem	ign/c	duct	ern	eng	taina	S	/idu	Inmu	ect	Lon	÷	-2	-3
Course Ou	utcomes (CO):	A	<mark>At the</mark> end o	f this course, le	arners wil	Il be able to:		97	Eng	Prot	Des	Con	Mod	The	Envi	Ethi	Indiv	Con	Proj	Life	PSC	PSC	PSC
CO-1:	Identify the variou	is conc <mark>epts f</mark> o	for data iden	tification		62-0 P	Sec. 19	1.21	3	÷.	-	-	2		-	-	-	-	-	-	-	1	-
CO-2:	Familiarize the lea	arners <mark>with va</mark>	<mark>/ario</mark> us analy	rsis tools		1.5			3		1	-	2		-	-	-	-	-	-	-	1	-
CO-3:	Enable the learne	ers to de <mark>velop</mark>	<mark>p sk</mark> ills requi	red for information	on interpre	tation	16 8 4		1				2	-	-	-		-	-	-	-	2	-
CO-4:	Acquire the know	ledge o <mark>f socia</mark>	<mark>ial in</mark> fluence	parameter of the	system			12	2	-		1	-	1	-	-	-	-	-	-	-	2	-
CO-5:	Outline the behav	rior ana <mark>lysis c</mark>	<mark>of gr</mark> oup and	l individual		1000			1		1.1	-	3	1	-	-	-	-	-	-	-	1	-
				24	Cont.	1.5		Q.S.		Ċ?				5									
Attributes	ocial Media Data Id	t-regular even	1 pression_iter	ative cleansing n	rocoss-sul	hset of neonle	-predictive analy	tics_do	ecrinti	ivo an	alutics	structu	rod da	tajung	tructure	d dat	a-hia d	ata				9	Hour
Unit-2 - Sc	ocial Media Data A	nalvsis	010331011-1101	alive cleansing p	100003-301		-predictive analyt	1103-000	scripti	ve an	aryucs	-511 UCIU	ieu ua	la-uns	ucuie		a-big u	ala				9	Hour
Four dimer	nsions of analysis ta	axonomy-dep	pth of analys	is-machine capa	city-doma	in analysis-ext	ternal social med	lia-inter	mal so	ocial n	nedia-	velocity	of dat	a-valio	dating t	he hy	othesi	s-deep	analy	sis soft	ware		mour
Unit-3 - In	formation Interpre	tation	(		1		100						1		Ŭ				,	-		9	Hour
Social ana	lytics process-findi	ng the right o	data-custom	<mark>iizi</mark> ng and modify	ing tools-	analyzing con	sumer -common	n visual	lizatio	n cha	rts-cor	nmon p	oitfalls-	visuall	y repre	<mark>senti</mark> n	g unst	ructure	ed data	-case	study-	inform	nation
interpretati	on	<u> </u>		1	1000	1. 1.16	ABOUR	1.1					1										
Unit-4 - Sc	ocial Influence Ana	alysis												10								9	Hour
Influence F	Related Statistics-e	age and node Polatod Apr	e measure-	Social Similarity	and Influei	nce-Influence	Maximization in	viral M	larket	ing-E>	kpert L	ocation	witho	ut Gra	on Con	straini	:s -Exp	ert Lo	cation 1	NITEN SC	ore PI	ropag	ation-
Unit-5 - Be	havior Analytics	ποιαιού Αμμ	pilaciies-E)		3161113.																	9	Hour
Individual L	Behavior Analysis-	Individual Be	ehavior Mod	eling- Individual I	Behavior F	Prediction Coll	ective Behavior:	Collect	tive B	ehavid	or Ana	lysis-C	ollectiv	e Beha	avior M	odelin	ig- Coll	lective	Behav	ior Pre	dictior	i- Exp	loring
Facebook'	s Social Graph API	's- Analyzing	g Social Grap	oh Connections													-						

	1	Mathew Ganis, Avinash Koihrkar Social Media Analytics IBM Press 2015 / 1st edition	4 Marshall Sponder, Social Media Analytics: Effective Tools for
Learning	2	Charu C. Aggarwal, Social Network Data Analytics, Springer, ISBN: 978-1-4419-8461-6	Building, Interpreting, and Using Metrics, McGraw Hill Education, 978- 0-07-176829-0
Resources	3	Reza Zafarani Mohammad Ali Abbasi Huan Liu, Social Media Mining, Cambridge University	
		Press, ISBN:10: 1107018854	

		and the second	Continuous Learning	Assessment (CLA)		Sum	mativa			
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (10	l Learning A-2 )%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		15%		15%	-			
Level 2	Understand	25%	100 C 100 C	25%		25%	-			
Level 3	Apply	30%	A State Server	30%		30%	-			
Level 4	Analyze	30%	1.	30%		30%	-			
Level 5	Evaluate	2011 - P.S.		1.		- 1 H I -	-			
Level 6	Create		the states	William Street		-	-			
	Total	10	0%	10	0%	10	0%			

Course Designers			
Experts from Industry	And the second	Experts from Higher Technical Institutions	Internal Experts
1 Mr.Baraneedhara Karthikeya	n, Director, Skylim Infotech Pvt Ptd	1 Dr. Bhuvaneshwari, Professor, MIT, Anna University, Chennai	1. Dr.C. Vimala, SRMIST



Course Code	Durse Code         21ECE473T         Course Name         DATA SCIENCE FOR IOT ENGINEERS: A SYSTEMS ANALYTICS           Code         21ECE473T         Name         APPROACH MEDIA ANALYTICS				A SYSTEMS ANALYTICS ALYTICS	Cour Categ	se ory	E			PROF	ESSIC	NAL E	ELECT	IVE		l	- T 3 0	P 0	C 3	
Pre-requ Cours	lisite es	Nil		Co- requisite Course <mark>s</mark>		Nil	P	rogres Cours	sive						Nil	1					
Course	Offering Departm	ent		ECE		Data Book / Codes / Stand	lards							Nil							
					-	Sector 1	-		1												
Course L	earning Rationale	(CLR): T	The purpose	e of learning this o	course is to:			61	1		Progr	am Ou	itcome	s (PO	)	1	1		- 5	ogra	m ic
CLR-1:	Explain the Basic	c Concepts o	of IoT techno	blogy	100	1	1	2	3	4	5	6	7	8	9	10	11	12	Ou	itcom	ies
CLR-2:	Explore the statis	stical and ma	achin <mark>e learn</mark>	<mark>ing te</mark> chniques	2		je		of	s of	1	iety			ĸ		0				
CLR-3:	Incorporates the	machine lear	rni <mark>ng algori</mark> t	hm on IoT applicat	ions	10000	wledo		ent c	ations	ge	soc		-	oW n		Jance	ŋ		l	
CLR-4:	Analyse the tech	niques of dat	t <mark>a analytic</mark> s	201			You Y	lysis	mdo	stig	Usa	anc	~~~		ean	uo	Ē	arnin		l	
CLR-5:	Create data anal	ytics based l	loT applicati	ons			eering !	em Ana	n/devel	ict inve ex prob	n Tool	ngineer	nment		lual & T	nunicati	t Mgt. 8	ong Lea	_		~
Course C	outcomes (CO):	4	At the end o	of this course, lea	rners will be	able to:	Engin	Proble	Design	Condu	Mode	The e	Enviro	Ethics	ndivic	Comm	Projec	Life Lo	-OSc	-OSc	S-OSc
CO-1:	Express the basi	c conce <mark>pts o</mark>	o <mark>f IoT</mark> , simula	ation and estimation	n techniques	A	3	2	-	-	-		-	-	-	-	-	-	3	-	-
CO-2:	Analyse the Stati	istical an <mark>d m</mark> a	achine learr	ning techniques for	IoT	A 10025 3	2	3	12	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Evaluate the app	lications of n	<mark>mach</mark> ine lea	rning techniques fo	r loT		12		3	-	-	-	-	-	-	-	-	-	-	3	-
CO-4:	Apply the data a	nalytics <mark>techr</mark>	niqu <mark>es on l</mark> a	σT	Sec. 1			-	3	-	-		-	-	-	-		-	3	-	-
CO-5:	Incorporate the D	Data ana <mark>lytics</mark>	<mark>s on l</mark> oT app	olications				-	3	-	-	-	-	-	-	-	-	-	-	3	-
11-14 4 1				2	Central																
The inter	ntroduction to lo l	nnlication do	mains IoT	reference model	Porformanco	evaluation and modelling o	f InT syst	ome l	oT Arc	hitoctu	n Dis	croto_c	wont s	imulati	on tec	hniquo	for lo	T - Ro	cortific	9 Sation	of lot
devices: a	a simple model, Red	certification o	of IoT device	es: a more complex	model, Gener	rating random numbers, Sim	ulation de	signs, i	Estima	tion tec	c, bis	es, Vali	idation	of a sir	nulatio	n mode	əl	1 110	Jonano	anon	01 101
Unit-2 - S	tatistical and Mac	hine Learnin	n <mark>g Techn</mark> iq	ues for loT				<u> </u>		14	17									g	Hour
Multivaria	ble linear regressio	n, Time serie	es, <mark>Principal</mark>	Component Analys	sis (PCA), Hie	erarchical clustering, k-mear	ns algorith	m, nai	ve baye	es clas	sifier, S	Suppor	t Vecto	or Mac	hines,	Hidder	n Marko	ov Mod	lels, D	igital	Twins.
Unit-3 - N	lachine Learning 1	Techniques	Case Stud	ies			100				125	_								9	Hour
Outliner a	nd fraud detection	using k meai	ans, fault de	tection using PCA,	market analy	rsis using linear regressing,	weather	foreca	sting us	sing tir	ne seri	es, fac	e dete	ction u	ising S	SVM, p	asseng	er trav	el patt	tern u	sing k
Inearest n	eignbour, smart agn ata Analytics Tecl	iculture using h <b>nologies</b>	g haive baye	25				1.0	-				-							g	How
Data Ana	lvsis and Machine L	earning Effo	ort in Health	care. Data Analvtic	s and Predict	ive Analvtics in the Era of B	Big Data, F	Risk M	odellind	and L	Data So	cience.	Hadoo	oo Tec	hnoloc	av					noui
Unit-5 - lo	T/Data Analytics	Case Studie	es	,						,						,,				g	Hour
Defragme Monitoring	nting Intelligent Tra	ansportation,	Connected	l and A <mark>utonomous</mark>	Vehicles, Sr	mart Home Services Using	the Inter	net of	Things	, Emo	ional I	nsight	s via V	Vearab	oles, H	lome H	lealthc	are an	d Ren	note F	Patien

	1	An Introduction to IoT Analytics, Harry G. Perros, 1st edition, CRC Press, Taylor &	3	Internet of Thoings and Analytics Handbook, edited by Hwaiyu Geng, Wiley, 2017	
Learning		Francis Group, 2021.	4	Research articles on data analytics/Machine learning for IoT.	
Resources	2	2 Data Science for IoT Engineers: A Systems Analytics Approach, P. G. Madhavan,			
		Mercury Learning and Information, 2022			

			Continuous Learning A	Sum	mativo					
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (10	Learning A-2 )%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		10%		15%	-			
Level 2	Understand	15%		10%		15%	-			
Level 3	Apply	20%	A Carlotter Server	20%		25%	-			
Level 4	Analyze	20%		20%		25%	-			
Level 5	Evaluate	15%		20%	-	20%	-			
Level 6	Create	15%	and the second second	20%		-	-			
	Total	10	0%	100	)%	10	0%			

Course Designers		
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1 Mr. Baraneedhara Karthikevan, Director, Skylim Infotech Pyt Ptd	1 Dr. Bhuvaneshwari, Professor, MIT, Anna University, Chennai	1 Dr.S. Kavalvizhi, SRMIST



Course Code	21ECE474T	ECE474T Course BIG DATA ANALYTICS TOOLS			C	course atego	e ry	E			PROF	ESSIO	NAL E	LECT	IVE		l	- T 3 0	P 0	C 3	
Pre-requi Course	site s	Nil	Co- Cou	requisite urse <mark>s</mark>	Nil		Pro	ogress ourse	sive es						Nil						
Course	Offering Departmo	ent	ECE		Data Book / Codes / S	Standards								Nil							
Course Le	arning Rationale	(CLR):	The purpose of lear	nina this cou	rse is to:		-		1		Progr	am Ou	tcome	s (PO)	)				P	rogra	m
CI R-1:	Gain knowledge	about the v	various tools and tech	niques used in	big data analytics		1	2	3	4	5	6	7	8	9	10	11	12	S	pecifi	C
	Loorn the funder	nontale of L	Hadoon and the relate					-	Ū	of	Ŭ	ty •		Ū		10		12	01	tcom	es
CLR-2.							adge		nt of	suc		ocie			Vork		nce				
CLR-3:				luons using Ma	pReduce, HDFS, Pig, Hive		owle	N.	mer	gatic ms	sage	s pu			am /	_	-ina	ing			
CLR-4:	Learn the basics	of Apache	Spark, Flink and und	erstand the im	portance of NoSQL databases		g Kn	alys	elop	vesti oble	ol U	er a	nt & itv		Τe	atior	t. & I	earr			
CLR-5:	Learn about Ente	erprise Data	a Science and data vi	isualization too	ls		erin	M M	/dev	ct in ex pr	n To	Igine	nmel		ual 8	unic	t Mg	ng L			
Course Or			At the and of this a		ra will be able to:	100	igine	oble	sign	uple mple	oder	e er	Ivirol Istaii	hics	divid	mma	ojeci	e Lo	SO-1	30-2	SO-3
	licomes (CO).		At the end of this c		is will be able to.		ш	P L	Å S	<u> </u>	ž	È	ц N	Ш	Ĕ	ŏ	Ъ	Ë	ď	ъ С	ď
CO-1:	Use the various t	ools and te	ecnniques in big data	analytics	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	241	3	3	-	2	-	-	-	-	-	-	-	-	-	2	-
CO-2:	Implement Hadoo	op and r <mark>ela</mark>	ated technologies to b	ig data analytic	CS		3	3	-	2	-	1	1	-	-	-	-	-	-	-	-
CO-3:	Construct big dat	ta applic <mark>atio</mark>	on using MapReduce	, HDFS, <mark>Pig</mark> , H	live		3	3	-	2	-	-	-	-	-	-	-	-	2	-	3
CO-4:	Apply Apache Sp	oark and <mark>Fli</mark>	<mark>link to</mark> applications an	d NoSQL datal	bases	12	3	-	3	-	2	1	-	-	-	-	-	-	2	3	-
CO-5:	Understand the a	applicatio <mark>ns</mark>	<mark>s of Ent</mark> erprise Data S	Science and da	ta visualization tools	1.1	3	3	3	-	2	200	-	-	-	-	-	-	-	3	-
Unit-1 - Bi	g Data Overview					12						£								9	Hour
Overview o	of Big Data Analytic	s- Introduc	ction to data analytics	and big data- I	Big Data Mining- Technical eleme	ents of the	Big D	ata pla	atform-	- Analy	tics To	olkit, (	Compon	nents c	of the D	Distribu	ted and	d Paral	lel Co	mputii	าg for
Unit-2 - Ha	adoop and YARN	ouu compu	iling and big Data- in-	-memory Comp	outing rechnology for big Data- r	пацоор Ес	USYSI	em- n	ne core	e mouu	les of	пацос	p							9	Hour
Introduction	n to Hadoop-Mapr	reduce -Sc	calin <mark>g Out-Dat</mark> a flow,	Combiner Fu	nctions -Hadoop Streaming -HL	DFS-Hado	op file	syste	ms-Intr	roductio	on to	YARN	YARN	I-Job	Sched	uling -	Hadoo	op I/O	-Data	Integ	grity -
Compressi	on - Serialization -	File based	l Dat <mark>a Structure</mark> s - De	veloping a Ma	preduce Application	100					15	_									
Unit-3 - Pi	g and Hive	of Dia Latin	n Introduction to Lliv	o Inotalling or	ad muching the Introduction to	Ulive OL 1	ntro di	ation	10 700	kaana	. In at		and mus	nin a T	7		ha 7a			9 // /	Hour
Architectur	n lo Pig - Basics ( e	or Pig Laur	n- introduction to Hiv	e- installing ar	ia running Hive- introduction to	HIVEQL- I	ntroau	ICLION	10 200	кеере	- msta	aming a	ana run	ning z	lookee	per- T	ne zoc	жеере	r Serv	ice- r	·iume
Unit-4 - N	oSQL						_													9	Hour
Introductio	n to Sqoop- Introd	lucing Ooz	zie- Apache Spark- <mark>lir</mark>	nitatations of H	adoop and overcoming the limit	itations- In	troduc	tion to	o Apac	he Flin	ik- Bat	ch ana	alytics u	using l	Flink- I	Installir	ng Flink	k- Big I	Data N	/lining	with
NoSQL- N	hy NoSQL? NoSQ ata Visualization	)L databasi Tools	es- Introduction to HE	Base- Introduct	ion to MongoDB, Cassandra															0	Hour
Enterprise	Data Science Ove	erview- Dat	ta Science Solutions i	in the enterpris	e- Enterprise data science – Ma	chine Lear	ning a	and Al	I- Ente	rprise I	nfrastr	ucture	solutio	ns- Vi	sualizi	ng Big	Data-	Using I	Pythor	and	R for
visualizatio	on- Big Data Visual	lization Too	ols- Data Visualization	n with Tableau-	Case Studies: Spark- Case Stu	dies: NoSo	ΩL					-				5 0		5			

Learning	1	Tom White, Hadoop: The Definitive Guide, 3rd Edition, O'Reilly, 2012.	3	Nataraj Dasgupta, Practical Big Data Analytics, Packt, 2018.
Resources	2	Sridhar Alla,Big Data Analytics with Hadoop3,Packt,2018	4	DT Editorial Services, Big Data Black Book, 2016.

Learning Assessn	nent											
			Continuous Learnin	g Assessment (CLA)		Summotivo						
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (10	g Learning _A-2 0%)	Final Examination (40% weightage)						
		Theory	Practice	Theory	Practice	Theory	Practice					
Level 1	Remember	15%		15%		15%	-					
Level 2	Understand	25%	10.000	20%	- 10	25%	-					
Level 3	Apply	30%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	25%		30%	-					
Level 4	Analyze	30%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	25%		30%	-					
Level 5	Evaluate	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	and the second second	10%		-	-					
Level 6	Create	· · · · ·		5%			-					
	Total	10	0%	10	0 %	10	0 %					

Course Designers	1 mar 1		a for
Experts from Industry	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Experts from Higher Technical Institutions	Internal Experts
1 Mr.Baraneedhara Karthikeyan, Directo	r, Skylim Infotech Pvt Ptd	1 Dr. Bhuvaneshwari, Professor, Mit, Anna University, Chennai	1 Mr. Maria Dominic Savio.M, SRMIST



Course Code	ourse Code         21ECE475T         Course Name         TOOLS FOR REAL-TIME DATA PROCESSING AND ANALYTICS		S C	cours atego	e ory	Е			PROF	ESSIO	NAL E	LECT	IVE		l	. T 3 0	P 0	C 3			
Pre-requ Course	isite es	Nil		Co- requisite Course <mark>s</mark>	Nil		Pro	ogres Cours	sive es						Nil						
Course	Offering Departme	ent		ECE	Data Book / Codes / Star	ndards								Nil							
Course Le	earning Rationale	(CLR): T	The purpose	<mark>of learnin</mark> g this c	ourse is to:		-	Č.	A	1.1	Progra	am Ou	itcome	s (PO	)				P	rogra	m
CLR-1: Create foundation innovative real-time data processing solutions.						1	2	3	4	5	6	7	8	9	10	11	12	S Ou	peciti itcom	iC 1es	
CLR-2:	Handle large am	ount of data i	in re <mark>al time u</mark>	using Apache Storr	n.		Φ	-	÷	of	3	ety			¥						
CLR-3:	Learn real time s	tream proces	ssi <mark>ng.</mark>		A 1998	10	ledg		ent o	tions	Je	soci			Vor		ance	5			
CLR-4:	Build storages se	rvices and a	analytics tools	s			Non	lysis	bmqo	stiga	Usaç	and	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		eam	и	k Fin	ming			
CLR-5:	Deploy AI and Io	T application	n in real time	hardware platform			eering h	em Anal	n/devel	uct inve ex prob	'n Tool	ngineer	nment inability		lual & T	nunicati	t Mgt. 8	ong Lea			~
Course O	utcomes (CO):	4	At the end o	f this course, lear	ners will be able to:	17	Engin	Proble	Design	Condu	Mode	The e	Envirc	Ethics	Individ	Comr	Projec	Life Lo	OSd	PSO-2	-OS4
CO-1:	Analyze large an	ounts o <mark>f dat</mark>	t <mark>a in r</mark> eal-time	9	A STATE OF A STATE OF A	4	3	1	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-2:	Develop storm cl	uster an <mark>d sto</mark>	orm topology	for real time data			1	1	2	-	3	-0	-	-	-	-	-	-	-	-	-
CO-3:	Process real time	e data in <mark> Azu</mark>	ire				2	1.	2	-	3	- 20	-	-		-	-	-	-	-	-
CO-4:	Implement storag	le servic <mark>es a</mark>	and analytics	tools for results		12	Print and	2	1	-	3	-	-	-	-	-	-	-	-	-	-
CO-5:	Write program or	n NVIDIA <mark>Jet</mark> s	t <mark>son N</mark> ano					3	1.1	- 1	-	2	- 100	-	-	-	-	-	-	-	-
l Init-1 - In	troduction to Rea	I-Time Data	Processing		Color of the second			ėR.				-								0	Hour
Overview	of real-time data p	rocessing, C	Characteristic	s of real-time data	, Use cases for real-time data process	sing, re	al tim	e data	a proce	essing t	ools, I	ntrodu	cing th	e Big	Data 1	echno	logy La	andsca	pe an	d Ana	alytics
Platform,	pache Storm									-	1										Hour
Getting Ac Storm Clu	equainted with Storr ster, Introduction to	n, Storm arci Trident and	hit <mark>ecture and</mark> Optimizing S	l its components, F <mark>Sto</mark> rm Performance	low and when to use Storm, Processin	ng Data	with S	Storm,	Settin	g Up S	torm o	n a Sii	ngl <mark>e M</mark> a	achine	, Settin	ig Up a	Storm	Cluste	ər, Moi	nitorin	ig the
Unit-3 -Mi	crosoft Azure Bas	ics	1 0		to that A will	11				100	120									9	Hour
Enterprise	Analytics Fundame	entals, Gettin	ng Data into /	Azure, Storing Inge	ested Data in Azure, Real-Time Proces	ssing in	Azure	e, Rea	l-Time	Micro-L	Batch F	Proces	sing in	Azure	, Batch	Proce	essing i	n Azur	е		
Unit-4 - St	torage services an	d Analytics	Tools	ing Lougs in Aruno	Intelligence and Machine Learning M	lononin	~ 1404	odata	in A=	no Dro	la atin a	Vaur	Data in	A =	Dourfo		Analiti	~~		9	Hour
Unit-5le	tson Nano	HOL AND CO	na Patri Serv	ing Layer in Azure,	intelligence and Machine Learning, M	lanagin	j met	auala	III AZU	re, Pro	ecung	YOUR	Dala In	Azure	, Penc	inning .	Anaiyu	cs		9	Hour
Introduction Programm	n to NVIDIA Jetsor ing, NVIDIA Jetsor	Nano, NVIE Nano I/O Pi	DIA Jetson N Programming,	lano Hardware Spe NVIDIA Jetson Ne	cifications What Can We Do with NVIL no Camera, Deep-Learning Computat	DIA Jets tion	son N	ano?,	Settin	g Up ar	nd Run	ning, A	Adminis	stering	NVIDI	A Jetso	on Nan	o, NVI	DIA Je	ətson	Nano

Learning	1	Sumit Gupta, Shilpi Saxena, "Real-Time Big Data Analytics", Packt publishing, 2016.	3	Zoiner Tejada, " Mastering Azure Analytics ", O'Reilly Media, 2017
Deseuress	2	Ankit Jain, Anand Nalya, "Learning Storm: Create real-time stream processing applications	4	Agus Kurniawan, " IoT Projects with NVIDIA Jetson Nano AI-Enabled Internet of Things
Resources		with Apache Storm", Packt publishing, 2014.		Projects for Beginners ", Apress, 2021.

Learning Assessme	ent			2-21C						
			C	motivo						
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native age of unit test 0%)	Life-Lon Cl (1	g Learning LA-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%	A REAL PROPERTY AND A REAL	15%		15%	-			
Level 2	Understand	25%		20%		25%	-			
Level 3	Apply	30%		25%	1.00	30%	-			
Level 4	Analyze	30%	and the second second	25%		30%	-			
Level 5	Evaluate	State - 199	1.2.	10%			-			
Level 6	evel 6 Create			5%		-	-			
	Total	10	0%	10	00 %	10	0 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1 Mr. Baraneedhara Karthikevan, Director, Skylim Infotech Pyt Ptd	1 Dr. Bhuvaneshwari, Professor, MIT, Anna University, Chennai	1 Mr. Joshua Jaferson A. SRMIST



Course Code	21ECE476T	Course Name	DATA ANALYTICS WI	TH SPARK USING PYTHON	Ca Ca	Course Category E					PROF	ESSIO	NAL E	ELECT	IVE		l	- T 3 0	P 0	C 3
Pre-requ Cours	isite es	Nil	Co- requisite Courses	Nil		Progr Cou	essi Irses	ive s						Nil						
Course	Offering Departme	ent	ECE	Data Book / Codes / Sta	andards								Nil							
Course L	earning Rationale	(CLR): <i>TI</i>	he purpo <mark>se of learnin</mark> g this cou	ırse is to:		1		1		Progra	am Ou	itcome	s (PO	)				Р	rogra	m
CLR-1:	Learn the overvie	w of the big o	data ecosystem including the ger	nesis and evolution of the spark		1 2	2	3	4	5	6	7	8	9	10	11	12	0 0	itcom	es
CLR-2:	Construct the bas	sic programm	ing <mark>building blo</mark> cks of Spark usin	g RDDs		Φ		<del>т</del>	of	1	ety			¥						
CLR-3: Explore the advanced constructs to program using Spark core API				66	wledg		ent o	ations	ge	soci			IOW L		lance	D		l		
CLR-4:	Analyze the Vario	ous Spark op	timization techniques		Sec. 1	Xuo	iysis	udo	stiga	Usa	anc	<u>م</u>		Lean	ы	S Ei	arnin		1	
CLR-5:     Implement the integration of Spark and SQL						sering		n/devel	ct inve ex prot	n Tool	gineer	nment		ual & T	unicati	t Mgt. a	ng Lea			_
Course O	utcomes (CO):	A	t the end of this course, learne	ers will be able to:	197	Engine		Design solutio	Condu compl	Moder	The er	Enviro Sustai	Ethics	Individ	Comm	Projec	Life Lo	PSO-1	PSO-2	PSO-3
CO-1:	Express the big d	lata eco <mark>syste</mark>	m especially Spark	A liter bure is	4.24	- 0	2	-	3	t.		-	-	-	-	-	2	-	-	3
CO-2:	Generate basic p	rogram <mark>ming</mark> .	building blocks of Spark using R	DDs		- 2	2	3	-	-		-	-	-	-	-	-	3	-	-
CO-3:	Develop advance	d progr <mark>ams l</mark>	using Spark core API			5	2	3	-	-	-	-	-	-	-	-	-	3	-	-
CO-4:	Analyze the appli	cation a <mark>nd va</mark>	a <mark>rio</mark> us optimization techniques of	Spark	12		3	3	-	-		-	-	-	-	-	-	2	-	-
CO-5:	Implement integra	ation of <mark>Spar</mark> l	<mark>k and</mark> Structured Query Languag	e	1.15	-	3	3	3	-		- 14	-	-	-	-	-	-	-	2
Unit-1 - Ir	troducing Big Dat	a, Hadoo <mark>p, a</mark>	and Spark	design of the second	2					1	£				•	•		•	9	Hour
Introduction Input/Output/O	on to Big Data, Distri out Types for Spark n	buted Compl Applications	uting, and Hadoop - Introduction - The Spark RDD - Functional I	to Apache Spark : Apache Spark Ba Programming Using Python: Data S	ackground Structures	d - Uses - Pytho	s for S on Ol	Spark bject	( - Prog Seriali	rammi zation ·	ng Inte - Pyth	erfaces on Fun	to Spa ctional	ark - Si Progr	ıbmiss ammin	ion Tyj g Basi	pes for cs - Ar	Spark natomy	Progi / ofa \$	rams- Spark
Unit-2 - P	rogramming with F	RDDs	1	2					7	- 7									9	Hour
Loading D	ata into RDDs: Cre	ating an RDL	D from a File - Methods for Crea	ting RDDs - Creating an RDD from	an Obje	ct File, I	Data	Sour	rce and	Progr	amma	tically -	Operation	ations	on RD	Ds: RL	DD Trai	nsforn	nation	s and
Actions -	ransformations on i	PairRDDs, S mina Llsina i	ets and Numeric RDDs - Join Tra the Spark Core API	anstormations - Joining Datasets in	Spark			-		1										Hour
Shared Va	ariables in Spark: Bro	padcast Varia	ables and Accumulators - Partition	ning Data in Spark : Controlling Parti	itions, Re	partitior	ning F	Funct	ions - F	DD St	orage	Options	s : RDI	D Cacł	ning, Pe	ersistin	g RDD	s - Ch	eckpo	inting
RDDs - Da	ata Sampling with S	park																		
Unit-4 - S	park Application a	nd Optimiza	tion	ng Spork: Filtor Forky Filtor Offen (	Datimizina	. 10000	loti vo	000	rotiona	Undo	rotono	ling the	Impor	tofEu	notion	and	Noouro	. Cor	<b>9</b>	Hour
for Collect	ing Data. Avoiding I	nefficient Pa	rtitioning. Diagnosin <mark>g Application</mark>	Performance Issues	punnizing	ASSOCI	alive	e Ope	rations	Unde	rstanu	ing the	тпрас	:l 01 Fu	ncuons	s anu C	losure	s, con	Sidera	wons
Unit-5 - S	park SQL																		9	Hour
Architectu Learning v	re - Getting Started vith Spark	with DataFra	ames - Using DataFrames - C <mark>acl</mark>	hing <mark>,</mark> Persisting, and Repartitioning	DataFrar	nes - S	aving	g Data	aFrame	Outpu	ut - Ac	cessing	g Spar	k SQL	- Usin	g Spar	k with I	HBase	) - Ma	chine

Learning	1	Data Analytics with Spark Using Python, by Jeffrey Aven, Released June 2018, First	2	Learning Spark by Holden Karau, Andy Konwinski, Patrick Wendell, and Matei Zaharia, Published
Desources		edition Addison- Wesley Professional		by O'Reilly Media,2015
Resources			3	Spark: The Definitive Guide by Bill Chambers and Matei Zaharia, 2018, Published by O'Reilly Media

<u>u</u>				Summative						
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Lon Cl (1	g Learn <mark>ing</mark> LA-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		15%		15%	-			
Level 2	Understand	25%		20%		25%	-			
Level 3	Apply	30%		35%		30%	-			
Level 4	Analyze	30%	A Real Provession	35%		30%	-			
Level 5	Evaluate	ST			and the second second		-			
Level 6	Create			San States		-	-			
	Total	10	0%	10	0%	10	0%			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1 Ms. Roshni Rajan, SDE II, Amazon, US.		1 Dr. E. Chitra, SRMIST
2 Mr. S. Ashish, Software Engineer, TCS – Digital, Chennai		



Course Code	21ECE477T	Course Name	BIG DATA AND HEAL	TH CARE ANALYTICS	Cours Catego	se ory	Е		F	PROF	ESSIO	NAL E	ELECT	IVE		l	- T 3 0	P 0	C 3
Pre-requis Course	site s	Nil	Co- requisite Courses	Nil	Pr	ogres Cours	sive es						Nil						
Course C	Offering Departme	nt	ECE	Data Book / Codes / Standa	rds							Nil							
Course Le	arning Rationale (	CLR): Tł	he purpose of learning this course	e is to:	Program Outcomes (PO)									Program		n			
CLR-1:	Provide basic insi	ght on Big da	ata an <mark>alytics in hea</mark> lth care	10 200	1	2	3	4	5	6	7	8	9	10	11	12	S Ou	pecifi	C es
CLR-2:	Gain knowledge a	about the var	ious data sources in health care ana	alytics	Φ		+	of	3	ety			¥						
CLR-3:	Learn the concept	ts of data mi	ning techniques in health care	1000	ledg		ent o	tions	ge	soci			Wor		ance	-			
CLR-4:	Understand the co	oncepts of a	dvanced data analytic tools in Health	n care	Non	ysis	bme	stiga	Usaç	and	৵		eam	ы	Fin	ming			
CLR-5:	Explore big data a	analytics for o	disease diagnosis	and Soliday in	ering h	n Anal	/develo	ct inve x prob	Tool	gineer	iment ability		al & T	unicatio	Mgt. 8	ng Lea			
Course Ou	tcomes (CO):	A	t the end of this course, learners	will be able to:	Engine	Probler	Design	Conduc	Moderr	The en	Enviror Sustair	Ethics	ndividu	Commu	Project	life Loi	-SO-1	-SO-2	-SO-3
CO-1:	Apply the basic co	oncepts of bi	g data analytics in health care	ALL ALL ALL ALL	3	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-2:	Incorporate variou	us data <mark>sourc</mark>	ces in health care analytics	the second of	3		12	-	-	-	<u> </u>	-	-	-	-	3	-	-	-
CO-3:	Implement the me	thods of dat	a mining techniques in health care		3		1	_	-	- 10	-	-		-	-	2	-	-	-
CO-4:	Express the conce	ept of a <mark>dvan</mark>	ced data analytic tools in Health car	е	1.14	3		-	-	-	-	-	-	-	-	3	-	-	-
CO-5:	Analyze disease u	using data ar	nalytic mechanism and standard		1023	3	1.1	-	-	2	-	-	-	-	-	3	-	-	-
	-		2. 4							-									
Unit-1 - Big	g Data Analytics fo	or Health <mark>ca</mark>	re							1								9	Hour
Data type, Characteristics of big data in health care, Analytical tools in health care: Hadoop distribution file system, MapReduce, Hive, Pig and Pig Latin, Zookeeper, Hbase, Need of big data in therapeutic intervention, Biological data capturing and processing: Architectural framework, data modeling, Maintaining of threshold quality of data, Interpretation of processed of clinical data: Qualitative approach, Quantitative approach, Patient data modeling, Maintaining of threshold quality of data, Interpretation of processed of clinical data: Qualitative approach, Quantitative approach, Patient data modeling, Maintaining of threshold quality of data, Interpretation of processed of clinical data: Qualitative approach, Quantitative approach, Patient data modeling, Maintaining of threshold quality of data, Interpretation of processed of clinical data: Qualitative approach, Quantitative approach, Patient data modeling, Maintaining of threshold quality of data, Interpretation of processed of clinical data: Qualitative approach, Quantitative approach, Patient data modeling, Maintaining of threshold quality of data, Interpretation of processed of clinical data: Qualitative approach, Quantitative approach, Patient data modeling, Maintaining of threshold quality of data, Interpretation of processed of clinical data: Qualitative approach, Quantitative approach, Patient data modeling, Maintaining of threshold quality of data, Interpretation of processed of clinical data.																			
Unit-2 - He	alth Care Data So	urce and Ba	asic Analytics						1									9	Hour
Health care	e data sources, Adv	anced data a	analytics for health care, Application	s and practical systems for health ca	re, Histor	y of Eł	HR, Co	mponer	nts of E	HR,C	oding s	system	: ICD,	CPT, S	SNOME	ED-CT,	LOIN	C, Rxl	Vorm
ICF, DRG,	UMLS, DICOM, Be	nefits of HEI	R, Challenges of using EHR data, P	henotyping algorithm	1.0				2										
Unit-3- Min	ning of Sensor Dat	a in Health	care	A CONTRACTOR OF THE OWNER	100		2.4											9	Hour
Mining sens Rule based	sor data in Medical I approaches, Patte	Informatics, ern based alg	Challeng <mark>es in Health</mark> Care data ana jorithms, Machine learning algorithn	lysis, Sensor data mining application: 1, Clinical text Corpora and Evaluatio	s, Noncli n Metrics	nical h s, Chai	ealth c llenges	are app of Proc	lication cessing	is, Mir clinic	<mark>ning info</mark> al repo	ormati orts, cli	on fron inical a	n clinic pplicat	al text, ions.	Currer	nt Meth	iodolo	gies:
Unit-4 - Ad	lvanced Data Anal	ytics for He	alth Care	· · · · ·		,	Ū					Ĺ						9 /	Hour
Statistical F	Prediction models : I	Linear Regre	ssion, Generalized addictive model,	Logistic Regression, Bayesian mode	el, Advan	ced Pr	ediction	n model	s: Multi	iple In	stance	learni	ng,Rei	nforcer	ment le	arning,	Spars	se met	hods
. Kernal me	ethods, Survival mo	dels, Evalua	tion and Validation																

# Unit-5 - Disease Diagnosis using Cloud Computing and Artificial Intelligence in Health Care Analytics

Big data respiratory in health care, Management and analysis of bigdata in healthcare, commercial platform for healthcare data analytics, Mathematical model of infectious disease and their development: SIR, SEIR, Agent based model, system architecture design and predictive analytics using machine learning, Electronic health records, Healthcare data management and its limitations: Data interoperability, data quality, data linsecurity, policy setting, theoretical framework, case study to predict skin cancer using big data analytics and AI techniques

	1	Peter Ghavami, "Big Dta Analytics Method", Walter de Gruyter Inc, 2nd Edition, 2020	4	Dietrich, D., Heller, B., & Yang, B., "Data science & big data analytics: discovering, analyzing,
Learning	2	Pantea Keikhosrokiani, "Big data Analytics for Health care: Data sets, Techniques, Life		visualizing and presenting data", Wiley, 2015.
Resources		cycles, Management, and Applications, Elsevier, 2022.	5	Nataraj Dasgupta, Practical Big Data Analytics, Packt, 2018.
	3	Chandan K.Reddy, Charu C. Agarwal, "Health care and data analytics", CRS Press, 2015		

Learning Assessm	nent		and the second sec					
	Continuous Learning Assessment (CLA)						Summotivo	
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)		Final Examination (40% weightage)		
		Theory	Practice	Theory	Practice	Theory	Practice	
Level 1	Remember	20%		15%		20%	-	
Level 2	Understand	20%		20%		<mark>2</mark> 0%	-	
Level 3	Apply	25%	to base to	25%		25%	-	
Level 4	Analyze	35%	The second second	25%		35%	-	
Level 5	Evaluate	1 Die 1 Die 1	10 C	10%		- 10	-	
Level 6	Create			5%		-	-	
	Total	10	0%	10	0 %	10	0%	

Course Designers								
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts						
1 Mr. Baraneedhara Karthikeyan, Director, Skylim Infotech Pvt Ptd	1 Dr. Bhuvaneshwari, Professor, MIT, Anna University, Chennai	1 Dr. T. Rajalakshmi, SRMIST						



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**Regulations 2021** 

Volume - 14D (Syllabi for Elctronics Engineering (VLSI Design and Technology )Programme Courses)



### SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

# ACADEMIC CURRICULA

Professional Elective Courses

**Regulations 2021** 



### SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code         21ECE260T         Course Name         INDUSTRIAL ELECTRONICS					Cat	Course Category         E         PROFESSIONAL ELECTIVE         L         T           3         0								P 0	C 3					
Pre-requis Course	site s	Nil	Co- requisite Courses	Nil		Prog Co	ress urse	sive s						Nil						
Course C	Offering Departme	ent	ECE	Data Book / Codes / S	Standards								Nil							
Course Le	arning Rationale	(CLR): T	he purpose of learning this cour	se is to:		17	1	X		Progra	am Ou	Itcome	s (PO)	)				Pi	rogra	m
CLR-1:	Know the basic c	omponents	of industrial electronics	Nº Sector		1	2	3	4	5	6	7	8	9	10	11	12	S Ou	peciti	c
CLR-2:	Understand the b	lock diagrar	m and working principle of rectifiers	5		e		<u>ب</u>	s of	2.	ety			¥						
CLR-3:	Understand the w	vorking princ	cip <mark>le of chopp</mark> ers and applications		5.7 6	ledç		ento	tions	e	soc		-	Wo		ance	0			
CLR-4:	Apply the compo	nents for sw	vitching applications			Nou	ysis	bmdc	stiga	Usa	and	<u>م</u> م		eam	E	Fin	rnin			
CLR-5:	Implement the dir	fferent devic	es in industrial electronics	1		bui	Anal	evelo	inve: prob	00	neer	hent a		I & T	icatio	lgt. 8	Lea			
	,		and the second second		-	neer	em	b/ug	duct	Lue	engi	onn aina	ş	idua	unu	sct I∕	-ong	-	-2	ς.
Course Ou	tcomes (CO):	4	At the end of this course, learner	s will be able to:	10. 2X	Engi	Prob	Desi	Conc	Mode	The	Envii Sust	Ethio	ndiv	Com	Proje	Life	PSO	DSG	PSO
CO-1:	Define types of s	emicon <mark>ducto</mark>	or devices for industrial application	S	54.24	2	2	1	- 1			-	-	-	-	-	-	2	-	-
CO-2:	Examine the wor	king pri <mark>ncipl</mark>	le and construction of rectifiers	ter an		3	-	1	-	-		-	-	-	-	-	-	1	-	-
CO-3:	Design the chopp	pers for indu	Istrial electronics	1.000		3	2	1	_	-	- 10	- 1	-	-	-	-	-	2	-	-
CO-4:	Analyze the work	ing prin <mark>ciple</mark>	e of analog and digital switches		200	14	2	3	-	-	2.	-	-	-	-	-	-	-	-	-
CO-5:	Illustrate the diffe	erent ap <mark>plica</mark>	tions of industrial electronics	1 - Tak - Tak	1115	3	-	14	3	-	1	-	-	-	-	-	-	-	-	-
Unit-1 - D PN junctio thyristors ( MOSEET	evices in Industri n, Transistors, BJ1 on alternating curre	<b>al Applicati</b> T, Mode of o ent, Diac, Tr	peration, MOSFET operation princ iac, Quadrac, Protection of Thyrist	iples, transistor devices in switc ors, Protection against Voltage	ching mode, Surges, Pro	Thyris	tors, 1 aga	Work ainst E	ing prin Direct O	ciple, l vercun	block o rents,	liagram MOS-C	n, Cont Control	trol of t	thyristo yristor,	ors on c The P	lirect ci ower T	urrent, Transis	<b>9</b> Cont stor, F	Hour trol of ower
Unit-2 - C	ontrolled Rectifie	rs	11 11		1				-	1									9	Hour
Single-Pha	ase Rectifiers, Sing	gle-Phase, F	Full- <mark>Wave Circu</mark> it with Centre-Tapp	ed Secondary, Single-Phase, F	Full-Wave Br	ridge F	Rectif	fiers, T	Three - F	hase H	Rectifie	ers, Thi	<mark>ee -</mark> Ph	ase H	alf-Wa	ve Con	trolled	Rectif	ïer, Tl	hree -
Phase, Fu	II-Wave Rectifiers,	Rectifier Efi	ficienc <mark>y and Dera</mark> ting Factor of Rec	ctifier Transformers, Dual Conve	erters		-	-		1										Haur
Introductio	n Principle of a D(	Chonner S	Sten-down and Sten-un Chonners	Sten-down Chopper Analysis w	vith DC Moto	or Load	I Ste	מוו-מי	Chonne	r Cho	nners	Based	on the	Quad	rants o	f Onera	ation S	econo	9 I 1-0ua	drant
Chopper,	Two-Quadrant Cho	opper, Four-	Quadrant Chopper, Speed Control	of a Chopper-Controlled DC Se	eries Motor, I	Morga	n Ch	opper	, Applic	ations	, Adva	ntages	and D	rawba	cks of	DC Ch	oppers	000110	Quu	urun
Unit-4 - Si	witching and Pow	er Supply																	9	Hour
Switching	Devices, Generato	ors, Multivibr	rators, Pulse-Pairs, Timers, Logic E	Elements, Overcurrent and Over	rvoltage Prot	tection	Moo	dules,	Voltage	, Stabi	lizers	and Re	gulato	rs, Oth	ner Fur	nctional	Modul	les for	Autor	matic
Devices, C	Iniversal Overcurre	ent Protectiv	e Relay, Universal Overcurrent Pro	btective Relay, Improvement of I	Microproces	sor-Ba	ased	Protec	ctive Re	lays									0	Hour
Introductio Heating, P	n, Uninterruptible I Principle of Inductio	Power Supp n Heating, V	lies Batteries, Inverters, Rectifiers, /oltage Source versus Current Sou	High-Voltage DC Transmission rce Inverters, Practical Circuit fo	n, Twelve-Pu	ılse Lir Heatin	ne Fr g. W	requer lelding	ncy Cor I. Typic	verter. al SMF	s, Con PS Usi	trol of I ng a Fl	HVDC vback	Conve Chopp	erters, i ber	DC Ciro	cuit-Bre	eakers	s, Indu	iction

Le	earning	1.	V. R. Moorthi, "Power Electronics Devices, Circuits and Industrial Applications" Oxford University Press, 2005	2.	Vladimir Gurevich," Electronic Devices on Discrete Components for Industrial and Power Engineering" Taylor & Francis, 2008
Ne	5001005				

Learning Assess	ment											
			Continuous Learnin	g Assessment (CLA)		Cumon.	noti vo					
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ige of unit test 0%)	Life-Long CL (10	ı Learning A-2 1%)	Final Examination (40% weightage)						
		Theory	Practice	Theory	Practice	Theory	Practice					
Level 1	Remember	40%	-	40%	·	30%	-					
Level 2	Understand	40%		40%	1	40%	-					
Level 3	Apply	20%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	20%		30%	-					
Level 4	Analyze	2	and the state			-	-					
Level 5	Evaluate					-	-					
Level 6	Create			Contraction of the second	-	-	-					
	Total	10	0 %	10	0 %	100	) %					

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mr. Leela Krishan Thota, Sr.Solution Engineer, Synopsys	1. Dr. G. P. Mishra, Dept. of ECE, NIT Raipur	1. Dr. Soumyaranjan Routray, SRMIST	
	2. Dr. K. P. Pradhan, Dept of ECE, IIITDM Kanceepuram	2. Dr. Raiesh Agarwal, SRMIST	



Course Code	Course Code         21ECE261T         Course Name         MEASUREMENTS AND INSTRUMENTATION						ATION	C	Cours atego	e ry	Е			PROF	ESSIC	NAL E	LECT	IVE		L	- T 3 0	P 0	C 3		
Pre-requi	isite es	Nil		(	Co- requ Course	iisite s		N	Jil		Pro	ogres: Course	sive es						Nil						
Course	Offering Department				ECE			Data Book	( / Codes / Sta	Indards	1.							Nil							
Course Le	earning Rationale (Cl	LR): 1	The purpo	ose of	learning	y this co	ourse is to	D:			-	đ			Progr	am Ou	utcome	s (PO	)				P	rogra	m
CLR-1:	Outline the fundame	entals of r	me <mark>asurem</mark>	n <mark>ents a</mark>	and error	s	1.15	200			1	2	3	4	5	6	7	8	9	10	11	12	S OI	pecifi utcom	ces
CLR-2:	LR-2: Illustrate the basic of Electromechanical Instruments								Ð		+	of	3.	ety			¥								
CLR-3:	CLR-3: Introduce signal generating circuits							ledg		ent o	tions	e	soci			Mol		ance	5						
CLR-4:	Explain the working	of Oscillo	loscopes fo	or disp	playing si	gnals		127			Non	lysis	opme	stiga	Usaç	and	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		eam	ы	Fin	rning			
CLR-5:	Demonstrate the co	ncepts of	f Test Sys	tems v	which are	e comput	er control	lled		2	eering h	em Anal	n/devel	uct inve lex prob	m Tool	ngineer	onment inability		dual & T	nunicati	ct Mgt. 8	ong Lea	-	2	3
Course O	utcomes (CO):		At the en	d of th	his cour	se, learn	ners will k	be able to:	Anaro	197	Engin	roble	Desig	Condi	Aode	he e	Enviro	Ethics	ndivi	Comn	roje	ife L	-OS	-OS	-OS
CO-1:	Apply the various m	ethods of	f measure	ements	5			Sec. 6		11.1	3	2	-	-	-	1	-	-	-	-	-	-	1	-	-
CO-2:	Analyze electromec	hanic <mark>al a</mark>	and digital	indica	ting instr	uments	The second	S- 1	ALC: N		-	2	2	-	-	-	<u> </u>	-	-	-	-	-	1	-	-
CO-3:	Implement signal ge	enera <mark>tor a</mark>	and Analyz	zer	27		1.1.2	12.5.2.2	8.24			2		2	-	- 10	-	-		-	-	-	1	-	-
CO-4:	Acquire knowledge	on di <mark>ffere</mark>	ent types o	of oscii	lloscope	s and Da	ta Acquis	ition System	100	12	14	2	-		-			-	-	-	-	2	1	-	-
CO-5:	Utilize the concepts	of Comp	outer Contr	rolled	Test Sys	tems	1 E T	1.5		1	22	2	6.4	-	-		-	-	-	-	-	-	1	-	-
Unit-1 - M	easurements and Fr	rors		4			i di se		W.							-				·			<u> </u>	9	Hour
Accuracy,	Precision, Significant	Figures,	Types of I	Errors	, Statisti	cal Analy	/sis, Limiti	ing Errors - E	3ridge M <mark>easu</mark> re	ements	(AC a	nd DC	bridge	es), Bo	urdon	Tube,	Pressu	ire Ga	uge, a	nd Mea	asurerr	nent of	Flow.	Analy	sis of
Linear Sys	tems: Time Domain R	Response	e, Zero ord	ler and	I First or	der time	domain s	ystem, First C	Order response	e for Ste	р Іпрі	ıt, Raı	np Inpl	ut &Imp	oulse I	nput									
Unit-2 - El	ectromechanical and	d Digital	Indicating	g Insti	ruments	unt Typo	Ohmmot	or Altornatin	na Curront India	ootina In	otrum	onte (	Movino	lron in	strum	onte o	loctrod	mamo	motor	instrur	nont)	D/A an		9 Conve	Hour
Digital Volu	tmeters. Vector Voltme	eter. Gua	ardina Tec	chniaue	es. Autor	nation in	Voltmete	er - Alternatin Pr	ly current inuic	Jauny In	Sirum	ents (I	vioving	1101111	Suum	enio, e	ieciiou	, namo	meter	monum	ienų -	DIA all	u AvD	COINE	11013
Unit-3 - Si	gnal Generation and	l Analysi	is			201		1.16	A ASSAULT	111				1.1	100	-								9	Hour
Sine Wave	Generator, Sweep Fr	requency	/ Generato	o <mark>r, Puls</mark>	<mark>se and</mark> S	quare wa	ave Gener	rator - Functio	on Generator A	Analyzer	, Wav	re Ana	lyzer, L	Distorti	on Ana	alyz <mark>er</mark> ·	- Harmo	onic Di	stortio	n Analy	vzer, S	pectrur	n Anal	yzer,	Logic
Analyzer.	collectore and Da	to Acqui	icition Su	otomo	_	1	1																	0	Hour
Simple CR	O. Dual Beam. Dual 1	Trace Sai	mplina Os	scillosc	cope An	alog and	Digital St	orage Oscillo	oscope - Data /	Acauisit	on Sv	stems	(DAS)	- Sino	le cha	nnel I	Aulti-ch	annel	Comp	outer ba	ased D	AS		9	noui
Unit-5 - Co	omputer Controlled	Test Sys	tems		<u></u>			<u></u>			<b>- )</b>		,)	cig					<u></u>					9	Hour
Testing an	Audio Amplifier, Testi	ing a Rad	lio Receive	er, Inst	truments	used in	Computer	r Controlled Ir	nstrumentation	n, Microp	oroces	sor ba	ised Sy	/stem a	and - N	leasur	ement	case s	tudies	- Interf	acing t	ransdu	cers to	Elect	ronic
ICONTROL AND	1 measuring system																								

	1.	Albert.D. Helfrick and William. D. Cooper, "Modern Electronic Instrumentation and	4.	A.K. Sawhney, "A course in electrical and electronic measurements and
		Measurement Techniques", PHI. Learning Private Limited 2010		instrumentation", Dhanapat Rai & Sons, 2000
Learning	2.	S. K. H. S. Kalsi, "Electronic Instrumentation", Tata McGraw Hill Publishing Company Ltd.,	5.	A.J. Bouwens, "Digital Instrumentation", McGraw Hill, 1986 Dominique Placko,
Resources		2010, 3rd edition.		"Fundamentals of Instrumentation and Measurement", ISTE Ltd., 2007
	3.	Earnest .O Doeblin, "Measurement Systems Application and Design", McGraw Hill	6.	Alan S. Morris and Reza Langari, "Measurement and Instrumentation: Theory and
		International editions, 5th edition, 2009.		application", Academic Press, 2015

ing / lococon		111	Continuous Learning	Assessment (CLA)		0			
	Bloom's Level of Th <mark>inking</mark>	Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (1)	g Learning A-2 0%)	Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%	John Street States	15%		15%	-		
Level 2	Understand	25%		20%		25%	-		
Level 3	Apply	30%		25%		30%	-		
Level 4	Analyze	30%		25%		30%	-		
Level 5	Evaluate	-		10%		-	-		
Level 6	Create		10 20 5 M	5%		-	-		
	Total	10	0%	10	0%	10	0%		

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Amrendra Kumar, Keysight	1. Dr. D. Kalpana, Assistant Professor, MIT, Chennai	1. Dr. R. Manohari, SRMIST
2. Mr. B. Anandhan, director, Base Electronics and Systems	2 Dr. S. Raiendiran, Assistant Professor, PEC, Pondicherry	



Course Code         21ECE262T         Course Name         LOW POWER SENSORS TECHNOLOGY						GY	Cours Catego	se ory	E			PROF	ESSIO	NAL E	ELECT	IVE		l	- T 3 0	P 0	C 3	
Pre-requ Cours	iisite es	Nil		Co- requ Course	isite s	N	11	Pr	ogres Cours	sive es						Nil						
Course	Offering Departme	ent		ECE		Data Book	/ Codes / Standard	s							Nil							
Course L	earning Rationale	(CLR):	The purpo	se of learning	this cou	rse is to:	IT THE	-				Progr	am Qı	Itcome	es (PO	)				P	rogra	m
CLR-1:	Low Power VLSI	concepts	and Power	Analysis.				1	2	3	4	5	6	7	8	9	10	11	12	S	pecifi	ic
CLR-2:	Describe the Low	Power v	ery fast Dyna	amic logic circl	ıits	1 m	-	e		4	of	3.	ety			¥						63
CLR-3:	Design of low pow	wer VLSI	Techniques	and Memories	1	A 100	is solo	/ledg		ent o	tions	ge	soci		-	Wor		ance	0			
CLR-4:	Concepts of sens	sors fun <mark>d</mark> a	ame <mark>ntal, em</mark> e	erging sensor t	echnologie	es and applications	- 10 Mar	Know	lysis	opme	stiga	Usa	and	৵		Feam	uo	& Fin	arnin			
CLR-5:	Design paramete	rs for sen	isor prototype	e and associat	ed electrol	nics		heering	em Ana	jn/devel	uct inve lex prot	em Tool	engineer	onment ainabilit <mark>v</mark>	s	dual & 1	nunicati	ct Mgt.	ong Lea	<u>.</u>	5	ę
Course O	utcomes (CO):		At the end	d of this cours	se, learnei	rs will be able to:	Anon 27	Engir	Probl	Desig	Cond	Mode	The e	Envir Susta	Ethic	Indivi	Comr	Proje	Life L	PSO.	PSO.	PSO.
CO-1:	Analyze the leaka	age mec <mark>h</mark>	<mark>anism i</mark> nfluei	ncing different	leakage c	urrents and its impac	t on CMOS design.	3	-	3	-	-		-	-	-	-	-	-	-	-	-
CO-2:	Design of Dynam	iic CMO <mark>S</mark>	<mark>latche</mark> s, Flip	-flops and pov	ver reducti	on.	요즘 크	2	1	3	-			-	-	-	-	-	-	2	-	-
CO-3:	Optimization of sp	beed an <mark>d</mark>	switching ac	tivity using spe	ecial te <mark>chn</mark>	iques also optimizatio	on inarithmetic level.	2	-	3	-	-	- 100	-	-		-	-	-	-	-	-
CO-4:	Organize the sen	sor tech <mark>n</mark>	<mark>ology a</mark> nd its	application.	100		100	2	-	3	-			-	-	-	-	-	-	3	-	-
CO-5:	Develop the vario	ous desi <mark>g</mark> i	<mark>n param</mark> eter	for sensor pro	totype and	low-power sensors a	applications	2	-	3	-	-	-	- 10	-	-	-	-	-	3	-	-
<b>Unit-1 - Ir</b> Needs for	ntroduction to Low low power VLSI-Sh	<b>Power V</b> nort circui	<b>/LSI and Hig</b> it current in C	<b>h-Level Pow</b> CMOS inverter	<mark>er Estima</mark> -CMOS lea	tion and Analysis	Current-Basic princi	oles of	low p	ower d	esign-l	Vetwor	k restr	ucturin	g and	reorga	nizatio	n- Gen	eric de	sign fl	<b>9</b> ow fo	<b>Hour</b> r Low
Power-Sy	stem Level-Algorithi	m level-Po	ower estimat nic Logic C	ion for hardwa ircuits	re impleme	entations	1111					10									0	Hour
Single clo Depender	ck latches and Flip-1 t power reduction	lops-High	throughput	CMOS circuit i	echniques	-Fast and efficient Cl	MOS functional circu	its-Ciro	cuit Pe	nalizat	ion-Vol	tage s	caling l	based c	circuit i	echniq	ues-Ci	rcuit T	echnolo	ogy-Inc	Jepen	dent-
Unit-3 - S	, pecial Low Power	VLSI Des	ign Techniq	<mark>ues an</mark> d Arith	metic Ope	erators	and the	1			1	1									9	Hour
Glitch red	uction-Clock gating-	FSM-Sta	te encoding-	Bus invert end	oding-Dat	a path –Precomputat	tion design techniqu	es-con	trol-Si	gnal ga	ating de	sign te	echniq	ue. Lov	v pow	er tech	niques	for SR	2AM ce	ll and l	DRAN	1 cell.
<u>Unit-4 - S</u>	ensors Basics, Pr	otypes a	and Applica	tions					1000												9	Hour
Sensor ba	isics-sensor types-l	vieasuren nsor <b>Pr</b> ov	totypes and	s-Applications-	Emerging	sensors and sensor	technologies-senso	r proty	oes ar	id app	lication	S									0	Hour
Developm sensor int	ent of sensor protot erfaces: review and	types and electronic	associated	electronics – A	low powe	er 65/14 nm stacked	CMOS image senso	rs-Ultra	a-low-j	oower	current	senso	rutilizii	ng Mag	netoel	ectric I	nanowi	res -lo	w Powe	ər bio-	impeo	lance

	1.	Yeap, Gary K. Practical low power digital VLSI design. SpringerScience & Business Media,	3.	Syed Kamrul Islam Mohammad Rafiqul Haider. Sensors and Low Power Signal
Learning		2012.		Processing,2010
Resources	2.	Piguet, Christian. Low-power CMOS circuits: technology, logicdesign and CAD tools. CRC	4.	Roy, Kaushik, and Sharat C. Prasad. Low-power CMOS VLSI circuit design. John Wiley &
		press, 2018.		Sons, 2009.
			1	

			Continuous Learning	g Assessment (CLA)		Cum	motivo		
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ige of unit test 0%)	Life-Long CL (1)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	20%		20%		20%	-		
Level 2	Understand	25%	Martin Cold	25%		25%	-		
Level 3	Apply	35%		35%		35%	-		
Level 4	Analyze	20%		20%		20%	-		
Level 5	Evaluate		A State of the second			-	-		
Level 6	Create			1	1 - 1 - 1		-		
	Total	10	0%	10	0 %	10	0 %		

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1 Mr. Leela Krishan Thota, Sr. Solution Engineer, Synopsys	1. Dr.S. Meenakshi. Professor. Anna University	1. Dr.P. Radhika. SRMIST



Course 21ECE263T	Course Code         21ECE263T         Course Name         MICRO - NANO - ELECTRO MECHANICAL DEVICES								PROF	ESSIO	NAL E	ELECT	IVE			- T 3 0	P 0	C 3
Pre-requisite Courses	Nil	Co- requisite Courses	Nil		Progre Cour	ssive ses						Nil						
Course Offering Depart	ment	ECE	Data Book / Codes / Sta	ndards	1						Nil							
			and the second		1	1.0										<b>D</b>		
Course Learning Rationa	le (CLR): The	e purpo <mark>se of learnin</mark> g this co	urse is to:	_		1	1.1	Progra	am Ou	Itcomes	s (PO)	)	r —			Pr Si	ograr necifi	n c
CLR-1: Introduce the p	properties of micro	o and <mark>nano elect</mark> romechanical	devices materials	1	2	3	4	5	6	7	8	9	10	11	12	Ou	tcom	es
CLR-2: Explore the ex	isting micro and n	a <mark>no fabricatio</mark> n technologies			2	of	s of	2.	iety			ork		е				
CLR-3: Recall the mici	ro mechanics prin	<mark>iciples an</mark> d design concepts of	micro sensors and micro actuators	- Poly		ento	ation	ge	soc		-	M C		anc	b			
CLR-4: Familiarize with	h micro senso <mark>r an</mark>	nd actuator use case design		N nov	alysis	lopm	stiga	Usa	r and	~~		Tean	ion	& Fir	arnin			
CLR-5: Reinstate the c	concepts of quant	um mechanics and nano fabric	cation		ecting m Ana	n/deve	uct inve ex pro	n Tool	nginee	nment		ual & .	nunicat	t Mgt.	ong Le	_	0	~
Course Outcomes (CO):	Att	the end of this course, learn	ers will be able to:		Proble	Desig	Condu	Mode	The e	Envirc Susta	Ethics	<mark>Individ</mark>	Comn	Projec	Life Lo	-OS4	PSO-3	PSO-3
CO-1: Propose the se	election of <mark>suitable</mark>	<mark>e m</mark> aterial for the intended app	lication	:	3 -	-	-	-	-	1	-	-	-	-	-	-	2	-
CO-2: Explain the fun	ndamental <mark>fabricat</mark>	tion process flow of microsyste	ems design	2	2 2	3	-	-	-	-	-	-	-	-	-	3	-	-
CO-3: Link the micro	mechanic <mark>s princip</mark>	ples and concepts for micro se	nsors and micro actuators design	2	2 2	3		-	- 10	-	-		-	-	-	-	3	-
CO-4: Apply the acqu	iired know <mark>ledge fo</mark>	o <mark>r</mark> the design of micro sensor a	and actuator	2	2 -	3	-	-	1	÷	-	-	-	-	-	-	3	-
CO-5: Comprehend to	he theoreti <mark>cal four</mark>	ndations of quantum mechanic	s and Nano systems		3 -	2	-	-	-	-	-	-	-	-	-	-	-	3
Unit-1 - Introduction to M	ems and Nems	1							-	×							9	Hour
Introduction to Design of M	EMS and NEMS,	Overview of Nano and Microe	lectromechanical Systems, Applicati	ons of Mid	ro and l	Vanoel	ectrome	chanic	al sys	tems, M	lateria	ls for l	MEMS	and NE	EMS: C	Crystal	struct	ure –
Orientation effects – crysta	l defects – Im <mark>purit</mark>	<mark>ties in</mark> Silicon – Properties of S	ilicon and Gallium Arsenide - Polyn	ner – Pol	vimide, l	PMMA,	PDNS,	LCP, S	SU8, F	Parylene	<del>)</del> ,							
Unit-2 - Micro and Nano F	abrication Tech	nologies						<u></u>						<u></u>			91	Hour
Substrates and water- Phot	tolithography, lon	Implantation, Diffusion, Oxidat	ion, CVD, Sputtering Etching techniq	ues, Micr	omachin	ing: Bu	lk Micro	machir	ning, S	Surface	Micror	machir	ning, Ll	GA N	licro s	/stem	oacka	ging-
Indendis, die level, device	crosvstem Desig	and Applications	preparation - Surface bonding-wire	bonung ·	seanny	-		1	-									Hour
Basic concepts – Bending	of thin plates – I	Mechanical vibration – Therm	o mechanics - Fracture mechanics	– Fluid m	echanic	s at mi	cro svs	tems- I	Desia	n consid	deratio	ons - F	rocess	, desia	n-masi	k lavoi	it des	ian –
Mechanical design.Fundan	nentals – Micro sy	stems and microelectronics -	working principle of microsystems –	Micro ser	isors, ad	coustic	sensor,	Bio se	nsor,	chemica	al sens	sor, pr	essure	senso	r, Tem	peratu	re ser	isor -
micro actuation techniques	- Actuation using	g thermal forces, actuation us	ing SMA, Actuation using piezo elec	tric effect	Actuati	on usin	g electr	o statio	c force	<mark>s –</mark> mic	cro grip	oper –	micro	motors	– mic	ro valv	'es – I	micro
pumps, types – micro heat	pipes																	
MEMS Sonsors: Docion of	lators	ansors Vibratory gyrosopo (	apacitivo Prossuro sonsors, Piozoo	lactric one	ray han	ostor .	and nic-	orogio	tivo ct	rain con	NOT F	Docian	of Act	intore:	Actuat	ion usi	9 I	nour
forces. Actuation using sha	ne memory Allove	s Actuation using piezoelectri	crustals Actuation using Electrosta	tic forces	Case S	Study F	RF Swite	ch. Con	nb dri	/e actua	ator	resiyii	UI AUL	101013.	nuludi	1011 431	ng ule	7111101

#### Unit-5 - Nano Mechanics and Devices

Atomic Structures and Quantum Mechanics, Shrodinger Equation, Requirements of nano systems - Development of nano electronics and structuring – Application of NEMS – Deposition of coatings – Three dimensional materials – Dewatering. Applications of Molecular nanotechnology (MNT) - Direct self-assembly- device assembly - Electrostatic self-assembly-nano tubes – Nano wire and carbon-60 - Dielectrophoretic nano assembly. Nano electronics with tunneling devices – Nano electronics with super conducting devices - Molecular nano technology

	1. Hsu, Tai-Ran. MEMS and microsystems: design, manufacture, and nanoscale	7. Charles P.Poojlejr Fran K J.Owners, "Introduction to Nano Technology", Willey student Edition
	engineering. John Wiley & Sons, 2008.	2008
	2. Marc Madou, – Fundamentals of MicrofabricationII, CRC press 1997.	8. Goser.K, Dienstuhl .J, Nano Electronics & Nanosystems, Springer International Edition, 2008.
Learning	3. Stephen D. Senturia, Micro system DesignII, Kluwer Academic Publishers, 2001	9. Michael Pycraft Inrushes, Nano Electro Mechanics in Engineering & biology, CRC press New
Resources	4. Chang Liu, – Foundations of MEMSII, Pearson education India limited, 2012	York, 2002.
	5. Sergey Edward Lyshevski, — MEMS and NEMS: Systems, Devices, and Structures, CRC	10. Gregory Timp, Nano Technology, Spinger International Edition, 1999.
	Press. 2002	11. Julian W.Gardner, Vijay K.Varadan, Osama O.Awadel Karim, Microsensors MEMS and Smart
	6. Mohamed Gad – el- Hak. The MEMS HAND book. CRC press 2005	Devices, John Wiby & sons Ltd. 2001.

Learning Assessm	nent			Sector Production						
			Continuous Learning	Assessment (CLA)		Sum	mativa			
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test )%)	Life-Long CL (10	g Learning "A-2 0%)	Final Examination (40% weightage)				
	-	Theory	Practice	Theory	Practice	<u>The</u> ory	Practice			
Level 1	Remember	15%		15%		15%	-			
Level 2	Understand	25%		20%	- Pinn	25%	-			
Level 3	Apply	30%		25%		30%	-			
Level 4	Analyze	30%		25%		<mark>30</mark> %	-			
Level 5	Evaluate		-	10%		-	-			
Level 6	Create	and the second		5%	1.4	-	-			
	Total Total	10	)%	- 10	0 %	10	0%			

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mr. Saivineeth, ML Accelerator Architect @ Google	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr. P. Eswaran, SRMIST	
2. Mr. Leela Krishna Thota, Sr. Solution Engineer II, SRG,	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai		
Synopsys India Pyt. Ltd	TAX PARAMADE FROM		

9 Hour

Course Code	se 21ECE361T Course CONSUMER ELECTRONICS AND TROUBLESHOOTING			C	Cours atego	e ory	E			PROF	ESSIO	NAL E	LECT	IVE		L 3	Т 0	P 0	C 3	
Pre-requis Courses	site s	Nil	Co- requisit Courses	e Nil		Pro	ogres Cours	sive es						Nil						
Course C	Offering Departme	nt	ECE	Data Book / Codes	s / Standards	1							Nil							
				the second se			1	1										_		
Course Learning Rationale (CLR): The purpose of learning this course is to:							C 13.	010	12.1	Progra	am Oı	<b>itcome</b>	s (PO)	)				Pr	ograr	n c
CLR-1: Know the basic components of consumer electronics					1	2	3	4	5	6	7	8	9	10	11	12	Ou	tcom	es	
CLR-2:	CLR-2: Understand the block diagram and working principle of consumer electronics					ge		of	s of	20	iety			ŗ		m				
CLR-3:	3: Apply the preamplifier and post amplifier circuit for signal conditioning					vledç		ento	ation	ge	soc			oW r		Jano	D			
CLR-4:	Understand the working principle of smart consumer electronics products		1	Knov	lysis	mdo	stiga	Usa	anc	৵		[ean	ю	& Fir	arnin					
CLR-5:	Implement the diff	ferent troul	bleshooting techniques in co	nsumer electronics		ering I	em Ana n/devel		ct inve	T Tool	igineer	nment		ual & T	unicati	t Mgt. 8	ng Lea			
Course Ou	tcomes (CO):		At the end of this course,	learners will be able to:	an. 27	Engine	Proble	Design	Condu	Moder	The en	Envirol Sustair	Ethics	Individ	Comm	Project	Life Lo	PSO-1	PSO-2	PSO-3
CO-1:	Define types of m	icropho <mark>nes</mark>	s with features	The same	C. S. G 1	2	2		-	1		-	-	-	-	-	-	2	-	-
CO-2:	Examine the work	ting prin <mark>cip</mark>	ole and construction of loudsp	peakers		3	Č 1	1	-	-	-	-	-	-	-	-	-	1	-	-
CO-3:	Design the pre-an	nplifier <mark>and</mark>	l feedback circuit configuratio	ons for consumer electronics		3	2		_	-	-	-	-	-	-	-	-	2	-	-
CO-4:	Analyze the worki	ing prin <mark>cipl</mark>	e of television and smart con	sumer electronics products	1000	14	2	3	-	-		-	-	-	-	-	-	-	3	-
CO-5:	Illustrate the differ	ent trouble	eshooting and maintenance t	echniques		3		1.1	3	-		-	-	-	-	-	-	-	2	-
<b>Unit-1 -</b> Microphon unit microp	e, Characteristics o	of Microph es and hea	ones, Carbon Microphones, adsets and its types, Types o	Crystal Microphones, Dynamic Mic f Headphones, Hearing Impairment	rophones, Cry	rstal N	Лісгор	hones,	Capac	itor Mi	crophe	ones, E	lectret	and G	Gun Mi	cropho	nes, W	ireless	<b>9 i</b> and	<b>Hour</b> dual-
Unit-2 - Lo	oudspeakers and	Speaker E	Baffles						14	-7									9 /	Hour
Ideal Loud	speakers, Basic Lo	oudspeake	rs, Types of Loudspeakers, I	oud Speaker Construction, Permai	nent Magnet,	Voice	Coil, I	Loud S	peaker	Imped	lance,	Acoust	tic Imp	edanc	e and i	resonal	nce, W	oofers	, Midr	ange
and extend	led range speakers	s, High free	quenc <mark>y Loudspe</mark> akers, Baffle	s, Infinite baffles system	_	-				1	-									
Circuit Cor	afigurations and No	of Stago	s Interstage coupling Cain	control Fraguancy Pospansa Cont	rol Nogativo I	Foodb	ack I	ow No	iso Cor	neidor	otion	Poquiro	monte	for a	idio pre	amplit	iors La	w lov	9 I al ami	nour
circuits and	d universal preamp	lifiers One	erational Amplifier TAA 300	IC 1W Class B Audio Amplifiers	TAA 320 IC an	d nea	k un a	mnlifie	ers	ISIUEI	au011, 1	\equile	mento	101 al		zampin	1613, LU		i ann	лшег
Unit-4 - Co	olour TV Standard	ls			7 1 1 0 2 0 1 0 an	u pou	n up c	Inpino	10										91	Hour
Dispersion	and recombination	n of lights,	Attributes of colours , Lumi	nance and Chrominance signals, C	olour Picture	tubes	and c	olour	TV cam	eras,	Colou	ır TV sy	stems	and l	broadc	asting	of TV p	orograi	ns, li	n-car
computers	, Electronic Ignition	n , Electroi	nic Ignition Lock syste <mark>m and</mark>	antilock system , Electronically con	trolledsuspens	sion ,	Ultras	onic ca	ar safety	/ belt s	system	n, Air ba	ig syst	em, Ve	ehicle p	oroximi	ty dete	ction s	ysterr	1 and
car naviga	tion system , Types	s of microv	vave ovens and cookin <mark>g syst</mark>	em, Air conditioning System and co	mponents															
Unit-5 -	hotwoon foilurss //		on time to repair (MTD) Mai	ntononco policy, potential problems	proventive	ointer	onoc	oorroo	tino ma	intora	noo 7	undom	ontol 7	rouble	Chool	ling Dr	andur	- Fei	91	Hour
Fault locat	ion. Trouble Shooti	ina Techni	an ume to repair (wirR), Mai ques. Divergent. convergent	and feedback path circuit	prevenuve m	amen	iance,	correc	uve ma	interia	nce, F	unuam	entai I	τουριε	511001	ing Pro	ceaure	s, ral	IL IOCƏ	illOII,

Learning Resources	1. 2.	S. P. Bali, Consumer Electronics, Pearson Education, 2008 R. G. Gupta, Audio and Video Systems by RG Gupta, Tata McGraw Hill Education Pvt Ltd, New Delhi, 2010	3.	RS Khandpur, Modern Electronic Equipment: Trouble shooting, Repair and Maintenance, Tata McGraw Hill Education Pvt Ltd, New Delhi
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Learning Assessn	nent		1000	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1						
			Continuous Learning		Gum	mativa				
	Bloom's Level of Thinking	Forma CLA-1 Averag (505	ative e of unit test %)	Life-Lon Cl (1	g Learning LA-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	40%	and the second second	40%		30%	-			
Level 2	Understand	40%		40%		40%	-			
Level 3	Apply	20%		20%	1.	30%	-			
Level 4	Analyze	2 × 1	112 - Taylor	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		-	-			
Level 5	Evaluate			100	and the second second		-			
Level 6	Create			States and		-	-			
	Total	100	%	10	00 %	10	0 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Leela Krishan Thota, Sr.Solution Engineer, Synopsys	1. Dr. G. P. Mishra, Dept. of ECE, NIT Raipur	1. Dr. Soumyaranjan Routray, SRMIST



Course Code	Durse Sode         21ECE362T         Course Name         QUALITY AND RELIABILITY ENGINEERING			C	Cours atego	e ry	Е			PROF	ESSIO	NAL E	LECT	IVE		L 3	Т 0	P 0	C 3				
Pre-requi Course	site s	Nil		Co- requisite Course <mark>s</mark>		Nil			Pro	gress	sive es						Nil						
Course (	Offering Departme	ent		ECE		Data Book /	/ Codes / Sta	ndards								Nil							
Course Le	arning Rationale (	(CLR): The	e purpose o	f learning this	course is	to:			-		1		Progr	am Oı	Itcome	s (PO	)				Pr	ogran	n
CLR-1:	Understand the co	oncept of statis	istical quality	control.					1	2	3	4	5	6	7	8	9	10	11	12	SI Our	pecific	;
CLR-2:	Implement the co	ntrol chart for p	proportion o	r fraction defect	tives.	<u></u>	-		Ð		f	of	3.	ety			¥				Uu	toome	,3
CLR-3:	Illustrate Lot by lo	t sampling.			1	199		10	vledg		ent o	utions	ge	soci			IOM L		ance	D			
CLR-4:	Analyze the failure of data.						1	Knov	Ilysis	mdo	stiga	Usa	r and	৵		Team	ion	& Fir	arnin				
CLR-5:	Improve reliability	' by applyi <mark>ng d</mark> i	lifferent tech	niques.					leering	em Ana	jn/devel ons	uct inve lex prot	rn Tool	engineer	onment	(0	dual & <sup>-</sup>	nunicati	ct Mgt.	ong Lei	5	5	3
Course Ou	itcomes (CO):	At t	the end of t	this course, lea	arners will	l be able to:	ANDER	197	Engir	Probl	Desig	Cond	Mode	The e	Envir Susta	Ethic	Indivi	Comr	Proje	Life L	PSO-	PSO-	PSO-
CO-1:	Summarize the th	neory of <mark>control</mark>	o <mark>l c</mark> hart for va	ariables.	5	12-0-05	1815	41-1	2	-	-	3	1	2	-	-	-	-	-	-	-	-	-
CO-2:	Articulate control	chart fo <mark>r variab</mark>	bles.	1.00			23 E.		3	1		3	1	-	2	-	-	-	-	-	-	-	-
CO-3:	Illustrate the conc	cept of a <mark>ccepta</mark>	<mark>an</mark> ce samplir	ıg	10.00	22	1.8.4	-		-		3	2	2	-	-		-	-	-	-	-	-
CO-4:	Apply life testing t	for relia <mark>bility te</mark> :	est.		1.25		-	12	3	-		3		2	-	-	-	-	-	-	-	-	-
CO-5:	Design the techni	iques fo <mark>r impro</mark>	<mark>ove</mark> ment of r	eliability.		100			2	-	14	3	2	-	2	-	-	-	-	-	-	-	-
Unit-1 - Int	roduction and Pro	ocess Control	l for Variab	les	100-00	1.1.1	- 11-	-						+	-		-					9 F	lour
Introduction – process o	n, definition of quali capability studies ai	ty, basic c <mark>once</mark> nd simple prob	ept of quality blems – The	, definition of SC ory of control ch	QC, benefi art- uses	its and limitation of control chart -	of statistically - Control char	r quality t for vai	contro riables	l (SQ Xcł	C), Qu nart, R	ality as chart a	surano nd II(S	e, Qua ) chart	ality cos	t-Varia	ation ir	n proce	ss- fact	ors – p	rocess	capal	bility
Unit-2 - Pr	ocess Control for	Attributes		1200	-		1.48	-				10	1									9 F	lour
Control cha	art for attributes –co	ontrol chart for	proportion of	or fraction defec	tives – p c	hart and np chai	rt – control ch	nart for o	defects	s – C a	and U	charts,	State	of con	tro <mark>l an</mark> a	proce	ss out	of con	trol ide	ntificati	on in c	charts.	
Unit-3 - Ac	ceptance Samplir	ng			<u> </u>	<u> </u>	· 00	10					13	-	1 0	,	,		<u> </u>			<u>9 F</u>	lour
Lot by lot s level) I TP	ampling – types – D (lot tolerance per	probability of a	acceptance	in single, doubl	le, multiple a quality lii	e sampling techi mit) concepts-str	niques – O.C. andard sampl	. (Opera ling plan	ating ( is for A	hara	cteristi accent	cs) cur able au	ves – ality le	produce vel) a	er's Ri nd I TP	sk and D- use	l consi s of st	umer's andaro	RISK. A sampl	AQL (ai ing plai	ccepta	ble qu	ality
Unit-4 - Lif	e Testing - Reliab	ility	<i>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</i>	orage out going	y quanty in		andara barnpi	ing plan	0 101 7			ioro qu	any re	voij ai		2 400	0 01 00	andara	oumpi	ng pia	10.	9 F	lour
Life testing	– Objective – fail	lure data analy	lysis, Mean	failure rate, me	an time to	o failure, mean	time between	n failure	, haza	ard ra	te, sys	tem re	liabilit <sub>.</sub>	r, serie	es, para	allel ai	nd mix	ed co	nfigurat	ion – s	imple	proble	əms.
Maintainab Unit-5 - Qu	ility and availability <b>iality and Reliabili</b>	' – simple probl <b>itv</b>	olems. Accep	itance sampling	based on	reliability test –	O.C Curves.															9 F	lour
Reliability in	mprovements – tec	hniques- use o	of Pareto and	alysis – design f	or reliabilit	<mark>ty – redunda</mark> ncy	unit and stand	dby red	undan	cy – C	) ptimiz	ation in	reliab	ility – I	Product	desig	n – Pro	oduct a	nalysis	– Prod	uct de	velopr	nent
– Product li	ife cycles.																						

Leonaina	1.	Montgomery, Douglas C. "Introduction to Statistical Quality Control", Hoboken, NJ:	3.	L.S. SRINATH, "Reliability Engineering" Affiliated East west press, 1991.
Learning		Wiley, 7 <sup>th</sup> edition, 2013.	4.	Monohar Mahajan, "Statistical Quality Control", Dhanpat Rai & Sons, 2001.
Resources	2.	Grant, Eugene .L"Statistical Quality Control ", McGraw-Hill, 1996	5.	R.C.Gupta, "Statistical Quality control", Khanna Publishers, 1997

Learning Assessm	nent			1000						
			Continuous Learning A	Assessment (CLA)		Summative Final Examination (40% weightage)				
	Bloom's Level of Thinking	Form CLA-1 Averag (50	ative ge of unit test %)	Life-Long CL (1)	g Learni <mark>ng</mark> _A-2 0%)					
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		15%	10	15%	-			
Level 2	Understand	25%		25%		25%	-			
Level 3	Apply	30%	100000000000000000000000000000000000000	30%		30%	-			
Level 4	Analyze	30%	A COLOR OF	30%		30%	-			
Level 5	Evaluate			1		- 11	-			
Level 6	Create	- III		ATT A CARL		-	-			
	Total	100	)%	10	0 %	10	0 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Leela Krishan Thota, Sr.Solution Engineer, Synopsys	1. Dr.S.Meenakshi, Professor, Anna University	1. Dr. Arijit Bardhan Roy, SRMIST
		2. Dr. Damodar Panigrahy, SRMIST



Course Code	21ECE363T	Course Name	ELECTR	ONIC PACKAGING	Cou Categ	se ory	E			PROF	ESSIC	NAL E	ELECT	IVE		1 3	. T 6 0	P 0	C 3
Pre-requis Course	site s	21ECC101J	Co- requisite Course <mark>s</mark>	Nil	P	rogres Cours	sive es						Nil						
Course C	Offering Departn	nent	ECE	Data Book / Codes / Stand	ards							Nil							
					4	1	1.0		_			(2.0)					D.		-
Course Lea	arning Rationale	e (CLR): The p	ourpose of learning this co	ourse is to:				-	Progr	am Ou	utcome	s (PO	)	r –	1		S	ogran pecifi	л С
CLR-1:	Explore differen	t types of electron	ic p <mark>ackaging,</mark> their function	s and challenges	1	2	3	4	5	6	7	8	9	10	11	12	Ou	tcom	es
CLR-2:	Identify electrica	al issues encounte	<mark>red and thei</mark> r corrective act	ions during packaging	ge		of	s of	10	tiety			¥		e				
CLR-3:	Study of IC asse	embly and multi- <mark>cl</mark>	hip types and design	1000	vled		ent	ation	ge	soc			۲ Wc		Janc	6			
CLR-4:	Design PCB usi	ng CAD tools and	study of surface mount tec	hnologies	Yuo Y	lysis	opm	stiga	Usa	and	જ		Fean	и	E E	arnin			
CLR-5:	Illustrate electric	testing fo <mark>r IC per</mark>	formance and design for te	stability methods	ing	Ana	eve	inve	Tool	neel	hent		8	licati	Agt	) Le			
					neel	lem	ign/d	duct	em	engi	ronn	S	/idua	mur	ect N	Lonç	-	5	-3
Course Ou	itcomes (CO):	At th	<mark>e end of this course, lear</mark>	ners will be able to:	Eng	Prob	Desi	Con	Mod	The	Envi	Ethi	Indiv	Corr	Proj	Life	PSC	PSC	PSC
CO-1:	Understand diffe	erent elec <mark>tronic pa</mark>	ckaging types	A Start Start	3	-	-	-	ł	-	-	-	-	-	-	-	2	-	-
CO-2:	Analyze electric	al issues <mark> in packa</mark>	ging	The second second	3		12	-	-	-		-	-	-	-	2	-	-	-
CO-3:	Design for chip	level pac <mark>kaging</mark>	Sec. Sec.	1. 19 C	3		2		-	-	_	-		-	-	2	2	-	-
CO-4:	Design of PCBs	which m <mark>inimize t</mark> i	he electromagnetic interfere	ence and operate at higher frequency	3		2		-	-	-	-	-	-	-	-	2	-	-
CO-5:	Analyze the con	cepts of t <mark>esting m</mark>	ethods	Section 2 and a section of the	3	-	2	-	-	2	-	-	-	-	-	3	3	-	-
										-									
Micro-syst	tems and technol	ectronic System	s Packaging	prarchy of packaging IC packaging tech	niques:	IEMS	nacka	aina c	neum	or and	modic	al alar	tronic	s nack	anina	trands	and	9 F hallor	10Ur
controlling	factors on packa	ging technology, I	materials for microelectronic	c packaging and properties, ceramics, po	olymers, a	and me	tals in	packag	ing, co	ompatil	ble sub	strate i	materia	als for	high de	ensity ir	itercor	nect	yes,
Unit-2 - El	lectrical Issues i	n Electronic Pac	kaging						01	- 1					<u> </u>			9 F	lour
Electrical i	issues encounter	ed in systems p <mark>ac</mark>	ckaging, signal and power of	distribution, concept of electromagnetic	interferen	ce and	l transı	nission	lines,	clock	distribu	tion, n	oise s	ources	digita	and R	F issu	es, de	sign
process, e	electrical design: i	nterconnect capac	citance, resistance, and ind	uctance fundamentals; packaging roadm	aps-hybr	id circu	lits-res	istive, c	apacit	ive, an	dinduc	tive pa	arasitic	;				01	Jour
Classificat	tions of IC assem	hly technologies a	nd their requirements bond	ding techniques: tape automated bonding	a flin chir	wafe	r level	nackad	ina re	liability	wafer	level l	hurn-in	and te	ost o	inale	chin	<u>y r</u> nacka	<u>iour</u> aina:
functions.	types, materials	processes, prope	rties, characteristics, trends	s, multi-chip packaging: types, design, c	omparisc	n and	trends.	syster	n - in -	- packa	age (SI	P): dis	crete	passive	əs. inte	arated.	and e	embed	ided.
future tren	ds										0 1	<i>'</i>			<i>.</i>	• •			,
Unit-4 – P	CB's and Funda	mentals of Boar	d Assembly															9 F	lour
Printed cir	rcuit board, CAD	tools for PCB de	sign, standard fabrication,	micro via boards, board assembly: sur	face mou	int teci ling rou	hnolog	y, throu	igh ho	le tecl	nnology	proce	ess co	ntrol a	nd des	ign cha	allenge	s, the	rmal
Unit-5 - El	lectrical Testing		and resis	ance, conduction, convection, and radie		ing rec	quirein	51113										91	lour
Electrical t	testing, over view	of reliability, basi	c concepts and environme	ntal interactions, thermal mismatch, and	fatigue, t	hermo	mecha	nically	induce	ed, eleo	ctrically	induc	ed, an	d chen	nically i	nduced	l failur	e anal	ysis,
electrical t	esting: system le	vel electrical testir	ng, interconnection tests, ac	tive circuit testing, design for testability															

Learning	1.	Tummala, Rao R., Fundamentals of Microsystems Packaging, McGraw Hill, 2001.	4.	Bosshart, Printed Circuit Boards Design and Technology, McGraw Hill, 1988.
Desources	2.	Blackwell (Ed), the Electronic Packaging Handbook, CRC Press, 2000.	5.	Michael L. Bushnell & Vishwani D. Agrawal, Essentials of Electronic Testing for Digital,
Resources	3.	Tummala, Rao R, Microelectronics Packaging Handbook, McGraw Hill, 2008.		memory & Mixed signal VLSI Circuits, Kluwer Academic Publishers, 2000.

Learning Assessm	ent		Continuous Learning	Assessment (CLA)			
	Bloom's Level of Thinking	Forr CLA-1 Avera (5	native age of unit test 0%)	Life-Lo (	ng Learning CLA-2 (10%)	Sum Final Ex (40% w	mative amination eightage)
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	A REAL PROPERTY AND A REAL PROPERTY A REAL PROPERTY AND A REAL PROPERTY AND A REAL PRO	40%		40%	-
Level 2	Understand	40%		40%		40%	-
Level 3	Apply	10%		10%	A CONTRACT OF	20%	-
Level 4	Analyze	10%		10%		-	-
Level 5	Evaluate	State 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1					-
Level 6	Create					-	-
	Total	10	0%		100 %	10	0 %
			125 C 23 6 1	1	Row Low		

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Abhijeet Pathak, Western Digital, Bangalore, India	1. Dr.S. Meenakshi, Professor, AnnaUniversity	1. Dr. Aditya Nath Bhatt, SRMIST
		2. Dr. Soumyaranjan Routray, SRMIST



B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

Course Code	21ECE364T	Course Name	Digit Archi	TAL SIGNAL I	PROCESSORS,	C	Cours atego	e ry	E			PROF	ESSIC	)nal e	ELECT	IVE		_L 3	. T 3 0	P 0	C 3
Pre-requi Course	site s	Nil	Co- requi Courses	isite	Nil		Pro	gres ours	sive es						Nil						
Course (	Offering Departme	ent	ECE		Data Book / Codes / S	tandards	5							Nil							
-						1	100	1	1												
Course Le	arning Rationale	(CLR): T	he purpo <mark>se of learnin</mark> g	this course	is to:				10	11	Progr	am Ou	utcome	es (PO	)				- PI	ograi	n ^
CLR-1:	Introduce the bas	sic concepts	in progr <mark>ammable</mark> DSPs.	- 10			1	2	3	4	5	6	7	8	9	10	11	12	Ou	tcom	es
CLR-2:	Understand the b	oasic archited	cture <mark>of TMS ser</mark> ies proce	essors.	Constant.	-	ge	3	of	s of	24	iety			ork		е				
CLR-3:	Familiarize the st	tudents with t	th <mark>e program</mark> ming of DSP	processors w	vith different addressing mod	es.	vled		ento	ation	ge	soc		-	۵ ر		Jano	D			ı
CLR-4:	Acquire knowledg	ge of the diffe	erent DSP architectures	& instruction :	sets.	24	Kno	Ilysis	mdo	stig: olem	Usa	ranc	∞ _		Tean	UO	& Fir	arnin			
CLR-5:	Provide strong fo	oundation for	designing real world app	olications usin	g DSP processors		eering	em Ana	n/devel	uct inve lex prot	m Tool	nginee	onment		dual & <sup>-</sup>	nunicat	ct Mgt.	ong Le:	-	2	<b>6</b>
Course Ou	tcomes (CO):	A	At the end of this cours	e, learners w	ill be able to:	. 197	Engin	Proble	Desig	Condu	Mode	The e	Enviro	Ethics	ndivid	Comn	Projec	Life L	-OSc	-OSc	So
CO-1:	Understand the b	oasic fea <mark>tures</mark>	<mark>s and</mark> needs for program	mable DSPs.	Alter Burth	192	3	1	3	-	-		-	-	-	-	-	-	2	-	
CO-2:	Demonstrate a g	ood und <mark>erst</mark> a	anding in the TMS320C5.	X processor a	nd its applications.		2		3	-	-	-		-	-	-	-	-	2	-	-
CO-3:	Develop progran TMS320C3X pro	nming p <mark>rofic</mark> i cessor.	iency using the various	addressing r	nodes and instructions of th	ne target	2		3	-	-		-	-	-	-	-	-	2	-	-
CO-4:	Demonstrate the its applications.	detailed stud	d <mark>y of</mark> the instructions, add	dressing mode	es in the TMS320C54X proces	ssor and	2		3	3				-	-	-	-	-	2	-	-
CO-5:	Analyse the rece	nt develo <mark>pm</mark> e	<mark>ent in</mark> DSP system desig	n and verify it	with different case studies.		2	67	3	-	-	-	-	-	-	-	-	-	-	2	-
						1															
Unit-1 - Ba	sics of Programi	mable DSP's	S		Kalian and Multinlian assure	datan A	A		- 4		h		ture in		0.0- 4	1.11:1.1.				91	lour
Memory _	l lo programmable // IW architecture	e DSPS - Al _ Pinelining .	-special addressing mod	PDSPS - Mul les in P-DSP	upiler and multiplier accurit	liator - N	loamec	i DUS	Struct	ure &	ous ai	critec	lure m	P- D3	5PSN	nuiupie	acces	s mem	ory – I	viunipo	riea
Init-2 - TN	IS320C5X Proces	sor				-	-			-	1									9/	Hour
Architectur	e of TMS320C5X	processor –	Status register – On chi	p memory – (	On chip peripherals – Addres	sina moo	les – li	nstruc	tion se	ets of C	5X pro	ocesso	r- Pipe	linina	in C5	X – Pr	oarams	s in C5	X for	proces	sina
real time si	ignals		,, <b>,</b>	a line	1 ARA M	J							1	5			0				- 0
Unit-3 - TN	S320C3X Proces	ssor		121					197											9	lour
Architectur	e of TMS320C3X p	processor – I	Memory o <mark>rganization –</mark> D	ata formats –	Addressing modes of C3X p	rocessor	– Instr	uctior	n sets d	of C3X	oro <mark>ces</mark>	sor –F	Progran	ns in C	C3X pro	cessol	-				
Unit-4 - TN	IS320C54X Proce	essor							_											91	lour
Architectur	e of TMS320C54	<i>c</i> processor	<ul> <li>Memory Organization</li> </ul>	– On chip p	eripherals - Addressing mo	des of C	54X pr	ocess	sor – I	nstruct	on se	ts of (	С54Х р	rocess	sor – P	rogran	ns in C	54X pro	ocesso	or	-
Unit-5 - Re	cent Trends in D	SP System	Design				Deele		. fen F					50	04 6-			41 -		91	lour
arithmetic a	or the application of algorithm –Case si	on DSP syst tudies	tems – Evolution of FPC	SA Dased DS	P system – Introduction to	FPGA –	Desigi	TION	for H	PGA b	ased s	system	aesign	– FP	GA Da	sea DS	sr sys	tem de	sign-	DISTRIC	uted
	0																				

	1.	B. Venkataramani and M. Bhaskar, -Digital Signal Processors -Architecture, Programming and	З.	Lapsley et al., DSP Processor Fundamentals, Architectures & Features II, S. Chand
Learning		ApplicationsII – Tata McGraw – Hill Publishing Company Limited. New Delhi, 2011.		& Co, 1 st Edition, 2000.
Resources	2.	Avtar Singh and S. Srinivasan, Digital Signal Processing –Implementations using DSP		
		Microprocessors with Examples fromTMS320C54xx, Cengage Learning India Pvt.Ltd, Delhi 2012.		

		-	Continuous Learning	Summativo					
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (10	Learning A-2 %)	Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	20%		20%		20%	-		
Level 2	Understand	20%	100 C 100 C	20%		20%	-		
Level 3	Apply	30%	States and	30%		30%	-		
Level 4	Analyze	30%	1	30%		30%	-		
Level 5	Evaluate	SVI - 25		10%		- 15 I -	-		
Level 6	Create		the states	5%		-	-		
	Total	10	0%	- 100	)%	10	0%		

Course Designers	ALL MARKED REPORT FOR A LARGE A	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Leela Krishan Thota, Sr. Solution Engineer, Synopsys	1. Dr.S. Meenakshi, Professor, Anna University	1. Dr.R. Prithiviraj, SRMIST.



Course Code	21ECE365T	Course Name	e e	DESIGN VERIFIC	ATION OF VLSI CIRCUITS	C	Cours atego	e ry	Е			PROF	ESSIC	NAL E	ELECT	IVE		L 2	. T	P 0	C 3
Pre-requ Course	isite es	Nil		Co- requisite Courses	Nil		Pro	ogres: Course	sive es						Nil						
Course	Offering Departm	ent		ECE	Data Book / Codes /	Standards	1							Nil							
					and the second s		100	1.0	100												
Course Le	earning Rationale	(CLR):	The purpos	e <mark>of learnin</mark> g this co	ourse is to:			( T)	10	11	Progr	am Ou	itcome	es (PO	)			. <u> </u>	Pr	ogra	m
CLR-1:	Features of Verile	og and sys	rstem Verilog <mark>i</mark> l	<mark>n verific</mark> ation domain	00 24		1	2	3	4	5	6	7	8	9	10	11	12	Ou	tcom	es
CLR-2:	System Verilog V	/erification	n metho <mark>dology</mark>		and the second		ge		of	s of	20	iety			¥		a)				
CLR-3:	Explains Test ca	ses, cover	rage <mark>analysis</mark>			100	vledo		ento	ations	ge	soc			oW r		ance	D			
CLR-4:	Fundamentals or	n IP Verific	cati <mark>on</mark>	100		20-1	<b>Von</b>	lysis	mqo	stige	Usa	and	<u>مح</u>		ean	uo	& Fir	arnin			
CLR-5:	Introduction to U	VM based	d <mark>Verificati</mark> on m	nethodology	1211212121		eering I	em Ana	n/devel	uct inve lex prob	m Tool	ngineer	onment	10	dual & T	nunicati	ot Mgt. 8	ong Lea	~	2	3
Course O	utcomes (CO):		At the end	of this course, learn	ners will be able to:		Engin	Proble	Desig	Condi	Mode	The e	Enviro	Ethics	ndivid	Comn	Projec	life L	-OSc	So	SOS
CO-1:	Learning Verilog	Basics an	nd programmin	g concepts	Sileo Aust	34121	3	1	-	-	2		-	-	-	-	-	-	3	-	-
CO-2:	Fundamentals of	<sup>f</sup> system <mark>Ve</mark>	<mark>/erilog f</mark> or writi	ng programs	Market Barret		-	3	1	-	2	-	-	-	-	-	-	-	-	-	-
CO-3:	Apply the OOPS	concep <mark>ts</mark>	of system Ver	ilog for advanced lea	arning		3	-	2	-	-	- 10	-	-		-	-	-	3	-	-
CO-4:	Evaluate the IP V	/erificati <mark>on</mark>	<mark>n meth</mark> odology			100	2	3		-			-	-	-	-	-	-	3	-	-
CO-5:	Analyse the sign	ificance <mark>of</mark>	<mark>f UVM in</mark> adva	nced verification don	nain		3	2	1.1	-	-			-	-	-	-	-	3	-	-
				21	Contract - and the last	- 64															
Operators	Pagio concento I	doptifior	Value set	Data tunan Paramat	tora Oparanda Oparatora Madu	los and no	to C	ata la	vol mo	dolling	Dataf		odollin	n Poh	oviour	ol mod	olling	Toot h	onoh	9	Hour
Functions	Switch level mode	uenuners, Ilina Tri st	state gates Us	er defined primitives	Combinational UDP Sequential	UDP	15, 00	ale-lei	vei mo	uenny,	Dalai		ouenni	J, Dell	avioura	ai iiiuu	enny,	Test De	fiich-	10583	s anu
Unit-2 - S	vstem Verilog	inig, in ot	iato gatos, oo		Compinational ODF , Coquondar	001				10	17									9	Hour
Introductio	n to System Verilog	g – Literal	l valu <mark>es-data T</mark>	ypes, Arrays, Data D	Declarations-attributes-operators,	expressions	, proc	edura	al state	ments,	and co	ontrol f	low.								
Unit-3 - O	bject Oriented And	alysis of S	System Verilo	D <b>q</b>							1	1								9	Hour
Simple Ve	rification Features-	Clocking E	Blocks- Introd	uction to objects, its	properties, methods, constructors	s- casting –	chain	ning -	Data h	iding a	nd end	apsula	ation –	Polymo	orphisr	n -Ran	dom S	timulus	-Basi	c Cla	sses-
Polymorph	nism and Virtuality-0	Class-Base	sed Rando <mark>m S</mark>	<mark>timulus -Int</mark> erfaces in	Verification -Cover group Covera	ge-Queues	and D	)ynam	nic and	Associ	ative A	Irrays	(QDA)-	Introd	uction	to Asse	ertion-E	Based V	/erifica	ition (	ABV)
Unit-4 - A	dvanced Feature i	in System	n Verilog																	9	Hour
System Ve	erilog assertion API	and cover	erage API. IP V	erification-Real Tim	e IP Verification Analysis -Introdu	ction to UV	M - U	VMEV	olutior/	1 -UVM	Struct	ural P	eces a	nd Cla	sses-F	hases	, Repo	rting.			Haur
Writing II	/M Testhench - IN	VM Classe	<b>9</b> As and Field I	Macros -UVM Enviro	nment Architecture, TR Ton To	st Environ	nont	Δαρη	t Sea	lencer	Drive	r Mon	itor S	nreho	ard_Sc	auono	o and	Segue	nco Ita		nour
Overriding	- Functional Covera	age UVM:	<u>: Signal lev</u> el F	unctional Coverage	-Transaction level Functional Cov	erage-Integ	rating	Func	tional	Covera	ge into	UVM	Testbe	nch.	u.u-00	quene		Coquer	100 110	a	0.01 y

Loorning	1.	Samir palnitkar," Verilog HDL", Pearson education, Second Edition, 2003.	4.	System Verilog For Verification: A Guide to Learning the T	estbench	Language
Decouroos	2.	J. Bhasker, a Verilog HDL Primer, Second Edition, Star Galaxy, 1999.		Features by Chris Spear & Greg Tumbush (3rd Edition),2013		
Resources	3.	System Verilog 3.1a – Language Reference Manual (Accellera Extensions to Verilog 2001), 2004.				

Learning Assessm	ent				A REAL PROPERTY OF					
			Continuous Learning	Assessment (CLA)		Summativa				
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test 0%)	Life-Lon C. (1	ng Learn <mark>ing</mark> LA-2 10%)	Final Ex (40% w	amination eightage)			
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%	and the second se	15%		15%	-			
Level 2	Understand	25%		20%		25%	-			
Level 3	Apply	30%		25%		30%	-			
Level 4	Analyze	30%	A REAL PROPERTY.	25%		30%	-			
Level 5	Evaluate			10%			-			
Level 6	Create			5%		-	-			
	Total	10	0 %	1(	00 %	10	0 %			
		24 J 1 2 2 3		1	Contraction of the					

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Vinod Srinivasan- Senior Verification Engineer – Qualcomm India (P) Ltd.,	1. Dr.J.Ramesh - Professor- ECE-PSG Institute of Technology, Pelamedu Coimbatore.	1. Dr.K. Suganthi, SRMIST
		2 Dr.L. Selvakumar SRMIST



Course Code	21ECE460T	Course Name	SYSTEM-BASED DESIGN	Cour Categ	Course Category         E         PROFESSIONAL ELECTIVE         L           3							T 0	P 0	C 3					
Pre-requ Course	isite es	Nil	Nil	Pi	ogres Cours	sive es						Nil	1						
Course	Offering Departm	ent	ECE	Data Book / Codes / Star	ndards							Nil							
Course Lo	earning Rationale	is to:		2		1.1	Progr	am Ou	utcome	s (PO	)				Pr	ogra	n		
CLR-1:	Define the funda	mentals of ARN	1 architecture	120	1	2	3	4	5	6	7	8	9	10	11	12	Specific Outcomes		
CLR-2:	Understand the u	ises of ARM pe	rip <mark>herals and</mark> debugging	- unorman	e e		of	s of	2.	iety			rk		e				
CLR-3:	Explain the mem	Explain the memory hierarchy and cache organization of ARM processor							ge	d soc			n Wo		Jano	b			
CLR-4:	Introduce the AR	M Interrupts <mark>an</mark>	d Exceptions Processing		Kno	alysis	lopm	estig: blem	Usa	r and	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		Tear	ion	& Fi	arnir			
CLR-5:	Discuss the appl	ications of ARM	I Processors		eering	em Ana	n/deve	ict inve ex pro	n Tool	nginee	nment		lual &	unicat	t Mgt.	ong Le			~
Course O	utcomes (CO):	Att	the end of this course, learners v	will be able to:	Engine	Proble	Design	Condu	Moder	The e	Enviro Sustai	Ethics	Indivic	Comm	Projec	Life Lo	PSO-`	PSO-2	PSO-S
CO-1:	Describe ARM p	rocesso <mark>r feature</mark>	es and their use.	ALC: CLE VS	4.21-5	2	3	-	-		-	-	-	-	-	-	-	-	2
CO-2:	Understand the a	architect <mark>ural mo</mark>	<mark>d</mark> el and debug issues on ARM pro	cessors and peripherals	-	2	2	-	-	-	Ę,	-	-	-	-	-	-	2	-
CO-3:	Explain ARM me		-	2	1	1	-	-	-		-	-	-	-	-	-			
CO-4:	Discuss the inter	ogram the interrupt controller.	12	-	2	2	-	-	-	-	-	-	-	-	-	2	-		
CO-5:	Analyze the featu	ires and archite	ecture of ARM7 in embedded applie	cations			3	2	2	2	-	-	-	-	-	-	-	2	2
Unit-1 - A	RM Architecture &	Instruction S	ets							e					•			9	Hour

ARM Processor Modes-ARM CPU Registers: General Registers, Status Registers-Change ARM Processor Mode- Instruction Pipeline- The ARM Architecture: The Acom RISC Machine, Architectural inheritance, ARM development tools - ARM Instructions: Condition Flags and Conditions, Branch Instructions, Arithmetic Operations, Comparison Operations, Logical Operations, Data Movement Operations, Immediate Value and Barrel Shifter, Multiply Instructions, LOAD and Store Instructions, Software Interrupt (SWI

#### Unit-2 - Architectural Support for System Development

The ARM memory interface: ARM bus signals, Simple memory interface, Control logic, Wait states, DRAM, Peripheral access- The Advanced Microcontroller Bus Architecture: Arbitration, Bus transfers, Bus reset, Test interface. Advanced Peripheral Bus, Advanced High performance Bus - The ARM reference peripheral specification: AHB multiplexed bus scheme, Base components, Memory map, Interrupt controller, Countertimers, Reset and pause controller, System design - Hardware system prototyping tools - The ARMulator, System - The JTAG boundary scan test architecture with Test signals - The ARM debug architecture Embedded Trace - Signal processing support -ARM Processor Cores:ARM7TDMI 9 Hour

#### Unit-3 - Memory Hierarchy and Cache

Memory size and speed, On chip memory, Unified and Harvard caches, Cache organization techniques - Memory Hierarchy and Cache memory, SRAM, DRAM, Peripheral Devices - Caches and Memory management units, Logical and Physical caches - Cache Architecture, Architecture of a Cache memory, Operation of cache controller, Relationship between cache and main memory, Set associativity, Write buffers, Measuring cache efficiency - Cache policy, write policy thorough - coprocessor and caches, Cleaning cache memory, ARM cached cores

9 Hour

#### Unit-4 - ARM Interrupts and Exceptions Processing

ARM Exceptions: Exception handling, Arm Processor exceptions and modes, Vector table, Exception Priorities, Return from Exception Handlers, Link registers offsets, Exceptions Vector Table - Interrupts and Interrupts Processing: Interrupt Types, Interrupt Controllers, Primary and Secondary Interrupt Controllers- Interrupt Processing: Vector Table Contents, Hardware Interrupt Sequence, Interrupts Control in Software, Interrupt Handlers, Non-nested Interrupt Handler.

#### Unit-5 - Embedded ARM Applications

9 Hour

9 Hour

ARM710T, The ARM710T cache organization, Cache power, Sequential accesses, Power optimization, ARM710TMMU, ARM710T write buffer- TheARMSIO, ARMS 10 characteristics, Double bandwidth cache-The VLSI Ruby II Advanced Communication Processor, Ruby II organization, Packaging - The VLSI ISDN Subscriber Processor, VIP organization, Memory interface, SO and Keypad interface, Clocks and timers.

	1	Wang "Embedded and Peal Time Operating Systems" Springer 2017	1	Vahid Frank and Civargis Tony "Embedded system design: a unified hardware/software
	1.	Wang, Eliberdu and Keal-Mineoperating Systems, Springer, 2017	Τ.	valid, Train and Ovalgis, Tony, Embedded System design. a diffied hardware/soltware
Learning	2.	Steve furber "ARM System-on-Chip Architecture", Pearson Education, 2000.		introduction", Vol. 52, 2002, Wiley New York.
Resources	3.	Andrew Sloss ET all, "ARM system developers guide" Designing and optimizing system,	5.	Xiao, Perry, "Designing Embedded Systems and the Internet of Things (IoT) with the ARM
		Elsevier, 2004.		mbed", 2018, Wiley Online Library.

Learning Assess	ment				and the second sec					
			Continuous Learning	Assessment (CLA)		Sum	mativa			
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test )%)	Life-Long CL (1)	g Learning A-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	<u>Th</u> eory	Practice			
Level 1	Remember	15%		15%	· · · · · · · · · · · · · · · · · · ·	15%	-			
Level 2	Understand	25%	The Martin	20%		<mark>25</mark> %	-			
Level 3	Apply	30%	200 - FE 100 - T	25%		<mark>- 3</mark> 0%	-			
Level 4	Analyze	30%		25%		<mark>3</mark> 0%	-			
Level 5	Evaluate			10%	-	-	-			
Level 6	Create		-	5%		- 1	-			
	Total	10	0 %	10	0 %	10	0%			

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mr. Leela Krishan Thota, Sr. Solution, Engineer, Synopsys	1. Dr.S. Meenakshi, Professor, Anna University	1. A. Ruhan B <mark>evi, SRM</mark> IST	



Course Code	urse 21ECE461T Course SEMICONDUCTOR MEMORY DESIGN							irse gory	E			PROF	ESSIO	NAL E	LECT	IVE		L	. T 3 0	P 0	C 3
Pre-requ Cours	iisite es	Nil	Co- re Cour	equisite se <mark>s</mark>		Nil		Progres Cours	sive ses						Nil						
Course	Offering Departme	ent	ECE		Data	Book / Codes / Star	ndards							Nil							
Course L	earning Rationale	(CLR): The J	purpos <mark>e of learn</mark>	ing this cou	ırse is to:	2		1			Progr	am Ou	utcome	s (PO	)				Pr	rogra	m
CLR-1:	Explain the basic	and detailed are	chitecture of SRA	M	00 2		1	2	3	4	5	6	7	8	9	10	11	12	S Ou	pecifi Itcom	c es
CLR-2:	Explain the basic	and detailed are	chitecture of DRA	М	1		a.		4	of	10	ety			논						
CLR-3:	Elaborate differer	nt types of non-v	olatile memory	1	1	1.5	ledo		ento	tions	ge	soci			Mo		ance	0			
CLR-4:	Understand the re	eliability issue al	nd failure prediction	on in memory	у		MOUY	lysis	opme	stiga	Usa	and	∞ .		eam	uo	& Fin	arnin			ĺ
CLR-5:	Discuss the advanced memory technology ,packing and its future direction					em Ana	n/devel	ict inve ex prob	ex prob	ngineer	onment inability		lual & T	nunicati	t Mgt. 8	ong Lea	_		~		
Course O	Irse Outcomes (CO): At the end of this course, learners will be able to:							Proble	Desig	Condu	Mode	The e	Enviro	Ethics	ndivio	Comm	Projec	-ife Lo	OSc	S-OS	S-OSc
CO-1:	Acquire knowledg	ge on S <mark>RAM and</mark>	d its operation.		100	Sare as	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Acquire knowledg	ge on D <mark>RAM arc</mark>	chitecture and its o	operation.	No.	A CONTRACT OF	3	2	12	-	-		-	-	-	-	-	-	2	-	-
CO-3:	Analyse non-vola	tile me <mark>mories a</mark> l	nd interpret its wo	rking	1.1.1.1.1	1.12	3	2	1.		-	-	-	-		-	-	-	2	-	-
CO-4:	Gain knowledge i	in reliab <mark>ility issu</mark>	es and reliability r	nodel of men	mory	1	2	2	14	-	-		-	-	-	-	-	-	1	-	-
CO-5:	Understand the c	onstruc <mark>tion and</mark>	basic of advance	d memo <mark>ry a</mark> r	nd memory pac	:king	3	2	1.1	-	I	1	-	-	-	-	-	-	2	-	-
Unit-1 - S	tatic Random Acce	ess Memorv	6	1	100			1.62				1								9	Hour
Introductio SRAM Arc	on semiconductor m chitectures and Tecl	emories- SRAN hnologies-Applic	A Cell Structures Cation Specific SR	(NMOS, CM AMs.	OS) – MOS SI	RAM Cell and Periphe	eral Circui	t Opera	tion-Bip	olar Sl	RAM T	echnol	logies-	Silicon	On In	isulato	r (SOI)	Techn	ology-	Adva	nced
Unit-2 - D	ynamic Random A	ccess Memory								1	-7									9	Hour
DRAM Te	chnology Developm	ent-CMOS DR <mark>A</mark>	<mark>AMs - DRA</mark> Ms Cel	I Theory and	Advanced Cel	I Structures Applica	ation Speci	fic DRA	Ms		11										
Unit-3 - N	on-Volatile Memor	у							-											9	Hour
Masked R Cell-One-	Read-Only Memories Time Programmable	s (ROMs)-High L e (OTP) EPRO <mark>I</mark>	Den <mark>sity ROM</mark> s-Pr Ms- Electrically E	ogrammable rasable PRC	Read-Only Me OMs (EEPRON	<pre>&gt;mories (PROMs)-CM 1s)-EEPROM Techno</pre>	MOS PROI	As-Eras Archited	able (L ture-No	IV) - Pr on-vola	ogram tile SR	mable AM-Fl	Road-0 ash Me	Only M emorie	lemorie s (EPF	es (EP ROMs	ROMs) or EEF	-Floatii PROM)-	ng-Gai -Advar	te EP nced i	ROM <sup>-</sup> lash
Memory A	Ircnitecture.			-					_	-	-	-	-							9	Hour
General R	Reliability Issues-RA	M Failure Mode	s and Mecha <mark>nism</mark>	-Non-volatile	Memory Relia	abilityDesign for Rel	liability-Re	liability													ioui
Unit-5 - A	dvanced Memory	Technologies a	and Memory Paci	king																9	Hour
Ferroelect and MCM	tric Random-Access s (3D)High Densit	Memories (FRA by Memory Pack	AMs)-Gallium Ars aging Future Dire	enide (GaAs ctions	s) FRAMs – An	alog Memories-Magne	neto-resisti	/e Rand	lom-Ac	cess M	emorie	s (MR	AMs)	Мето	ry Hyb	orids ar	nd MCI	Иs (2D)	-Mem	ory Si	lacks

	1.	Ashok K. Sharma, "Semiconductor Memories", Two-Volume Set, Wiley-IEEE Press, 2003.	4.	Fundamental and High Speed Topics", Wiley-IEEE Press, 2nd Edition, 2008.
Learning	2.	Ashok K. Sharma, "Semiconductor Memories: Technology Testing and Reliability" Wiley, 2014.	5.	Betty Prince, "High Performance Memories: New Architecture DRAMs and SRAMs
Resources	3.	Brent Keeth, R. Jacob Baker, Brian Johnson, Freng Lin, "DRAM Circuit Design, Wiley-IEEE		Evolution and Function", Wiley, Revised Edition, 1999.
		Press, 2007		

			Continuous Learning	Assessment (CLA)		Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	For CLA-1 Aver (5	mative age of unit test 50%)	Life-Long CL (1)	g Learning "A-2 0%)				
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	40%		40%		25%	-		
Level 2	Understand	40%		40%		45%	-		
Level 3	Apply	20%	and the second second	20%		20%	-		
Level 4	Analyze				and the second second	10%	-		
Level 5	Evaluate			and the second second	1	- EF -	-		
Level 6	Create		and the second	Walks a			-		
Total		1	00 %	- 10	0%	10	0 %		

Course Designers	ALL MARTINE THE REAL PROPERTY OF	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.T.Leela Krishna, Senior Solution Engineer Synopsys	1. Dr.N.B.Balamurugan, Associate Professor, Department of Electronics	1. Dr.V. Sarada, SRMIST
India Pvt. Ltd	andCommunication Engineering, Thiagarajar College of Engineering	



Course Code	21ECE462T Course Name MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE FOR ELECTRONICS DESIGN						ours atego	e ry	E			PROF	ESSIO	NAL E	LECTI	VE		L 3	Т 0	P 0	C 3
Pre-requi Course	site es	Nil		Co- requisite Course <mark>s</mark>	Nil		Pro	gress	sive es						Nil						
Course	Offering Departme	ent		ECE	Data Book / Codes / St	tandards	1							Nil							
						1			100												
Course Le	arning Rationale	(CLR): Th	he purpo <mark>se of</mark>	<mark>Flearnin</mark> g this cou	urse is to:			C 12	10	1.1	Progra	im Ou	tcome	s (PO)					Pro	n o	
CLR-1:	Provide fundame	ntal concepts	s of Ma <mark>chine L</mark>	earning.			1	2	3	4	5	6	7	8	9	10	11	12	Out	tcom	es
CLR-2:	Introduce neural	networks and	d its <mark>algorithm.</mark>		and the second second	-	ge		of	s of	20	iety			ĸ		a				
CLR-3:	Study how mach	ine learning <mark>c</mark>	ca <mark>n help in p</mark> hy	sical design	A 1978 C	ALC: N	vled		ento	tion	ge	soc			No I		anci	D			
CLR-4:	Automatic sizing	and layout of	f analog ICs us	sing deep learning	and artificial neural networks (ANN	Vs)	Vou	lysis	opme	stiga elema	Usa	and	<b>∞</b> δ		ear	uo	& Fin	arnin			
CLR-5:	Apply ANNs to the placement part of the layout generation process							m Ana	n/devel	ct inve ex prob	n Tool	Igineer	nment		ual & T	unicati	t Mgt. 8	ng Lea			
Course Or	itcomes (CO):	4	t the end of t	a and of this source, learners will be able to:				roble	esign	upuo mple	oder	ne er	nvirol ustaii	thics	divid	omm	roject	fe Lo	S0-1	S0-2	SO-3
CO-1:	Al une end of units course, rearners will be able to:							2	<u> </u>	<u> </u>	2	E	ш S	<u>ш</u> -	-	<u> </u>	<u>م</u>	1	<u> </u>	-	<u> </u>
CO-2·	I Inderstanding of	f ML alg <mark>orithm</mark>	ns through pra	octice codina	Station Billion		1	2		-		-		-		-	-		-	-	-
CO-2:	Apply concents of	f machi <mark>no los</mark>	arning for rosiz	ving analog IC		-	1	-	2			-						3	3		
CO-3.	Apply concepts of						1	-	2	2	-	-	-	-	-	-	-	0		-	-
CO-4:	Develop machine		dels for IC plac	cement.			-	2	5	3	-	-	-	-	-	-	-	3	-	3	-
CO-5:	Analyze the Mac	hine learning	models for lith	nography and mas	k pattering.	100	3	2	1	-	3	-	-	-	-	-	-	3	-	3	-
Unit-1 - F	undamentals of N	lachine Lear	rnina		and the second	-					1	-			-					91	Hour
Machine I	earning, Types of r	nachine learn	ning and its co	mparison. Basic ty	pes of data and data pre- process	ing, mode	lling a	nd ev	aluatic	n, supe	ervised	learn	ing: cla	ssifica	tion an	d regr	ession,	unsup	ervised	d lean	ning,
Bayesian	concept learning.			N																	
Unit-2 - P	ractice Algorithm	IS Maahina k	a a main a mutha a	librariaa maabin					hours	denini		uning	n o o i luit	10.000	intro	luction	to NINI		ontinai	<u>9 F</u>	lour
stop requ	or machine learnin Ilarization Deen le	ig, machine ie arning: improv	earning python wement of Deel	n neural network	convolutional network	ieam: ĸ-ne	earest	neigi	DOULS	decisi	on tree	using	SCIKIL	-iearri,	Introd	uclion	lo inin,	MLP,	opumiz	zers, e	earry
Unit-3 - N	IL for Electronics	Desian I		p nourui notmorit, t		Of the local division of the			-		197	-								91	Hour
Using AN	N to size analog IC	C: Design flow	w, Problem and	d Dataset Definitio	on, Regression–Only Model, Using	the ANN	for C	ircuit	Sizing,	Classit	fication	and I	Regress	sion M	odel, 1	Test Ca	ase–Re	gressi	on: Sir	igle-S	stage
Amplifier	with VoltageCombi	ners, Two-Sta	age Miller Amp	<mark>olifier, cla</mark> ssificatior	and regression model case studies	S		1.24										-		-	
Unit-4 - N	IL for Electronics	Design II																		9 F	lour
ANN for a	automatic analog I	C placement:	: Layout Synth	iesis by Deep Lea	arning, development of ANN mode	el: Circuit	Used	for T	ests, L	Dataset	Archite	ecture	, Neura	al Netv	vork A	rchitec	ture: P	reproc	essing	the L	Data,
Init-5 - N	I for Electronics	Manufacturi	eniai Resuits, t <b>ina</b>	ase studies. Maci	ine Learning for Design Space Exp	0101 811011 11	INLS													91	Hour
ML for Li	thography and nh	vsical design	: Machine Lea	arning for Compa	t Lithographic Process Models: Ir	mportance	of I	ithoar	aphic	Pattern	ina Pro	ocess	to the	Econo	mics (	of Com	nputina	Repre	entai	tion n	f the
Lithograp	hic Patterning Proc	cess, Machine	e Learning of C	Compact Process N	Nodels, Lithography Hotspot Detect	tion, Macl	hine L	earnir	ng for C	Optical I	Proxim	ity Co	rrection	, Mach	hine Le	earning	for SI	RAF In	sertion	i, Mac	chine
Learning	for Lithography Sin	nulation.																			

	1. Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, Machine Learning, Pearson	on 4. Gavin Hackeling, Machine Learning with scikit-learn, Packet publishing, O'Reily, 2018
	Education India, 2018.	5. Huang, Guyue, et al. "Machine learning for electronic design automation: A survey." A
Loorning	2. Joao P. S. Rosa, Daniel J. D. Guerra, Nuno C. G. Horta, Using Artificial Neural Networks for	for Transactions on Design Automation of Electronic Systems (TODAES) 26.5 (2021): 1-
Decourses	Analog Integrated Circuit Design Automation, Springer, https://doi.org/10.1007/978-3-030-	30- https://doi.org/10.1145/3451179
Resources	35743-6, 2019.	6. Phil Kim, MATLAB Deep Learning: With Machine Learning, Neural Networks and Artifi
	3. Elfadel, Ibrahim Abe M., Duane S. Boning, and Xin Li, eds. Machine learning in VLSI	SI Intelligence, Apress, ISBN-13 (pbk): 978-1-4842-2844-9, 2017.
	computer- aided design. Springer, 2019	

			Continuous Learning	Assessment (CLA)	1.1	Summativa				
	Bloom's Level of <mark>Thinking</mark>	Forr CLA-1 Avera (5	native age of unit test 0%)	Life-Lon Cl (1	g Learning LA-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		15%		15%	-			
Level 2	Understand	25%		20%		20%	-			
Level 3	Apply	30%		25%		20%	-			
Level 4	Analyze	30%		25%		30%	-			
Level 5	Evaluate		10 00 5 10	10%		10%	-			
Level 6	Create			5%		<mark>5%</mark>	-			
	Total	10	0%	10	0 %	10	0 %			

Course Designers	The second se						
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts					
1. Dr. Bhaskar Sahu, Schneider Electric Ltd, bhaskar.sahu@se.com	1. Dr. K. S. Swarup, IIT Madras, ksswarup@iitm.ac.in	1. Dr. S. Malarvizhi, SRMIST					
2. Dr.S. Paramasivam, ESAB, paramsathya@yahoo.com	<ol> <li>Dr.S. Chandramohan, Professor, CEG, Anna university, c_dramo@annauniv.edu</li> </ol>	-					



Course Code	ourse Code         21ECE463T         Course Name         SCRIPTING LANGUAGE FOR ELECTRONIC DESIGN AUTOMAT						E			PROF	ESSIC	)NAL E	ELECT	IVE		L 3	. T 0	P 0	C 3
Pre-requ Course	isite es	Nil	Co- requisite Courses	Nil	Pr	ogres Cours	sive es						Nil	1					
Course	Offering Departme	nt	ECE -	Data Book / Codes / Standa	irds							Nil							-
					1	1	1.0										<b>D</b>		
Course Le	earning Rationale (	CLR): T	he purpos <mark>e of learnin</mark> g this	course is to:		1	1	1.1	Progr	am O	utcome	es (PO	)	1	1		Pr Sr	ograr	n c
CLR-1:	Understand the ba	asic features	s of TCL		1	2	3	4	5	6	7	8	9	10	11	12	Ou	com	es
CLR-2:	Construct TCL sci	ripts for EDA	4.	the second in	e	5	f	s of	3	ety			¥		0				
CLR-3:	Identify the basic	constructs in	n T <mark>k.</mark>		ledo		ento	tions	e	soc			Ŵ		ance	-			
CLR-4:	Explain the basic	concepts of	PERL		Mon	ysis	bmdc	stiga	Usaç	and	o7		eam	Б	Fin	rnin			
CLR-5:	Summarize the ac	' Ivanced fea	tures of PERI		- Bu	Anal	evelo	inve	8	leer	ent		& T	catio	gt. 8	Lea			
					Teer	em	p/ug	uct olex	Lme	engii	onm	s	dua	unu	ict M	ong-	÷	-5	က္
Course O	utcomes (CO):	A	At the end of this course, lea	rners will be able to:	Engir	Probl	Desig	Cond	lode	The e	Envir	Ethic	ndivi	Com	Proje	life L	SO	OSo	SO
CO-1:	Discuss the basic	features of	TCL	A MARCINE WAR		2	-	2	-		-	-	-	-	-	-	-	-	-
CO-2:	Illustrate the adva	nced fe <mark>atur</mark>	es of TCL scripting language.		- 1	2	12	3	2	1	-	-	-	-	-	-	-	-	2
CO-3:	Demonstrate the o	concep <mark>ts of</mark>	Tk.	NUMBER OF STREET				3	2	-	-	-	-	-	-	-	-	-	2
CO-4:	Explain the basics	s of PE <mark>RL</mark>			1.10	-	3	-	2		-	-	-	-	-	-	-	-	-
CO-5:	Describe the adva	anced c <mark>once</mark>	e <mark>pts o</mark> f PERL to write the scrip	for automation.		2	1.1	-	2	1	-	-	-	-	-	-	-	-	-
Unit 1 T	CI Pasias		1	Color in the second		Ċ.				-								0.1	Hour
Tcl (Tool (	Command Language	) fundamen	tals language syntax variable	es expressions-String processing -Tcl List	s-control	struct	ure cor	nmand	Proce	durea	nd scon	e-Tcl	arravs	Worki	na with	files a	nd Pro	yram:	<u>1001</u>
Unit-2 - A	dvanced TCL	/	, , , , , , , , , , , , , , , , , , ,	з, стр. соло сол. 3 р. сосо 13 <u>-</u> со											9			91	lour
Quoting is	sues and Regular ex	xpressions <mark>-</mark> 3	Script libraries and Packages-	Reflection and debugging-Namespaces-Int	ernationa	lizatio	n-Evei	nt drive	n progi	rammi	ng-S <mark>oc</mark>	ket pro	ogramr	ning					
Unit-3 – T	K basics		1	and the second					14									9	lour
TK(Tool K	it) fundamentals-The	e pack geon	netr <mark>y man</mark> ager, The grid geom	etry manager, The place geometry manage	er, Bindin	g com	mands	s to eve	nts-TK	widge	ets							0.1	
History an	d Concepts of PERL	-Scalar Dat	ta-Arrays and List Data -Conti	ol structures –Hashes-Basics I/O-Regular	Expressi	ons–F	unctior	ns- Mise	cellane	ous co	ontrol st	tructur	es-For	mats				91	1001
Unit-5 - A	dvanced Concepts	of PERL			_,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		anotio		, on carre	040 00		. a otar		mato				9	lour
Directory a	access-File and Dire	ctory Manip	oulation-Process Management	Packages and Modules.															
Learning	1. John K	. Ousterhou	It, Ken Jones, "Tcl and the Tk	Toolkit", Pearson Education, 3.	LarryV	/all, To	om Chi	ristians	ən, Joh	n war	t, "Prog	rammi	ing PE	RL",Or	eilly Pu	blicatio	ons, 4 <sup>th</sup>	ed 20	)12

Learning	Second Edition, 2010.	<ol> <li>Naveed Sherwani, Algorithms for VLSI physical design Automation, Kluwer Academic</li></ol>
Resources	2. Chromatic "Modern Perl "Fourth Edition, 2015	Publishers, 2013.

			Continuous Learning	Assessment (CLA)		0					
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (10	g Learning A-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%		15%		15%	-				
Level 2	Understand	25%	-	20%	- N. T	25%	-				
Level 3	Apply	30%		25%	/s -	30%	-				
Level 4	Analyze	30%	-	25%	2.00	30%	-				
Level 5	Evaluate	100		10%		-	-				
Level 6 Create			1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	5%		- III	-				
	Total	10	0%	10	0%	100 %					

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Ms. Shivangi Soni, Application Engineer Sr, Synopsys	1. Dr. J.Ramesh , Professor , PSG Institute of Tech ,	1. Mrs.N. Saraswathi, SRMIST.	
Inc.,shivangisoni.0104@gmail.com	jr.ece@psgtech.ac.in	and the second sec	



Course Code	Code         21ECE464T         Course Name         STATISTICAL ANALYSIS AND OPTIMIZATION FOR VLS						Cours atego	e ry	E			PROF	ESSIO	NAL E	ELECT	IVE		L	. T 0	P 0	C 3
Pre-requ Course	isite es	Nil		Co- requisite Course <mark>s</mark>	Nil		Pro	ogress ourse	sive es						Nil						
Course	Offering Departme	nt		ECE	Data Book / Codes /	Standards								Nil							
Course Le	earning Rationale (	CLR): 7	The purpos	e of learning this co	urse is to:		-	đ	1		Progr	am Ou	<mark>itcom</mark> e	s (PO	)				P	rograr	m
CLR-1:	Understand the ba	asic statisti	ical modeling	g			1	2	3	4	5	6	7	8	9	10	11	12	0 0	pecifi itcom	c es
CLR-2:	Compute the perf	ormance of	f the s <mark>tatistic</mark>	cal model.	and the second second		e		f	of	3.	ety			¥						
CLR-3:	Apply convex opti	mization fo	or c <mark>urve fittin</mark>	g	A 1997	1000	rledg		ent o	tions	e	soci			Wol		ance	5			
CLR-4:	Implement geneti	c algorithm	f <mark>or optimi</mark> za	ation of VLSI design			Non	ysis	mdc	stiga lems	Usaç	and	<u>مح</u>		eam	ы	Fin	rning			
CLR-5:	Calculate of powe	r estimatio	n by using G	GA routing procedure	and states		eering h	em Anal	n/devel	uct inve ex prob	m Tool	ngineer	onment inability	1	dual & T	nunicati	ot Mgt. 8	ong Lea	-	5	
Course O	utcomes (CO):		At the end	of this course, learn	ers will be able to:	1.1.197	Engin	Proble	Desig	Condi	Aode	The e	Envire	Ethics	ndivi	Comn	roje	life L	-OSc	-OSc	- S O-
CO-1:	Summarize the ba	asic statistic	ical modeling	<u>j.</u>	ALL OF ALL OF	34.21	1		3	-			-	-	-	-	-	-	-	-	2
CO-2:	Articulate statistic	al perfo <mark>rma</mark>	ance	- 1 mart	Marken House		-	2	3	-	-	-	-	-	-	-	-	-	-	-	1
CO-3:	Illustrate the conv	ex opti <mark>miza</mark>	ation		1.		-	2	3	_	-	- 100	-	-		-	-	-	-	-	3
CO-4:	Apply Genetic alg	orithm <mark>for \</mark>	VLSI design		A state of the state of the	200	1		3	2		-		-	-	-	-	-	-	-	3
CO-5:	Describe GA rout	ing proc <mark>edı</mark>	<mark>ure an</mark> d pow	er estimation.			25	2	11. J.	3	-		-	-	-	-	-	-	-	-	1
Unit-1 - Si	tatistical Modeling			<		12		en.			1	÷								9	Hour
Modeling s	sources of variations	, Monte Ca	<mark>arlo tech</mark> niqu	ies, Process variatio	n modeling- Pelgrom's model, Prin	ncipal comp	onent	-base	d mod	eling, C	uad tr	ee-bas	sed mo	deling,	, Perfo	rmance	e mode	eling- R	espor	ise sui	rface
methodolo	gy, delay modeling, tatistical Performa	interconne	ect delay mod	dels. d Analysis		-			_		-									0	Hour
Statistical	timing analysis, par	ameter spa	ace techniqu	ies, Bayesian netwo	ks Leakage models, High level s	statistical an	alysis	, Gate	e level	statisti	cal and	alysis,	dynam	іс рои	ver, lea	kage j	oower,	temper	ature	and p	ower
supply var	iations, High level y	eld estimat	tion and gate	e level yield estimation	n.	-		-			1										
Unit-3 - C	onvex Optimization	<u>1</u>									1		"			.,				<u>91</u>	Hour
Convex se	ets, convex function	s, geometr na <b>-</b> Monom	ric programm	ning, trade-off, and a	sensitivity analysis, generalized g	geometric p	rograr	nming	i, geor	netric p	rograr	nming	applied	d to di	gital ci	rcuit ga	ate sizi	ng, Flo	or pla	nning,	wire
Unit-4 - G	enetic Algorithm	ig- monom	iidi iittiiriy, ivic		nynorniai nuing.					-										9/	Hour
Introductio	n, GA Technology-	Steady St	tate Algorith	m-Fitness Scaling-Ir	version GA for VLSI Design, L	ayout and	Test	autorr	nation-	partitic	ning-a	automa	atic pla	cemen	nt. rout	ing tea	chnoloc	iv. Mai	pniq	for FF	PGA-
Automatic	test generation- Pa	titioning al	Igorithm Tax	onomy-Multi-way Pa	titioning Hybrid genetic-encoding	- local impro	oveme	nt-WL	OFR C	, mparis	on of (	CAS-S	tandaro	d cell p	lacem	ent GA	SP alg	orithm-	unified	l algor	ithm.
Unit-5 - G	A Routing Procedu	ires and P	Power Estim	nation			-								-	-				9 /	Hour
Global rou encoding-	ting-FPGA technolo fitness function-GA	ogy mappin Vs Conver	ng-circuit ge ntional algori	neration-test genera ithm	li <mark>on in a GA frame</mark> work-test gen	neration pro	cedur	es, Po	ower e	stimatio	on- ap	plicatio	on of G	GA Sta	ndard	cell pl	aceme	nt-GA i	for AT	G-pro	blem

	Learning Resources	1. 2. 3.	Ashish Srivastava, Dennis Sylvester, David Blaauw, "Statistical Analysis and Optimization for VLSI: Timing and Power "Springer, 2008. Stephen Boyd, Lieven Vandenberghe, "Convex Optimization", Cambridge University Press, 2009. Pinaki Mazumder, E. Mrudnick, "Genetic Algorithm for VLSI Design, Layout and Test Automation", Prentice Hall, 2014.	4. 5.	S Rajasekharan, G.A Vijaya Lakshmi Pai, Neural Networks, Fuzzy logic, and Genetic algorithms, Synthesis and Applications, Prentice Hall of India, 201 Jorge Nocedal, Stephen Wright, "Numerical Optimization",Springer, 2014
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			Continuous Learning	Assessment (CLA)		Cum	mativa
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (1)	g Learning "A-2 0%)	Final Ex (40% w	amination eightage)
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%		15%		15%	-
Level 2	Understand	25%	attaction line	20%		25%	-
Level 3	Apply	30%		35%		30%	-
Level 4	Analyze	30%		30%		30%	-
Level 5	Evaluate		and the second second	eV - Carlos a			-
Level 6	Create			1	25 J	-	-
	Total	10	0%	10	0%	10	0%

Course Designers	P. M. HAME		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mr. Leela Krishan Thota, Sr.Solution Engineer, Synopsys	1. Dr.S.Meenakshi, Professor, Anna University	1. Dr. Damodar Panigrahy, SRMIST	



Course Code	Course Code         21ECE465T         Course Name         PROCESS AND DEVICE MODELING				Cou Cate	rse gory	E	:			PROF	ESSIC	onal e	ELECT	IVE		l	- T 3 0	P 0	C 3							
Pre-requ Course	isite es		Nil			Co- requi Courses	site		-	Nil	-	F	Progre Cour	ssiv ses	e						Nil	1					
Course	Offerin	g Departme	ent			ECE			Data F	Book / Co	odes / Standa	ds	1.1							Nil							
									1	1.1		<u>.</u>	1														
Course Le	earning	Rationale	(CLR):	The purp	pose o	f learning	this c	ourse is t	to:				1	19	12	11	Progr	am Ou	Itcom	es (PO	)				Pr	rogra	m
CLR-1:	Deve (CAD	lop a firm foi	undation i	in the use o	of Com	outer-Assi	sted te	echniques t	for IC dev	vice and p	process Design	1	2		3	4	5	6	7	8	9	10	11	12	S Ou	pecifi itcom	ic ies
CLR-2:	Deter	mine key in	dicators c	of devic <mark>e p</mark>	erforma	ance by lin	king pr	rocess sim	nulation to	o device s	simulation						10		>								
CLR-3:	Gene electr	rate two-dir ical contact	mensiona s	nl (2D <mark>) or</mark>	three-c	limensiona	al (3D)	) structure	s includi	ing dopin	g profiles and	de		J	5	is of	1	ciety	inabilit		ork		e				
CLR-4:	Simul physi	late numerio cal devices	cally the combined	ele <mark>ctrical t</mark> d i <mark>n a</mark> circu	behavic iit	or of a sing	gle sei	miconduct	tor device	e in isola	tion or severa	nowled	Sis	nment		tigatior	Jsage	and soc	k Susta		am W	ç	Financ	ning			
CLR-5:	Unde condi	rstand the tions, enviro	physics-b onment a <mark>r</mark>	a <mark>sed an</mark> al <mark>nd physi</mark> ca	lytical i I chara	nodeling a	approa	ich to pred	dict devi	ce opera	tion at specific	ering K	n Analy	develo	S	t inves x proble	Tool L	gineer a	ment 8		lal & Te	inicatio	Mgt. &	ng Lear			
Course O	utcome	es (CO):		At the e	end of t	his cours	e, lear	rners will l	be able 1	to:	3.54	Engine	Problen	Design/	solution	Conduc	Modern	The en	Environ	Ethics	Individu	Commu	Project	Life Lor	PSO-1	PSO-2	PSO-3
CO-1:	Unde	rstand the p	hysics- <mark>ba</mark>	ased mode	elling of	semicond	uctor d	devices and	d their fa	brication	process.	3	1	1	-	-	3	_		-	-	-	-	-	-	-	3
CO-2:	Desig mode	n, analyze Is	and optin	nize semic	conduct	or technol	ogies a	and device	es with fu	undamen	tal and accura	te 3		Z			3		-	-	-	-	-	-	-	-	3
CO-3:	Creat opera	te a two-dim ations	nensiona <mark>l</mark>	(2D) or th	nree-din	nensional	(3D) d	levice with	1 multiple	e regions	using geometr	ic 3	-	4	X	-	3	1	-	-	-	-	-	-	-	-	3
CO-4:	Comp descr	oute termina ibes the car	al current rier distrit	s, voltage: bution and	s, and condu	charges b ction mech	ased anism	on a set o Is	of physic	cal device	e equations the	at 3	-		-	-	3	1	-	-	-	-	-	-	-	-	3
CO-5:	Apply	numerical i	models in	virtual en	vironme	ent for devi	ice opt	timization.			1 Acres	3	-		-	-	3	-	-	-	-	-	-	-	-	-	3
-						100					1.11						10										
Unit-1 - Te	echnolo	ogy – Proce	ess Flow				1	1.1						_			10									9	Hour
Process s	imulatio	n flow, Con	ventional	role of TC	CAD in I	C process	ing, Pi	rocess ste	ps involv	ved in the	manufacturing	of an	IC, St	eps i	invo	lved in	devic	e simu	lation,	Histor	y of pro	ocess	simulat	tion, Ev	olutior	ו of T	CAD,
TCAD-bas	ed elec	trical charac	cterization	i, Process	synthe	sis, ICAD	and co	ompact mo	odel, Par	ameter e	xtraction, TCAL	) for na	anoele	ctron	nc, N	Aateria	als use	d in int	egrate	d circu	its						Harris
Drococo o	necnn	ology	lonimal	Iontation [	Diffuncio	Lithogra	nhy F	tobing Ma	otollizatio	n Cunon	NO TOAD TOO	lo Dro		da	inc	oimula	tion: F		aonora	tion F		oimulo	tion			9	nour
Process si	mulalio		i, ion inipi ria Strua	turee	Jiiusio	i, Lilliogra	pily, E	coning, we	Hamzalio	n, synop	SYS ICAD 100	IS, PIO	285-10	)-aev	nce	SIIIUla	UOII. L	evice	yenera	llion, L	evices	sinua	1011				Haum
Unit-3 - G	n to So	ng Geomet ntourus Stri	ric Struct	itor Model	ling I In	t and Mod	loling E	Dango cro	ooting o l	Now Struc	turo Basic 20	Shan	os odi	tina (	א מכ	Chanor	simn	lifving	2D Str	ucturo	s Eloc	tricala	nd The	rmal (	`ontaci	te Do	fining
Areas for I	Mesh Ri	efinement o	r Donina	Mesh Ref	ling Oni Sinemen	t Definition	Defir	ning Donin	auny a n na Profile	s' Consta	nt Doning Pro	iles A	nalvtic	Don	ina l	Profile	s Exte	ernal 21	20 3u ) and :	aciare 3D Doi	s, Elec sina Pr	nfiles	Particlu	a Donir	in Prot	s, Dei file	mmy
Unit-4 - C	reating	and Meshi	ng Devic	e Structur	re		i, Dom	ning Bopin	ig i ionio	0. 0011010	in Doping 110	100,71	lalyao	Bop	ingi	Tomo	о, <b>с</b> лео		o una c		ing i i	omoo,	artiore	o Dopin	91101	9	Hour
Typical too	ol flow w	vith device s	imulation	using Ser	ntaurus	Device, C	omma	and File, El	lectrode	Section, I	Physics Section	n, Plot	Sectio	n, M	ath .	Sectio	n, Solv	ve Sect	ion, Pa	aramet	er File	, Exar	ple: Si	mulatic	on of P	'N Jur	nction
diode and Models. Pa	MOSFI aramete	ET, Abrupt a	and Grad	led Hetero lependent i	ojunctio Materia	ns, Physic Is	al Moc	dels and th	he Hierai	rchy of T	heir Specificati	ons - I	Regior	i-spe	cific	and I	Materia	al-spec	ific Mo	odels, l	nterfac	e-spec	ific Mc	odels, E	Electro	de-sp	ecific
																							-			-	-

#### Unit-5 - Physics in Sentaurus Device

Electrostatic Potential, Equilibrium Solution, Quasi-Fermi Potential with Boltzmann Statistics, Fermi Statistics, Carrier Transport Models, Numeric Parameters for Continuity Equation, Current Potential, Semiconductor Band Structure -Selecting the Bandgap Model, Effective Masses and Effective Density-of-States, Overview of Sentaurus Workbench, Mixed-Mode CMOS Inverter Simulation

	1	C.A. Armstrong, C.K. Maiti, "TCAD for Si SiCo and CoAo Integrated Circuita", Published by The	1	Variab Singh Chauban Daraan Duana Lu, Vanuranalan Sriramkumar, Saurabh
	1.	G.A. Armstrong, C.K. Malli, TCAD for SI, Side and GaAs integrated Circuits, Published by The	4.	rogesh Singh Chaunan, Darsen Duane Lu, Vanugopalan Sinamkumar, Sourabh
		Institution of Engineering and Technology, London, United Kingdom, 2007.		Khandelwal, Juan Pablo Duarte, Navid Payvadosi, Ai Niknejad, Chenming Hu,
Learning	2.	Robert W.Dutton, Zhiping Yu, "Technology CAD Computer Simulation of Processes and Devices",		"FinFET Modeling for IC 'Simulation and Design: Using the BSIM-CMG Standard",
Resources		Kluwer Academic Publishers, 1993.		Academic Press - Elsevier ,2015.
	3.	Yung-Chun Wu • Yi-Ruei Jhan, "3D TCAD Simulation for CMOS Nanoeletronic Devices", Springer	5.	Synopsys Sentaurus TCAD Manual.
		Nature Singapore Pte Ltd. 2018	1	

Learning Assessm	ient		1 1 1 1 1 1 1 1 1								
			Continuous Learning A	ssessment (CLA)		Cum	motivo				
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test %)	Life-Long CL (1)	g Learning _A-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	20%		20%		20%	-				
Level 2	Understand	20%	to bus Vill	20%		<mark>20</mark> %	-				
Level 3	Apply	40%		40%		40%	-				
Level 4	Analyze	20%		20%		<mark>20</mark> %	-				
Level 5	Evaluate	1 1 2 3				-	-				
Level 6	Create	The second		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		-	-				
	Total	100	0 %	10	0 %	100	) %				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		1 Dr. Maria Jossy A SPMIST



B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

9 Hour

Course Code	21ECE466T Course Name LOW POWER CIRCUIT DESIGN			Cour Categ	se ory	E			PROF	ESSIO	NAL E	ELECT	IVE		L 3	T 0	P 0	C 3	
Pre-requisite         Nil         Co- requisite         Nil           Courses         Nil         Courses         Nil							sive ses						Nil	,					
Course (	Offering Departme	ent	ECE	Data Book / Codes / Standar	ds							Nil							
Course Le	arning Rationale (	CLR):	The purpose of learning this cou	irse is to:	1	1			Progr	am Ou	utcome	es (PO	)				Pı	rogra	m
CLR-1: Learn the Low Power VI SI concepts and Power Analysis						2	3	4	5	6	7	8	9	10	11	12	S	pecifi	C
CLR-2:	Gain Knowledge	on the Lo	w Powe <mark>r very fast</mark> Dynamic logic cir	cuits	a)			of	30	ety			×				Uu		63
CLR-3:	Design of low pov	ver VI SI	Techniques and arithmetic		edg		nt of	ions	e	socie			Wor		ance	_			
CIR-4	Linderstand the c		Adiabatic Techniques and Memorie	2	Non	/sis	bme	tigat	Jsag	and			eam	c	Fina	ning			
CLR-5	Apply the Low Power CMOS Circuite in VI SL applications					Analy	svelo	nves	ool	eer	ent 8 ilitv		& Te	catio	gt. &	Lear			
OLN-0.					leeri	em /	pu/de	uct i lex r	mT	angir	onm	6	dual	nuni	ct	ong	<u>-</u>	2	<b>с</b>
Course Ou	itcomes (CO):		At the end of this course, learne	ers will be able to:	ingir	Probl Desig			Aode	he	Envin	Ethics	ivibr	Comr	roje	ife L	-OS	-os	-OS
CO-1:	:0-1: Manifest the Knowledge of Low power VLSL Power estimation and its impact on future of CMOS					-	-		-		-	-	-	-	-		3	-	-
CO-2:	Design Dynamic	CMOS lat	ches. Flip-flops with power reduction	1	3	3	3	1	_	-	_	-	-	-	-	-	3	-	-
CO-3:	Optimize speed a	nd switch	ing activity using special techniques		3	3	3	2	_	-	-	-	_	-	-	-	3	-	-
CO-4:	Relate Adiabatic a circuits.	and ene <mark>rg</mark>	y recovery techniques to trade dynam	nic power dissipation for delay in switchin	g _	3	3	6	-		-	-	-	-	-	-	3	-	-
CO-5:	Apply low power t	echniqu <mark>e</mark>	concepts in various Applications.			3	3	_	3		-		-	-	-	-	3	-	-
Unit-1 - In	troduction to Lov	v Power	VLSI and High-level Power Estim	ation and Analysis					74	2	-	-	-					9	Hour
Introductio	on - Needs for low	power VL	SI, Short circuit current of CMOS in	nverter-CMOS leakage current, Basic P	rinciple	s of Lo	о рои	ver des	gn-Re	duced	switchi	ng vol	tage, r	reduce	d capa	citance	. Gene	eric di	esign
flow for lo	w power application	ns, Low p	ower design flow. System level pow	ver analysis.				14	1										
Unit-2 - Lot	ow Power Very Fa	st Dynar	nic Logic Circuits	Pane DVSL Static DAM latch Single tra	ncictor	olooko	d diffo	rontial l	otob T		ouble r	ninolin		DD too	hniquo	Voltar		<b>9</b> I	Hour
circuit tecl	hniques- Multiple v	oltage Tec	chniques. Low voltage swing	iops-DVSE Static RAM laten, Single tra	1515101	CIUCKE	u ume	ienilai i	alun	SFUL		Jipeiin	e, cdi	-D lec	innque	, voitag	le sca	iiriy b	aseu
Unit-3 - S	pecial Low Power	VLSI De	sign Techniques and Arithmetic	Operators	1	120	1	110										9 /	Hour
Introductio	on: Glitch reduction	, Gate-lei	vel, Block-Level control. Clock gatir	ng-Flip flop-based design, FSM-Gated	clock F	SM, Si	tate er	ncoding	FSM	Partiti	oning E	Bus In	vert er	ncoding	ı, Data	Paths:	Preco	omput	ation
design, Lo	w power arithmetic	coperator	s: Adder, Any multiplier implementat	tion															Harm
Introductic	on: Adiabatic Techniqu	utation	Complementary Adiabatic Logic A	diabatic Power supplies Implementatio	n leeur	os Δdi	ahatic	Power	sunnli	ios Pr	wer ef	ficienc	v of a	diahati	ic Ioair	Pass	trans	<b>9 I</b> istor	nour Logic
synthesis,	Low power technic	ques for S	SRAM cell		1 10000	.o, Au	abalic	1 Ower	Suppli	03, 70		noiono	y or u	ulubuli	c logic	, 1 000	uunsi	13101 1	Logic
Únit-5 - A	pplications of Lov	v Power	VLSI Design															9 /	Hour
High Spee	ed, Low power usi	ng MTCM	IOS, MTCMOS-DSP , Power consu	Imption of CMOS Adders and Multiplier	s, Dela	y Bala	nced N	<i>Aultiplie</i>	rs for	low po	wer/low	v volta	ge DS	SP core	, Powe	ər Analy	ysis Te	echnic	ques:
Glitch red	uction technique																		

	1.	Yeap, Gary K. Practical low power digital VLSI design. Springer Science & Business Media,	4.	Piguet, Christian. Low-power CMOS circuits: technology, logic design and CAD tools. CRC
Learning		2012.		press, 2018.
Resources	2.	Roy, Kaushik, and Sharat C. Prasad. Low-power CMOS VLSI circuit design.	5.	Chandrakasan, Anantha P., and Robert W. Brodersen, eds. Low-power CMOS design. New
	3.	John Wiley & Sons, 2009.		York: IEEE press, 1998

earning Assessn	nent		Continuous Learning	Assessment (CLA)		0			
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (10	Learning A-2 0%)	Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	20%		20%		20%	-		
Level 2	Understand	20%		20%		20%	-		
Level 3	Apply	30%	A State Server	30%		30%	-		
Level 4	Analyze	30%	1	30%		30%	-		
Level 5	Evaluate				1	L 151 L -	-		
Level 6	Create		Section Section	17 - S.		-	-		
	Total	10	0%	10	0%	10	0 %		

Course Designers	ALL STREET, ST	2
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad,	1. Dr.S.Meenakshi, Professor, Anna University	1. Dr. P. Aruna Priya, SRMIST
kumaranuj.anii@gmail.com		
2. Mr. Hariharasudhan - Johnson Controls, Pune,	State State State	(
hariharasudhan.v@jci.com		



Course Code	3     21ECE467T     Course Name     HIGH SPEED IC DESIGN				Cour Categ	se ory	E			PROF	ESSIO	NAL E	ELECT	IVE		L 3	. T	P 0	C 3		
Pre-requisite Nil Co- requisite Nil Courses Nil									sive es						Nil						
Course C	Offering Departme	ards							Nil												
Course Learning Rationale (CLR): The purpose of learning this course is to:								2	1	211	Progr	am Ou	itcome	s (PO	)				Pr	rograi	m
CLR-1:	Introduce the bas	ic need of	f high-spe <mark>ed circu</mark>	its.		<	1	2	3	4	5	6	7	8	9	10	11	12	Ou	tcom	c es
CLR-2:	Understand the d	ifferent clo	ocking <mark>styles.</mark>						1	of	24	Æ									
CLR-3:	Familiarize the st	udents wit	th th <mark>e different</mark> nor	n clocking style.	<mark>s for high-speed c</mark>	ircuits.	edge		nt of	ions (	θ	societ			Work		ance				
CLR-4:	Acquire knowledg	e of th <mark>e</mark> d	liff <mark>erent latch</mark> ing st	rategies.			INOL	sis.	ome	igat	sag	pue			am	c	Fine	ning			
CLR-5:	Provide strong foundation for designing real world applications using different clock generation techniques.					ering Kr	m Analy	/develop	ct invest ex proble	n Tool U	igineer a	nment & nability		ual & Te	unicatio	t Mgt. &	ng Lean				
Course Ou	tcomes (CO):	-	At the end of th	is course, lea	rners will be able	e to:	Engine	Proble	Design	Condu	Moder	The er	Enviro	Ethics	Individ	Comm	Project	Life Lo	PSO-1	PSO-2	PSO-3
CO-1:	Understand the basic features and needs for clocking styles					3	-	2			-	-	-	-	-	-	-	2	-	-	
CO-2:	Demonstrate a good understanding in the advanced clock logic styles and its applications.					2	-	3			-	<i>.</i>	-		-	-	-	2	-	-	
CO-3:	Develop a good p	roficien <mark>cy</mark>	<mark>/ in the</mark> different no	on-clocking logi	c styles.	E 19 1 1 1	2	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-4:	Demonstrate a go	od und <mark>er</mark>	<mark>rstandin</mark> g in the wo	orking of differe	nt latching strateg	ies.	2	-	3	1.1	-		-	-	-	-	-	-	2	-	-
CO-5:	Analyse the differ	ent cloc <mark>k</mark>	generation technic	ques.		-	2		3	-			-	-	-	-	-	-	-	2	-
Unit-1 - C Single rail	locked Logic Style domino logic styles	<b>es</b> s, Domino	CMOS, Multiple of	output domino la	ogic, compound d	omino logic, NORA logic	c, Dual-Ra	ail dom	nino str	uctures	, Differ	ential	domino	, cross	s-coup	led dor	nino, M	lodified	dual-i	<b>9 I</b> rail do	<b>Hour</b> mino
Unit-2 - A	dvanced Clock Lo	aic Style	es	1	12		-				-7									9	Hour
Latched do	omino structures, s	ample-set	t diffe <mark>rential log</mark> ic,	Enable/disable	CMOS differentia	l logic, Latch domino, Di	fferential	curren	t switch	logic, s	switche	ed out	out diffe	e <mark>ren</mark> tial	struct	ure, clo	ocked p	ass-ga	te logi	c, dyn	iamic
compleme	ntary pass gate log	gic.	100	- 7	1. 1. 1.	A STATE	CPR-	-			1									0	Haur
Static com	binational CMOS I	oaic, pulsi	ed static logic. Dif	ferential cascoo	le voltage switch	logic. Differential split-le	vel loaic.	casco	de non-	-thresh	old loa	ic. CM	OS pas	s aate	& trar	nsmissi	ion gate	e loaic.	DCVS	s loaic	: with
pass gate,	complementary pa	ass gate lo	ogic.		J. J	- 3, <u></u>						-,		Je gene			July July				
Unit-4 - La	atching Strategies	<b>5</b>	statis and done a	ia latabaa latal		- in			litere D		days for				01/0 /-	4-1	-4-4-1		4-4	91	Hour
Basic Late	n design, storage ( * precharged logic.	elements, cross-cou	, static and dynam upled differential o	utput.	т сюскіпд, pseud	o-inverter latch, True sir	igie-pnas	e cioci	king, D	oudie e	age tri	ggere	а пір-по	ops, Di	CVS la	icnes,	static i	KAM la	tcnes,	Race	) Tree
Unit-5 - C	locking Styles.																			9	Hour
Clocking s Water-mai	tyles, clock jitter, c in clock distribution	lock skew	v, clock generatior	n, PLL based de clocking techn	esig <mark>ns, off-chip os</mark> iques	scillator-based design, D	elay lock	ed loo	ps, clo	ck distr	ibution	, Distri	ibuted k	buffers	, place	ement o	optimiz	ation &	stand	ard w	iring,
ato					7																

	1.	Kerry Bernstein, Keith M. Carrig, "High Speed CMOS Design Styles", Kluwer Academic	3.	David Harris, "Skew Tolerant Domino Design", IEEE Journal of Solid- State Circuits, 2001.
Learning		Publishers, 2002.		
Resources	2.	Evan Sutherland, Bob Stroll, David Harris," Logical Efforts, Designing Fast CMOS Circuits",		
		Kluwer Academic Publishers, 1999		

		Summativo					
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (10	ן Learning A-2 געריין (אינט אינט אינט אינט אינט אינט אינט אינט	Final Ex (40% w	amination eightage)
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%		20%		20%	-
Level 2	Understand	20%		20%		20%	-
Level 3	Apply	30%	States and	30%		30%	-
Level 4	Analyze	30%		30%		30%	-
Level 5	Evaluate			10%	1	L 18 L -	-
Level 6	Create		Sec. Section	5%		-	-
	Total	10	0%	- 10	0%	10	0%

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Leela Krishan Thota, Sr.Solution Engineer, Synopsys	1. Dr.S. Meenakshi, Professor, Anna University	1. Dr.R. Prithiviraj, SRMIST.


Course Code	21ECE468T	Course Name	S	SYSTEM AND	) NETWO	RK ON CHIP		Cours Catego	se ory	E			PROF	ESSIO	NAL E	LECT	IVE		L 3	T 0	P 0	C 3
Pre-requis Course	site s	Nil	Co- Cou	requisite urses		Nil		Pr	ogres Cours	sive es						Nil						
Course C	Offering Departme	ent	ECE			Data Book / Code	s / Standar	ds	_						Nil							
Course Le	arning Rationale	(CLR): T	The purpose of lear	ming this co	ourse is to			1	d	1	111	Progr	am Ou	itcome	s (PO)	)				Pr	ograr	n
CLR-1:	Learn System on	chip fundam	mentals, their applica	ations.	1912	-		1	2	3	4	5	6	7	8	9	10	11	12	S Ou	becific tcom/	c es
CLR-2:	Identify new tech	niques for m	naxim <mark>izing perfor</mark> mal	nce and mini	imizing pov	ver usage	-	e		Ŧ	s of	1	ety			논		0				
CLR-3:	Create insights to	the concept	ot o <mark>f network</mark> - on – c	chip	1			vledç		ent o	ations	ge	soc			oV r		ance	D			
CLR-4:	LR-4: Acquire knowledge on router architecture designs						Knov	lysis	mdo	stiga	Usa	and	৵		Team	и	& Fir	arnin				
CLR-5:	CLR-4:       Acquire knowledge on router architecture designs         CLR-5:       Provide in depth knowledge about fault tolerance network - on - chip         Sourse Outcomes (CO):       At the end of this course, learners will be able to:         CO-1:       Discuss the basic principle of System on Chip design						ring	Ana	level	inve	Tool	ineer	nent ability		ရန္က	nicati	Mgt. 8	g Lea				
	Course Outcomes (CO):  At the end of this course, learners will be able to:  Course Discuss the basic principle of System on Chin design						100	inee	blem	ign/c	nduct	dern	eng	ironr taina	cs	vidua	Inwu	ect	Lon	-	0-2	e S
Course Ou	tcomes (CO):	A	<mark>At the</mark> end of this c	ourse, learn	ers will b	e able to:	(Bro. 2)	Eng	Pro	Des	Cor	Mod	The	Env	Ethi	Indi	Co	Proj	Life	PS(	PS(	PS(
CO-1:	Discuss the basic	c princip <mark>le of</mark>	<mark>f Sys</mark> tem on Chip de	sign		the birth	N. 54.	-	-	3	-	2	-	-	-	-	-	-	-	3	-	-
CO-2:	Manipulate to do	optimiz <mark>ation</mark>	<mark>n of p</mark> ower in combin	national and s	sequential	logic machines for S	SoC Design	- 1	2	3	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Apply the knowle	dge of r <mark>oute</mark> r	<mark>er arc</mark> hitecture to des	sign inter <mark>co</mark> nr	nects on N	etwork on Chip	8.4		-	3	2	-		_	-		-	-	-	3	-	-
CO-4:	Analyze different	routing <mark>algo</mark> i	o <mark>rithm</mark> s, security and	l services for	Network c	n Chip	100	10	3	-	2	-		-	-	-	-	-	-	-	-	2
CO-5:	Synthesize a thor	rough gr <mark>asp</mark>	of three dimensiona	al networks -	on-chip ar	chitectures		Ex	-	3	2	-	-	-	-	-	-	-	-	3	-	-
Unit-1 - S System-or SoC-Embe	<b>ystem-On-Chip D</b> n-Chip, SoC Devel added Processor S	esign lopment life o Subsystem fo	cycle, IP Design De or system on chip-Er	ecision, SoC mbedded mei	Design Fi mories- Pr	low, High Level Des otocol, Mixed Signa	sign method	lology, l blocks,	Core L Third	Develo Party I	oment, P cores	Proces	ssor S	ubsyste	em cor	e, Lou	v Powe	er Soc	Design	, Cons	9 H stituen	<b>lour</b> its of
Unit-2 - S	OC Synthesis and	d Static Tim	ne Analysis	12.23								-7				_			_		91	lour
SoC synth	esis, Design rule - IR and Cross Tal	constraints, Ik Analysis, F	SoC Design Synth Flectrical Rule check	esis, High Fa k. Desian Rul	anout Net: le violation	<ol> <li>Low power Synth Check-Design Tap</li> </ol>	esis SoC s e out	tatic Tir	ning A	nalysi	s, SoC	physic	al Des	sign Ve	rificatio	on-Ele	ctromi	gration-	Electro	static	Disch	arge
Unit-3 - In	troduction to Net	twork on Ch	hip	i, Doolgii i tai	io violatori	<u>encon Booign rap</u>	0 000	1.1				1	-								91	Hour
Introductio	n to NoC – OSI la	yer rules in	NoC - Interconnect	ion Networks	s in Netwo	rk-on-Chip Network	Topologies	- Switc	hing T	echniq	ues - F	Routing	Strate	egies - I	Flow C	Control	Proto	col Qua	ality-of-	Servic	e Sup	port,
Switching	Techniques and P	acket Forma	at - Asynchronous Fl	FO Design - G	GALS Style	of Communication	- Wormhole	Router	Archite	ecture	Design	- VC R	outer A	rchitec	ture De	esign -	- Adapi	tive Ro	uter Arc	chitect	<u>re De</u> I O	)sign Hour
Packet rol	uting-Qos, congest	tion control a	and flow control – r	outer design	– networ	k link design – Effic	cient and De	adlock-	Free	Tree-B	ased M	ulticas	t Rout	ing Met	thods ·	- Path	-Based	1 Multic	ast Ro	uting t	for 2D	) and
3D Mesh	Networks- Fault-	Tolerant Rou	uting Algorithms - Re	eliable and A	daptive Ro	outing Algorithms Se	ecurity in N	etworks	-on-Ch	nips-Fo	rmal V	erificat	ion of	Comm	unicati	ions in	Netw	orks-or	h Chips	, Test	and I	Fault
I olerance	tor Networks-on-C	Unip, Intrastri I Integration	ructures-Monitoring n of Network-on-Cl	Services for	Networks-	on Chips				-	-										91	Hour
Three-Dim	nensional Network	s-on-Chips A	Architectures. – A I	Novel Dimen	sionally-D	ecomposed Router	for On-Chi	Comm	unica	tion in	3D Arc	hitectu	res -	Resour	ce Allo	ocatior	n for G	oS On	ChipC	commι	inicati	ion –
Networks-	on-Chip Protocols-	-On-Chip Pro	ocessor Traffic Mod	elling for Net	works-on (	Chip																

	1.	Veena S. Chakravarthi, "A Practical Approach to VLSI System on Chip (SoC) Design" Springer	5.	Konstantinos Tatas and Kostas Siozios "Designing 2D and 3D Network-on-Chip
		2020		Architectures" 2013
Loorning	2.	Wayne Wolf, Modern VLSI Design – System – on – Chip Design, Prentice Hall, 3rd Edition, 2008	6.	Hoi-jun yoo, Kangmin Lee, Jun Kyoung Kim, "Low power NoC for high performance
Deseurees	З.	Chrysostomos Nicopoulos, Vijaykrishnan Narayanan, Chita R.Das" Networks-on - Chip"		SoC desing", CRC press, 2008.
Resources		Architectures Holistic Design Exploration", Springer	7.	Vijay.k Madisetti Chonlameth Arpikanondt, "A Platform-Centric Approach to System-
	4.	Fayezqebali HqhahedWatheq E1-Kharashi "Networks-on-Chips theory and practice CRC press	1.1	onChip (SOC) Design", Springer, 2005.
		2007		

			Continuous Learning	Assessment (CLA)	~	Cum	motivo			
	Bloom's Level of <mark>Thinking</mark>	oom's CLA-1 Average of unit test (50%)			g Learning LA-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		15%		15%	-			
Level 2	Understand	25%		20%		25%	-			
Level 3	Apply	30%		25%		30%	-			
Level 4	Analyze	30%		25%		<mark>30</mark> %	-			
Level 5	Evaluate		10 0 a 5 10	10%		-	-			
Level 6	Create			5%		-	-			
	Total	10	0%	10	0 %	100 %				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Leela Krishan Thota, Sr.Solution Engineer, Synopsys	1. Dr.S.Meenakshi, Professor, Anna University	1. Dr. Kasthuri Bha J K, SRMIST



# ACADEMIC CURRICULA

# UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES (With exit option of Diploma)

(Choice Based Flexible Credit System)

**Regulations 2021** 

Volume - 14E (Syllabi for Elctronics and Computer Engineering Programme Courses)



# SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

# ACADEMIC CURRICULA

Professional Core Courses

**Regulations 2021** 



# SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21ECC212T	Course Name	DATA STRUCTUR	ES AND ALGORITHMS	Co Cate	urse egory	С			PR	OFESS	SIONA	L COR	E.			L T 3 0	P 0	C 3
Pre-requ Course	isite es	Nil	Co- requisite Courses	Nil		Progre Cour	essive rses						Nil	1					
Course	Offering Departme	ent	ECE	Data Book / Codes / Sta	andards							Nil							
Course Lo	earning Rationale	(CLR): T	he purpose of learning this cou	rse is to:		17	1		Progr	am Oi	utcome	es (PO					P	rogra	m
CLR-1:	Learn about basi	c lists and ar	ray operations	Nº Section	1	2	3	4	5	6	7	8	9	10	11	12	S OI	pecifi utcom	ic Ies
CLR-2:	Impart knowledge	e on stacks a	and gueues	and and and	a	,	-	of	30	ety			×						
CLR-3:	CLR-3: Identify and analyse trees and their implementation					D 5 5	ent o	tions	e	soci			Wor		ance			l	
CLR-4:	Acquire the know	ledae about	araphs		- Mou	Vsis	bme	stiga	Usaç	and	~		eam	Б	Ein	rning		l	
CLR-5:	Practice coding for	or various se	earching, sorting algorithms and ha	sh functions		m Anal	/develo	ict inve	n Tool I	ngineer	nabilitv		lual & T	nunicatio	t Mgt. 8	ong Lea	_		~
Course O	Course Outcomes (CO): At the end of this course, learners will be able to:				Loci	Proble	Desig	Condu	Mode	The e	Enviro	Ethics	Individ	Comr	Projec	Life Lo	-OSd	-OS	-OS-
CO-1:	Implement abstra	nct data <mark>type</mark> :	<mark>s usi</mark> ng arrays and linked list.	A REAL PLANE AND	1	2	3	-			-	-	-	-	-	-	3	-	-
CO-2:	Apply the differer	nt linear <mark>data</mark>	structures like stack and queue to	various computing problems	1	2	3	-	-	1	-	-	-	-	-	-	2	-	-
CO-3:	Implement differe	ent type <mark>s of t</mark> i	ree structures to solve problem.		1	2	3	-	-	-	-	-		-	-	-	2	-	-
CO-4:	Draw graph struc	tures an <mark>d pe</mark>	e <mark>rfor</mark> m various operations on graph	s to find solutions	1	-3	2	-	-	1	-	-	-	-	-	-	-	-	3
CO-5:	Analyse the vario	ous sorti <mark>ng a</mark> i	<mark>nd se</mark> arching algorithms, hashing t	echnique and hash functions.	1	3	2	-	-	1	-	-	-	-	-	-	-	2	-
Unit-1 - Li Operation Unit-2 - Li	inear Data Structu s on Arrays, Two-di inear Data Structur	res –Array a imensional A res – Stacks,	and List vrays, singly linked lists- circularly , Queues	linked lists- doubly-linked lists, O	perations of	n array	rs and I	ists, Ins	ertion,	Deleti	ion, Me	rge, Ti	raversa	al, App	lication	is of Li	nked l	9 _ists 9	Hour Hour
Operation	s on a Stack, Linked	Representa	<mark>tion of Stac</mark> ks, Applications of Stac.	ks, Types of Queues, Circular Que	ue – Priority	Queue	e-deQi	ueue, Ap	plication	ons of	Queue	s.							
Unit-3 - N	on-LinearData Struc	tures – Tree	es Directed Cranha Denrado	tation of Cranks Crank Traverse	1 Alacarithma	Char	to of Do	th Alman	itherea	and A	nnlingti		Crank					9	Hour
пеарs, ві Unit-4 - N	on-Linear Data St	ructures –H	eaps, Directed Graphs, Represer eaps and Graphs	itation of Graphs, Graph Traversa	i Algoritrim	s, shor	iesi Pa	III AIGOI	unns,	anu A	ppiicau		Graph	S.				9	Hour
Heaps, Bi	nomial Heaps, Appl	ications of H	leaps, Directed Graphs, Represer	tation of Graphs, Graph Traversa	l Algorithm	s, Shor	test Pa	th Algor	ithms,	Applic	ations	of Gra	phs		;				
Unit-5 - S	earching, Sorting a	and Hashing	g Techniques	Sort Insortion Sort Selection	Sort More	in Sort	Quial	Sort	Dadix 9	Sort	Hoan	ort S	boll S	ort Tre	o Sort	Com	aricor	9	Hour
Algorithms	s, Hash Tables , Ha	ash Function	s , Different Hash Functions			5011	, Quick	. <i>SUI</i> , 1		50IL,	neap 3	<i>on,</i> 3	nen St	лс, пе	5 JUIL	,σοπρ	an 1501	1013	ung

	1	Mark Allen Weiss, – Data Structures and Algorithm Analysis in C 2nd Edition,	3	Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein, Introduction to
Learning		Pearson Education, 1997.		Algorithms", Second Edition, Mcgraw Hill, 2002.
Resources	2	Reema Thareja, – Data Structures Using C, Second Edition, Oxford University	4	Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, – Fundamentals of Data Structures in C,
		Press, 2011		Second Edition, University Press, 2008

		-	Continuous Learning	Assessment (CLA)		Sum	motivo			
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (10	l Learning A-2 )%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	20%		20%		20%	-			
Level 2	Understand	20%	1. St. C.	20%		20%	-			
Level 3	Apply	20%	and the second second	20%		20%	-			
Level 4	Analyze	20%	1	20%		20%	-			
Level 5	Evaluate	10%		10%	1	10%	-			
Level 6	Create	10%	the state of the s	10%		10%	-			
	Total	10	100%		0%	100%				

Co	urse Designers		
Ex	perts from Industry	Experts from Higher Technical Institutions	Internal Experts
1	Mr. Anuj Kumar, Program Delive <mark>ry Mana</mark> ger, Nagarro Software's Pvt Ltd.	1 Dr. Meenakshi, Professor of ECE, CEG, Anna University	1 Dr.J. Subhashini, SRMIST
2	Mr. Saivineeth, ML Accelerator Architect @ Google	2 Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai	



Course Code	21ECC213J Cou Nar	ne ANALOG DEV	ICES AND CIRCUITS	C	Cours atego	se ory	С			PR	OFESS	IONAI	COR	E			L T 3 0	P 2	C 4
Pre-requi Course	site Nil	Co- requisite Courses	Nil		Pr	ogres Cours	sive es						Nil	1					
Course (	Offering Department	ECE	Data Book / Codes	s / Standards	3							Nil							
0	in D-til- (OLD)-	The summer of the second states of the second state			4	-	100	_	Dura			- (DO					D	roara	m
Course Le	arning Rationale (CLR):	The purpose of learning this col	irse is to:				-		Progr		Itcome	s (PU	)	-	1	1	s	pecif	ic
CLR-1:	Describe the basic struct	ure, opera <mark>tion and char</mark> acteristics of E	BJT and MOSFET		1	2	3	4	5	6	7	8	9	10	11	12	Οι	itcom	es
CLR-2:	Study the basic principle	s, configu <mark>rations and</mark> practical applica	tions of op-amp	-		100	1	of	$\mathbf{A}_{\mathbf{c}}$	tz									
CLR-3:	Design BJT and MOSFE	T ampl <mark>ifier for a g</mark> iven configuration		5500	adge		t of	Suc		ocie			Vork		JCe				
CLR-4:	Understand the effects determine the frequency	of fe <mark>edback on</mark> amplifier circuits, and of o <mark>scillation.</mark>	I study RC and LC oscillator	circuits to	Knowle	alysis	lopmer	estigation	Usage	r and s	t & V		Team V	tion	& Finaı	arning			
CLR-5:	Explore the various type	s of power amplifier circuits		-	neering	em Ana	gn/deve	luct inve lex pro	ern Too	enginee	onment	S	idual &	municat	ict Mgt.	-ong Le	-	-2	ę
Course Ou	Itcomes (CO):	At the end of this course, learned	ers will be able to:		ingir	robl	)esic		lode	hee	Envir	thic	ivipu	- mo	roje	ife L	SO	SO	SO
CO-1:	Ascertain the operating of	haracteristics of BJT and MOSFET.	A 11 245	1229		-	3	-	-		-	-	-	-	-	2	2	-	-
CO-2:	Determine the character	istics of op amp for designing amplifie	rs and rectifiers	1 - F			1		-	- 1	1	-	-	-	-	2	-	2	-
CO-3:	Analyze and design bipo response characteristics	plar amplifier circuits to meet certain	specifications with appropriate	te frequency	-	2	3	-	-		-	-	-	-	-	-	2	-	-
CO-4:	Apply principles of feedb	<mark>ack in the</mark> design of amplifier circuits a	and oscillator circuits		2.5	2	3	-	-	1		-	-	-	-	-	-	-	2
CO-5:	Categorize the classes of	f <mark>power a</mark> mplifiers, with focus on maxi	mum amplifier efficiency		-	2	3	-	ł	-		-	-	-	-	-	-	2	-
Unit-1 - Tra	ansistor Characteristics	12							-									15	Hour
BJT- Physi - Physical : <b>Practice</b> : E	cal structure, Device oper structure, Device operation 3JT Biasing Circuits. BJT a	ratio <mark>n of BJT,</mark> Current-Voltage charac n and I-V characteristics of E-MOSFE nd MOSFET Switching Circuits	teristics of Common Emitter, T and D-MOSFET, MOSFET	Common Ba as an amplii	se an ïer, Bi	d Corr asing	nmon Circuit	Collecto s for M	r BJT OSFE	config T: Gate	uration e bias.	, BJT	biasing	g circui	ts –Vo	ltage o	livider,	MOS	S-FET
Unit-2 - Op	perational Amplifier and	its Applications	1. S. T. S.						125	1								15	Hour
Internal str Differentiat	ucture of operational am or and Integrator circuit, A	plifier, characteristics of operational ctive rectifiers.	amplifier, Inverting & Non-in	verting volta	ge an	nplifier	rs, Vol	tage fo	llower,	AC a	amplifie	r, Diffe	erentia	l ampli	fier, In	istrume	entatio	n am	olifier,
Practice: E	Basic op-amp circuits, Integ	grators and Differentiators, Active recti	fiers	_	_			-	-									45	
AC analysi	s of Common-Emitter B IT	priner $2$ amplifier using hybrid- $\pi$ model AC a	nalusis of Common-Base B IT	Camplifier co	oficiur	ation	isina h	vhrid_π	mode		nalveid	of Co	mmon	Collor	tor B I	Tamn	lifior u	13 sina h	vbrid-
π model, F of Common <b>Practice:</b> [	requency response analys n-Drain MOSFET amplified Design and analyze BJT ar	sing injunct dang hydro in hidder, AC ar is of a basic BJT CE amplifier, AC ar configuration, Frequency response a mplifier configurations, Design and and	alysis of Common-Source MC nalysis of a basic FET CS amp lyze multistage amplifier confi	OSFET ampli Difier, Design igurations	fier cc of mu	onfigur Iltistag	ration, le amp	AC ana lifier	lysis c	of Corr	imon-G	ate M	OSFE	T ampli	ifier co	nfigura	ation, A	AC an	alysis

### Unit-4 - Feedback Amplifiers and Oscillators

Basic feedback concepts, general feedback structure, Properties of negative feedback, Feedback Topologies: Voltage-Series & Current-Series feedback connections, Feedback Topologies: Voltage-Shunt & Current-Series feedback connections, Freedback Amplifier Circuits. Oscillators: Principles of Oscillation, Types of Oscillators: RC Phase Shift Oscillator, Wein Bridge Oscillator, Hartley Oscillator, Colpitts and Clapp Oscillators, Crystal Oscillators

Practices: Design and analyze negative feedback amplifier configurations, Design and analyze RC oscillators, Design and analyze LC oscillators.

#### Unit-5 - Power Amplifiers

Definition and amplifier types, Q point placement, Class A amplifier, Class B and Class AB push-pull amplifiers, Class C amplifiers, Class D, IC Biasing and Amplifiers with Active Load: BJT current sources: 2- & 3transistor current sources using BJT, Analysis of BJT differential amplifier with active load, Analysis of FET differential amplifier with active load **Practice**: BJT & FET Current Sources, Design and analyze BJT CE amplifier with active load, Design and analyze FET CS amplifier with active load

	1	David A. Bell, Electronic Devices and Circuits, 5th ed., Oxford University Press, 2015	5	Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits: Theory and Applications,
Loorning	2	Donald Neamen, Electronic Circuits: Analysis and Design, 3rd ed., McGraw-Hill Education, 2011		OUP, 20146. Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit
Deseuress	3	Roy Choudhury, Shail Jain, Linear Integrated Circuits, 4th ed., New Age International Publishers,		Theory, 11th ed., Pearson Education, 2013
Resources		2014.	6	Albert P. Malvino, David J. Bates, Electronic Principles, 8th ed., Tata McGraw Hill,
	4	Muhammad Rashid, Microelectronic Circuits: Analysis & Design, 2nd ed., Cengage Learning, 2010		2015

Learning Assessn	nent			Sector Sector						
		V 1 24	Continuous Learning	Assessment (CLA)		Summative Final Examination (40% weightage)				
	Bloom's Level of Thinking	Form CLA-1 Avera (4-	native nge of unit test 5%)	Life-Long CL (1	g Learning _A-2 5%)					
	and the second	Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%	the set of a set of the		15%	15%	-			
Level 2	Understand	20%			20%	20%	-			
Level 3	Apply	25%		and the second	25%	25%	-			
Level 4	Analyze	25%			25%	<mark>2</mark> 5%	-			
Level 5	Evaluate	10%			10%	10%	-			
Level 6	Create	5%		-	5%	5%	-			
	Total	10	0%	10	0 %	10	0 %			

Course Designers	Contraction and the second sec		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mr. Saivineeth, ML Accelerator Architect @ Google	1 Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr.T. Rajalakshmi, SRMIST	
<ol> <li>Mr. Anuj Kumar, Program Delivery Manager, Nagarr Software's Pvt Ltd.</li> </ol>	2 Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai		

15 Hour

Course Code	IN AND PROGRAMMING	Cou Categ	se ory	С			PR	OFESS	IONAL	COR	E			L T 3 0	P 2	C 4			
Pre-requ Cours	iisite es	Nil	Co- requisite Courses	Nil	P	rogres Cours	sive ses						Nil	1					
Course Offering Department         ECE         Data Book / Codes / Standards         Nil																			
Course L	earning Rationale	is to:		2	1	211	Progr	am Ou	Itcome	s (PO)	)				Р	rogra	m		
CLR-1:	Utilize class and	build dom	ain model for real-time programmers	1200	1	2	3	4	5	6	7	8	9	10	11	12	- S Οι	pecifi Itcom	c es
CLR-2:	Utilize C++ progr	ams using	n meth <mark>od overloadi</mark> ng and operator overlo	pading for real-time programmers	ge		of	s of	10	iety			ırk		e				
CLR-3:	Construct inline,	friend and	virtu <mark>al functio</mark> n, and create application o	levelopment programs for real-tim	e vied		ent o	ation	ge	d soc			n Wo		nano	b			
CLR-4:	Utilize exception	handlin <mark>g</mark> a	an <mark>d collectio</mark> n. for real-time object oriente	ed programming	Kno	alysis	lopr	estig	Use	r and	× ×		Tear	ion	Ш Ф	arnir			
CLR-5:	Construct UML C	omponen	t and deployment diagram for design of a	application	eering	em Ana	n/deve	uct inve lex pro	m Tool	nginee	onment		dual &	nunicat	ct Mgt.	ong Le	-	2	e
Course O	utcomes (CO):		At the end of this course, learners w	vill be able to:	Engin	Probl	Desig	Cond	Mode	The e	Envird	Ethics	Indivi	Comr	Proje	Life L	PSO-	PSO-	PSO-
CO-1:	Apply the concep	t of clas <mark>s</mark>	and build domain model	New York WH	213	3	2	-		1	-	-	-	-	-	-	3	-	-
CO-2:	Develop C++ pro	grams u <mark>si</mark>	<mark>ng me</mark> thod overloading and operator ove	erloading	-	3	1	-	3		-	-	-	-	-	-	-	2	-
CO-3:	Write program using inlin <mark>e, friend</mark> and virtual function, construct program using standard template						2	-	3	-	-	-		-	-	-	-	2	-
CO-4:	D-4: Construct C++ program using templates and exception handling							-	-		-	-	-	-	-	-	-	3	-
CO-5:	Create UML Corr	iponent <mark>al</mark>	nd deployment diagram.	and the second second		3	2	2	2	1	-	-	-	-	-	-	-	3	-
			10 64							1									

Unit-1 - Basic OOPS and Constructor

Comparison of Procedural and Object Oriented Programming- OOPS and its features-I/O Operations, Data Types, Variables, static- Constants, Pointers, Type Conversions –Features : Class and objects- -Feature Abstraction and Encapsulation - Application of Abstraction and Encapsulation - Types of constructor (Default, Parameter)- Static constructor and copy constructor- Feature Polymorphism: Constructor overloading - Method Overloading – Example of method overloading.

Practices on : I/O operations, Classes and object diagram, methods of constructor

Unit-2 - Polymorphism and Overloading

Method Overloading: Different parameter with different return values - Constructor and Method overloading - Operator Overloading and types - Overloading Assignment Operator - Overloading Unary Operators - Example for Unary Operator overloading - Overloading - Overloading - Overloading Binary Operators - Example for Unary Operator overloading - Polymorphism : Operators Overloading - UML Interaction Diagrams - Sequence Diagram - Collaboration Diagram - Example for Binary Operator overloading - Polymorphism : Operators Overloading - UML Interaction Diagrams - Sequence Diagram - Collaboration Diagram - Example Diagram - Feature: Inheritance - Inheritance and its types - Feature Inheritance: Single and Multiple - Inheritance: Multilevel- Inheritance: Hierarchical - Inheritance: Hybrid-Inheritance Example Programs - Inheritance and its types - Feature Inheritance: Single and Multiple - Inheritance: Multilevel- Inheritance: Hierarchical - Inheritance: Hybrid-Inheritance - Inheritance - In

Practices on : Constructor and Method Overloading- polymorphism: Operator Overloading

15 Hour

#### Unit-3 - Overview of Inheritance, Abstract Class and Templates

Advanced Functions: Inline, Friend – Advanced Functions: Virtual, Overriding- Advanced Function: Pure Virtual function -Example for Virtual and pure virtual function- Abstract class and Interface - Example Program - Virtual Function and Abstract class - UML Class Diagram and its components - Class Diagram relations and Multiplicity -UML Component Diagram - Class Diagram - Access specifies – public, private - Access specifies - protected, friend, inline - UML use case Diagram, use case, Scenario - Use case Diagram objects and relations - Method, Constructor and Destructor - Example program for constructor -Methods and Constructor, Use case.UML Component Diagram - UML Deployment Diagram - Example Package, Deployment, Package diagram - Templates: Introduction-Function templates- Example programs Function templates - Class Templates- Example programs for Class and Function templates - Templates- Exceptional Handling: try and catch

Practices on: Inheritance and its type- virtual function and abstract classes – UML class and object diagram – UML Interaction diagram – Templates.

## Unit-4 - Exception Handling and UML

Exceptional Handling: Multilevel exceptional - Exceptional Handling: throw and throws- Exceptional Handling: finally - Exceptional Handling: User defined exceptional - Example Programs using C++ - Exceptional Handling - Dynamic Modeling: Package Diagram - UML Diagrams Introduction- I/O operations - Feature :Class and Objects - Examples of Class and Objects - UML State Chart Diagram - Example State Chart Diagram - UML Activity Diagram - Example Activity Diagram - State Chart and Activity Diagram-Generic -UML Component, UML Interaction Diagram Deployment, Package diagram. Practices on: State chart and activity diagram - Exception handling – UML component and activity diagram

#### Unit-5 - STL Container and File Handling

STL: Containers: Sequence and Associative Container - Sequence Container: Vector, List- Sequence Container: Deque, Array- STL : Stack - STL Containers - Associative Containers: Map, Multimap- Iterate and Specialized iterate- Functions of iterator - Algorithms: find(), count(), sort() - Algorithms: search(), merge() - STL Associative containers and algorithms - Function Object : for each(), transform()-Example for Algorithms - Streams and Files: Introduction - Classes and Errors - Disk File Handling Reading Data and Writing Data - Streams and File Handling- storing objects in files Practices on: STL container – STL Associative container and algorithm – Stream and file handling.

	1	Grady Booch, Robert A. Maksimchuk, Michael W. Engle, Object-Oriented Analysis and Design	4	Robert Lafore, Object-Oriented Programming in C++, 4th ed., SAMS Publishing,
Learning		with Applications, 3rd ed., Addison-Wesley, May 2007	- C - 1	2008
Resources	2	Reema Thareja, Object Oriented Programming with C++, 1st ed., Oxford University Press, 2015	5	Ali Bahrami, Object Oriented Systems Development", McGraw Hill, 2004
	3	Sourav Sahay, Object Oriented Programming with C++, 2nd ed., Oxford University Press, 2017	6	Craig Larmen, Applying UML and Patterns, 3rd ed., Prentice Hall, 2004

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Learning Assessm	nent internet			1.	10 M						
			Continuous Learning	Assessment (CLA)	ć	Sum	mativa				
	Bloom's Level of Thinking	Forr CLA-1 Avera (4	native age of unit test 5%)	Life-Long CL (1:	g Learning "A-2 5%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	20%			10%	20%	-				
Level 2	Understand	20%			10%	20%	-				
Level 3	Apply	30%			30%	30%	-				
Level 4	Analyze	20%	V16 V 101	1. 1. 1. 1. 1. 1.	30%	30%	-				
Level 5	Evaluate	10%	-		20%	-	-				
Level 6	Create		-			-	-				
	Total	10	0 %	10	0%	10	0 %				

Course Designers								
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts						
1 Mr. Mohan, Embedded 360, Chennai	1 Dr. R. Venkatesan, Sr. Scientist, NIOT, Chennai	1 Dr.J. Selvakumar, SRMIST						
2 Mr. Sai Vineeth, ML Silicon Architect,	2 Dr. Meenakshi, Professor of ECE, CEG, Anna University	2 Mr. S, TAarthi, SRMIST						
Google Cloud TPU, USA								

B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

15 Hour

15 Hour

Course Code	Course Code         21ECC233L         Course Name         DATA STRUCTURES LAB						С		Course         C         PROFESSIONAL CORE         L         I           Category         0         0         0         0         0         0							 (	_ T 0 0	P 4	C 2
Pre-requ Cours	uisite ses	Nil	Co- requisite Courses	Nil		Progre Cour	ssive ses						Nil						
Course	Offering Departm	ent	ECE	Data Book / Codes / Sta	ndards	1						Nil							
Course L	earning Rationale	(CLR): 7	he purpose <mark>of learnin</mark> g this o	ourse is to:		1	4	1	Prog	ram Ou	utcome	s (PO	)	1	1	Г	P	rogra	m
CLR-1:	Learn about basic	lists and arı	ay operations		1	2	3	4	5	6	7	8	9	10	11	12	Oi	itcom	es
CLR-2:	Impart knowledge	on stacks a	nd q <mark>ueues</mark>	1 June 19 19 19 19 19 19 19 19 19 19 19 19 19	e		of	s of	5	iety			ork		e				
CLR-3:	Identify and analy	se trees and	their implementation	1 11111	vled		ento	ation	ge	soc			۲ Wc		Jano	D			
CLR-4:	R-4: Acquire the knowledge about graphs						lopm	estige	Usa	r and	∞		Tean	U	& ⊟i	arnin			l
CLR-5:	Practice coding fo	r various sea	<mark>arching,</mark> sorting algorithms and	hash functions	Teering	em Ana	gn/deve	luct inve	ern Tool	enginee	onment	ş	idual & <sup>-</sup>	municat	ect Mgt.	-ong Le	-	-2	က္
Course C	Outcomes (CO):		<mark>At the</mark> end of this course, lea	rners will be able to:	Enai	Prob	Desi	Conc	Mode	The	Envii	Ethic	Indiv	Com	Proje	Life I	PSO	PSO	PSO
CO-1:	Implement abstrac	ct data t <mark>ypes</mark>	using arrays and linked list us	ing C Programming.	9129-	1	2	-	3	-	-	-	-	-	-	-	3	-	
CO-2:	Apply the different Programming	t linear d <mark>ata</mark>	structures like stack and queue	to various computing problems using	С -	1	2		3	-	-	-	-	-	-	-	2	-	-
CO-3:	Implement differe	nt types <mark>of tr</mark>	<mark>ees</mark> and apply them to problem	solutions using C Programming		1	2	-	3	-	-	-	-	-	-	-	2	-	-
CO-4:	Discuss graph stru Programming	ucture a <mark>nd u</mark>	nderstand various operations o	n graphs and their applicability using C	-	1	2	0	3	11	-	-	-	-	-	-	-	-	3
CO-5:	Analyse the variou Programming.	us sortin <mark>g an</mark>	d searching algorithms, hashir	g technique and hash functions using	с <sub>-</sub>	1	2	-	3	ç	-	_	-	-	-	-	-	2	-
Unit 1	laing C programm	ina	150	1/					<u> </u>	-	_							12	Hour
•	Construct stack o Simulate the work Simulate the work	f integers an king of a que king of a Circ	nd to perform the various opera ue of integers using an array cular queue and Deque of integ	itions on stack yers using an array				Z	1		J	5							1001
Construct	a singly linked list	and perform in a	the various operations on it	the state and the		-	_	-	13	-			-					12	Hour
•	Construct stack o Simulate the work Simulate the work	f integers an king of a que king of a Cirk	nd to perform the various opera- ue of integers using an array cular queue and Deque of inter-	tions on stack	u.	d,		Ð	Ţ	P								12	nour
Unit-3 - L	Ising C programm	ing																12	Hour
•	Construct a binary Traverse the tree Display the eleme	y search tree using all the ents in the tre	e of integers. e methods i.e., inorder, preorde ee	er and postorder.															

Unit-4 -	Usina (	C program	ımina
•	oomg .	, program	

- •
- •
- Represent, implement and traverse graphs in data structure. Implement the adjacency list representation of a graph with m vertices and n edges Find the minimum spanning tree of an undirected Graph using greedy approach •

## Unit-5 - Using C programming

- •
- Implement linear search algorithm and binary search algorithm. Implement Selection sort algorithm, Insertion sort algorithm Implement Bubble sort algorithm, and Quick sort algorithm • •
- Mark Allen Weiss, Data Structures and Algorithm Analysis in C 2nd Edition, Pearson Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein, Introduction to 3 1 Learning Education, 1997. Algorithms", Second Edition, Mcgraw Hill, 2002. 2 Reema Thareja, <u>Data Structures</u> Using 4 Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, - Fundamentals of Data Structures in C, Resources Second Edition C. Oxford University Press, 2011 Second Edition, University Press, 2008

Learning Assessmer	nt			A State Salar								
				Continuous Learni	ing Assessment (CLA)							
	Bloo <mark>m's</mark> Level of <mark>Thinking</mark>	CLA-1 Avera expe (3	age of first cycle priments 30%)	CLA-2 Average experii (30	of second cycle ments %)	Practical E (40% w	Examination reightage	Final Examination (0% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember		20%	1000	20%	1	20%	-	-			
Level 2	Understa <mark>nd</mark>	/ - E	20%	1111-141	20%	5-10-1	20%	-	-			
Level 3	Apply		20%		20%	1.1.1	20%	-	-			
Level 4	Analyze	-	20%		20%		20%	-	-			
Level 5	Evaluate		10%	-	10%		10%	-	-			
Level 6	Create	100	10%		10%	- 1.54	10%	-	-			
	Total	1	00 %	100	%	10	0 %		-			
		Provide State										

Co	urse Designers	100	5 - 2 M F	
Ex	perts from Industry	Ex	perts from Higher Technical Institutions	Internal Experts
1	Mr. Anuj Kumar, Program Delivery Manager, Nagarro Software's Pvt Ltd.	1	Dr. R. Venkatesan, Sr. Scientist, NIOT, Chennai	1 Dr.J. Subhashini, SRMIST
2	Mr. Sai Vineeth, ML Silicon Architect, Google Cloud TPU, USA	2	Dr. Meenakshi, Professor of ECE, CEG, Anna University	

12 Hour

Course Code         21ECC312T         Course Name         HARDWARE INTERFACING AND NETWORKING							(	Cours Catego	se ory	С			PR	OFESS	IONAI	COR	E		ļ	- T 3 0	P 0	C 3		
Pre-requi Course	site s	Nil			Co- requ Course	isite		Nil		Pr	ogres Cours	sive						Nil						
Course	Offering Departme	ent		1	ECE		1	Data Book / Codes /	Standard	s							Nil							
Course Le	arning Rationale	(CLR):	The pur	rpose o	of learninc	this cou	irse is to:	- service		Program Outcomes (PO)												P	rogra	m
CLR-1:	Acquire knowledg	ge of CAN	standard	ds, elec	trical requi	rements a	and signalii	ng		1	2	3	4	5	6	7	8	9	10	11	12	S	pecifi utcom	iC Ies
CLR-2: Overview of CANopen protocol used in industrial controllers								e		÷	of	2.	ety			¥		0						
CLR-3:	Outline LIN bus, I	MODBUS	ProfiBus	s used i	for automc	tive netwo	orks			vledg		ent o	tions	ge	soci			I Wol		ance	b			
CLR-4: Organize the Flexray protocol standard for automotive control networks.							<b>Know</b>	lysis	opme	stiga	Usa	and	<b>∝</b> δ		eam	u	& Fin	arnin						
CLR-5:         Incorporate Automotive Ethernet in an automotive application						eering h	em Ana	n/devel	uct inve lex prob	m Tool	ngineer	onment inability		dual & T	nunicati	ot Mgt. 8	ong Lea	~	2	3				
Course Ou	utcomes (CO):	_	At the e	end of	this cours	e, learne	ers will be	able to:	1. 17	Engin	Proble	Desig	Condi	Mode	The e	Envire	Ethics	Individ	Comn	Proje	Life L	-OSC	-OSc	-OS-
CO-1:	Illustrate the CAN	l electri <mark>ca</mark>	<mark>l, mech</mark> an	nical sta	andards ar	nd signalin	ng methods	CO CLERN		3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Analyze a typical	applica <mark>tic</mark>	<mark>n base</mark> d o	on CAI	√open pro	tocol	1000			3		12	2	-	-	<u> </u>	-	-	-	-	-	-	-	-
CO-3:	Interpret the LINb	ous, MO <mark>DI</mark>	<mark>BUS, a</mark> nd	d Profib	us protoco	ls for soft	ware interfa	acing		3	1		-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Construct codes i	in C to i <mark>nt</mark>	erface sol	o <mark>ft</mark> ware i	or Flexray	protocol a	application		100	1	3	2	-	-		-	-	-	-	-	-	1	-	-
CO-5:	Comprehend the	case st <mark>ud</mark>	<mark>lies in t</mark> he	e autom	otive <mark>e</mark> nvir	onment.	1.5					3	2	-	1	-	-	-	-	-	-	1	-	-
Unit-1 - CA	AN Bus Introductio	on		1					12						÷								9	Hour
Introduction	n to CAN – Electric	al propert	ie <mark>s –</mark> CAN	N signa	ling and da	ata rates -	- CAN data	a frame format- Collisi	ion and arl	bitratio	n- Des	sign ex	amples	-Erro	r hand	ling – E	i <mark>rror</mark> st	ate dia	igram -	- CAN	control	ler blo	ck dia	igram
Unit-2 - CA	AN and CAN open			Ciriy- C	AN GEVEIO		Dis- Demon	Silation of a typical C.			emnud	011.	75	1									9	Hour
CANopen	overview Commu	inication r	equir <mark>eme</mark>	ents for	embeddec	l networki	ing- The ob	ject dictionary conce	ot- Commu	unicati	on ent	tries- S	DO and	1 PDO	- PDC	) linking	- Ident	ifying (	objects	COB-	ID -ED	S and	DCF,	PDO
communica	ation -SDO commu	nication- I	Vetwork n	manage	ment and	safety crit	tical feature	9.	-	-	-	-			-								0	Hour
Profibus, n	etwork topologies-	Network (	Configurat	tion-Ac	tive compo	onents – F	Passive cor	mponents: connectors	s, cables, e	etc- Te	sting o	of profi	bus – L	IN bus	basic	s- LINb	us pro	tocol; r	naster	slave o	configu	ration	– Bas	cics of
MODBUS	- MODBUS protoco	ol – MODI	BUS appli	lica <mark>tion</mark>		200	-			_	1.2.													
Unit-4 - Fle	exray Protocol	rchitoctur	ne Prote	ocolon	oration co	atrol contro	ovt Oporat	ional overview. Prote	col oporat	ion co	ntrol n	racass	Roh	viour	durino	norma	lonor	tion (	odina	and de	coding		9	Hour
– Wakeup	and startup- Clock	synchroni	zation – (	Control	ler host int	erface- Sy	ystem para	meters.	cor operall		ni or p	100000	- Dene	aviour	uunny	nonna	opera		Jouing	anu ue	count		ay pa	yillau
Unit-5 Aut	omotive Ethernet																						9	Hour
Introduction	n to Automotive ne rotocol- Measurem	etworking ent_calib	– Electric ation_dia	cal requ annostic	iirements -	– Network	k layer pro	tocols, TCP/IP, UDP	– Ports a	nd so	ckets -	– Audi	o, Vide	o brid	ging- /	Audio/V	ideo ti	anspo	rt prot	ocol –	IEEE1	122- A	udio/	Video
a anoport p		on, ound	alon, ulu	grioolit	0.																			

Learning Resources	1. 2. 3.	Olaf Pfeiffer, Andrew Ayre and Christian Keydel, "Embedded networking with CAN and CANopen", Copper hill Technologies Corporation, 2008. SGS-Thompson, "Lin Application note AN1278", SGS - Thompson Ltd. 2002. Modbus-IDA, "MODBUS application protocol specification", Modbus-IDA, 2006. Siemens, "Profibus network manual", Siemens manual, 2009.	4. 5.	Xiu Ji, "Profibus in practice: Sys Domnique parot "Flexray and Wiley online library, 2012.	tem A its	rchitecture and applications:	Design", Real	CRC pro time	ess, 2015. multiplexed	network",
				and the second se						

		1	Continuous Learning	g Assessment (CLA)		Sum	mativo		
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (1)	g Learning "A-2 0%)	Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%		25%		15%	-		
Level 2	Understand	25%	States Line	20%		25%	-		
Level 3	Apply	30%	1.2.2.1	30%		30%	-		
Level 4	Analyze	30%		25%		30%	-		
Level 5	Evaluate		and the second			-	-		
Level 6	Create				25-13 · 16-	-	-		
	Total	10	0%	10	0%	10	0%		

Course Designers										
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts								
<ol> <li>Mr. Saivineeth, ML Accelerator Architect @ Google</li> </ol>	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr. K. Vadivukkara <mark>si, SRMI</mark> ST								
2. Mr. Anuj Kumar, Program Delivery Manager, Nagarro	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai									
Software's Pvt Ltd.										



Course Code	21ECC313P	Course Name	e EMBEDD	ED MICRO	CONTROLLERS	Cou Cate	rse gory	С			PR	OFESS	SIONA	L COR	E			L T 3 1	P 0	C 4
Pre-requ Course	isite es	Nil	Co- requisit Courses	e	Nil	1	Progres Cours	ssive ses						Nil	1					
Course	Offering Departm	ent	ECE		Data Book / Codes / Stand	lards	1.1						Nil							
						-	-	1						<u> </u>						
Course Le	earning Rationale	(CLR):	The purpose of learning the	is course is	to:			1	2	Progr	am O	utcome	es (PO	)	1			- e	rogra Snecif	m ic
CLR-1:	Apply the basic of	concept of	digital fundamentals to Microp	processor ba	sed personal computer system	1	2	3	4	5	6	7	8	9	10	11	12	0	utcom	ies
CLR-2:	Solve basic bina	ry math op	eration <mark>s using the</mark> microproce	essor / Micro	controller				of	2.	ţ									
CLR-3:	Demonstrate pro / microcontroller	gramming	profi <mark>ciency us</mark> ing the various a	addressing i	nodes of the target microprocess	vledge		ient of	ations o	ge	d societ			n Work		Jance	Ð			
CLR-4:	Analyse the prop	erties of N	lic <mark>roproces</mark> sors & Microcontro	ollers.	12 STL 22	Kno	lysis	opm	stig	Usa	and	৵		Fear	U	& Fi	arnir			
CLR-5:	Design and inter	face of var	ious peripheral chips with 805	51 and PIC r	nicrocontroller	eering	em Ana	n/devel	uct inve	n Tool	ngineer	nment		lual & <sup>-</sup>	nunicati	t Mgt.	ong Lea	_	0	~ ~
Course O	utcomes (CO):		At the end of this course, I	learners wi	I be able to:	Engin	Proble	Desig	Condu	Mode	The e	Enviro	Ethics	Individ	Comn	Projec	Life Lo	-OS4	PSO-2	PSO-3
CO-1:	Illustrate the CAI	V electri <mark>ca</mark>	<mark>l, mech</mark> anical standards and s	ignaling me	thods.	- 12	-	3	÷ -	2	- 1	-	-	1	-	-	-	3	-	-
CO-2:	Analyze a typical	l applica <mark>tio</mark>	n based on CAN open protoco	ol	the state was a	1		3	-	2	-	-	-	1	-	-	-	3	-	-
CO-3:	Interpret the LIN	bus, MO <mark>DI</mark>	BUS, and Profibus protocols fo	or software	nterfacing	-	- 1	-	3	2	-	-	-	1	-	-	-	-	3	-
CO-4:	Construct codes	in C to i <mark>nte</mark>	erface software for Flexray pro	otocol applic	ation	-	-	-	3	2	2	-	-	1	-		-	-	3	-
CO-5:	Comprehend the	case stud	<mark>lies in th</mark> e automotive environr	ment.		1 .		h.Y	3	2	- 4	-	-	1	-	-	-	-	3	-
<b>Unit-1 - M</b> Basics of operation,	l <b>icroprocessor</b> Microprocessor, 80 shift operation, Ma	86 registe x mode sj	rs and its functions, Instructio ystem configuration, Advanced	on set of 800 d instruction	6 and simple Programs, Microp s, Interrupt processing, HALT and	orocesso d WAIT fo	<sup>r</sup> bus, a or test si	nd sig tates, l	nals, 80 DMA,	)86 Ha	rdwar	e archit	ecture	<mark>, M</mark> in r	node s	system	configi	uration	<b>12</b> 1, arith	Hour metic
Case stud	lies: 8086 to transfe	er data, do	arith <mark>metic and</mark> logical operatio	ns		-	_	_	_	-		_							10	How
Compariso Programm Case stud	ons between Micro ning- I/O programm <b>lies:</b> 8051 to transf	processors ing, Timer er data Se	s and microcontroller, 8051 al programming, 8051 interrupts rially, receive data Serially, tim	rchitecture, Programm	Pin functions, Memory organiza ng, ter. serial communication using .	tion, Spe Interrupt	ecial Fu	inction	Regist	ers, In	structio	o <mark>n set-c</mark>	classifi	cation,	Instru	ction s	et-addr	ressiną	g mod	les, C
Unit-3 - E	xternal Peripheral	Interfacii	ng	ior and cour		apt													12	Hour
- LCD inte Case stu	rfacing, Keyboard i dies: Interfacing Li	interfacing ED / 7- se	, Interfacing with external RO gment / LCD displays/ keyboar	M, ADC inte rd, Interfacir	rfacing, DAC interfacing, Senso g DC motor / stepper motor / ser	or interfactor vo motor	cing, St	epper	motor i	nterfac	ing, D	C moto	r inten	facing,	DS12	887 R1	C inter	facing	<b>]</b> ,	
Unit-4 - P	IC Microcontroller													·				-	12	Hour
PIC Archit Programm <b>Case Stu</b>	tecture, Registers of hing in assembly, Pi <b>dies:</b> PIC microcon	organizatio rogrammin troller bas	n, Memory organization, add ng in Embedded C, ed embedded system for logic	lressing mo al, arithmeti	des, Instruction set: classification of the set of the	on, logica	l opera	ation, A	Arithme	ic ope	ration,	branch	ning, ti	me de	lay loc	p, aritl	nmetic	opera	tion, (	CALL,

### Unit-5 - PIC Peripheral Interfacing

12 Hour

Timers, Interrupts, I/O ports, I2C bus, LCD Interfacing, CCP modules, Flash and EPROMS, ADC Interfacing, DAC Interfacing, PIC timer programming, serial port programming, interrupt programming, CCP programming,

Case studies: Interfacing LCD displays, Interfacing ADC / DAC, Timer, Serial, Interrupt, CCP.

	1.	Krishna Kant, "Microprocessor and Microcontrollers, Architecture, Programming and System	4.	Subrataghoshal "8051 Microcontroller Internals Instructions, Programming and
		Design 8085, 8086, 8051, 8096 <mark>", PHI, 2013</mark> .		Interfacing",2nd edition Pearson 2010
Learning	2.	Muhammad Ali Mazidi and Janice Gillispie Mazidi, "The 8051 - Microcontroller and Embedded	5.	Muhammad Ali Mazidi-Rolin-D-Muckinlay, Danny Caussey. "Pic Microcontroller And
Resources		systems", 7th Edition, Pearson Education, 2011.		Embedded System Using Assembly And C For Pic 18" Pearson Education, 2021.
	3.	Anbazhagan K "Beginning 8051 Microcontroller Projects Handson", Independently Published,		
		2020		

Learning Assessm	nent	<u>~ / / / / / / / / / / / / / / / / / / /</u>		-			-		
		1 A A	Cont	inuous Learning A	ssessment (CLA)				
	Bloom's Level of Thinking	Forn CLA-1 Avera (20	native ge of un <mark>it</mark> test 0%)	Project Base CLA (60	ed Learning A-2 %)	Report an (2	d Viva Voce 20%)	Final Ex (0% we	amination eightage)
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	5%		10 C 2 C	5%	200 - 200	5%	-	-
Level 2	Understand	5%	1.1	1.0	5%	- A	5%	-	-
Level 3	Apply	25%			25%		20%		-
Level 4	Analyze	25%			20%		25%	-	-
Level 5	Evaluate	20%			20%	- A.	20%	-	-
Level 6	Create	20%			25%	-	25%	-	-
	Total	10	0%	100	%	10	00 %		-

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Saivineeth, ML Accelerator Architect @ Google	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr.S. Kayalvizhi, SRMIST
2. Mr. Anuj Kumar, Program Delivery Manager, Nagarro	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai	
Software's Pvt Ltd.	Address of the second s	

Course Code	21ECC314J	Course Name	EMBEDDED HARDWARE /	AND OPERATING SYSTEMS	Cour Categ	rse Jory	С			PRO	OFESSI	ONAL	COR	E			L T 2 0	P 2	C 3
Pre-requ Cours	iisite es	Nil	Co- requisite Courses	Nil	P	rogres Cours	sive es						Nil						
Course	Offering Departme	ent	ECE	Data Book / Codes / Stan	dards							Nil							
Course L	earning Rationale	(CLR):	The purpose of learning this cours	e is to:		1	18		Progra	n Ou	tcomes	s (PO)	)				Pi	rogra	m
CLR-1:	Recoanize the fu	ndamental	ls of ARM instruction set architectures	12 12	1	2	3	4	5	6	7	8	9	10	11	12	S	pecifi	C
CI R-2:	Emphasize on Al	RM cortex	microcontroller features		0			of		ŝt			×				00		53
CLR-3	Realize the threa	d manadei	men <mark>t and parallel programming in RT</mark> I	25	edge		nt of	ions	Φ	socie			Worl		ance				
CLR-4:	Comprehend the	scheduling	a process in RTOS		Non	/sis	pme	tigat	Jsag	and	~*		eam	Ę	Fina	rning			1
CLR-5:	Study and implen	nent the ca	ase study through sample use cases		eering K	em Anal	In/develo	uct inves lex probl	rn Tool (	ngineer	onment 8 inability	"	dual & T	nunicatic	ct Mgt. &	ong Leai	1	2	3
Course O	utcomes (CO):		At the end of this course, learners	will be able to:	Engin	Proble	Desig	Cond	Aode	The e	Envire	Ethics	ndivi	Comr	roje	ife L	-OSc	-OS	-OS
CO-1:	Write program wi	th the A <mark>RN</mark>	<i>M microprocessor instructions</i>	Carlo Anne Mar	3	-	-	-	2	7	-	-	-	-	-	-	-	-	-
CO-2:	Interpret the arch	itectura <mark>l fe</mark>	eatures of microcontrollers	HAR BUSE	3		12	-	2	-	_	-	-	-	-	-	-	-	-
CO-3:	Apply the concep	ts of thr <mark>ea</mark>	d management in RTOS	1.952 0.02 0.0	3		1.1	-	2	-	-	-		-	-	-	3	-	-
CO-4:	Explicate the sch	eduling <mark>an</mark>	d services of embedded operating sys	stems	3	-	14		-	-	-	-	-	-	-	-	3	-	-
CO-5:	Analyze the featu	res and <mark>R</mark>	TOS services through related sample	use cases	3	1	6.3	2	-	24	-	-	-	-	-	-	3	-	-
Unit-1 - N Cortex-M debugging Practice	licroprocessor and Processor architector example with simu ARM Cortex assem	I Microcor ure- ARM ( lation- Mei bly Janqua	ntroller Cortex assembly language - Program mory management. ge with simulator. C. & assembly prog	ning exercises -ARM Cortex micro	controller i	nterfac	e stano	ards- II	DE softv	vare t	tools- E	mbed	ded de	buggin	ng tools	s in Kei	il IDE-	<b>12</b> Embe	Hour dded
Unit-2 - N	licrocontroller Fea	tures			1.0				1									12	Hour
Parallel I/ capture re OS consic <b>Practice</b> :	O programming- Sa gisters - SSI interfa lerations of I/O devi Interrupts and timer	mple progr ce- SSI pro ces s in C and	rams- Interrupt processing basics- Sys ogramming with interrupt- Analog I/O; I assembly, A/D interfacing, Debugging	stem tick; periodic interrupts- Cond A/D converter interfacing- Progran g hardware with target board	litional exe nming exar	cution- nple-	UART	prograi	nming-	Digiti	al signa	l time	measi	uremer	nt- Use	of time	ers an	d com	pare,
Unit-3 - T	hread Managemen	t																12	Hour
Introduction Operation	on to RTOS- Concu s on semaphores- F	rrent progra Resource s	ramming- Thread fundamentals- Share sharing- Conditional variable- Thread ( - DTOS Multitume data and institution in the	ed resources and Critical sections- communications- Process manager	Consumer ment- Dyna	<sup>-</sup> produ amic lir	cer pro nking ar	blem- S nd loadi	witchin ng.	g thre	eads- Pi	rofiling	g the C	IS- Ser	naphoi	res and	t imple	menta	ation-

Practice: Simple thread programming in RTOS, Multithreaded application in RTOS, Program profiling

### Unit-4 - RTOS Services

Spin-lock semaphore, Cooperative scheduler, Blocked state- Implementation- Thread rendezvous- Example- FIFO & Little's theorem- Three semaphore implementations- Kahn process networks- Thread sleeping-Deadlocks, monitors- Fixed scheduling

Practice: Two semaphore implementation, one semaphore implementation, Multithreaded application with communication, Priority based scheduling; threads and communications

## Unit-5 - Real-Time Embedded Systems

Real time systems: Data acquisition system- Approach- Performance Metrics-Examples- Multilevel feedback queue- priority scheduler- DMA / high speed interface- Solid state disk- Flash device driver- SD card interface- Communication systems with Ethernet- Application layer protocols for embedded systems- CoAP, MQTT

Practice : Priority based scheduling; threads and communications, Semaphore implementation experiment in RTOS, Application programs using RTOS

Loorning	1. Jonathan Valvano, "Real time operating systems for ARM Cortex-	3. Quing Li, "Real time techniques for embedded systems", CMP Books, 2003
Desources	Microcontrollers, Embedded systems - Volume 3", Jonathan Valvano, 2017.	4. K.C. Wang, "Embedded and Real time operating systems", Springer, 2017.
Resources	2. Andrew Sloss ET all, "ARM system developer's guide", Elsevier, 2004.	5. www.arm.com, for ARM cortex M references

			Continuous Learning	Assessment (CLA)		Summotivo				
	Bloom's Level of Thinking	Form CLA-1 Averag (45	ative ge of unit test %)	Life-Long CL (1:	a Learning A-2 5%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice			
Level 1	Remember	15%			15%	15%	-			
Level 2	Understand	25%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1	15%	<mark>25</mark> %	-			
Level 3	Apply	30%	10 S 10 S 10 S 10		30%	30%	-			
Level 4	Analyze	30%		1	30%	30%	-			
Level 5	Evaluate	1200		UHD- AUX	5%	-	-			
Level 6	Create		· · ·	A PARTY OF	5%		-			
	Total	100	100 %		0%	100 %				

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mr. Saivineeth, ML Accelerator Architect @ Google	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr. P. Radhika, SRMIST	
2. Mr. Anuj Kumar, Program Delivery Manager, Nagarro	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai		
Software's Pvt Ltd.	2 A. (* 131 A. 196		

12 Hour

Course Code	21ECC315T	Course Name	)	DATA BASE M	ANAGEME	INT SYSTEMS		C	Cours atego	e ry	С			PR	OFESS	SIONA	L COR	E			L T 3 0	P 0	C 3
Pre-requi Course	site s	Nil		Co- requisite Courses		Nil			Pro	ogres Cours	sive es				_		Ni	1					
Course	Offering Departme	ent		ECE		Data Book / C	Codes / Sta	indards	1							Nil							
					-	-	-		<u>.</u>	1	1												
Course Le	arning Rationale	(CLR):	The purpose	of learning this co	ourse is to							1	Progr	am Ou	utcome	es (PO	)		1		- 5	rogra	m ic
CLR-1:	Understand the f	undamenta	als of Databas	<mark>e Mana</mark> gement Sys	tems, Arch	itecture and Lar	nguages		1	2	3	4	5	6	7	8	9	10	11	12	0	itcom	es
CLR-2:	Conceive the date	abase desi	ign pr <mark>ocess th</mark>	<mark>roug</mark> h ER Model an	nd Relation	al Model	arrest in			3			24		lity								
CLR-3:	Design Logical D Language Featur	atabase S es	Sche <mark>ma and m</mark>	apping it to implem	nentation le	evel schema thr	rough Datal	base	edge		nt of	ons of	0	society	stainabi		Work		nce				
CLR-4:	Understand the recovery	practical p	problems of c	oncurrency control	and gain	knowledge abo	out failures	and	Knowl	alysis	lopme	estigati blems	l Usage	er and s	t & Sus		Team	tion	& Fina	arning			
CLR-5:	Familiarize the ba	asics of dis	stributed datab	ase management s	systems				heering	em An:	gn/deve	luct invi	ern Too	enginee	onmen	s	dual &	munica	ct Mgt.	ong Le	t-	5	က္
Course Ou	tcomes (CO):		At the end o	f this course, learn	ners will b	e able to:	2000		Engir	robl	Desig	Cond	Aode	The	Envir	Ethic	ndivi	Com	roje	ife L	SO.	0SC	0Sc
CO-1:	Identify and defin usiness informati	e the in <mark>forr</mark> on prob <mark>lem</mark>	mation that is	needed to design a	database i	management sy	stem for a		3	2		-			-	-	-	-	-	-	3	-	-
CO-2:	Create conceptua	al and lo <mark>gic</mark>	<mark>cal dat</mark> abase o	esigns for a busine	ss informat	tion problem	100		2	3		-	3	-	-	-	-	-	-	-	-	-	-
CO-3:	Build a database queries	managem	ent system the	at satisfies relationa	al theory an	d provides user	rs with busir	ness	3	3	2	63	-		-	-	-	-	-	-	3	-	-
CO-4:	Describe transact	tion proc <mark>es</mark>	<mark>ssing an</mark> d cond	currency control con	ncepts.	1	No.	1	2	2	-	-	3	-	-	-	-	-	-	-	-	2	-
CO-5:	Understand distri	buted data	abase systems	architecture and de	esign			C.	2	1	-	-	3	-		-	-	-	-	-	-	-	-
Unit-1 - Da	tabase Systems	d Transacti	ione: database		fdatabaaa	ovetem view o	f data, rolat	tional d	otobor	an d	atabaa	o orobi	tooture	trans	action	monor	amon	tData N	Indolo	· Tho ir	nnorto	9	Hour
models, Ba	asic building blocks Cursors and Trans	, Business saction. Co	s rules, The evolutions and	olution of data mod	lels, Degre es, Procedi	es of data abstr ures and Functi	raction PL-S	SQL: Be tions Ha	a abas eginnir andlind	ng wit ng wit	h PL /	SQL, I With (	dentifie Clause	ers and H	d Keyw lierarch	ords, (	Operati Operati etrieva	ors, Ex I. Triao	pressic pressic iers.	ons, Se	quenc	es, C	ontrol
Unit-2 - Da	tabase Design					ALC: N				,,								.,				9	Hour
Entity-Rela	tionship model - E- Id Normal Form, M	-R Diagran	ns - Enhanced	I-ER Model - ER-to-	-Relational	Mapping - Fund	ctional Depe	endenc	ies - N	lon-lo	ss Dec	compos	sition -	First, S	Second	l, Thirc	d Norm	al Forr	ns, Dej	bender	icy Pre	serva	ntion -
Init-3 - Re	a Normal Porm - Mi	uili-vaiueu	Dependencie		ai Fuini - Ju	Jin Dependencie	es anu riiui	1 NUITIG	IFUII	1	-											9	Hour
Relational	Algebra and Calcul	lus: Relatio	onal algebra: ii	ntroduction, Selectio	on, and pro	jection, set ope	rations, ren	naming,	Joins,	Divis	ion, sy	ntax, s	emant	ics. Op	perator	s, grou	iping a	nd ung	rouping	g, relati	ional c	ompa	rison
Calculus: 1	uple relational cal	culus, Dom	nain relational	Calculu <mark>s, calculus v</mark>	<mark>/s algebra</mark> ,	computational of	capabilities	s															
Unit-4 - Tr	ansaction Manage	ement							,						,				•			9	Hour
I ransaction	n processing - Coi Case study	ncurrency	control - ACIL	property - Serializ	zability of s	scheduling - Lo	cking and t	timesta	np-ba	sed s	chedu	ers - r	nulti-ve	ersion	and op	otimisti	c Con	currenc	cy Con	trol sch	nemes	-Data	ibase
1000vory- C																							

Unit-5 - Distributed Database Management Systems	9 Hour
Distributed Databases: Architecture, – Client/Server, Peer to peer, MDBS Systems, Distributed Data Processi	ing, -Promises of DDBSs, - Complicating factors- Design Alternatives- Fragmentation
1. Data base Management Systems, Raghu Ramakrishnan, Johannes Gehrke, McGraw	4. S. Sudarshan, McGraw Hill Education (India) Private Limited I, 6th edition, 2011
Hill Education (India) Private Limited 2rd Edition 2002	E Detabage Systems Design Implementation and Management Bater Bab & Carlos Caronal

			Bata base management bystems, ragna randanoman, bonamice benne, mobila	1 1.	e. Eddaronan, meeraw nin Eddoalon (india) i nivato Ennicou i, otri editori, zern
l	Loarning		Hill Education (India) Private Limited, 3rd Edition, 2003	5.	Database Systems Design, Implementation, and Management, Peter Rob & Carlos Coronel,
ľ	Descuress	2.	Fundamental of Database Systems, Ramez Elmasri, Shamkant B. Navathe, Pearson	1.1	7th Ed., 2011.
ľ	Resources		Education, 6th edition, 2011	6.	Principles of Distributed Database Systems, Ozsu, Pearson Publication, 2011
l		3.	Data base System Concepts, A. Silberschatz, and Henry, F. Korth,	7.	.6. Distributed Database Mangement Systems, Rahimi & Haug, Wiley, 2010

Learning Assessn	ient		Continuous Learnin	a Assessment (CLA)	9	_	
	Bloom's Level of <mark>Thinking</mark>	Forn CLA-1 Avera (50	native ge of unit test 0%)	g Learning _A-2 0%)	Sum Final Ex (40% w	mative amination eightage)	
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%		15%		15%	-
Level 2	Understand	25%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	20%		25%	-
Level 3	Apply	30%		25%		30%	-
Level 4	Analyze	30%	to bush he	25%	10 1 1 1 A	30%	-
Level 5	Evaluate			10%		-	-
Level 6	Create	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		5%		- H	-
	Total	-10	0 %	10	0%	10	0%

Course Designers								
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts						
1. Mr. Saivineeth, ML Accelerator Architect @ Google	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr.K. Kalimuthu, SRMIST						
2. Mr. Anuj Kumar, Program Delivery Manager, Nagarro	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai							
Software's Pvt Ltd.	The second se							



Course Code	e 21ECC317T Course DATA COMMUNICATION AND PLC							С			PR	OFESS	IONA	L COR	E			- T 3 0	P 0	C 3
Pre-requi Course	site s	Nil	Co- req Cours	uisite es	Nil	P	rogres Cours	sive ses						Nil	1					
Course (	Offering Departme	nt	ECE		Data Book / Codes / Standa	rds							Nil							
Course Le	arning Rationale (	CLR): 7	The purpo <mark>se of learnin</mark>	g this course	is to:	Program Outcomes (PO)										Program				
CLR-1:	Obtain knowledge	in Physica	al layer	- 10	0.22	1	2	3	4	5	6	7	8	9	10	11	12	01 01	pecifi itcom	c es
CLR-2:	Know the various	data link la	yer p <mark>rotocols and</mark> multij	ole access sch	emes	e		f	s of	20	iety			¥		0				
CLR-3:	-3: Understand various network layer protocols								s	ge	soc			oW r		ance	D		 	
CLR-4:	CLR-4: Describe the functionality of transport and application layer							mdo	stiga	Usa	and	∞ .		earr	uo	Z Fin	arnin		 	
CLR-5:         Gain knowledge on programmable logic controllers							n Ana	/devel	t inve x prob	Tool	gineer	ment		lal & T	nicati	Mgt. 8	ng Lea			
Course Ou	itcomes (CO):	(CO): At the end of this course, learners will be able to:				Engine	robler	Design	Conduction	Aoderr	he en	Enviror	Ethics	ndividu	Commu	roject	ife Lor	SO-1	SO-2	SO-3
CO-1:	Apply modulation,	sampling r	multiplexing techniques	for effective d	ata communication	2	3	-	-	-		-	-	-	-	-	-	-	-	-
CO-2:	Incorporate data to share themedi	link la <mark>yer</mark> ium	protocols to have erro	or and flow c	ontrol and multiple access schem	es _	2	3	3	-	-	2	-	-	-	-	-	2	-	-
CO-3:	Analyze various n	etwork <mark>laye</mark>	er protocols and multiple	e acc <mark>ess</mark> schei	nes	-	2	1	3	-		-	-	-	-	-	-	-	-	-
CO-4:	Demonstrate the o	concep <mark>ts of</mark>	<sup>f</sup> transportation and App	lication layer p	protocols		-	2	10.2	3		-	-	-	-	-	-	-	-	2
CO-5:	Implement Progra	mmabl <mark>e lo</mark> g	<mark>gic co</mark> ntrollers in suitabl	e applications		-	-	2	-	3	-	-	-	-	-	-	-	-	-	2
Unit-1 - Ph Line coding Impulse Tra Noise, Bas Synchrono Unit-2 - Da Framing, B	ysical Layer n, Modulation-Amplin ain Sampling, Reco ic digital modulatic us Versus Asynchro ta Link Layer Prot it Stuffing, Flow Co	tude modul nstruction of on scheme. onous TDM, ocols and ntrol-The S	lation, Over modulation of the Continuous-Time s- Amplitude-Shift Key Modems, Transmissio Multiple Access Sche Stop-and-Wait Protocol,	and Distortion, Signal, Stater ing, Frequenc n media -Twist <b>mes</b> Error Detectio	, Single-Sideband Suppressed-Carr nent of the Sampling Theorem, Pro y-Shift Keying, Phase-Shift Keying ed Pair, Coaxial Cable, Optical Fibe on-Parity Checking, Two-Dimensior	ier Ampli of of the , Media r, Fiber N al Parity	tude N Samp acces lodes,	lodulat ling Th s shar Wirele ic Redu	ion, Fre leorem, ing sch ss med undancy	equenc Analo nemes- ium, C v Chec	y Mod g-to-D - Freq hanne cking,	lulation, Digital C Uuency I impair Error C	Phase onverse Division ments control	e Modu sion: F on Mul - Atten Protoc	ulation, from PA tiplexin nuation, cols- Si	Sampi AM to F g, Tim Noise, top-and	ling The PCM-P le Divis Distor	eorem CM, Q sion M tion, E ARQ.	9 - Anal Juantiz Jultiple Equaliz 9 Go-Ba	Hour yzing ation xing, zation Hour ack-N
ARQ, Sele Polling, Tol	ctive Repeat ARQ, ken Passing, Rando	Data Link om Access	Control Protocols-High Schemes, Aloha Syste	level Data Lin <mark>n, Slotted Alol</mark>	k Control, Point-to-Point Protocol, I ha, CSMA, CSMA/CD, CSMA/CA	Aultiple /	Access	Schei	mes- O	rthogo	nal Ac	cess S	cheme	es, Col	ntrolled	Acces	s Sch	emes-	Centra	alized
IP Address	<b>twork Layer</b> , Maximum Transmi	ission Unit.	IP Version 4 Addressin	g, IP Subnettin	g, Variable Length Subnet Mask Ne	tworks.II	Pv6-IP	v6 Hea	der, Co	ncept	of Flex	kible Ad	dressi	ing in II	Pv6, Ro	outing A	Algorith	nms-St	9 atic V	Hour ersus

IP Address, Maximum Transmission Unit, IP Version 4 Addressing, IP Subnetting, Variable Length Subnet Mask Networks, IPv6-IPv6 Header, Concept of Flexible Addressing in IPv6, Routing Algorithms-Static Versus Dynamic Routing, Link-State Versus Distance–Vector Routing, Flat Versus Hierarchical Routing, Host-Based Versus Router-Intelligent Routing, Centralized Versus Distributed Routing, Routing Metrics, Distance– Vector Routing Algorithms, Link-State Routing Algorithms, Open Shortest Path First Protocol, The Dijkstra's Algorithm

### Unit-4 – Transport Layer and Application Layer

TCP Basics, TCP Ports, TCP Sockets, TCP Segment Format, TCP Connection Establishment, TCP Connection Release, TCP Connection Management, TCP Flow Control-Slow start, Congestion avoidance, Fast retransmit, Fast recovery, UDP, Application layer-Dynamic Host Configuration Protocol-DHCP Basics, Discovery Phase, Offer Phase, Request Phase, Acknowledgment Phase, DNS-Structure of the DNS, DNS Queries, Name-to-Address Resolution Process, DNS Zones, DNS Zone Updates, Dynamic Update 9 Hour

#### Unit-5 – Programmable Logic Controllers

controllers, programmable logic controllers, Hardware of PLC system, Internal architecture, Input devices- Temperature sensors, strain gauges, output devices-Relay, directional control valves, Examples of applications-A robot control system, Liquid level monitoring, Ladder and functional block programming-Ladder diagrams, PLC ladder programming, Latching, Multiple outputs, Entering programs- ladder symbolsprogram examples-location of stop switches-safe systems-PLC systems and safety.

1.4

Learning	1.	Oliver C. IBE, Fundamentals of Data Communication Networks, Wiley, 2018.	3.	W.Bolton, Programmable logic controllers, Sixth edition, Newnes, 2015
Resources	2.	Robert Techo, Data Communications-An introduction to concepts and design, Springer, 2013	4.	Frank D.Petruzella, Programmable logic controllers, Mc-Graw Hill Eucation, 2016

Learning Assessm	nent		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1							
		N 1	Continuous Learning	g Assessment (CLA)	· · /* ·	Cum	mativa			
	Bloom's Level of Thinking	Form CLA-1 Averag (50	ative ge of unit test %)	Life-Long CL (10	g Learning A-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice			
Level 1	Remember	15%	the Arrest Co	15%		<u>15%</u>	-			
Level 2	Understand	25%	A REAGE	20%		<mark>25</mark> %	-			
Level 3	Apply	30%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	25%		<u>30%</u>	-			
Level 4	Analyze	30%		25%		<u>30%</u>	-			
Level 5	Evaluate	No. of Concession		10%		-	-			
Level 6	Create			5%		-	-			
	Total	100	%	10	0%	10	0%			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Saivineeth, ML Accelerator Architect @ Google	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr.S. Krithig <mark>a, SRMIST</mark>
2. Mr. Anuj Kumar, Program Delivery Manager, Nagarro	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai	
Software's Pvt Ltd.	a second s	

Course Code	21ECC412J	MING WITH PYTHON	Ca	Cours atego	e ory	С	PROFESSIONAL CORE							P 2	C 3						
Pre-requ Course	isite es	Nil		Co- requisite Course <mark>s</mark>	Nil		Pro	ogres Cours	sive es						Nil	1					
Course	Offering Departm	ent		ECE	Data Book / Code	s / Standards	2							Nil							
Course Le	earning Rationale	(CLR):	The purpo	se <mark>of learnin</mark> g this c	ourse is to:		-	1			Progra	am Ou	Itcome	s (PO	)				Pi	rogra	m
CLR-1:	Introduce the bas	sics of Pyth	hon	-			1	2	3	4	5	6	7	8	9	10	11	12	S Ou	pecifi Itcom	ic 1es
CLR-2:	Explore the adva	nced featu	ures lik <mark>e clas</mark>	ses and modules	in the second		e			s of	1.	ety			¥		0				
CLR-3:	CLR-3: Define System Programming for optimization of codes								ent o	tions	ge	soci			No No		ance	5			
CLR-4:	Implement the in	ternet prog	gra <mark>mming fo</mark> i	r different web page a	pplications		<ul><li>Anov</li></ul>	lysis	mdo	stiga	Usa	and	∞ŏ .		earr	и	Z Fin	arnin			
CLR-5:	Use Python Prog	ramming <mark>f</mark>	fo <mark>r autom</mark> atin	ng the various tasks			ering I	n Ana	/devel	st inve x prob	Tool	gineer	ability		lal & T	unicati	Mgt. 8	ng Lea			
Course O	utcomes (CO):	_	At the end	of this course, lear	ners will be able to:		ngine	robler	esign	onduc	oderr	he en	nviror ustain	thics	dividu	ommu	roject	fe Lor	SO-1	S0-2	SO-3
CO-1:	Write simple pyth	non progra	ms using dif	ferent data types and	control statements	1.10	<u>ш</u>	3		08 -	3	E	<u>ш</u> о	<u>ш</u> -	3	<u> </u>		-	2	<u> </u>	-
CO-2:	Define own class	ses and fun	nctions to or	nanize the code			-	3	12	-	3	1		_	3	-	-	-	2	-	-
CO-3:	Optimize the app	lications u	ising multithr	reading	11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1					2	3			-	3	-	-	-	-	-	2
CO-4:	Perform data cor	nmunicatio	on between v	websites and develop	interactive web pages	120.0	14			3	3			_	3	-	-	-	-	-	3
CO-5:	Automate the val	rious tasks	s using Pytho	on Programs.	, , , , , , , , , , , , , , , , , , ,		23	12	3	-	3	2	-	-	3	-	-	-	-	-	3
			0,									6							I		
Unit-1 - P	ython Basics								<u> </u>			-								12	Hour
Introductio	n to Python - Pytho	on Interpret	eter and its w	orking - Syntax and S	emantics - Data Types - Assig	nments and Ex	press	sions -	Contro	ol Flow	Staten	ients -	- Seque	ences	- Lists	- Tuple	es - Dic	tionari	es - Fu	inctio	ns
Practice:	Simple programs to	o compute	mathematic	al Formulas. Program	ming on Functions. Programm	ina on Lists. Tu	ıples	and D	ictiona	ries											
Unit-2 - A	dvanced Python F	eatures				<u> </u>					1									12	Hour
Iterations a	and Comprehensio	ns - Handli	ling text files	- Modules - Classes -	OOPs - Exception Handling -	Strings and Re	gular	Expre	essions		1										
Practice:	Programming on C	lass, String	g Manipulatio	o <mark>ns, Re</mark> ading and Wri	ting Text Files	IL D'AN					1										
Unit-3 - S	ystem Programmi	ng																		12	Hour
System I c	ools: sys module - (	)S module	e - File Tools	- Directory Tools - Pa	rallel System Tools: Threads, I	Program Exits,	multi	proce	ssing n	nodule											
Practice:	erogramming using ternet Programmi	ina ina	s, Programm	ing using Directory T	JOIS,				-		-									12	Hour
Network S	criptina: Socket Pro	ogrammino	a. Handlina M	Multiple Clients - Clier	t-Side Scripting: FTP and SM1	P - Server Side	e Scr	intina	CGL	Scripts v	vith Us	erInte	raction	Pass	ina Pa	ramete	ers			12	noul
Practice:	Socket Programmi	ng, Prograi	mming on F	TP, Passing paramete	ers in URLs		2 0011	,y		5		5		,							

## Unit-5 - Automating Tasks using Python

Patten Matching: Phone number detection, Strong Password detection, Organizing Files: Copying, Moving, Renaming and deleting of Files and File Folders, Compressing files with the zipfile module, Drawing shapes and text

Practice: Verification of phone number, Detection of Strong Password, Drawing shapes and text

Learning	1.	"Learning Python" by Mark Lutz, 5th Edition, O'Reilly Media, June 2013	3. "Automate the Boring Stuff with Python" by AI Sweigart, 2015, William Pollock
Resources	2.	"Programming Python" by Mark Lutz, 4th Edition, O'Reilly Media, 2010,	

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arning Assessn	nent		Sec.		~							
	Continuous Learning Assessment (CLA)											
	Bloom's Level of Th <mark>inking</mark>	Form CLA-1 Avera (45	ative ge of unit test %)	Life-Lon Cl (1	g Learning _A-2 5%)	Final Examination (40% weightage)						
		Theory	Practice	Theory	Practice	Theory	Practice					
Level 1	Remember	15%			15%	15%	-					
Level 2	Understand	15%			15%	25%	-					
Level 3	Apply	30%	Carl Maria		30%	30%	-					
Level 4	Analyze	20%			20%	30%	-					
Level 5	Evaluate	10%	1 - CH2 10		10%	-	-					
Level 6	Create	10%		E. Starte	10%	-	-					
	Total	100	)%	10	0%	10	0%					

Course Designers							
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts					
1. Mr. Anuj Kumar, Program Delivery Manager, Nagarro	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University,	1. Dr. E. Chitra, SRMIST					
Software's Pvt Ltd.	meena68@annauniv.edu						
2. Ms. Roshni Rajan, SDE II, Amazon, US.	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in						
Mr. S. Ashish, Software Engineer, TCS – Digital, Chennai							



B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

Course Code         21ECC413T         Course Name         FPGA BASED EMBEDDED SYSTEMS								ourse tegor	y	С			PR	OFESS	IONAI	L COR	E		l	- T 3 0	P 0	C 3
Pre-requis Courses	site s	Nil		Co- requisite Courses		Nil		Prog	gress ourse	sive es						Nil						
Course C	Offering Departme	ent		ECE		Data Book / Codes / S	Standards	1							Nil							
Course Lea	arning Rationale (	CLR):	The purpo	se of learning this	course is to	Serie		-	4	1	11	Progra	m Ou	itcome	s (PO	)				Pr	rogra	m
CLR-1:         Understand the basic concepts of FPGA architecture         1         2         3         4         5         6         7         8         9         10         11								11	12	Specific Outcomes												
CLR-2:	Employ VHDL as	a design	entry l <mark>angua</mark>	age for FPGA Syster	m design		-	e		Į	s of	10	ety			논		0				
CLR-3:	<b><i>R-3:</i></b> Design and construct simple system design using arithmetic and logic units									ento	tions	ge	soci			Wo		ance	0			
CLR-4:	Acquire the know	ledge of e	mbedded p	rocessor and hardwa	are accelerat	ed design.	24.7	Vou	lysis	opme	stiga Iems	Usa	and	~~~		eam	ы	Ë	Inin			
CLR-5:         Practice coding for various application using FPGA tools								ering h	n Ana	/devel	ot inve x prob	Tool	gineer	iment ability		al & T	unicati	Mgt. 8	ng Lea			
Course Outcomes (CO): At the end of this course, learners will be able to:						Engine	Probler	Design	Conduc comple	Moderr	The en	Enviror Sustair	Ethics	ndividu	Commu	Project	-ife Loi	-SO-1	SO-2	SO-3		
CO-1:	Acquire knowledg	e on FP <mark>G</mark>	A architect	ure and practice on I	HDL lan <mark>guag</mark>	0	141-1	3	-	-	-	2	-	-	-	-	-	-	-	-		-
CO-2:	Design and imple	ment th <mark>e</mark>	digital circui	ts using VHDL.	A States of	- 100 C.E.		2	-	3	-	3	-		-	-	-	-	-	2	-	-
CO-3:	Construct various	subsys <mark>te</mark>	ems for FPG	A system design	10.000	5 - 10 C		2	-	3	-	3	- 10	-		-	-	-	-	-	-	-
CO-4:	Develop the embe	edded h <mark>ar</mark>	rdware acce	lerated design for re	al time applic	cations	100	14		3	-	2	-	-	-	-	-	-	-	3	-	-
CO-5:	Implement the va	rious ap <mark>pl</mark>	<mark>lications</mark> usii	ng SysGen and Viva	do tool for pr	actice		-	-	3	-	3	2	-	-	-	-	-	-	3	-	-
I Init-1 – FF	GA Architecture			<	Contine							1	÷.	<u></u>							9	Hour
FPGA Intro	duction- FPGA Inte	, ernal archi	itectures- Fin	ne, medium, and coa	rse-grained a	architectures- CLBs, LAB	Bs &Slices-L	ogic I	mple	mentat	ion us <mark>i</mark>	ng MUX	( and	LUTs-	Progra	ammak	le Inter	rconne	ctions-	Anti-fu	ise, Si	RAM-
Fine, EEPF	OM-Embedded m	ultipliers, J	Adders, <mark>M</mark> A	Cs-Embedded proce	essor cores-c	lock tree and clock man	ager-gener	al purp	oose	1/O, Ha	ard IP,	Soft IP	and F	Firm IP-	FPGA	Imple	mentat	ion pro	cess fo	or Digi	tal log	ics
Unit-2 – Di	gital Circuit Desig	n with V	HDL						, ,		-				4 1115						9	Hour
Introduction	-Code design stru	ctures-Da	ta types and	their conversions-	Operators an	d Attributes-Concurrent	code -Seq	uentia	l cod	e-Flip-	-lops-L	oata sh	ift reg	listers-N	Aultifre	equenc	sy gene	rator				
Unit-3 – Ar	itnmetic, Logical	Program	ming and S	imple System Desi	ign motio and La	ais Unit Dom donian on	d Logio imp	lomor	tatia		dooigr	Count	for do	oian on	d Into	facing	Diaito	Lalaak	doolan	andl	9 ntorfo	Hour
Init-4 – Ha	rdware Accelerat	ad Desia	upiy –Accui ns		metic and Lo	gic Unit-Rom design an	u Logic imp	iemen	itatio	II-RAM	uesigi	-Couri	er ue	signan	u me	nacing	i-Digita	I CIUCK	uesign	anu n		Hour
A simple en	nbedded processo	r-soft core	e processor	on an FPGA –Real t	time clock an	d Interface protocol Pro	arammina-l	nter-Ir	nteara	ated cir	cuit Int	erface	Proar	ammino	a-UAR	RT- Sei	rial peri	pheral	interfa	ce pro	arami	nina
Unit-5 – Sy	sGen and Vivado	tool Pra	ctice		,		J		3/ 0						,	201					9	Hour
Use and Int	erfacing methods	of some B	Blocksets-Sy	rstem d <mark>esign and Im</mark>	plementation	using SysGen tool. Zyn	nq 7 series a	archite	ecture	e-Use N	/ivado	design	flow t	o build	an Err	nbedde	ed Syst	em-Ad	ding IP	cores	in PL	

Learning	1. Raj, A. Arockia Bazil," FPGA-Based Embedded System Developer's Guide"	3. https://www.xilinx.com/support/university.html
Desources	Taylor & Francis, CRC Press, 2018	4. Sass and Schmidt, "Embedded system design with Platform FPGAs", Morgan Kaufmann, 2010.
Resources	<ol><li>Clive Maxfield, "FPGAs world class designs, Newnes 2009</li></ol>	5. www.arm.com for processor architecture

Learning Assessm	ent		Contraction of the	5-92.62 C						
			Continuous Learning	Assessment (CLA)		Sum	mativa			
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test 0%)	Life-Loi C (	ng Learn <mark>ing</mark> CLA-2 10%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	20%	and the second se	20%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	20%	-			
Level 2	Understand	25%		25%		25%	-			
Level 3	Apply	35%		35%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	35%	-			
Level 4	Analyze	20%	and the second second	20%		20%	-			
Level 5	Evaluate	N		1000			-			
Level 6	Create			San Street Street		-	-			
	Total	10	0%	1	100 %	10	0 %			
					Contra la					

Course Designers		1
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Saivineeth, ML Accelerator Architect @ Google	1. Dr. Elango Sekar, Assistant Professor (Level -III), BIT Sathyamangalam, TN, India	1. Dr. P. Radhika, SRMIST
<ol> <li>Mr. Anuj Kumar, Program Delivery Manager, Nagarro Software's Pvt Ltd.</li> </ol>	2. Dr. Meenakshi, Professor of ECE, CEG, Anna University	



# ACADEMIC CURRICULA

Professional Elective Courses

**Regulations 2021** 



# SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	rse 21ECE210P Course IOT SYSTEM DESIGN			Ca Ca	ours atego	e ry	Е			PROF	ESSIO	NAL E	LECT	IVE		L 2	. T ? 1	P 0	C 3						
Pre-requis Courses	site S	Nil		Co C	- requisit ourse <mark>s</mark>	te		Nil			Pro	gres	sive es						Nil						
Course C	Offering Departme	ent		E	<u>E</u>		Da	ita Book / (	Codes / Stan	dards							_	Nil							
Course Lea	ourse Learning Rationale (CLR): The purpose of learning this course is to:									Program Outcomes (PO)									Pr	ogra	m				
CLR-1: Classify the components and protocols required to build IoT network.						1	2	3	4	5	6	7	8	9	10	11	12	Ou	pecifi	c es					
CLR-2:	Evaluate suitable	protocols	s for th <mark>e IoT</mark>	network		S	1	10-00	4	-	ge		of	s of	2	iety			ırk		e				
CLR-3:	Develop IOT syst	tem for var	rious <mark> applic</mark>	ations	-	- /			200	а.	wledg	<i>(</i> 0	ient o	ation	ge	d soc			n Wo		Jano	ő			
CLR-4:	Analyze the archi	itecture of	<sup>r</sup> lo <mark>T commu</mark>	unication	layers			MC in		1	Knov	lysis	opu	stig:	Usa	anc	৵		Fear	uo	& Fii	arnir	1		
CLR-5:	Demonstrate the	technique	es of Data A	nalytics	and secur	rity for IoT I	networks	;		2	eering	em Ana	n/devel	uct inve ex prot	rn Tool	ngineel	onment inability		dual & <sup>-</sup>	nunicati	st Mgt.	ong Lei	-	2	~
Course Ou	tcomes (CO):		At the en	d of this	course,	learners v	will be ab	ble to:	Autor	17	Engin	roble	Desig	Cond	lode	he e	Enviro	Ethics	ndivic	Comn	rojec	ife Lo	-OS	SO-S	S-OS
CO-1:	Categorize the co	ompone <mark>nts</mark>	s and protoc	cols requ	i <mark>ire</mark> d to bu	uild IoT net	work.	- A.	24.54	1.1	3	-	-	2	1	-	-	-	-	-	-	-	2	-	-
CO-2:	Appraise suitable	protoc <mark>ols</mark>	s for th <mark>e</mark> loT	network				1 B	1955 - S		3		2	-	2	-	-	-	-	-	-	-	-	-	-
CO-3:	Evaluate IOT sys	tem for <mark>va</mark>	<mark>arious a</mark> pplic	cations	15	100		12.09	1.1		3	-	2	-	2	- 10	-	-		-	-	3	3	-	2
CO-4:	Distinguish the ar	rchitectu <mark>re</mark>	<mark>es of lo</mark> T cor	mmunica	tion layer:	s	6470		1.1	2	3	-	2	-	-		-	-	-	-	-	-	-	-	-
CO-5:	Demonstrate the	techniq <mark>ue</mark>	<mark>es of Da</mark> ta A	nalytics	and secur	rity for IoT i	networks	3			3	-	1	2	-	1	-	-	I	-	-	2	3	-	-
<b>Unit-1 - IoT</b> Sensors, A 802 15 4e	<b>Technology</b> ctuators and Sma loT Access Techno	art Objects	's, Smart se	ensor ot	ject hard	lware and or measurir	software	e, Energy r	management	of noc	les, C	Comm	unicat	ion sta	ndard	IEEE8	802.15.4	4, IoT	Acces	s Tecl	nologi	es IEE	E 802.	<b>9</b> .15.4g	<b>Hour</b> 7 And
Unit-2 - IoT	Communication	<u>.</u> .	, and the second	oo otaa			ig enperi	intent denig	le l'illeue					12	-7									9	Hour
IEEE802.11	WiFi communica	tion, Light	tweight IP s	stack, IP	/6 for sma	art object r	networks,	, RPL routi	ing in smart o	objects	Case	Studie	es: Co	mmuni	cation t	hroug	h WiFi,	Comr	nunicat	ion thr	ough B	luetoot	h		
Unit-3 - IoT	Design Applicat	tions aion Smo	ort Crid Sm	ort Citio	c Smort (	oition and I	Urban no	otworka Ha	mo outomotiv	on Pui	Idina	outon	otion	2000 8	udioo	Confi	aurotion	of Dr	onhor	n Di / E	Doordo	Poord	oirouit	9   t with	Hour basia
peripherals.	Non-IP smart object technologies, Smart Grid, Smart Cities, Smart cities and Urban networks, Home automation, Building automationCase Studies: Configuration of Raspberry-Pi/ Beagle Board circuit with basic peripherals. IoT Data Logging using Beaglebone Black and Thingspeak																								
Unit-4 - Pro	Unit-4 - Protocols for IoT 9 Hour																								
Need for Optimization and Nodes, Networks, Optimizing IP For IoT, IoT Layers: : Physical And Controllers – Connectivity Edge Computing And Upper Layers, Core IoT Functional Stack: Sensors And Actuators Layer – Communication Network Layer – Access Network Layer – Gateways And Backhaul , Network Transport – Sublayer – IoT Network Management Sublayer – Applications And Analytics Layer, Data Versus Network Analytics- Smart ServicesIoT Data Management & Compute Stack , IoT Application Transport Methods And ProtocolsCase Studies : IoT Gateway router, Cloud connectivity																									
Unit-5 - Dat	ta Analytics and	Security																						9	Hour
loT Data Al – Predictive Kafka, Lam	IoT Data Analytics Overview & Challenges, Machine Learning Networks: Overview – Supervised & Unsupervised Learning – Neural Networks, Machine Learning Networks & Getting Intelligence From Bigdata – Predictive Analysis, Big Data Analytics Tools and Technology: Massively Parallel Processing Databases – NoSQL Databases., Big Data Analytics Tools And Technology: Hadoop And Ecosystem – Apache Kafka, Lambda Archttecture, IoT SecurityCase Studies: IoT Cloud data analysis, IoT Security																								

	1.	James, A., Seth, A., Mukhopadhyay, S.C. IoT System Design-a Project Based approach. In: IoT	4.	Arsheep Bahga, Vijay Madlseti, "Internet of Things: A hands-on approach",
		System Design. Smart Sensors, Measurement and Instrumentation, vol 41. Springer, Cham, 2022.	5.	Elsevier, 2009.
Learning	2.	Hanes David, Salgueiro Gonzalo, Grossetete Patrick, "IoT fundamentals: Networking technologies,	6.	Adrin McEwan, Hakim Cassimally, "Designing for Internet of Things", John Wiley,
Resources		protocols and use cases for the Internet of Things", Cisco, Pearson India, 2015.		2014.
	З.	Jean-Philippe Vasseur, Adam Dunkels, "Interconnecting Smart Objects with IP, The next Internet",		
		Morgan Kofmann, 2010.		

			Со	ntinuous Learnin	g Assessment (CL	_A)				
	Bloom's Level of Thin <mark>king</mark>	Forr CLA-1 Avera (2	native age of unit test 0%)	Project Bas CL (60	ed Learning A-2 0%)	Report an (2	d Viva Voce 0%)	Final Examination (0% weightage)		
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	
Level 1	Remember	20%		Street - Kalan	15%	-	20%	-	-	
Level 2	Understand	20%	E 27 6 3		20%	-	20%	-	-	
Level 3	Apply	30%			25%	-	30%	-	-	
Level 4	Analyze	20%	1.1	China and	25%		30%		-	
Level 5	Evaluate	10%		C 22 000	10%	Constant of the		-	-	
Level 6	Create		-	242.14	5%	-		-	-	
	Total 100%		0%	10	0%	10	00%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Program Delive <mark>ry Manag</mark> er, Nagarro Software's Pvt Ltd.	1 Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr.T. Deepa, SRMIST
2. Mr. Saivineeth, ML Accelerator Architect @ Google	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai	



Course Code	urse 21ECE211T Course ELECTROMAGNETICS AND ANTENNA THEORY					Ci	Cours atego	e ory	E			PROF	ESSIO	NAL E	ELECT	IVE		L 3	L T P C 3 0 0 3				
Pre-requi Course	site 2	1PYB101J		Co- requisite Courses		Nil	-	Pro	ogres Cours	sive es						Nil							
Course (	Offering Departme	ent		ECE		Data Book / Codes / Sta	andards								Nil								
Course Le	Course Learning Rationale (CLR): The purpose of learning this course is to:								1	1		Progra	am Ou	utcome	s (PO	)				P	rogra	m	
CLR-1: Gain knowledge on the basic concepts and insights of Electric field							1	2	3	4	5	6	7	8	9	10	11	12	S Oi	pecifi utcom	C		
CLR-2:	Attain knowledge of Maxwell's equ	on the basi ations.	ic con <mark>cepts</mark> a	and insights of Ma	ignetic fie	ld with emphasis on the signific	cance	ge		of	s of	25	tiety			rk		e					
CLR-3:	Acquire knowled	ge about the	e va <mark>rious a</mark> nt	enna parameters	. /	1. Sec. 18. G		vled		ent o	ation	ge	soc			۲ Mo		Janc	g			l	
CLR-4:	Analyze the vario	ous func <mark>tions</mark>	s of special j	ourpose antennas	s.	and the state little	1.1	<b>Kno</b>	lysis	mdo	stige	Usa	anc	৵		ean	ы	& Fir	arnin			l	
CLR-5:	Explain the mech	anisms of p	olanar anteni	nas and radio wav	ve propag	ation in the atmosphere.		leering	em Ana	In/devel	uct inve lex prot	ern Tool	engineer	onment iinability	0	dual & <sup>-</sup>	nunicati	ct Mgt.	ong Le:	<b>5</b>	5	ę	
Course Ou	itcomes (CO):		At the end	of this course, le	arners w	ill be able to:		Engir	Probl	Desig	Cond	Node	The e	Envin Susta	Ethics	Indivi	Com	Proje	Life L	-OSG	-OSc	-SO-	
CO-1:	Apply the concep	ots and know	wledge to so	lve problems rela	ted to ele	ctric field.	210	2	3	-	- 1			-	-	-	-	-	-	-	-	-	
CO-2:	Implement the co	oncepts <mark>of M</mark>	<mark>/agne</mark> tic field	and Maxwell's e	quations	in the real-world application	1	2	3	1		-	-	-	-	-	-	-	-	-	-	-	
CO-3:	Familiarize the fu	Indamen <mark>tal  </mark>	parameters	of antenna and ra	diation			3	2	121		-	-	-	-	-	-	-	-	-	_	-	
CO-4:	Analyze the perfo	ormance <mark> var</mark>	<mark>rious</mark> special	purpose antenna	as		1	3	2		12	-		-	-	-	-	-	-	1	_	-	
CO-5:	Acquire the know	/ledge o <mark>n pla</mark>	l <mark>anar a</mark> ntenn	as and radio wave	e p <mark>ropag</mark> a	tion mechanism	1	3	2		-	-			-		-	-	-	3	-	-	
Unit 1 El	lastractation	_		5 - A - A	and and		-					74	1	-							0	How	
Introduction	n to electrostatics-	Rectangula	nr co-ordinate	- Cylindrical & St	pherical C	o-ordinate- Review of vector of	alculus-	Could	omb's	Law a	nd field	intens	itv- Ele	ectric fie	eld due	e to co	ntinuoı	ıs char	ae dist	ributic	n-Cor	ncept	
Derivation	of E due Infinite Lii	ne charge, S	S <mark>heet cha</mark> rge	e and volume Cha	arge, Elec	tric flux density, Gauss <mark>law</mark> ap	olication-	point	char	e and	line cha	arge, F	Relatio	n be <mark>twe</mark>	en E8	V.			9				
Unit-2 - Ma	agnetostatics and	Maxwells I	Equations				1														9	Hou	
Biot savart	law-Magnetic field	l intensity du Iux density	ue to Infinite Maxwell's e	line charge- H- du	Je finite a	nd semi finite line charge- Amj aday's law Displacement curre	pere's cil	cuital	lawo	applic	ation: li mo var	ntinite i vina fie	line cu	irrent- li	ntinite	Sheet	curren	t- Infini	tely lor	g coa	xial		
Unit-3 - Ar	offinite- Magnetic i ntenna Fundamen	tals and Ra	adiations	qualion for static .		iday s iaw, Displacement curre	<i>in, wax</i>	ven 30	squali		me var	ying ne	<i>.</i>								9	Нош	
Basic Ante	nna parameters - A	Antenna field	d zones - An	tenna Reciprocity	/ Theoren	ns - Friis transmission equation	n- Radiat	ion M	lechai	nism- F	Radiatio	n: Ret	arded	potentia	al - Fa	r Field	due to	an alte	ernating	g curre	ent ele	men	
- Power Ra	diated by a curren	t element - I	Far field due	to sinusoidal cur	rent distri	bution for half wave dipole and	Quarter	wave	e mon	opole.	-												
Unit-4 - An	itenna Types and	its Applica	ations	Lita Dadiation Day	aiotonoo	Folded dinale enterna Horn	ontonno	Hal	ical a	ntonno	dooign	Dof	octor /	Intonno	o Vo	<u>ai 11a</u>	la anta		00 000	india (	9	Hou	
I naveling w	vave antennas - So anar Antennas	juare Loop a	antenna ano	ils Radiation Res	sistance -	Folded dipole antenna - Horn	antenna	- nei	ical a	nenna	aesign	- Relie	ecior P	Antenna	s-ra	gi - Ua	a ante	nna - L	og peri	ouic a	nterin Q	a Hou	
Micro strip	antenna design – (	Circular pola	arized Patch	antennas - Arrav	s and Fee	d Networks – Planar Array - A	ntenna b	eamf	ormin	g, Moc	les of ra	dio wa	ave pro	opagatio	on and	l wave	charad	cteristic	s- Cas	e stuc	ly on S	Sman	
antenna sy	stems	,											,	, , ,	-	-			-	-			

Learning Resources	1. 2. 3.	Matthew N. O. Sadiku., S. V. Kulkarni, Elements of Electromagnetics, 7th ed., Oxford university Press, 2018 Constantine Balanis. A, "Antenna Theory: Analysis and Design", 4th Edition, Wiley, 2016. K.D. Prasad, SatyaPrakashan, "Antennas and Wave Propagation," Tech. India Publications, New Delhi, 2001	4. 5.	John D Kraus , Ronald J Marhefka, Ahmed S Khan "Antenna and wave propagation" 5th Edition, McGraw Hill Education 2017 G. S. N. Raju, Electromagnetic Field Theory and Transmission Lines, Pearson Education, 2006

		Summotivo							
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test 0%)	Life-Lon Cl (1	g Learning LA-2 0%)	Final Ex (40% w	amination eightage)		
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%		15%		15%	-		
Level 2	Understand	25%	And and the second	20%		25%	-		
Level 3	Apply	30%		25%		30%	-		
Level 4	Analyze	30%		25%		<mark>3</mark> 0%	-		
Level 5	Evaluate		and the second second	10%		-	-		
Level 6	Create			5%	1 - 1 - 1 -	-	-		
	Total	10	0%	10	0 %	100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. V. Sangeetha, Manger R&D (Networking and	1. Dr.B.Manimegakai, Professor, Thiagarajar college of Engineering,	1. Dr.S. Bashyam, SRMIST
Communications), FLDEC Systems, Pvt Ltd., Chennai	Madurai, Tamilnadu	
2. Mr. Raji Kumar, Sr. Manager Core Corporation (Airtel)	2. Dr.S. Ram Prabhu, SSN College of Engineering,	2. Dr.M. Susila, SRMIST
	Kalavakkam, Tamilnadu.	



Course Code	Course Code         21ECE212T         Course Name         CONTROL SYSTEMS: THEORY AND APPLICATIONS					urse egory	E				PROF	ESSIC	NAL E	ELECT	IVE		;	L T 3 0	P 0	C 3
Pre-requi Course	site es	Nil	Co- requisite Course <mark>s</mark>	Nil		Progro Cou	essive rses	•						Nil	1					
Course	Offering Departme	nt	ECE	Data Book / Codes / Stand	lards								Nil							
Course Le	Course Learning Rationale (CLR): The purpose of learning this course is to:							5		Progr	am Ou	itcome	s (PO	)				Р	rogra	m
CLR-1: Know mathematical modeling techniques of mechanical and electrical systems, block diagram reduction and signal flow graphs						2	:	3	4	5	6	7	8	9	10	11	12	S Oi	pecif utcom	ic 1es
CLR-2:	Gain knowledge a	bout the tran	sie <mark>nt and stea</mark> dy state error and	analysis	92	a a	of		s of	15	iety			ork		е				
CLR-3:	Identify and analy.	ze stabilit <mark>y of</mark>	<mark>a system</mark> using Routh array and	l root locus technique	poly		lent		ation	ge	soc			n Wo		Janc	þ			
CLR-4:	Know different fre	quency do <mark>ma</mark>	in analytical techniques	- 14-5m 19-7	Kno	ineering Knov olem Analysis		-	duct investiga	ol Use	r and	~		Tear	ion	& Fi	arnir			
CLR-5:	Acquire the knowl	edge of <mark>a cor</mark>	troller for specific applications a	nd tuning methods			an/deve	Juveve		ern Tool	enginee	onment	Ş	idual &	municat	ect Mgt.	-ong Le	-	-2	ۍ
Course Or	utcomes (CO):	At	the end of this course, learne	rs will be able to:			Desid	solut	Conc	Node	The (	Envir	Ethic	ndiv	Com	Proje	_ife [	SO	OSc	OS <sup>c</sup>
CO-1:	Determine Transfe flow graphs	er function of	a system by mathematical mod	eling, block diagram reduction and sig	gnal 3	3 2		-	-	-	1	-	-	-	-	-	-	-	-	-
CO-2:	Analyze the time of error	lomain <mark>respo</mark>	nse of a control system for stand	lard test inputs, transient and steady s	tate 3	3 3			-	-	- 24	-	-	-	-	-	-	-	-	-
CO-3:	Evaluate the syste	em stab <mark>ility us</mark>	<mark>sin</mark> g Routh array and root locus	techniques	3	3 3		-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Analyze the freque	ency do <mark>main</mark>	<mark>spe</mark> cifications from bode and po	lar plots	- 1-	3	E.	1	1	-	1	-	-	-	-	-	-	3	-	-
CO-5:	Design a closed lo	oop cont <mark>rol sy</mark>	r <mark>stem</mark> for specific application, co	ntroller parameters and tuning	6.5	} -		2	-	-		-	1	-	-	-	-	3	-	-
Unit-1 - Sy Open and of transfer reduction - Unit-2 - Tii Standard t system for PD, PI Unit-3 - St Poles and Design of C	rstem Component closed loop control s function- Conversio - Signal flowgraphs me Response Ana est signals and the different damping f and PID control sys ability Analysis zeros of a system - Compensator using f	and it's Rep system Trans ns of Mechar and evaluatio <b>lysis</b> ir expression actor based tems Pole zero pl oot locus-Lea	resentation fer function of a system Need for nical system to Electrical system on of transfer function- Block dia -Type number and order of a on step response- Time domain ot and concept of s plane - Con od Compensation	r mathematical modelling- Representa f-V and f-I electrical analogies- Bloc gram to signal flow conversion system- Transfer function of First ord o specifications and their significance- propert of stability - Significance of Rou	ation of diagr ck diagr er syste Transie th Hurw	mechai am rec em for ent and vitz Tec	nical t luctior Step, Stea hniqu	ransi rule ramµ dy st e wit	lationa es and o, Imp tate er th diffe	ulse a ror ar	rotatio hodolo andpar palysis cases	nal sys gy -Ev abolic : -Static -Root le	tems ( aluation signal and c	using a on of ti - Gene lynami echniqu	lifferen ransfer eral tra ic Erroi ues-Rc	tial equ functionsfer f coeffice ot locu	iation a on usir unctior cients. s plot c	and de ng blo n of se Analyn of typica	9 termir ck dia 9 econd tical d 9 al sys	Hour ation gram Hour order lesign Hour tems-

Unit-4 - Frequency Domain Analysis 9 Ho
Frequency domain specifications- Bode plot approach and stability analysis- Rules for sketching Bode plot of typical systems - Design of Compensator using Bode Plot-Lag Compensation -Polar plot a
significance-Sketching the Polar plot of typical systems-Nyquist stability criterion.
Unit-5 - Control System Analysis using State Variable Methods and Applications 9 Ho
State variable representation-Conversion of state variable models to transfer function -Conversion of transfer functions to state variable models-Solution of state equations-Concepts of Controllability and Observabil
Fuzzy logic-based control system-Adaptive Controller

Loarning	1. Nagrath.J and Gopal.M, "Control System Engineering", 5th Edition, New Age, 2007	<ol><li>Gopal.M, "Control System Principles and Design", 2nd Edition, TMH, 2002</li></ol>
Decourses	2. Benjamin C Kuo, "Automatic Control System", 9th edition, John Wiley & Sons, 2010.	4. Sivanandam and Deepa, "Control system Engineering using MATLAB", 2nd edition, Vikas
Resources		publishers, 2007", FexRay Consortium, 2010.

ning Assessm	ient									
	Bloom's Level of Thinking	Eorm	Continuous Learn	ing Assessment (CLA)	a Loorning	Summative Final Examination (40% weightage)				
		CLA-1 Avera (50	ge of unit test )%)	CL CL (1	A-2 0%)					
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		15%		15%	-			
Level 2	Understand	20%	to bush	15%		25%	-			
Level 3	Apply	25%		15%		30%	-			
Level 4	Analyze Analyze	20%	C	20%		30%	-			
Level 5	Evaluate	20%		20%		-	-			
Level 6	Create	No. of Contraction		15%		-	-			
	Total	100	)%	10	0%	10	0%			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Saivineeth, ML Accelerator Architect @ Google	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr. K. Vadivukkarasi, SRMIST
2. Mr. Raji Kumar, Sr. Manager Core Corporation (Airtel)	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai	1



Pre-requisite Course         21ECC204T         Co-requisite Course         Nil         Progressive Course         Nil           Course Offering Department         ECE         Data Book / Codes / Standards         Nil         Nil           Course Offering Department         ECE         Data Book / Codes / Standards         Nil         Nil           Course Learning Rationale (CLR):         The purpose of learning this course is to:         Progressive         Nil         Progressive         Nil           ClR-1:         Understand the concept of analcy to digital conversion         1         2         3         4         5         6         7         8         9         10         11         12         0         1         2         3         4         5         6         7         8         9         10         11         12         0         1         2         3         4         5         6         7         8         9         10         11         12         0         1         2         3         4         5         6         7         8         9         10         11         12         0         10         11         12         0         10         10         10         10	Course Code	21ECE310J	Course Name	APPLIED DIGITAL SIGNAL PROCESSING					e ry	E			PROF	ESSIO	NAL E	ELECT	IVE			- T 2 0	P 2	C 3				
Course Offering Department         ECE         Data Book / Codes / Standards         Nil           Course Learning Rationale (CLR):         The purpose of learning this course is to:         Program Outcomes (PO)         Progra	Pre-requisite         21ECC204T         Co- requisite         Nil           Courses         Nil         Nil         Nil							Pro	ogres Cours	sive es						Nil										
Course Learning Rationale (CLR):       The purpose of learning this course is to:       Program Outcomes (PO)       Program Specific         CLR-1:       Understand the concept of analog to digital conversion       1       2       3       4       5       6       7       8       9       10       11       12       0       11       12       3       4       5       6       7       8       9       10       11       12       0       1       1       2       3       4       5       6       7       8       9       10       11       12       0       1       1       2       3       4       5       6       7       8       9       10       11       12       3       4       5       6       7       8       9       10       11       12       3       4       5       6       7       8       9       10       11       12       3       4       5       6       7       8       9       10       11       12       3       4       5       6       7       8       9       10       10       11       12       3       4       5       6       7       8       9<	Course (	Offering Department	t	EC	CE	Data Book / Codes /	Standards	1							Nil											
Course Learning Rationale (CLR):       The purpose of learning this course is to:       Program Outcomes (PO)       Program Outcomes (PO)         CLR-1:       Understand the concept of analog to digital conversion       1       2       3       4       5       6       7       8       9       10       11       12       2       3       4       5       6       7       8       9       10       11       12       2       3       4       5       6       7       8       9       10       11       12       2       3       4       5       6       7       8       9       10       11       12       2       3       4       5       6       7       8       9       10       11       12       2       3       4       5       6       7       8       9       10       11       12       2       3       4       5       6       7       8       9       10       11       12       2       3       4       5       6       7       8       9       10       11       12       2       3       1       1       10       10       10       10       10       10       10							11	-	-	1		_			(5.6)					D	oara	m				
CLR-1:       Understand the concept of analog to digital conversion       1       2       3       4       5       6       7       8       9       10       11       12       Outcomes         CLR-2:       Understand the need for Multirate DSP and Poly Phase Decomposition       0 <td colspan="3">Course Learning Rationale (CLR): The purpose of learning this course is to:</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>rogra</td> <td>im Ou</td> <td>tcome</td> <td>s (PO</td> <td>)</td> <td>1</td> <td></td> <td></td> <td colspan="3">Specific</td>	Course Learning Rationale (CLR): The purpose of learning this course is to:								rogra	im Ou	tcome	s (PO	)	1			Specific									
CLR-2:       Understand the need for Multirate DSP and Poly Phase Decomposition       B       Volume       Volum       Volum       Volu	CLR-1:	Understand the con	cept of ana	alog to <mark>digital con</mark>	version			1	2	3	4	5	6	7	8	9	10	11	12	Ou	tcom	ies				
CLR-3:       Study the architecture of TMS320C54x Processor       The processor <thte processor<="" th=""> <thte processor<="" th=""></thte></thte>	CLR-2:	Understand the nee	ed for Multira	ate <mark>DSP and</mark> Pol	ly Phase Deco	mposition		ge		of	s of	2	iety			rk		æ								
CLR.4:       Study the architecture of TMS320C6748 Processor       Image: Study the architecture of TMS320C	CLR-3:	Study the architectu	ire of TMS3	3 <mark>20C54x P</mark> rocess	sor	1 1980	2816	vledç	(0	lent o	ation	ge	l soc			n Wo		Janc	b							
CLR-5:       Design DSP system for real time applications       Image: Construction of the constr	CLR-4:	Study the architectu	ire of TM <mark>S3</mark>	320C6748 Proces	ssor	WEG- G		Kno	lysis	opm	stig: olem	Usa	and	৵		[ear	uo	& Fii	arnir							
Course Outcomes (CO):       At the end of this course, learners will be able to:       Image: Course outcomes (CO):       At the end of this course, learners will be able to:       Image: Course outcomes (CO):	CLR-5: Design DSP system for real time applications						eering h	eering I	eering h	eering h	eering h	eering I	em Ana	jn/devel ons	uct inve lex prot	ern Tool	engineer	onment ainability	S	dual & 7	nunicati	ct Mgt.	ong Lea	<del></del>	5	ę
CO-1:       Acquire knowledge of sampling and quantization and understand the errors that arise due to quantization.       3       2       - <td>Course Ou</td> <td>itcomes (CO):</td> <td>At</td> <td>t the end of this</td> <td>course, learn</td> <td>ers will be able to:</td> <td>11.127</td> <td>Engir</td> <td>Probl</td> <td>Desig</td> <td>Cond</td> <td>Mode</td> <td>The (</td> <td>Envir Susta</td> <td>Ethic</td> <td>Indivi</td> <td>Com</td> <td>Proje</td> <td>Life L</td> <td>PSO.</td> <td>PSO.</td> <td>PSO.</td>	Course Ou	itcomes (CO):	At	t the end of this	course, learn	ers will be able to:	11.127	Engir	Probl	Desig	Cond	Mode	The (	Envir Susta	Ethic	Indivi	Com	Proje	Life L	PSO.	PSO.	PSO.				
CO-2:       Explore the need for Multirate signal processing       2       -       3       -	CO-1:	Acquire knowledge	of sa <mark>mpling</mark>	<mark>g an</mark> d quantization	n and understa	and the errors that arise due to qua	antization.	3	2		-	-	1		-	-	-	-	-	-	-	2				
CO-3:       Implement DSP algorithms using TMS320C54x Processor       -       3       2       -	CO-2:	Explore the need fo	r Mul <mark>tirate s</mark>	<mark>sig</mark> nal processing	g			2	( e.)	3	-	-	-0	-	-	-	-	-	-	-	-	1				
CO-4:       Implement DSP algorithms using TMS320C6748 Processor       3       2       -       1 <td>CO-3:</td> <td>Implement DSP alg</td> <td>orithm<mark>s usir</mark></td> <td>ng TMS320C54x</td> <td>Processor</td> <td>1</td> <td></td> <td>2</td> <td>3</td> <td>2</td> <td>-</td> <td>-</td> <td>- 24</td> <td>-</td> <td>-</td> <td></td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td>3</td>	CO-3:	Implement DSP alg	orithm <mark>s usir</mark>	ng TMS320C54x	Processor	1		2	3	2	-	-	- 24	-	-		-	-	-	-	-	3				
CO-5:       Infer Knowledge on DSP system based design and applications       -       2       3       -       -       -       1         Unit-1 - Digital Conversion of Analog Signals       12 How         Basic Elements of DSP, Advantages and applications of DSP, Sampling of analog signals Sampling theorem, Aliasing and Quantization of continuous amplitude signal, Quantization noise, Errors due to truncation and Rounding off, Realization of digital filters - Direct form I realization, Canonical structure Realization, Parallel and Cascade Structures       12 How         Practice: Generation of Continuous and discrete time fundamental signals, Study of sampling theorem and Aliasing Effects, Circular convolution of DT Signals       12 How         Unit-2 - Multirate Signal Processing       12 How         Decimation of Signals, Interpolation of Signals, Sampling rate conversion by a rational factor I/D, Polyphase structure of decimator, Polyphase decimation using z transform, Polyphase structure of interpolation using z transform, Polyphase structure of interpolation polyphase interpolation using z transform, Polyphase structure of anti-aliasing filter         Unit-3 - Architecture and Programming - TMS320C54x       12 How         DSP Systems – Introduction, Harvard Architecture and Von- Neuman Architecture, Texas Instruments TMS320 Family, TMS320C54x DSP Functional Block Diagram and Explanation, MAC Unit, Pipeling and Parall	CO-4:	Implement DSP alg	orithm <mark>s usir</mark>	ng TMS320C674	48 Processor		100	3	2	-	-	-	-	-	-	-	-	-	-	-	-	3				
Unit-1 - Digital Conversion of Analog Signals       12 Ho         Basic Elements of DSP, Advantages and applications of DSP, Sampling of analog signals Sampling theorem, Aliasing and Quantization of continuous amplitude signal, Quantization noise, Errors due to truncation and Rounding off, Realization of digital filters - Direct form I realization, Canonical structure Realization, Parallel and Cascade Structures         Practice: Generation of Continuous and discrete time fundamental signals, Study of sampling theorem and Aliasing Effects, Circular convolution of DT Signals         Unit-2 - Multirate Signal Processing         Decimation of Signals, Interpolation of Signals, Sampling rate conversion by a rational factor I/D, Polyphase structure of decimator, Polyphase decimation using z transform, Polyphase structure of interpolation Polyphase interpolation using z transform, Polyphase structure of interpolation and decimation on signals, Design of anti-aliasing filter.         Practice: Design of anti-aliasing filter, Effect of interpolation and decimation on signals, Design of anti-imaging filter         Unit-3 - Architecture and Programming - TMS320C54x         DSP Systems – Introduction, Harvard Architecture and Von- Neuman Architecture, Texas Instruments TMS320 Family, TMS320C54x DSP Functional Block Diagram and Explanation, MAC Unit, Pipeling and Parall	CO-5:	Infer Knowledge on	DSP system	<mark>m b</mark> ased design	and application	ns		2		2	3	-	2	-	-	-	-	-	-	-	-	1				
Basic Elements of DSP, Advantages and applications of DSP, Sampling of analog signals Sampling theorem, Aliasing and Quantization of continuous amplitude signal, Quantization noise, Errors due to truncation and Rounding off, Realization of digital filters - Direct form I realization, Canonical structure Realization, Parallel and Cascade Structures Practice: Generation of Continuous and discrete time fundamental signals, Study of sampling theorem and Aliasing Effects, Circular convolution of DT Signals Unit-2 - Multirate Signal Processing Decimation of Signals, Interpolation of Signals, Sampling rate conversion by a rational factor I/D, Polyphase structure of decimator, Polyphase decimation using z transform, Polyphase structure of interpolation Practice: Design of anti-aliasing filter, Effect of interpolation and decimation on signals, Design of anti-imaging filter Unit-3 - Architecture and Programming - TMS320C54x DSP Systems – Introduction, Harvard Architecture and Von- Neuman Architecture, Texas Instruments TMS320 Family, TMS320C54x DSP Functional Block Diagram and Explanation, MAC Unit, Pipeling and Parall	Unit-1 - Di	gital Conversion of	Analog Sig	ynals			72		Ċ.				ę.								12	Hour				
Unit-2 - Multirate Signal Processing       12 Ho         Decimation of Signals, Interpolation of Signals, Sampling rate conversion by a rational factor I/D, Polyphase structure of decimator, Polyphase decimation using z transform, Polyphase structure of interpolator         Polyphase interpolation using z transform,         Practice: Design of anti-aliasing filter, Effect of interpolation and decimation on signals, Design of anti-imaging filter         Unit-3 - Architecture and Programming - TMS320C54x         DSP Systems – Introduction, Harvard Architecture and Von-Neuman Architecture, Texas Instruments TMS320 Family, TMS320C54x DSP Functional Block Diagram and Explanation, MAC Unit, Pipeling and Parall	Basic Elem and Round <b>Practice:</b> (	nents of DSP, Advanta ling off, Realization of Generation of Continu	ages and a <sub>l</sub> f digital filter Ious and dis	pplications of DS rs - Direct form I screte time funda	SP, Sampling o realization, Ca amental signals	f analog signals Sampling theore monical structure Realization, Pa s, Study of sampling theorem and	m, Aliasing <mark>rallel and C</mark> I Aliasing E	and G ascad ffects,	Quanti. le Stru Circu	zation ( Ictures lar con	of conti volutior	nuous n of DT	amplii Signa	tude sig als	nal, G	Quantiz	ation n	oise, E	rrors d	lue to t	runca	ition				
Decimation of Signals, Interpolation of Signals, Sampling rate conversion by a rational factor I/D, Polyphase structure of decimator, Polyphase decimation using z transform, Polyphase structure of interpolation polyphase interpolation using z transform, Polyphase structure of interpolation polyphase interpolation using z transform, Polyphase structure of interpolation polyphase interpolation using z transform, Polyphase structure of interpolation polyphase interpolation using z transform, Polyphase structure of interpolation polyphase interpolation using z transform, Polyphase structure of interpolation polyphase interpolation polyphase interpolation polyphase interpolation polyphase interpolation polyphase interpolation polyphase interpolyphase	Unit-2 - Mu	ultirate Signal Proce	essing		1.10		-					1	0								12	Hour				
Polyphase interpolation using z transform, Practice: Design of anti-aliasing filter, Effect of interpolation and decimation on signals, Design of anti-imaging filter Unit-3 - Architecture and Programming - TMS320C54x DSP Systems – Introduction, Harvard Architecture and Von-Neuman Architecture, Texas Instruments TMS320 Family, TMS320C54x DSP Functional Block Diagram and Explanation, MAC Unit, Pipeling and Parall	Decimation	of Signals, Interpola	ation of Sigi	nal <mark>s, Samplin</mark> g r	rate conversior	n by a rational factor I/D, Polyph	ase structu	re of c	decim	ator, P	olyphas	e deci	imatio	n using	<mark>z t</mark> rai	nsform	, Polyp	hase s	structu	re of ir	nterpo	olator,				
Unit-3 - Architecture and Programming - TMS320C54x       12 Hot         DSP Systems - Introduction, Harvard Architecture and Von-Neuman Architecture, Texas Instruments TMS320 Family, TMS320C54x DSP Functional Block Diagram and Explanation, MAC Unit, Pipeling and Parall	Polyphase Proction:	interpolation using z	transform, a filtor Effor	at of interpolation	and desimativ	on on signals. Design of onti imag	aina filtor																			
DSP Systems – Introduction, Harvard Architecture and Von-Neuman Architecture, Texas Instruments TMS320 Family, TMS320C54x DSP Functional Block Diagram and Explanation, MAC Unit, Pipeling and Parall	Unit-3 - Ar	chitecture and Prod	ramming -	TMS320C54x		on on signals, Design of anti-imag	ging men		1.1												12	Hour				
	DSP Syste	ms – Introduction, Ha	rvard Archit	tecture and Von-	Neuman Arch	itecture, Texas Instruments TMS	320 Family,	TMS	320C5	4x DSI	P Funct	ional E	Block L	Diagran	n and E	Explan	ation, I	AC U	nit, Pip	eling a	nd Pa	arallel				
Processing, Instruction Set of TMS320C54x, Addressing Modes of TMS320C, Introduction to code composer studio and Procedure to work on ccs using target	Processing	, Instruction Set of TI	MS320C54>	x, Addressing Mo	odes of TMS32	OC, Introduction to code compos	er studio ar	nd Pro	cedur	e to wo	ork on <mark>c</mark>	cs usir	ng targ	get		•				-						
Practice: Arithmetic operations using processor (Addition, Subtraction, Multiplication) - Assembly and C language	Practice: /	Arithmetic operations	using proce	essor (Addition, S	Subtraction, Mu	ultiplication) - Assembly and C lar	nguage					_														

Unit-4 - Architecture and Programming - TMS320C6748	12 Hour
Introduction to TMS320C6748, Advanced Features of C6748, Dual Core Architecture, RISC, Block Diagram and Explanation, Instruction Set of C6748 processor, Addressing Modes of C6748, F	Procedure to work
with non-real time projects, Procedure for working with the real time projects using c6748	
Practice: Basic Programs and Random wave generation using processor	
Unit-5 - DSP Applications	12 Hour
Dual tone Multi-Frequency Signaling, Software Defined Radio, QAM Transmitter and QAM Receiver, u-Law for Speech Companding, Acoustic Direction Tracker, Multirate Filter, Neural Network for Su	ignal Recognition,
PID Controller, Four-Channel Multiplexer for Fast Data Acquisition, Video Line Rate Analysis, MP3 Player, DSP Automotive application	
Practice: Audio signal processing. PID Controller. Filtering Applications	

	1. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing, Principles,	4. Sanjit Mitra, "Digital Signal Processing – A Computer Based Approach", McGraw Hill, India, 4th
Learning Resources	Algorithms and Applications", Pearson Education, 4th edition, 2007	Edition, 2013.
	2. Alan V. Oppenheim, Ronald W. Schafer, John R. Buck, "Discrete	5. Ronald D.Crochier, Lawrence R.Rabiner, Multirate Digital Signal Processing, 1st edition, 1983
	3. Time Signal Processing", Pearson Education, 8th edition, 2011	Prentice Hall series.
		6. TMS320C54x and TMS320C6748 - Lab Manual - Texas Instruments

Learning Assessm	ient 🔹			Constant of the second							
			Continuous Learning A	0 "							
	Bloom's Level of Thinking	Forn CLA-1 Avera (45	native ge of unit test 5%)	Life-Long CLA (159	Learning A-2 %)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice				
Level 1	Remember	15%			15%	15%	-				
Level 2	Understand	25%		and a second second	15%	25%	-				
Level 3	Apply	30%			30%	<mark>- 30</mark> %	-				
Level 4	Analyze	30%		a series of the	30%	<mark>3</mark> 0%	-				
Level 5	Evaluate	and the second			5%		-				
Level 6	Create	1.0		-	5%		-				
	Total	10	0 %	100	%	10	0%				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Athif Shah, CTO, Abe Technologies, Chennai	1. Dr.V.Masilamani, Associate Professor, Computational Engineering, III D&M, Kancheepuram	1. Dr. S. Dhanalakshmi, SRM IST
2. Mr.A. Vishwanath, Research and Innovation Scientist,	2. Dr.V.Sathiesh Kumar, Assistant Professor, Electronics Department	; 2. D <mark>r. S. Latha</mark> , SRMIST
Genet.IO.Hyderabad	MIT, Chennal	

Course Code	21ECE311T	Course DIGITAL COMMUNICATION SYSTEMS					e ry	E	PROFESSIONAL ELECTIVE         L         T         P           3         0         0         0         0         0									C 3		
Pre-requisite Courses         21MAB203T         Co- requisite Courses         NIL				-	Pro C	ogress ourse	sive es						Nil							
Course	Offering Departme	ent	ECE	Data Book / Codes / St	tandards	1.7							Nil							
Course Le	earning Rationale (	CLR): The pu	rpo <mark>se of learnin</mark> g this course	is to:		-	đ	1	1.1	Progra	am Ou	tcome	s (PO)	)				P	rogra	m
CLR-1: Understand the basics of digital modulation and detection techniques					1	2	3	4	5	6	7	8	9	10	11	12	2 Outc		es	
CLR-2:	Investigate differe	ent modulation sch	emes and analyze the probabil	ity of error		e		4	s of	1	ety			¥						
CLR-3:	Identify the conce	pts of informa <mark>tion</mark>	theory and source coding			vledç		ent o	ations	ge	soci	~~~	-	No!		ance	ວ			
CLR-4:	Interpret various e	error detecti <mark>on and</mark>	l correction codes in digital con	munication systems	24.7	Knov	lysis	mqo	stige	Usa	and			Fean	u	& Fir	arnin			
CLR-5:	Explore the principles of spread spectrum communication systems						n Ana	deve	t inve x prot	Tool	ginee	ment		al & -	Inicat	Mgt.	jg Le			ł
Course O	se Outcomes (CO): At the end of this course, learners will be able to:			1	Engine	Probler	Design	Conduc	Modern	The en	Environ	Ethics	ndividu	Commu	Project	Lor	-SO-1	SO-2	-SO-3	
CO-1:	Interpret the cond	epts of <mark>digital co</mark> m	munication system	ALC: NAME OF	4.2	2	2	-	-	-		-	-	-	-	-	-	3	-	-
CO-2:	Analyze the mech	nanism <mark>of digital</mark> m	odulation schemes and data tra	ansmission		-	2	3	-	-	-0	-	-	-	-	-	-	2	-	-
CO-3:	Illustrate the oper	ation of <mark>informa</mark> tion	n theory and error coding techr	iques in digital systems	1	2	-	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-4:	Examine the fund	lamenta <mark>ls of cha</mark> nr	nel coding		12	3	2	1	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Review the data t	ransmis <mark>sion usin</mark> g	spread spectrum		120	3	2		-	-	-	-	-	1	-	-	-	-	2	-
Unit-1 - In Elements o	troduction to Digit of digital communica	al Communication ation system, adva	n System ntages and disadvantages, pul	se code modulation (PCM) - sa	ampling, q	uantiz	ation	and co	oding, <mark>q</mark>	uantiza	ation e	rror, co	mpano	ding in	PCM	system	s, diffe	rential	<b>9</b> PCM,	Hour delta
modulation	n, adaptive deita mo igital Modulation T	echniques	10		-			_	1	19			-						9	Hour
Introductio	on, ASK modulator,	coherent and non-	coherent ASK detector, FSK m	odulator, spectrum of FSK, co.	herent re	ceptio	n, nor	n-cohe	rent de	ection	of FS	K, BPS	K tran	smitter	r, cohe	rent re	ception	of BF	PSK, E	)PSK,
QPSK, QA	AM Data transmission	on: Baseband signa	al receiver, probability of error,	optimum filter, matched filter, p	probability	of eri	ror of .	ASK, I	-SK, Bł	SK an	id QPS	SK	_						9	Hour
Discrete n	nessages, concept	of amount of infor	mation and its properties, aver	age information, entropy and	its prope	rties, i	inform	nation	rate, m	utual ii	nforma	tionSo	urce c	oding:	Introd	uction,	advan	tages,	Shar	inon's
theorem, b	bandwidth – S/N trad	de-off, Shannon-Fa	ano coding, Huffman coding			_	1.11												0	Hour
Introductio	on, matrix description	n of linear block co	des, error detection and error c	orrection capabilities of linear b	block code	es, har	mming	g code	s, cyclic	codes	s - enc	oding, s	syndro	me ca	Iculatic	n, dec	oding, d	convol	ution (	codes
- introducti	ion, encoding and d	ecoding				·			-			0.					0.			
Unit-5 - Pi Model of a	rinciples of Spread a spread spectrum of	<b>i Spectrum</b> ligital communicati	on system, direct sequence so	read spectrum, effect of de-sp	preading o	n a na	arrowl	hand in	nterfere	nce a	enerati	ion of F	N sea	uence	frequ	encv h	onned	spread	<b>9</b> d sper	Hour Strum
CDMA bas	sed on IS-95, case s	study - Recent tren	ds in diversity, case study - MI	MO systems						, gt		0.1 01 1			,qu	0.109 11	oppou	0,01000	. 0000	
Learning Resources	1. 2. 3.	Bernard Sklar and Ray, Digital Communications-Fundamentals and Applications, Pearson Education, 3rd Edition, 2014. Herbert Taub and Donald L Schilling, Principles of Communication Systems, Tata McGraw-Hill, 3rd Edition, 2009. B. P. Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, Oxford University Press, 4th Edition, 2010.	5. 6. 7.	John G Proakis and Masoud Salehi, Fundamentals of Communication Systems, 2014 Edition, Pearson Education. Ian A Glover and Peter M Grant, Digital Communications, Pearson Education, 3rd Edition, 2010. R. Bose, Information Theory, Coding and Cryptography, McGraw-Hill Education, 3rd Edition, 2016.																
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	4.	Simon Haykin, Digital Communication Systems, John Wiley & Sons, 1st Edition, 2014.																		

			Continuous Learning	Assessment (CLA)		Summative Final Examination (40% weightage)					
	Bloom's Level of Th <mark>inking</mark>	Forr CLA-1 Avera (5	native age of unit test 0%)	Life-Lon Cl (1	g Learning _A-2 0%)						
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	20%		20%		20%	-				
Level 2	Understand	25%		25%		25%	-				
Level 3	Apply	35%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	35%		35%	-				
Level 4	Analyze	20%	and the second second	20%	7	<mark>2</mark> 0%	-				
Level 5	Evaluate		Contraction of the	1 - 1 - V - V		-	-				
Level 6	Create			Contraction of the second		-	-				
	Total	10	0 %	10	0 %	10	0%				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Raji Kumar, Sr. Manager Core Corporation (Airtel)	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr. Sachin Kumar <mark>, SRMIS</mark> T
2. Mr. Anuj Kumar, Program Delivery Manager, Nagarro	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai	
Software's Pvt Ltd.		



Course Code	Course 21ECE410T Course ASIC DESIGN							Co Cate	urse egory		E			PROF	ESSIC	)nal e	ELECT	IVE			L T 3 0	P 0	C 3	
Pre-requi Course	site s	Nil		Co- requis Courses	site		Nil			Progr Cou	essi Irse	ive s						Nil						
Course (	Offering Departm	ent		ECE		D	ata Book /	Codes / Stan	dards								Nil							
Course Le	arning Rationale	(CLR):	The purpo	se <mark>of learnin</mark> g	this course	e is to:				17	t	1		Progr	am Oı	Itcome	s (PO	)				P	ogra	m
CLR-1	Prenare the stud	lent to be a	an entry-leve	l industrial stan	dard ASIC c	or FPGA	designer			2	,	3	4	5	6	7	8	, _ 9	10	11	12 S		pecifi	C
	Linderstand the k		A Arobitootu				doolghol					U	ď	Ŭ	ty .	,	Ū	v	10		12	01	tcom	es
CLR-2:	Cive the student	asic FPGA		es	related to	A CIC da	alara	1. S.		2 P		nt of	Suc		ocie			Vork		nce				
CLR-3:	Give the students	s an under:		ssues and tools	s related to A	ASIC de	sign	1.41		i i	2	mer	igatio	sage	s pu			am /	_	Final	ing			
CLR-4:	Analyze the parti	ition and pl	lacement iss	ues	_	_	-	1	X		laiy	/elop	vesti	ol U	er a	nt & ity		č Te	atior	t. & I	earr			
CLR-5:	Understand the o	concept of	clock plannii	ng in ASIC desi	gn		1.1.2		erin e	N N	2	ns ns	ct in ex pr	n To	Igine	nmel		ual 8	unic	t Mg	ng L			
Course Ou								-				sigr	uple mple	oden	le er	Ivirol	nics	divid	mma	oject	e Lo	9-1	<u>0-2</u>	0-3
	It is to restand in a d	:#	At the end	Tor uns course	e, learners v	will be a		1000	ů			d S	8 8	ž	É	ц N	Ш	lnc	ö	Å	Ľ.	ъ В С	6	Ĕ.
CO-1:		interent FP	GA Architec	ture and their in	iterconnect i	mecnan	ISM	122.3154	3			-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	Familiarize the v	arious p <mark>rog</mark>	grammable A	ASICs	<u> </u>	1.1		1.5	-	i	3	3	-	2	-	1	-	2	-	-	-	3	-	-
CO-3:	Summarize the c	optimizat <mark>ior</mark>	<mark>n algor</mark> ithms	in ASIC and ap	plying the c	concept of	of partitionin	ng		-		3	2	2	- 100	-	-	2	-	-	-	3	-	-
CO-4:	Illustrating floor p	olanning <mark>an</mark>	<mark>nd cloc</mark> k plan	ning	1000	5.00	1			2	2	6	-	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Analyzing the va	rious rou <mark>tir</mark>	<mark>ng algo</mark> rithm	Second State	1.00	- 10			3	3	3	2	2	-		-	-	2	-	-	-	3	-	1
Unit-1 - Int VLSI Desig cells-ASIC architecture	troduction to Asia In Flow-Types of <i>I</i> I/O cells-Program e-Types of CPLD	c ASIC-Progr nmable inte	rammable A erconnects	SICs design tyj - FPGA-Types	be-Antifuse- of FPGA-F	-SRAM-I Programi	EPROM bas mable FPG,	sed ASICs-AS A-ASIC I/O C	SIC fusin Cells: DC	g base Input-	d or - AC	n EPR C Inpu	OM-EE	PRO C I/O	M bas Cells-	ed ASI DC/AC	Cs-FA outpu	MOS d It-Cloci	descrip k Input	tion-Pr t- Intro	ogram ductior	mable 1 to C	9 ASIC PLD-(	Hour logic CPLD
Unit-2 - Pro	ogrammable Asio	: Logic Ce	ells		Arabitaatuu	ro Viliny	I CA interne	larabitaatura	Loh 2.C	onorot		TI not	ligtfor	diait	al airau	it and a	noluzi	then	rform		(iliny E		<b>9</b>	Hour
Xilinx EPLL features- A design lang	Architecture-Acter D Internal Architec Itera MAX 5000 : I guage-PLA tools, E estem Partitioning	interconnec sture-Xilinx Interconnec EDIF-CFI do and Floo	ct delay anal LCA Interco ct Delay ana design repres	vsis-Xilinx LCA onnect-Xilinx EF lysis- ALTERA' sentation- Lab 4	-Architectur PLD Intercor S FLEX 800	nnect-Al 00/10000 tation of	tera MAX 70 tera MAX 70 : Architectul KL algorithn	ai architecture- 2000, - Archite 1re-ASIC Design 1 in EDA envir	- Lab 3:G ecture-Alte gn syster ronment	enerat era Ma n: Intro	e R I ax 9 oduc	1 L net 000 : 1 ction-E	Archite Design	a digita cture- Systei	al circu Altera ms: De	Max 90 tailed a	000 : i analys	e the pe ntercoi is-Logi	nnect r c Synti	ncex nechar hesis-F	hism-A lalf gat	PLD A Itera Ir e ASI	nterco C-Low	nnect level
System Pa	rtitioning Objective	s-System	partitioning I	Procedure-Parti	tioning Meth	hods-Me	asuring Cor	nnectivity-Prol	blem on (	Constru	uctiv	/e Par	titionin	g-Con	structi	/ePartit	tioning	-Iterati	ive Par	titionin	g Impro	oveme	nt-Pro	blem
on Iterative	Partitioning Impro	ovement-Th	he Kernighai	n–Lin Al <mark>gorithm</mark>	-The Ratio-	Cut Algo	vrithm- ASIC	C floor planning	g-Channe	el Defii	nitio	n-I/O a	and Po	wer P	lannin	g -Cloci	k Plan	ning-			0 1			
Unit-4 - Pla	acement and Rou	i <b>ting</b> hmo Eicon	n valua place	mont algorithm	Itorative pl	lacomar	timprovem	ont Timo driv	on placer	nont m	othe	odo In	troduct	ion to	Doutin	na oina		or alah	al rout	na oin		or data	<b>9</b> ilod w	Hour
wire length- Global Routing Methods-Routing between blocks-inside flexible blocks-Detailed Routing- Algorithms routing							s-Left Edg	ge algo	orith	m-Are	a routi	ng alg	orithm	-Multile	vel Ro	outing-	Timing	driven	detaile	ed rout	ing-Sp	vecial		

#### Unit-5 - Optimization Methods and ASIC Testing

I Trade off issues at System Level-Solutions to the issues at system level-Optimization with regard to speed-Optimization with regard to area- Optimization with regard to power-Optimization trade off factor-Asynchronous and low power system design- Boundary scan test – Faults – Fault simulation – Automatic test pattern generation algorithm: D-algorithm, PODEM – Built in self-test

	1.	Smith, Michael. Application-Specific Integrated Circuits. United Kingdom, Addison Wesley	4.	Golshan, Khosrow. Physical Design Essentials: An ASIC Design Implementation
		Professional, 2008	1	Perspective. Ukraine: Springer US, 2007.
Learning	2.	Douglas J. Smith, Fundamentals of HDL Design: An Engineering Approach. India: Pearson	5.	Herwani, Naveed A. Sherwani, Naveed A. Algorithms for VLSI Physical Design
Resources		Education, 2010.		Automation. United States: Springer US, 2013.
	З.	Taraate, Vaibbhav. ASIC Design and Synthesis: RTL Design Using Verilog. Germany: Springer		D'IVA
		Singapore, 2021.		

Learning Assessn	nent	1 1 1 A										
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	Continuous Learnir native ige of unit test 0%)	ng Assessment (CLA) Life-Long CL (1	g Learning "A-2 0%)	- Summative Final Examination (40% weightage)						
		Theory	Practice	Theory	Practice	Theory	Practice					
Level 1	Remember	15%	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	15%		15%	-					
Level 2	Understand	25%	the bear of	20%	100 B	25%	-					
Level 3	Apply	30%	the second	25%		30%	-					
Level 4	Analyze	30%	S	25%		<mark>30%</mark>	-					
Level 5	Evaluate	1 1 2 3		10%			-					
Level 6	Create	The second		5%		-	-					
	Total	10	0%	10	0 %	10	0 %					
		0.000		A DOUBLE A								

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Saivineeth, ML Accelerator Architect @ Google	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr. K. Ferents Koni Jiavana, SRMIST
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Course Code	21ECE411T	Course Name		EM	BEDDED	LINUX		(	Cours Catego	se ory	Е			PROF	ESSIO	NAL E	LECT	IVE		l	- T 3 0	P 0	C 3
Pre-requi	isite es	Nil	Co- r Cou	equisite Irse <mark>s</mark>			Nil		Pr	ogres Cours	sive es						Nil						
Course	Offering Departme	ent	ECE			Data Bo	ook / Codes / S	Standard	S							Nil							
Course Le	earning Rationale (	CLR): T	The purpos <mark>e of lear</mark>	ning this o	course is	to:		-		1			Progra	am Ou	utcome:	s (PO)	)				Р	rogra	m
CLR-1:	Develop the skill i	to use Linux	coperatin <mark>g system</mark>	-	(Q)	1.20			1	2	3	4	5	6	7	8	9	10	11	12	S Oi	pecifi utcom	ic Ies
CLR-2:	Develop the skill t	to write prog	gram <mark>s in C and</mark> Scrip	ting langua	ages and	interfacing v	with Git reposit	tory	le	3	f	s of	3	iety			ĸ		0				
CLR-3:	Acquire knowledg	je on softwal	are <mark>developm</mark> ent pro	cess for Er	nbedded i	Linux			vledç		ent c	ations	ge	soc			n Wo		Jance	g			
CLR-4:	Become familiar v	vith the meth	t <mark>hods of s</mark> oftware de:	sign for Err	nbedded L	Linux		34.1	<nov< td=""><td>lysis</td><td>mdo</td><td>stig</td><td>Usa</td><td>anc</td><td>∞ .</td><td></td><td>ean</td><td>uo</td><td>&amp; Fir</td><td>arnin</td><td></td><td></td><td></td></nov<>	lysis	mdo	stig	Usa	anc	∞ .		ean	uo	& Fir	arnin			
CLR-5:	Develop the skill	of writing em	nbedded application	s, in Linux	platform	-	234		ering h	m Ana	lavel	ct inve ex prob	n Tool	Igineer	nment nability		ual & T	unicati	t Mgt. 8	ng Lea			
Course O	utcomes (CO):	A	At the end of this c	ourse, lea	rners will	l be able to	):	1.17	Engine	Proble	Design	Condu	Moder	The er	Enviro Sustai	Ethics	Individ	Comm	Projec	Life Lc	PSO-1	PSO-2	PSO-3
CO-1:	Implement the Lir	nux ope <mark>rating</mark>	<mark>ig sys</mark> tem and the co	mmands a	ssociated	d	See.	E.	3		-		3		-	-	-	-	-	-	-	-	-
CO-2:	Create C progran	ns and i <mark>nterf</mark> a	f <mark>ace</mark> with GIT reposit	ory.		1	1000		-		3	-	3			-	-	-	-	-	-	-	-
CO-3:	Analyze the GNU	develo <mark>pme</mark> r	ent tool chain with C	and shell p	rogrammi	ing	119 2		12.5		3		3	-	-	-	-	-	-	-	3	-	-
CO-4:	Develop a flash b	ased e <mark>mbed</mark>	<mark>dded</mark> Linux device di	rivers	2.5	10.00		1	1	-	3	-	3		-	-	-	-	-	-	3	-	-
CO-5:	Implement Embe	dded Li <mark>nux b</mark>	based application pr	ograms		100			E-1		14	3	3	1	-	-	-	-	-	-	3	-	-
Unit-1 - Li Introductio "bash": the	nux Essentials n to Linux, Linux fil Borne shell Shell	le system ar	rchitecture, Linux co	ommands:	User leve	el, Linux cor	mmands: Syste	em level (	Superu	user s	pecific	), "vi" te	ext edi	tor- cc	ommand	ls, "ge	dit" tex	kt edito	or - con	nmand	ls, Intr	<b>9</b> oducti	Hour ion to
Unit-2 - Li	nux Programming	Fundamen	ntals	rcommand	13 & 113 US			9				1	19									9	Hour
Revision o terminal us	n "C" w.r.t GNU C sina adb Introducti	compiler, GI on to Git rep	NU Tool chain: intro pository, Cloning files	duction & s from Git I	installatio Hub. Gites	on, editing s ssentials, A	ource code in dvanced Git fe	C with "ge atures. Pr	edit" or rogram	r IDE, mina i	Comp usina (	iling an Git hub	d build	ling ex	(ecutabl	le, Intr	oductio	on to "	gdb", F	Running	g the p	orogra	m on
Unit-3 - El	ements of Embedo	ded Linux	<i>y,</i>				A activ			5	- 0		19									9	Hour
Introductio cross platfe Simple ker	n to embedded Lini orm use, Booting pr nel programs,	ux, Generic . ocess and bo	Archite <mark>cture of an</mark> E boot loader, <mark>Linux ke</mark>	mbedded nel; introd	Linux Sys uction, Po	stem, Cross orting and co	s platform tools onfiguring theke	s, Types c ernel, Sim	of Host ple typ	/Targe ical ke	et Deve ernel p	elopmei rogrami	nt Setu ming, E	ıps, Ty Buildin	v <mark>pes of</mark> g root fil	Host/T le syst	arget em, Se	Debug electing	Setup g a buil	s, Sarr d syste	iple pr em; bu	ogran ild pro	ns for icess,
Unit-4 - Sy	it-4 - System Architectures and Design Choices																					9	Hour
Embedded of device d	edded system storage; choosing the parameters, Flash memory and system memory operation, <i>i</i> vice drivers, Module utilities, writing sample device driver; char device, block device, Debugging					eration, Access bugging the de	s time con vice drive	siderat r, Maki	tions, i ing the	Introdu e "init",	iction to Kernel	devic progra	e drive mmin	ers - idei g - Devi	ntifying ce Dri	g and ι ver pro	ising th gramn	nem, In ning	ternals	; and a	archite	cture	
Unit-5 - Embedded Applications																			9	Hour			
Process ar Use of gra	rocess and threads, POSIX thread commands; syntax and use, Memory allocation and management; leak detection, GDB debugging revisited, Tracing and Profiling tools, FT- Trace utility and its use in debugging, se of graphics plotting tools; Installing and using FT trace utilities, Debug/test data collection and profiling, Real time Linux,																						

	1.	Karim Yaghmore, Jon Masters, Gilad Ben Yosef, Phillepe Gerome, "Building Embedded	4.	Richard Stones, Neil Mathew, "Begining Linux Programming", WileyPublications,
Looming		Linux Systems, Oreilly Publications, Safari Books, 2nd Reprint, 2008.		4th edition, 2008.
Deseurose	2.	Chris Simonds, "Mastering Embedded Linux Programming", Packt Publishing,	5.	Willam Rothwell, "Jump start your Linux programming skills", Addison Wesley, 2017.
Resources		Open source, 2015.	6.	Christopher Hallinan, "Embedded Linux Primer", A practical real world approach",
	3.	https://www2.packtpub.com/books/subscription/packtlib.	<u> </u>	Prentice Hall, 2010

Learning Assessin		101	Continuous Learning	Assessment (CLA)		2					
	Bloom's Level of Thinking Remember Understand Apply Analyze Evaluate	Form CLA-1 Avera (50	native ge of unit test )%)	Life-Long CL (1)	g Learning A-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%	A Carton Carto	15%		15%	-				
Level 2	Understand	25%	123.000	20%		20%	-				
Level 3	Apply 📃	30%		25%		20%	-				
Level 4	Analyze	30%		25%		30%	-				
Level 5	Evaluate			10%		10%	-				
Level 6	Create		1 345 W	5%	- 20- 20-	<mark>5%</mark>	-				
	Total	10	0%	10	0 %	100	0%				

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mr. Saivineeth, ML Accelerator Architect @ Google	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Mrs. V. Padmajothi, SRMIST	
2. Mr. Anuj Kumar, Program Delivery Manager, Nagarro Software's Pvt Ltd.	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai		



Course Code	ourse Sode         21ECE412T         Course Name         ALGORITHMS FOR CRYPTOGRAPHY				Cours Catego	se ory	Е	PROFESSIONAL ELECTIVE										L T P 0 3 0 0			
Pre-requi	isite es	Nil	Co- requisite Courses	Nil	Pr	ogres Cours	sive es						Nil	1							
Course	Offering Departme	nt	ECE	Data Book / Codes / Standard	S	-						Nil									
Course Le	earning Rationale (	CLR): The pu	urpose of learning this course i	s to:	-	1		11	Progr	am Ou	itcome	s (PO)	)				P	rogra	m		
CLR-1:	Utilize the classic	al and symmetric	encryption standards	1	1	2	3	4	5	6	7	8	9	10	11	12	S Ol	pecif utcom	ic 1es		
CLR-2:	Illustrate Public a	nd Private key c <mark>ry</mark>	<mark>yptography</mark>	IL PORTONION	ge		of	s of	2	iety			Ł		a		l l	(			
CLR-3:	Analyze Key man	agement, distribu	ution and certification		vledo		ento	ation	ge	soc			oW ۲		Jano	b		l			
CLR-4:	CLR-4: Describe the enhancements made to IPv4 by IPSec				Knov	Ilysis	lopm	estige	Usa	r anc	৵ঽ৾		Tean	U	& Fir	arnin		i			
CLR-5:	Analyze the vario	us firewall <mark>s an</mark> d w	veb security	1.2010	ering	em Ana	n/devel	ict inve ex prot	n Tool	nginee	nment		lual & <sup>-</sup>	Iunicat	t Mgt.	ong Lee			~		
Course O	utcomes (CO):	At the	end of this course, learners wi	II be able to:	Engine	Proble	Design	Condu	Moder	The el	Enviro Sustai	Ethics	Indivic	Comm	Projec	Life Lo	PSO-`	PSO-2	PSO-3		
CO-1:	Differentiate symr	netric a <mark>nd asym</mark> n	netric encryption systems and thei	ir applications.	2	3	-		-		-	-	-	-	-	-	2	-	-		
CO-2:	Apply the concept	ts of Nu <mark>mber the</mark> o	ory		-	3	$(\mathcal{C})$	-	-		-	-	-	-	-	-	- 1	3	-		
CO-3:	Discuss about th availability	e impo <mark>rtance a</mark> n	d application of each of confider	ntiality, integrity, authentication and	3		2		-		-	-	-	-	-	-	-	2	-		
CO-4:	Explain the variou	is aspe <mark>cts of IPs</mark> e	эс		3		2	120	-		-	-	-	-	-	-	- 1	2	-		
CO-5:	Analyze various e	ffects in <mark>system</mark> s	security		2	3	u.v	-	-		-	-	-	-	-	-	2	<u> </u>	-		
Unit-1 - Cl	lassical Encryption	Techniques																9	Hou		

Cryptography, Cryptanalysis and Brute-Force Attack. Cryptography Concepts and Techniques: Introduction, plain text and cipher text, Symmetric Cipher Model Substitution Techniques, Caesar Cipher, Monoalphabetic Cipher, Play fair Cipher, Hill Cipher, Polyalphabetic Cipher, One Time Pad.DES and the nature of the DES algorithm, timing attacks. Traditional block Cipher structure, stream Ciphers and block Ciphers. Block Cipher Modes of Operation.

#### Unit-2 - Cryptographic Algorithms and Public-Key Cryptography

Symmetric key Ciphers: AES, Blowfish, RC5, IDEA and CAST-128 Asymmetric key Ciphers: Principles of public key cryptosystems, Number Theory, RSA algorithm, Public Key Management, Public Key Certificate Generation and Verification, X. 509 Certificates and Diffie-Hellman Key Exchange.

### Unit-3 – Cryptographic Hash Function

Message Authentication, MD5, SHA-1, Secure Hash Algorithm (SHA-512), Message authentication codes: Authentication requirements, HMAC, CMAC, Digital signatures. Key Management and Distribution: Symmetric Key Distribution Using Symmetric & Asymmetric Encryption, Distribution of Public Keys, Kerberos.

#### Unit-4 - IP Security

IP Security overview, applications of IPsec, benefits of IPsec, Routing applications, IPsec documents, IPsec services, transport and tunnel modes - combining security associations, authentication plus confidentiality, basic combinations of security associations, internet key exchange, key determinations protocol, header and payload formats, cryptographic suits. .IP Security policy, Security associations, Security associations, backet associations, backet associations, backet associations database, Security policy database, IP traffic processing, Encapsulating Security payload, ESP format, encryption and authentication algorithms, Padding, Anti replay service.

9 Hour

9 Hour

#### Unit-5 - Web Security and Firewalls

Transport-level Security: Web security considerations, Secure Socket Layer and Transport Layer Security, HTTPS, Secure Shell (SSH), Wireless Network Security: Wireless Security, Mobile Device Security, IEEE 802.11 Wireless LAN, IEEE 802.11 Wireless LAN Security, Introduction to Firewall Types and Configurations, Trusted system.

Learning Resources	1. 2.	Stallings, William, "Cryptography and Netwo <mark>rk Security: Princ</mark> iples and Practice", 7th ed., Pearson Higher Education, 2016 Bruce Schneider, Applied Cryptogra <mark>phy, 2nd ed.</mark> , 2015	<ol> <li>BehrouzA.Forouzan, Debdeep Mukhopadhyay, Cryptography and Network Security, 2nd ed., Tata McGraw Hill, 2010</li> </ol>

		For	Continuous Learning native	Assessment (CLA) Life-Long	g Learning	Summative Final Examination					
	Level of Thinking	CLA-1 Avera	age of unit test 0%)	Cl (1	A-2 0%)	(40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%		15%		15%	-				
Level 2	Understand	25%		25%		25%	-				
Level 3	Apply	30%		30%		30%	-				
Level 4	Analyze	30%		30%		30%	-				
Level 5	Evaluate	-	100 Star 5 M S	1.1.1.1		-	-				
Level 6	Create	and states		- Card	-	-	-				
	Total	10	0 %	10	0 %	10	0%				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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Course Code	Course Code         21ECE231T         Course Name         PRINCIPLES OF CLOUD COMPUTING						rse gory	E			PROF	ESSIO	NAL E	ELECT	IVE		l	- T 3 0	P 0	C 3
Pre-requis Course	site s	Nil	Co- requ Courses	isite s	Nil	F	Progres Cours	sive es						Nil						
Course C	Offering Departm	ent	ECE		Data Book / Codes / Standard	ds							Nil							
Course Lea	arning Rationale	(CLR):	The purpo <mark>se of learnin</mark> g	this cours	e is to:		1	1	1.1	Progr	am Ou	utcome	s (PO)	)				P	rogra	m
CLR-1:	Understand the f	fundamer	ntal ideas beh <mark>ind Cloud</mark> Corr	nputing, as w	ell as current and future challenges	1	2	3	4	5	6	7	8	9	10	11	12	01 01	itcom	es
CLR-2:	Work effectively	on the sh	ared inf <mark>rastructure.</mark>	10	1 martine	е		f	s of	2.	ety			¥		0				
CLR-3: Explore cloud storage technologies and relevant distributed file systems					vledo	'	ento	tions	ge	soc			Wo		ance	D				
CLR-4: Get detailed understanding of various cloud-based platforms and simulators						Anov	lysis	mdo	stiga	Usa	and	~~~		earr	uo	& Fin	arnin			
CLR-4.       Get detailed understanding of various cloud-based platforms and simulators         CLR-5:       Understand the cloud security threats and protective mechanism for cloud computing						eering h	em Ana	In/devel	uct inve lex prob	m Tool	ngineer	onment	(0	dual & T	nunicati	ct Mgt. 8	ong Lea	-	2	3
Course Ou	tcomes (CO):		At the end of this cours	se, learners	will be able to:	Engin	Probl	Desig	Cond	Mode	The e	Envire Susta	Ethics	Indivi	Comr	Proje	Life L	-OS4	PSO-	PSO-
CO-1:	Apply fundament	tal conce <mark></mark>	<mark>ots in clo</mark> ud infrastructure fo	r cloud appli	cations	3	1.1	-	-		-	-	-	-	-	-	-	-	-	-
CO-2:	Explore the princ	ciples of <mark>v</mark>	<mark>rirtualiza</mark> tion and virtual mac	hines		3	2	1	-		-	-	-	-	-	-	-	-	-	-
CO-3:	Illustrate the fund	damenta <mark>l</mark>	concepts of cloud storage a	and demonst	rate their use in storage systems	3	2		-	-		-	-		-	-	-	3	-	-
CO-4:	Identify the secu	rity issue <mark>s</mark>	s related to cloud computing	to handle th	e security threats and provide solutions	s 3	2	1	-	-	-	-	-	-	-	-	-	3	-	-
CO-5:	Analyze cloud pr	ogramm <mark>i</mark> i	<mark>ng model</mark> s and apply them to	solve proble	ms on the cloud using cloud simulators	s -	3		2	2	-	-	-	-	-	-	-	-	2	-
Unit-1 - Clo	oud Introduction	and Clo	ud Infrastructure	New York	14-5 C					1	ę.								9	Hour
Cloud Com	puting: Benefits a	nd applic	ations, Grid computing and	Utility comp	ting Vs Cloud Computing, Cloud deliv	ery m	odels a	nd ser	vices, C	Cloud o	deployi	ment m	odels,	<b>Eth</b> ica	l issue	s and i	najor c	hallen	iges, (	Cloud
infrastructu	re: Amazon Web or private clouds: I	Services, Eucalyptu	Google cloud, Microsoft Az	ure, Energy	use and ecological impact of large-sc	ale da	ta cent	ers, Se	rvice- a	and co	mplian	ce-leve	l agree	ements	s, Case	e Study	: Open	-sourc	ce sofi	tware
Unit-2 - Clo	oud Resource Vi	-ucaryptu rtualizati	on	10		-			-	-									9	Hour
Virtualizatio	on, Layering and V	/irtualizat	ion, Virt <mark>ual Machin</mark> e Monitor	rs, Virtual Ma	chines, Performance isolation, Full vir	tualiza	ation an	d para	-Virtual	ization	, Hard	ware Si	upport	for vir	tualizat	ion				
Unit-3 - Clo	oud Storage system	ms		7.94	$1 M A \rightarrow L D +$	1													9	Hour
Storage mo	odels, file systems	s, and dat	tabases, Distributed File sys	stems, Goog	le File system, Apache Hadoop, Onli	ne Tra	ansactic	on Proc	essing,	NoSC	QL Dat	abase,	Cloud	Datab	bases (	HBase	, Mong	ioDB (	Cassa	ndra,
Unit-4 - Clo	oud Security					_	_	_	-										9	Hour
Cloud Secu	ırity risks, Threat	Agents,	Cloud Security Threats, Clo	ud Security	Mechanisms, Identity and Access Ma	nagei	nent, S	ingle S	Sign-On	: Kerb	eros a	uthenti	cation,	One	time Pa	asswor	d, VMI	N and	VM t	ased
threats, Sec	curity of Virtualizations	and Clo	ted VMM ud Simulators				-												9	Hour
Cloud Appl	ications: Processi	ng Pipelir	nes, batch Processing Syste	ms and Web	Applications, Architectural Styles, Ma	pRed	uce Pro	gramn	ning mo	del, C	loud si	mulator	r: Intro	ductio	n, unde	rstand	ing Clo	udSin	ים ו simu	ilator,
CloudSim A	Architecture(User	code, Clo	udSim, GridSim, SimJava)	Understandii	ng Working platform for CloudSim, Intr	oduct	ion to G	reenCl	loud								-			

	1.	Dan C. Marinescu," Cloud Computing Theory and Practice", Second Edition Copyright © 2018 Elsevier Inc.	4.	K. Chandrasekaran, "Essentials of Cloud Computing", Chapman and Hall/CRC Press, 2014, ISBN 9781482205435
Learning Resources	2. 3.	Rajkumar Buyya, James Broberg, AndrzejGoscinski, Cloud Computing Principles and Paradigms, Wiley Publications, 2017. Thomas Erl, ZaighamMahmood, and RichardoPuttini, "Cloud Computing: Concepts, Technology & Architecture", Prentice Hall/PearsonPTR, Fourth Printing, 2014, ISBN: 978013338752.	5.	Arshdeep Bahga, Vijay Madisetti, "Cloud Computing: A Hands-On Approach", University Press, 2016, ISBN-13: 978-0996025508.

		1.1.1	Continuous Learning	Assessment (CLA)		Summative Final Examination (40% weightage)					
	Bloom's Level of Th <mark>inking</mark>	Form CLA-1 Avera (50	native ige of unit test 0%)	Life-Lon Cl (1	g Learning _A-2 0%)						
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%		15%		15%	-				
Level 2	Understand	25%		20%		25%	-				
Level 3	Apply	30%		25%		30%	-				
Level 4	Analyze	30%		25%		30%	-				
Level 5	Evaluate		0.0.15.10	10%		-	-				
Level 6	Create			5%		-	-				
	Total	10	0%	10	0 %	100 %					

Co	urse Designers		and the second	
Ex	perts from Industry	Ex	perts from Higher Technical Institutions	Internal Experts
1.	Mr. Anuj Kumar, Program Delivery Manager, Nagarro Software's Pvt Ltd.	1.	Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr.M.S. Vasanthi, SRMIST
2.	Mr. Saivineeth, ML Accelerator Architect @ Google	2.	Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai	



Course Code	21ECE232T	21ECE232T Course Name DATA ANALYSIS AND VISUALIZATION						E			PROF	ESSIC	)NAL E	ELECT	IVE		Ĺ	- T 3 0	P 0	C 3
Pre-requi Course	isite es	Nil	Co- requi Courses	isite	Nil	F	rogres Cours	sive es						Nil						
Course	Offering Departmen	it	ECE	-	Data Book / Codes / S	tandards							Nil							
Course Le	arning Rationale (C	:LR): 7	The purpo <mark>se of learnin</mark> g	this course i	is to:		2		11	Progr	am Ou	utcome	es (PO	)				Pi	rogra	m
CLR-1:	Learn to handle dat	ta and the	various statistical techni	ques in data h	andling	1	2	3	4	5	6	7	8	9	10	11	12	S   Ου	pecifi itcom	c es
CLR-2:	Know the various re	egression	and <mark>classificatio</mark> n technic	jues	and and and	e		of	s of	2	iety			¥		a				
CLR-3: Identify various data sources and dealing with messy date								ento	ations	ge	soc			٥ ۸		Jance	D			
CLR-4:	Knov	Ilysis	mdo	stiga	Usa	r anc	∞		Tean	io	& Fir	arnin								
CLR-5:	CLR-5: Appreciate the various visual effects								ct inve ex prol	n Tool	Igineer	nment		ual & .	unicat	t Mgt.	ng Le			
Course Ou	utcomes (CO):		At the end of this cours	e, learners w	ill be able to:	Engine	Proble	Design	Condu	Moder	The er	Enviro	Ethics	ndivid	Comm	Project	Life Lo	-SO-1	2-02	-SO-3
CO-1:	Handle data and sta	atistic <mark>al dis</mark>	stributions	15	inter the start is	3	2	-	-	-		-	-	-	3	-	-	-		-
CO-2:	Classify regression	mode <mark>ls</mark>	2		the second	3	3	12	-	-	1.	<u>.</u>	-	-	-	-	-	-	-	-
CO-3:	Deal data from vari	ious s <mark>ourc</mark> e	es and messy data	1000	1995 - 1997 - P.		3		3	-	- 10	-	-	-	-	-	-	-	-	-
CO-4:	Choose right data v	visuali <mark>zatio</mark>	on technique	14.25		100	3	16		3	-	-	-	-	-	-	3	-	-	-
CO-5:	Add appropriate vis	sual eff <mark>ects</mark>	5			34		1.1	-	-	2	-	-	-	2	-	-	-	-	-
<b>Unit-1 - Sh</b> Univariate	h <b>ape of Data</b> data, Frequency disi	tributions -	- Measures of central te	ndency, Sprea	ad, Population, sampling, an	d estimation	- Proba	ability o	listribut	ions, N	Aultiva	riate da	a <mark>ta: R</mark> e	elation	ships b	etweer	n singl	e cate;	<b>9</b> gorica	<b>Hour</b> I and
single cont Basics - A <b>Unit-2 - Pr</b>	tinuous variable - Re tale of two interpreta redicting Continuou	elationship <mark>s</mark> itions. San i <b>s Variable</b>	s between two categorica npling from distributions es	al variables - I - Binomial dist	Relationship between two co tribution, Problems in binomi	ontinuous vari al distribution	ables – -Norm	Covai al distr	iance, ibution,	Correla Proble	ation c ems in	oefficie norma	ents - ( I distril	Compa bution	ring m - Three	ultiple ( e sigma	correlat <u>a rule a</u>	tions, I nd usi	Proba ng z t <b>9</b>	bility: ables <b>Hour</b>
linear mod	lels- Linear regressio	on, Multiple	e r <mark>egression -</mark> Regressio	on with a non	-binary predictor, Kitchen si	ink regressior	- The	bias	variance	e trade	e off: (	Cross v	<mark>/alid</mark> ati	ion, S	triking	a bala	nce - l	_inear	regre	ssion
diagnostics	s, Second, third and Iom forests Choosin	fourth ans In a classif	scomb <mark>e relationship</mark> - Ac fier: vertical and diagona	ivancements, al boundary - (	Predicting categorical variat Choosing a classifier: cresce	bles: k neares	t neigh bound	ibors - larv	Confus	ion m	atrix ,	Logisti	c regr	ession	- Role	e of sig	moid fi	unctior	ı, Dec	ision
Unit-3 - Da	ata sources	3 4 6 4 3 6 1		. soundary C			Jound												9	Hour
Relational Complete of Stochastic	databases, SQL - JS case analysis, Pairwi regression imputatio	SON, XML ise deletion on, Multiple	Other data formats, H n, Unsophisticated metho e imputation - Analysis w	andling data fi ods for dealinı vith sanitized c	rom online repositories - Dea g missing data: Mean substit lata. checking for out of bour	aling messy c tution, Hot de nds and data	lata - A ck impl type - (	Analysi Itation Checkii	s with n - Unso <mark>n</mark> ng for u	nessy phistic nexpe	data T ated n cted ca	ypes, L nethods ategorie	Jnsoph s for de es, out	nisticat ealing liers, t	ed met missing /pogra	thods f g data: phical (	or deal Regre errors	ing mi ssion Checki	ssing imput ing ur	data: ation, likely

data - Other messiness

#### Unit-4 - Classification of Visualization

Complexity - Infographics vs data visualization, Exploration vs explanation - Information vs persuasive vs visual art, Looking data as designer - Role of designer, Looking data as reader - Creation of visualization for other people, Contextual

considerations Context of use, The goal and supporting data - Knowledge before structure, Choosing appropriate visual encodings: natural order, distinct values, redundant encoding, Defaults vs innovative formats - Readers context - Compatibility with reality - Patterns and consistency, Selecting structures: Comparisons, bad structures - Abused structure and simplicity in designing

#### Unit-5 - Positioning

Layout - Positioning: axes, Placement and proximity Semantic distance and relative proximity, absolute placement, Representation of physical space - Logical and physical relationships - Patterns and grouped objects, Patterns of organizations: Graphs, layouts - Axis styles Using circles and circular layouts - Applying encodings: Color, Leverage Common color - Cognitive interference and Stroop test. Color theory sizes: Conveying size, Size: Comparing size - Text and typography, Shapes and lines - Keys Vs direct labeling of data points

Learning	1.	Tony Fischetti, Data Analysis with R, Packt publishing, 2015.	3.	Trevor Hastie, Robery Tibshirani, Jerome Friesman, The Elements of Statistical Learning, Data
	2.	Noab Iliinsky, Julie Ste <mark>ele, Designing</mark> data visualizations, O' Reilly publishers, 2011.		mining, Inference and prediction, 2nd Edition, Springer, 2010.
Resources			4.	Charles D. Hansen and Chris R. Johnson, Visualization Handbook, Academic Press, 2004

			Continuous Learning A	ssessment (CLA)		Quin	mativa				
	Bloom's Level of Thinking	Form CLA-1 Averag (50	ative ge of unit test %)	Life-Long CL (1)	g Learning _A-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice				
Level 1	Remember	20%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	20%	- "Hat" -	20%	-				
Level 2	Understand	20%		20%	- Parent	20%	-				
Level 3	Apply	30%		30%		30%	-				
Level 4	Analyze	30%		30%	-	30%	-				
Level 5	Evaluate		· · · · ·	Contraction of the local division of the loc			-				
Level 6	Create	and the second second	- 107	and a second	1100	-	-				
	Total	100	)%	10	0 %	10	0%				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Program Delivery Manager, Nagarro	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr. Diwa <mark>kar R Marur</mark> , SRMIST
Software's Pvt Ltd.	Date of Sall Santa Street and	
2. Mr. Saivineeth, ML Accelerator Architect @ Google	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai Industry:	

B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

9 Hour

Course Code	Course 21ECE330T Course Name FULL STACK DEVELOPMENT							e ry	Е			PROF	ESSIO	NAL E	ELECT	IVE		l	- T 3 0	P 0	C 3
Pre-requ Cours	isite es	Nil	Co- requ Course	iisite s	Nil		Pro	ogres:	sive es						Nil	1					
Course	Offering Departm	ent	ECE		Data Book / Codes /	Standards	100							Nil						·	_
r					m half it has																
Course L	earning Rationale	(CLR): TI	he purpose of learning	g this course	) is to:			C 12	1	111	Progra	am Ou	Itcome	s (PO)	)				Prog		
CLR-1:	Introduce full sta	ck developme	ent and J <mark>ava</mark>	- 10	10 200		1	2	3	4	5	6	7	8	9	10	11	12	0ı	itcom	ies
CLR-2: Gain knowledge in JAVA programming							ge	3	of	s of	2.	iety			rk		a)				
CLR-3: Acquire knowledge on database management and internationalization using JAVA						Sale	vledo		ento	tion:	ge	soc			No I		ance	0		1	
CLR-4:	CLR-4: Understand servlets and communication							lysis	mdo	stige	Usa	- and	৵		[ear	on	& Fir	arnin			
CLR-5:	CLR-5: Explore the Java Server Pages								In/devel	uct inve lex prot	m Tool	Ingineer	onment	(0)	dual & J	nunicati	ct Mgt.	ong Lea	-	2	3
Course O	utcomes (CO):	A	At the end of this cour	se, learners i	will be able to:	11.27	Engir	Probl	Desig	Cond	Mode	The e	Envin	Ethic	ndivi	Comr	Proje	_ife L	-OSc	-OSc	-OSc
CO-1:	Apply Java progr	amming strue	ctures for full stack dev	elopment	Siles burg	34127	3	-	2	-		1	-	-	-	-	-	-	3	-	-
CO-2:	Develop program	nming sk <mark>ills in</mark>	<mark>1 JA</mark> VA				3		2	-	-	1	-	-	-	-	-	-	3	-	-
CO-3:	Explore Java for	web de <mark>velo</mark> p	ment	1000			3	-	2	-	-	-	-	-		-	-	-	3	-	-
CO-4:	Analyze the serv	lets and <mark>inter</mark>	<mark>ser</mark> vlet communication	100		000	3	-	2	-	-		-	-	-	-	-	-	3	-	-
CO-5:	Analyze JSP for	web dev <mark>elopı</mark>	ment	1.1	The second		3	1	2	-	-	-	-	-	-	-	-	-	3	-	-
linit 1 in	traduction to Full	Steek Web	Development and (A)	(A		- 64						-									Hour
Introductio	in to Full Stock Dow	olonmont In	troduction to IAVA IAV	A // programm	ing onvironmont Programm	ing structure	nc in T	<u> </u>	Data	types	Jariah	los or	oratore	otrino	ne inn	ut and	output	Contre	ol flow	Arro	nour
Init-2 - P	rogramming Using	οιοριτιστιά, πα γ.ΙΔVΔ		n programm	ing environment, i rogramm	ing structure	53 111 01		- Dala	types,	vanabi	ies, op	6101013,	, sume	<b>J</b> S, IIIP	ut anu	οαιραι,	Contro		<u>, Ana</u>	Hour
Objects a	nd classes - Introd	uction to Obj	ject Oriented Program	ning, classes	, objects, defining class, In	heritance - o	classe	s. su	per cla	ass. su	b class	s. inte	rfaces,	Lambo	da Exp	oressio	ns, Inn	er clas	ses.	Excep	tions.
Assertions	s, and Logging, Coll	lections, Con	currency														,		,	'	,
Unit-3 - J	AVA Web Develop	ment		100 C		and the second s		-			125	1								9	Hour
Database	management, ODB	C API, JDBC	CAPI, <mark>Establishing</mark> conn	ection with da	atabase, JDBC URL, Localiz	ation, Const	ructor	s and	metho	ods of L	ocale a	and Re	esource	bundl	e class	s, Deve	eloping	I18N-b	ased	applic	ation,
Unit-4 - S	ervlets Working v	vith Servlets	and Inter Serviet Co	mmunication					100											9	Hour
Webserve	r. Servlets and their	r characterist	tics, Working of Servlet.	Lifecycle of S	Servlet, servlet interface. H1	TP Servlet.	HTTP	Reau	uest ar	nd Resp	onse.	The G	ET and	POST	meth	ods. H	TTP Se	ervlet R	eques	st Inte	rface.
Session tr	acking and techniq	ues for sessio	on tracking, HTTP Sess	ion interface,	Request Dispatcher, Servle	et Context, In	nplem	enting	g Inter	servlet	comm	unicat	ion via a	a prob	lem st	atemei	nt				,
Unit-5 - Ja	ava Server Pages	(JSP)																		9	Hour
Need for J Elements,	ISP, Life cycle of JS Custom Tags, Exp	SP: Example, ression Lang	Structure of JSP, JSP juage, Model view conti	Ele <mark>ments, Sc</mark> oller (MVC), e	<mark>ripting</mark> Elements, Implicit Ob example in JSP	ojects, Types	s Of Di	irectiv	ves, JS	P direc	tives, l	Implici	t Object	's, Buf	fer, Ind	clude a	nd Tag	lib dire	ctive,	JSP A	Action

Learning Assessn	ient		Continuous Learning	Assessment (CLA)		0					
	Bloom's Level of Thinking	Form CLA-1 Avera (50	ative ge of unit test %)	Life-Long CL (1)	g Learn <mark>ing</mark> _A-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Practice	Theory	Practice					
Level 1	Remember	15%		15%		15%	-				
Level 2	Understand	25%		20%		25%	-				
Level 3	Apply	30%		25%	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	30%	-				
Level 4	Analyze	30%	and the second second	25%		30%	-				
Level 5	Evaluate	····		10%			-				
Level 6	Create			5%			-				
	Total	10	0%	10	00%	10	00%				
					22. 10						

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Program Delive <mark>ry Mana</mark> ger,	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr. Sudhanya P, S <mark>RMI</mark> ST
Nagarro Software's Pvt Ltd.	An of the Carolina Pills and the second second	
2. Mr. Saivineeth, ML Accelerator Architect @ Google	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai	



Course Code	21ECE331T	Course Name		DATA MINI	NG AND ANALYTIC	CS	Cou Cate	rse gory	E			PROF	ESSIO	NAL E	ELECT	IVE		L	- T 3 0	P 0	C 3
Pre-requi Course	isite es	Nil		Co- requisite Courses		Nil	F	Progres Cours	sive ses						Nil						
Course	Offering Departn	nent		ECE	Data Be	ook / Codes / Standa	ards							Nil							
		(0) D)	<b>T</b> /		-		1	-	1.0		_	•		(50					D	oara	m
Course Le	earning Rationale	e (CLR):	I ne purpose	of learning this co	ourse is to:	-	_			-	Progr	am Ol	Itcome	s (PO	)				S	pecifi	ic
CLR-1:	Know the basic	terminologies	es used in data	<mark>minin</mark> g			1	2	3	4	5	6	7	8	9	10	11	12	Ou	tcom	es
CLR-2:	Study the assoc	ciation and ru	ules u <mark>sed in da</mark>	ta mining			e		f	s of	10	iety			¥		a				
CLR-3:	Acquire knowled	dge on variou	us c <mark>lassificat</mark> io	n algorithms	1 1	1000	vled		ento	ation	ge	soc			oW r		Jano	D			
CLR-4:	Ability to analyze clusters						Knov	lysis	mdo	stige	Usa	anc	৵		[ean	u	& Fir	arnin			
CLR-5:	Familiarize with	amiliarize with outlier analysis and applications						em Ana	n/devel	ict inve ex prot	n Tool	enginee	nment		lual & J	nunicati	t Mgt.	ong Lea	_		~
Course Ou	utcomes (CO):	comes (CO): At the end of this course, learners will be able to:						Proble	Design	Condu	Moder	The el	Enviro Sustai	Ethics	Indivic	Comm	Projec	Life Lo	PSO-`	PSO-2	PSO-3
CO-1:	Develop necessary insights to carry out data mining process						3	1	-	-	I	1	-	-	-	-	-	-	2	-	-
CO-2:	Analyze associa	ation and <mark>rule</mark>	<mark>es in d</mark> ata minii	ng	121-22	1000	3	2	12	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Apply different t	ypes of c <mark>lass</mark>	<mark>sificat</mark> ion algori	thms	0.000	19. 8	3	1.			2	-30	-	-		-	-	-	-	-	1
CO-4:	Evaluate variou	s kinds o <mark>f clu</mark>	<mark>uster </mark> analysis t	echniques	100		3	2	-			2		-	-	-	-	-	-	-	1
CO-5:	Implement outlie	er analysi <mark>s fo</mark>	<mark>or vari</mark> ous data	mining application	S		3		3	-	-	1	-	-	-	-	-	-	3	-	-
Unit-1 - Da	ata Mining Overv	view	-		Contract of the							~								9	Hour
Data minin	g introduction, Ki	nds of data a	and patterns s	uited for mining, A	pplications suitable	for data mining, Issu	es in Da	ata min	ing, Da	ita obje	cts an	d Attri	bute typ	es, Si	atistica	al desc	ription	s of da	ta, Ne	ed for	r data
preprocess	sing and data, Dat	ta cleaning, <mark>C</mark>	Data integration	n, Data reduction,	Data transformation	n, Data cub <mark>e and</mark> its u	sage.		0.		11								-		
Unit-2 - As	ssociation Rule I	Vining		12.2							-7									9	Hour
Mining freq	quent patterns: Ba	isic concepts,	s, M <mark>arket bask</mark> e	et analysis, Freque	nt item sets, Closed	d item sets, Decision i	ree indu	iction, /	Associa	ation ru	es- Int	roduct	ion, Apr	riori al	gorithn	n - theo	pretical	approa	ach, Aj	oply A	priori
algoninn c	Association ana	els, Generalii Ivsis to corrol	ang association	Comparison of n	nt item sets, improv	ning eniciency of Apri	on, Pau	em gro	win ap	proacri,	WIITIITI	g irequ		n sets	susing	vertica	ai uala	iormal,	SILOU	ig ruie	35 VS.
Unit-3 - Cl	assification Alac	orithms				,usuros.			12.5	1.1	-									9	Hour
Classificati	Classification: Basic concepts, General approach to classification, Decision tree induction, Algorithm for decision tree induction, Numerical example for decision tree induction, Attribute selection measure, Tree									Tree											
pruning, Se	uning, Scalability and decision tree induction, Bayes' theorem, Naïve Bayesian classification, IF-THEN rules for classification, Rule extraction from a decision tree, Metrics for evaluating classifier performance,																				
Cross valid	lation, Bootstrap,	Ensemble m	nethods: introd	iction, Bagging an	d boosting, Overvie	w of random forests							_							_	
Cluster An	uster Analysis	n Roquiromo	onts and overvi	aw of different cate	aories Partitioning	method: introduction	k-moon	s k-mo	doids	Hioraro	hicalm	othod	introdu	iction	Analo	morativ	h av a	ivisivo	motho	<b>y</b> d Dis	tanco
measures	in algorithmic met	hods, BIRCH	<u>H technique,</u> D	BSCAN technique,	STING technique,	CLIQUE technique, E	valuatio	on of clu	istering	techn	ques			ouon,	- yyi0i	ncialiv	0 v3. U	131001	netiiU	u, DIS	unce

9 Hour Outliers: introduction, Challenges of outlier detection, Outlier detection methods: introduction, Supervised and semi-supervised methods, Unsupervised methods, Statistical and proximity-based methods, Statistical approaches, Statistical data mining, Data mining and recommender systems, Data mining for financial data analysis, Data mining for intrusion detection

	1.	Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques", 3rd Edition,	3.	Mohammed J. Zaki, Wagner Meira, Jr., Wagner Meira, Data Mining and Analysis: Fundamental
Learning Resources	2.	Morgan Kauffman Publishers, 2011 Kris Jamsa, Introduction to Data <u>Mining and</u> Analytics, First Edition, Jones & Barlett		Concepts and Algorithms, Cambridge University Press, 2014.
		Learning, 2021.	-	

Learning Assessme	ent	1. 1. 1. 1.	State of the second		C. J.							
			Continuous Learnin	g Assessment (CLA)	the second secon	Cum	matik in					
	Bloom's Level of <mark>Thinking</mark>	Form CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (1)	g Learning .A-2 0%)	Final Examination (40% weightage)						
		Theory	Practice	Practice	Theory	Practice						
Level 1	Remember	15%		15%		15%	-					
Level 2	Understand	25%		20%		25%	-					
Level 3	Apply	30%	-	25%	And the second second	<mark>30</mark> %	-					
Level 4	Analyze	30%	100 Sec. 5.10	25%		<mark>30</mark> %	-					
Level 5	Evaluate			10%		-	-					
Level 6	Create			5%		-	-					
	Total	Total 100% 100%					100%					

Course Designers	A State Street Street	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Program Deliver <mark>y Manage</mark> r,	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr. Diwakar R. Marur, SRMIST
Nagarro Software's Pvt Ltd.		
2. Mr. Saivineeth, ML Accelerator Architect @ Google	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai	



Course Code	Course Code         21ECE332J         Course Name         MULTI-CORE ARCHITECTURE AND PROGRAMMING							e ry	E			PROF	ESSIO	NAL E	ELECT	IVE			- T 2 0	P 2	C 3
Pre-requ Cours	uisite ses	Nil	Co- r Cou	equisite rse <mark>s</mark>	Nil	-	Pro	ogres Cours	sive es						Nil	1					
Course	Offering Departme	ent	ECE		Data Book / Codes / Sta	ndards								Nil							
Course L	earning Rationale	(CLR): Th	he purpo <mark>se of learr</mark>	ning this cours	e is to:	T	-	1	A	111	Progra	am Ou	utcome	s (PO)	)				Pr	rogra	m
CLR-1:	Understand muti-	core process	sors and architecture	e	1022		1	2	3	4	5	6	7	8	9	10	11	12	01	pecifi itcom	ic Ies
CLR-2:	Learn parallel and	d multi thread	d pro <mark>gramming</mark>	2	1 contractor		е	103	Ŧ	s of	1	ety			ž		0				
CLR-3:	Study various par	rallel program	nming concepts	N		10	/ledc		ent o	tions	ge	soc			Wo		ance	5		 	
CLR-4:	CLR-4: Exploit loop level parallelism approach						Knov	lysis	mdo	stiga	Usa	and	∞ .		earr	uo	& Fin	arnin			
CLR-5:         Study the need for synchronization in parallel programs							ering h	m Ana	I/devel	ct inve	n Tool	Igineer	nment		ual & T	unicati	t Mgt. 8	ng Lea			
Course C	Course Outcomes (CO): At the end of this course, learners will be able to:					17	Engine	Proble	Design	Condu	Moder	The er	Enviro Sustai	Ethics	Individ	Comm	Projec	Life Lo	PSO-1	PSO-2	PSO-3
CO-1:	Evaluate the char	racterist <mark>ics of</mark>	<mark>f mu</mark> lti-core process	ors	The our is	4.24	3	÷.		-	1		-	-	-	-	-	-	-	-	-
CO-2:	Compile parallel µ	orogram <mark> para</mark>	adigms				3	2	12	-	-	-	<u> </u>	-	-	-	-	-	2	-	-
CO-3:	Apply shared me	mory pr <mark>ogran</mark>	<mark>nmi</mark> ng with open MF				-	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Express parallel e	executio <mark>n in c</mark>	open MP	1000		100	3	-	-	-		-	-	-	-	-	-	-	-	-	-
CO-5:	Analyze synchror	nization <mark>in sha</mark>	<mark>ared</mark> memory parall	el programs	100		2	3	1.1	-	-	1	-	-	-	-	-	-	-	-	-
Unit-1 - N	Aulti-Core Process	or Architect		100	1000	-		67				÷	<u>.</u>							12	Hour
Introducti	on to multi-core arc	hitecture, SI	MD and MIMD, Inte	erconnection ne	tworks, Distributed shared memo	ory arch	itectu	res, C	Cache	coherer	ce, Pa	arallel	prograi	n desi	gn.						
Practice:	Programs on paralle	el programmil pradiams	ng in multi core arch	nitecture.		-				-	-				_					12	Hour
Performa	nce, Scalability, Syn	chronization,	Data sharing, Data	races, Synchro	nization, Mutex, Locks, Semapho	ores, De	ad loo	cks ar	nd live	locks, T	hread	comn	nunicati	on, Me	essage	queue	əs, Pipe	es		12	noui
Practice:	Programs on sema	phores, muter	x, <mark>message q</mark> ueues	400		1					1				•						
Unit-3 - C	Open Mp			200	ALC STUD	116				100	1									12	Hour
Performa Explicit sy Practice	nce with open MP, ynchronization, Redu y Programs on a sim	Parallel com Iction clause	aputer structure, Co	mmunication a	nd data environment, Run time e	executio	on mo	del o	f open	MP, C	ommu	nicatio	on and	data s	scopin	g, Syno	chroniz	ation ii	1 the s	imple	loop,
Unit-4 - L	oop Level Paralleli	ism																		12	Hour
Usage of the load, <b>Practice</b> :	parallel do directive, Static and dynamic s Program on Loops a	Controlling d scheduling, C and subroutin	lata sharing, Shareo Comparison of run tir ne calls. Parallelizati	l clause, Private me sch <mark>eduling b</mark> ion of loop nest	clause, Default variable scopes, I <mark>ehavi</mark> or.	Private v	variab	le init	ializati	on and f	inaliza	ation,R	Removin	ig data	a depei	ndence	es, Sch	eduling	1 loops	to ba	lance

### Unit-5 - Synchronizatio

Need for synchronization, Synchronization mechanism in open MP, Mutual exclusion synchronization, Critical section, Atomic directive, Event synchronization, Custom synchronization. **Practice**: Program on Data race, Critical section

Learning Assessm	ent										
		100	Continuous Learning	Assessment (CLA)		Summative Final Examination (40% weightage)					
	Bloom's Level of Thinking	Form CLA-1 Averag (45	ative ge of unit test %)	Life-Long CL (1-	g Learning A-2 5%)						
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%		100 C 100 C 100 C	15%	15%	-				
Level 2	Understand	25%		100000	20%	25%	-				
Level 3	Apply	30%	the second second		25%	30%	-				
Level 4	Analyze	30%	A REAL	1000	25%	30%	-				
Level 5	Evaluate			「おおいて生み」	10%		-				
Level 6	Create				5%		-				
	Total	100	)%	10	0%	10	00%				

Course Designers					
Experts from Industry		Exp	erts from Higher Technical Institutions	Int	ernal Experts
1. Dr. N.R. Shanker Manag	ng Director	1.	Dr. Meenakshi, Professor of ECE, CEG, Anna University	1.	Mrs. M.K. Srilek <mark>ha, SRMI</mark> ST
Chase Research and dev	elopment centre, Chennai.				
2. Mr. Anuj Kumar, Program	Delivery Manager, Nagarro	2.	Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT,		
Software's Pvt Ltd.					



B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

Course Code	21ECE333T	Course Name	HARDWARE S	HARDWARE SOFTWARE CO-DESIGN							PROF	ESSIO	NAL E	LECT	IVE	L T P C 3 0 0 3					
Pre-requi Course	site es	Nil	Co- requisite Courses	Nil		Prog Co	ress urse	sive s						Nil							
Course	Offering Departme	ent	ECE	Data Book / Codes / S	Standards								Nil								
Course Le	arning Rationale (	(CLR): T	he purpo <mark>se of learnin</mark> g this co	urse is to:		17	ł.			Progra	am Ou	tcome	s (PO)					P	rogra	m	
CLR-1:	Study the design	of embedde	d computing system	00 200		1 :	2	3	4	5	6	7	8	9	10	11	12	01	itcom	ies	
CLR-2:	Understand the c	oncept of sys	stem partitioning and interfacing	in real time systems	-	e	1	Ŧ	of	10	ety			¥							
CLR-3:	Analze the conce	pt of design	te <mark>chnologie</mark> s in digital signal pro	cessing		vledç		ent o	ations	ge	soc			oW r		Jance	g				
CLR-4:	Learn hardware/s	oftware cosi	mulation emulation			Vouy -	IJSIS	opm	stiga	Usa	anc	≪ _		Tean	ы	ž.	arnin				
CLR-5:	<b>R-5:</b> Design and implement hardware software framework							n/devel	uct inve ex prot	rn Tool	ngineer	onment inability		dual & J	nunicati	st Mgt.	ong Lea	-	~	~	
Course Ou	se Outcomes (CO): At the end of this course, learners will be able to:							Desig	Condu	Mode	The e	Enviro Susta	Ethics	Individ	Comn	Projec	Life L(	PSO-	PSO-S	PSO-3	
CO-1:	0-1: Compile the characteristics of digital system and real time embedded system						-	-	-	1		-	-	ł	-	-	-	-	-	-	
CO-2:	Apply interfacing	of real t <mark>ime</mark> r	multitasking system			3	2	3	-		-		-	-	-	-	-	2	-	-	
CO-3:	Implement embed	dded so <mark>ftwar</mark>	r <mark>e in</mark> real time digital signal proce	essing system		3	2		-	-	-	-	-	-	-	-	-	2	-	-	
CO-4:	Incorporate the fr	amewo <mark>rk for</mark>	simulating heterogenous syster	n	100	3	2	1		-	-	-	-	-	-	-	-	-	-	-	
CO-5:	Design embedde	d syste <mark>m ap</mark>	olication	1	1218		-	3	-	-	4	-	-	1	-	-	2	2	-	-	
Unit-1 - Co	synthesis of Emh	edded Com	puting System			Ne				-	-								0	Hour	
Architectur	e of hardware softw	vare partition	ning, Hardware software cosynth	esis for digital system, Constr <mark>aint</mark> a	analysis, Sy	stem p	artio	oning,	Synthe	sis of r	real tin	ne emb	edded	syster	n, Haro	dware	softwar	e cos	ynthes	sis for	
microcontr	ollers, Software orie	ented cosynt	hesis approach, Microcontroller	system modeling, Cosyma system	1																
Unit-2 - Sy Hardware/	<b>vstem Level Partiti</b> software manning a	oning, Synt	n <mark>esis, and Interfacing</mark>	rocessor system. Cosynthesis alor	orithm for dis	stribute	den	nhedo	led com	nutina	svste	n Inter	face o	osvnth	esis te	chniau	e for ei	mhedr	9 Ied sv	Hour stem	
Interface g	eneration for hardw	are software	e co <mark>design, R</mark> eal time multi taski	ng in software synthesis.		Janbato	u on	nooud	ou oom	puting	oyotoi	n, mor	1400 0	ooynan	001010	onniqu	0 101 01	noouu	ou oy	storn,	
Unit-3 - Im	plementation Gen	eration In R	Real Ti <mark>me Digital</mark> Signal Proces	ssing System.	Nº C.L.					2									9	Hour	
Design of I	real time digital sign	nal processin	ng system, Data flow in multi rate	e signal processing algorithm, Men	nory manag	ement	in ei	mbed	ded net	work a	opplica	tion, La	tency	of VLI	W ASI	P data	path, C	Constra	aint in	DSP	
Unit-4 - Co	simulation and E	or argital sign mulation	naiprocessor.			_			-										9	Hour	
Framework	for simulating hete	erogenous s	ystem, Synthesis and simulatior	of digital system interfacing, Hard	dware softw	are co	desi	gn for	DSP a	pplicat	tion, C	osimula	ator fo	r embe	dded s	system	desigi	n and	debug	jging,	
Cosynthes	is of mixed hardwa	re software s	system						_											11	
Unit-5 - Embedded System Design and Application Electronic Design For HP Ink Jet Plotter, Design Of Robot Control System, Hardware Software Rapid Prototyning F						work	Port	ahle l	)evice l	or Win	reless	Informa	ation Δ	00000	Proce	ssor-C	onroce	ssor I	<b>9</b> Archite	nour	
For High E	nd Video Applicatio	n	solgh of Hober Control Oystom,		, ping raine	mon, I	orti				0000					0001 0	0000	00017		-oturo	

		1.	DeMicheli, Giovanni, and M. G. Sami, eds. Hardware/software Co-design. Vol. 310.	3.	Florea, Adrian, and Teodora Vasilas. "Optimizing the integration area and performance of VLIW
	l comine		Springer Science & Business Media, 2013.		architectures by hardware/software co- design." International Conference on Modelling and
Resources	2.	De Micheli, Giovanni, et al. Readings in hardware/software co- design. Morgan		Development of Intelligent Systems. Springer, Cham, 2021.	
		Kaufmann, 2002.	4.	Ghaffari, Sina, et al. "A novel hardware-software co-design and implementation of the HOG	
					algorithm " Sensors 20.19 (2020): 5655

		1	Continuous Learnin	g Assessment (CLA)		Summative Final Examination (40% weightage)					
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test 1%)	Life-Lon Cl (1	g Learning LA-2 0%)						
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%		15%		15%	-				
Level 2	Understand	25%	States line	20%		25%	-				
Level 3	Apply	30%		25%		30%	-				
Level 4	Analyze	30%		25%		30%	-				
Level 5	Evaluate		and the second sec	10%			-				
Level 6	Create			5%		-	-				
	Total	10	0%	1(	00%	100%					

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. N.R. Shanker Managing Director Chase Research and development centre	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Mrs. M.K. Srilekha, SRMIST
2. Mr. Anuj Kumar, Program Delivery Manager, Nagarro Software's Pvt Ltd	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai	



Course Code	21ECE430T	OMPUTING		Cour Categ	Course         E         PROFESSIONAL ELECTIVE         L         I           Category         E         PROFESSIONAL ELECTIVE         3         0									L T 3 0	P 0	C 3								
Pre-requi Course	site s	Nil		Co Co	- requisite ourses	9		Nil	e	Pr	ogres Cours	sive es						Nil	1					
Course	Offering Departme	ent		EC	Æ		Data	a Book / Codes	s / Standar	ds							Nil							
Course Le	arning Rationale	(CLR):	The purp	o <mark>se of le</mark>	<mark>arnin</mark> g thi	is course	e is to:	5-1-1-		-	2		1.1	Progr	am Ou	utcome	s (PO	)				Р	rogra	m
CLR-1:	Gain expertise or	n the con	cept of virtu	ualization	and types	; <mark>o</mark> f virtue	alizations.			1	2	3	4	5	6	7	8	9	10	11	12	01	utcom	IC 1es
CLR-2:	Familiarize with th	he server	virtuali <mark>zatio</mark>	on, virtual	machines	and hyp	ervisors.	1	No.	e		of	s of	10	iety			¥		D.				
CLR-3:	Emphasize virtua	alization i	infras <mark>tructur</mark>	<mark>re an</mark> d ap	plication th	hat is fur	ndamental t	o cloudcomputi	ing.	vledç		ento	tion	e	soc			oW r		ance	D			
CLR-4:	Deploy practical	virtualiz <mark>a</mark> t	tion solution	ns and exp	pertise soli	utions.		Real Property in		<b>S</b> nov	lysis	mdo	stige	Usa	and	∞ŏ		ean	ы	& Fir	arnin			
CLR-5:	CLR-5: Gain knowledge on cloud platform architecture.							leering h	em Anal	jn/devel	uct inve lex prob	im Tool	angineer	onment	6	dual & T	nunicati	ct Mgt. 8	ong Lea	5	5	ę		
Course Ou	Course Outcomes (CO): At the end of this course, learners will be able to:						Sec. 27	Engir	Probl	Desig	Cond	Mode	The e	Envir Susta	Ethic	ndivi	Com	Proje	-ife L	-OSC	-OSc	-OSC		
CO-1:	<b>O-1:</b> Categorize storage virtualization, network virtualization and its management.						122	3	2	-	-	-			-	-	-	-	-	-	-	-		
CO-2:	Perform server vi	irtualiza <mark>tic</mark>	on.	7	1.5		199	12.5	6 F	3	5	2	-	-	-		-	-	-	-	-	-	-	-
CO-3:	Apply the concep	t of virtu <mark>a</mark>	<mark>alization</mark> in c	cloud com	puting.	5	1993	2 H H H	1.0	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Deploy and optim	nize virtu <mark>a</mark>	<mark>alization</mark> solu	lutions		1.1	11.1		1.15	3	-	1		-	2	-	-	-	-	-	-	-	-	-
CO-5:	Identify the archit	ecture, i <mark>n</mark>	<mark>frastruc</mark> ture	e and deliv	/ery model	ls of clou	ıd computin	g.	1.2.2	3	~	1.1	-	-	1	-	1	-	-	-	2	-	1	-
Unit-1 - Vi	rtualization	_		-		L.C.M	-		1.					<u>_</u>									9	Hour
Basics of Maximizati	virtual machines, P on, Architectures- \	Process V Virtualizat	/irtual Mach tion Manage	hine, Syste ement, Ste	em Virtual orage Virtu	l Machine ualization	e, Emulatio n, Network \	n, Interpretation Virtualization.	n, Binary T	ranslati	on, Ta	axonon	ny of V	irtual I	Machir	ies. Vir	tualiza	ition- N	Manage	ement	Virtuali	zation	, Har	dware
Unit-2 - Hy	pervisors and Vir	tual Mac	hines				2		N. IL					1									9	Hour
Server Virt	ualization: Understa	anding Se	erver Virtual	alization, I	ypes of se	erver virtu	ualization, v	rirtual machine t	basics, type	s of vir	tual ma	achine	, hyper	lisor c	oncep	s and t	ypes.	_					0	Hour
Comprehe	nsive Analvsis – R	esource l	Pool – Test	ting Envir	onment –	Virtual V	Vorkloads -	- Provision Virtu	ual Machine	es – De	sktop	Virtua	lization	– App	licatio	n Virtua	alizatio	n - Im	plemer	ntation	levels	of virt	ualiza	tion –
virtualizatio	on structure – virtua	alization o	of CPU, Men	mory and	I/O device	s – virtua	al clusters a	and ResourceMa	anagement	– Virtu	alizatio	on for a	lata cei	nter au	tomati	on		,						
Unit-4 - Vi	rtualization Soluti	ons		11: 0								0.1			10	<u> </u>	<i>r</i>			• 0	0	<u> </u>	9	Hour
Virtualizatio	ding Microsoft's Vin on Achieving the B	tualizatior Senefits of	n solutions: f Client Virtu	Microsoft	S Infrastru	ucture Op a the Ber	otimization I nefits of Clo	Model, Virtualiza udVirtualization	ation and th	e Infras	tructu	re Opti	mizatio	n Mod	elBene	efits of	Virtuali	zation	, Achie	ving th	e Bene	ifits of	Datad	centre
Unit-5 - Int	troduction to Clou	d Archite	ecture			1									_								9	Hour
Migrating in as a Servic	nto a Cloud- Challe e, Types of Clouds	nges whil s, Public C	le migrating Clouds, Priv	g to Cloud vate Cloud	- Migratior Is, Hybrid	n Risks a Clouds, (	and Mitigatio	on, Introduction Clouds, Econol	to cloud de mics of the	livery n Cloud,	nodel / Open	Archite Challe	cture, I nges, (	nfrastr Cloud I	ucture nterop	/ Hardv erability	vare a / and \$	s a Se Standa	rvice, F Irds, So	Platforn calabili	n as a ty and	Servic Fault	e, Soi Tolera	'tware ince.

Broberg, Andrzej Goscinski, John Wiley & Sons, Inc. 2011 Online - Michael Miller - Que 2008
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		111	Continuous Learning	Assessment (CLA)		Summative					
	Bloom's Level of Th <mark>inking</mark>	Form CLA-1 Avera (5)	native ige of unit test 0%)	Life-Lon CL (1	g Learning _A-2 0%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	30%	And the second states	30%		30%	-				
Level 2	Understand	25%		25%		25%	-				
Level 3	Apply 📃	25%		25%		25%	-				
Level 4	Analyze	20%		20%		20%	-				
Level 5	Evaluate					-	-				
Level 6	Create		2012/10			-	-				
	Total	10	0%	10	0%	100%					

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Anuj Kumar, Program Delivery Manager, Nagarro Software's Pvt Ltd.	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr B Priyalakshmi, SRMIST
2. Mr. Saivineeth, ML Accelerator Architect @	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT,	



Course Code	21ECE431T	Course Name	М	OBILE COMP	UTING	Ca	ourse tegoi	e ry	Е			PROF	ESSIO	NAL E	LECT	IVE			L T 3 0	P C 0 3
Pre-requis Courses	site	Nil	Co- requisit Courses	te	Nil		Pro	gres: ourse	sive es						Nil					
Course C	offering Departm	nent	ECE		Data Book / Codes / S	Standards								Nil						
Course Lea	arning Rationale	(CLR):	The purpose of learning th	is course is t	to:				1		Progra	am Ou	Itcome	s (PO)					Pi	ogram
CLR-1:	Impart basic und	derstanding d	of the concepts of mobile co	mputina	1.0		1	2	3	4	5	6	7	8	9	10	11	12	S	pecific
CLR-2	Familiar with the	network pro	ntocol stack	npulling	C			-		of		ţ,		Ū	~				00	tcomes
CLR-2.	CLR-3: Investigate the working model of mobile telecommunication system									suo	0	socie			Worl		nce			
CLR-3.	-	MOL	SiS	omei	igati	sage	and s			am	c	Fina	ning							
CLR-4:	Exposed to the		u-noc networks			:	g Kr	naly	velo	roble		er a	ent & litv		& Te	atio	Jt. &	-ear		
CLR-5:	Gain knowledge	e about differe	ent mobile platforms and ap	olication devel	opment		eerir	am A	n/de	uct ir ex p	n To	ngine	nme		lual	Junic	t Mç	l gnc	-	
Course Out	tcomes (CO):		At the end of this course.	learners will	be able to:		ngin	roble	esig	ondu	lodei	he el	nvirc ustai	thics	divid	umo	rojec	ife Lo	°-OS	So.S
CO-1:	Categorize diffe	rent mobile r	platforms and application dev	velopment		Va l	ш 3	-	2	- 0	2	-	<u>ш</u> о	<u>ш</u> -	- 1-	-	 _	-	<u>م</u>	<u> </u>
CO-2:	Analyze differen	nt Services a	nd Architecture of Mobile Te	lecommunicat	ion system		3	-			3	_			_	-	-	-	_	
CO-3 <sup>,</sup>	Infor the various		hitecture of WI AN technolo	av	ion system		0		3		0	2							_	
CO-3.	Deresive the set	noonto of Mo	bile Ad bas Naturatio	yy .		1	2	2	5		-	2	-	-	-	-	-	-	-	
00-4:	Perceive line coi		Dile Ad-Noc Networks		e and anothite shows		3	3		- 14	-		-	-	-	-	-	-	-	
CO-5:	Apply the knowl	eage in vario	bus Mobile Computing applic	ation, service.	s and architecture	100	-	3		-	-	-	-	-	3	-	-	-	-	
Unit-1 - Inti	roduction to Ma	bile Compu	Iting	1296.0	and the second second	-					11		-							9 Hour
Applications Technologie	s of Mobile Comp es-Multiplexing – v: SWOT analysi	outing- Interr – Spread spe is of Mobile	net-Ubiquitous networks, An ectrum -MAC Protocols — S Computing	chitecture and DMA- TDMA-	l three-tier architecture fo FDMA- CDMA	r Mobile Co	omput	ting, l	Design	consid	eratio	n for N	Aobile (	C <mark>om</mark> pi	iting. G	Genera	tions o	f Mobil	e Com	munication
Unit-2 - Mo	bile <b>Telecomm</b>	unication S	ystem	115							1									9 Hour
Introduction Architecture Case Study	to Cellular Sys — Protocols — r: Explore the pos	stems-Global Connection ssible opport	System for Mobile Comr Establishment — Frequency unities and future extension	nunication (G Allocation — problems of N	SM) – General Packet ( Routing — Mobility Mana Iobile Cloud after the Evo	Radio Servi agement— I lution of 5G	ice (( Hando Tech	GPRS over - nnolog	5) – L — Sec gy.	Iniversa urity.	l Mob	ile Te	elecomr	nunica	tion S	System	UMTS	5) <i>—LTE</i>	E-5G-	Services &
Unit-3 - Mo	bile Internet Pro	tocol and Tr	ransport Layer			<u> </u>		0.0 // 5				TOP								9 Hour
Overview o	f Mobile IP – F ≏	eatures of I	Mobile IP – K <mark>ey Mechan</mark> is	m in Mobile	IP – route Optimization.	Overview	of T	CP/IP	? – Ar	chitectu	re of	TCP/I	P- Ada	ptatio	n of T	CP W	indow-	- Impr	oveme	nt in TCP
Unit-4 - Mo	o. bile Ad-Hoc Ne	tworks																		9 Hour
Ad-hoc Bas –Security. <b>Case Study</b>	ic Concepts – Cl r:Location aware/	haracteristics /Location ser	s – Applications – Design Iss nsitivity	sues – Routing	g – Essential of Traditiona	I Routing Pi	rotoco	ols –F	Popula	r Routin	g Prot	tocols	– Vehio	cular A	d Hoc	netwoi	rks (VAI	VET)-N	IANET	'Vs VANET

 Unit-5 - Mobile Platforms and Applications
 9 Hou

 Mobile Device Operating Systems — Special Constraints & Requirements — Commercial Mobile Operating Systems — Software Development Kit:iOS, Android, BlackBerry, Windows Phone — MCommerce –

 Structure — Pros & Cons — Mobile Payment System — Security Issues.

 Case Study: Power Management -System level energy saving techniques

	1.	Prasant Kumar Pattnaik, Rajib Mall, "Fundamentals of Mobile Computing", PHI Learning Pvt.	5.	Jonathan Rodriguez, Fundamentals of 5G Mobile Networks,, Wiley Publishers, 2015
		Ltd, New Delhi – 2012.	6.	Android Developers: http://developer.android.com/index.html
Learning	2.	Raj Kamal, "Mobile Computing", Oxford University Press, 2007, ISBN: 0195686772	7.	Apple Developer: https://developer.apple.com/
Resources	3.	Asoke K. Talukder, Hasan Ahmad, Mobile Computing Technology- Application and Service	8.	Windows Phone Dev Center: http://developer.windowsphone.com
		Creation, 2nd Edition, McGraw Hill Education.	9.	BlackBerry Developer: http://developer.blackberry.com
	4.	Jochen Schiller, Mobile Communications, Pearson Education Asia, 2008.		

Learning Assessm	nent											
			Continuous Learning	Assessment (CLA)		Oursentius						
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (10	g Learning A-2 0%)	Final Ex (40% w	mative amination eightage)					
		Theory	Practice	Theory	Practice	<u>The</u> ory	Practice					
Level 1	Remember	15%	the state of the	15%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	<u>15</u> %	-					
Level 2	Understand	25%	200 200 C	25%		25%	-					
Level 3	Apply	30%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	30%	100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100	30%	-					
Level 4	Analyze	30%		30%		<u>30</u> %	-					
Level 5	Evaluate	1000	-			-	-					
Level 6	Create					-	-					
	Total	10	0%	10	0%	10	00%					

Co	urse Designers	1.1			
Ex	perts from Industry	Exp	perts from Higher Technical Institutions		Internal Experts
1.	Mr. Anuj Kumar, Program Delivery Manager, Nagarro	1.	Dr. Meenakshi, Professor of ECE, CEG, Anna University	1	1. Dr.C. T. Manimegalai, SRMIST
2.	Mr. Raji Kumar, Sr. Manager Core Corporation (Airtel)	2.	Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai		As

Course Code	21ECE432T	Cours Name	e QUANTUM	COMPUTING	Cou Categ	rse Jory	E			PROF	ESSIC	NAL E	ELECT	IVE		;	_ T 3 0	P 0	C 3
Pre-requi Course	site s	Nil	Co- requisite Courses	Nil	P	rogres Cours	sive ses						Nil	1					
Course (	Offering Departme	ent	ECE	Data Book / Codes / Stand	ards							Nil							
Course Le	arning Rationale	(CLR):	The purpose of learning this cours	e is to:	1	1		211	Progr	am Ou	utcome	s (PO	)				P	rogra	m
CLR-1:	Learn about fund	amentals	of quantum mechanics	10 226	1	2	3	4	5	6	7	8	9	10	11	12	0 0	pecifi itcom	ic ies
CLR-2:	Become familiar	with the fu	Indame <mark>ntal concep</mark> ts of quantum circui	ts and postulates	je e		of	s of	10	iety			¥		0				
CLR-3:	Learn the differer	t insights	behi <mark>nd basic q</mark> uantum algorithms,	10000	vledç		ento	ations	ge	soc			oW r		ance	D			
CLR-4:	Become acquaint	ed with q	ua <mark>ntum cryp</mark> tography and the suprema	cy of quantum computing	- Vor	lysis	mdo	stiga	Usa	and	৵ঽ		Team	и	& Fir	arnin			
CLR-5:	Acquire knowledg		leering	em Ana	In/devel	uct inve lex prot	rn Tool	ngineer	onment	6	dual & J	nunicati	ct Mgt.	ong Lea	-	2	3		
Course Ou	tcomes (CO):		At the end of this course, learners	will be able to:	Engin	Proble	Desig		Mode	The e	Envire	Ethics	ndivi	Comr	<sup>2</sup> roje	_ife L	-OSc	-OSc	-OSc
CO-1:	Define the use of	linear alg	ebra in quantum computing	Site buse and	3	2	-	-		-	-	-	-	-	-	-	-	-	-
CO-2:	Construe quantui	n comp <mark>ut</mark>	ing Postulates and quantum circuits		3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Examine quantur	n comp <mark>ut</mark>	er algorithms			-	3	2	-	- 10	-	-	-	-	-	1	-	-	-
CO-4:	Investigate crypto	ography <mark>ir</mark>	quantum computing		-	2	-	3		-	-	-	-	-	-	1	-	-	-
CO-5:	Understand, Des	ign and <mark>T</mark>	est quantum circuits on IBMQ			-	3	-	2	-	-	-	-	-	-	1	-	-	-
<b>Unit-1 - Qu</b> Linear alge	antum Mechanica bra basics, Vector	<b>s-Fundar</b> Spaces,	nentals Tensor products, inner and outer products	oduct, Hilbert space, N dimensiona	l inner p	roduct,	Infinit	e dime	nsiona	l inner	produc	ct <mark>, S</mark> ch	warz's	s Inequ	iality, I	Hilbert	space	<b>9</b> exan	Hour nples,
Probabilitie	s and Measuremei antum Circuits a	nts, Speci nd Postu	tral decomposition, Quantum entangler	nent, Spectral decomposition, Bell's	inequaliti	es, De	nsity o	perator	S			-						9	Hour
Quantum C	computing and its a	dvantage	e, Pos <mark>tulates of</mark> Quantum mechanics, C	oubits and Dirac notation, Bloch sphe	ere, Quai	ntum G	ates-S	ingle a	nd Mul	ti-qubi	t, <mark>Quan</mark>	tum ci	rcuits-l	basic					nour
Unit-3 - Qu	antum Algorithm	s			Sec. 1				1									9	Hour
No-Cloning	Theorem, Deutsci	h-algorith	m, Deuts <mark>ch-Jozsa a</mark> lgorithm, Grover's .	Search algorithm, Quantum Fourier	Transfor	n, Sho	r's fact	oring al	gorithr	n, Vari	atioable	e quan	tum al	gorithn	ns such	n as QA	IOA, I	<u>/QE</u>	Harris
Ouantum c	rvntography-Introd	<b>priy</b> uction ∩	antum Key Distribution BB84 Protoco	L B92 Protocol EPR Protocol Quar	ntum Tela	enortet	ion											9	nour
Unit-5 - Pr	ogramming Quan	tum Com	puter	, 2021 101000, El 111 101000, Quar		pond												9	Hour
The IBMQ,	Bell test, GHZ stat	e, W stat	e, Quantum circuits for specific applica	tion-Design, graphically building qua	ntum cir	cuits, L	Dynami	c circui	t desig	n usin	g Qiskit								

Learning Resources	1. 2. 3. 4.	Michael A. Nielsen and Issac L. Chuang, "Quantum Computation and Information, Cambridge (2002). Quantum Computing, A Gentle Introduction, Eleanor G. Rieffel, and Wolfgang H. Polak MIT press (2014) David McMahon-Quantum Computing Explained-Wiley- Interscience, IEEE Computer Society (2008) N. S. Yanofsky and M. A. Mannucci, Quantum Computing for Computer Scientists. Cambridge, England: Cambridge University Press, 2022.	5. 6. 7.	A. Ozaeta, W. van Dam, and P. L. McMahon, "Expectation values from the single-layer Quantum Approximate Optimization Algorithm on Ising problems," Quantum Sci. Technol., 2022. A. Peruzzo et al., "A variational eigenvalue solver on a photonic quantum processor," Nat. Commun., vol. 5, no. 1, p. 4213, 2014. www.quantum-computing.ibm.com
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-		1 1 1 A	Continuous Learning	g Assessment (CLA)		Cum	mativa				
	Bloom's Level of <mark>Thinking</mark>	Forn CLA-1 Avera (50	native ge of unit test	Life-Long CL (1)	g Learning A-2 0%)	Final Examination (40% weightage)					
	1.5	Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%		15%		15%	-				
Level 2	Understand	25%		20%		<mark>2</mark> 0%	-				
Level 3	Apply	30%		25%		20%	-				
Level 4	Analyze	30%	to bard to	25%		30%	-				
Level 5	Evaluate		10 10 10 10 10 10 10 10 10 10 10 10 10 1	10%	100	10%	-				
Level 6	Create	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		5%		<mark>5%</mark>	-				
	Total		0%	10	0%	10	0%				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Arun Sehrawat, Director of Quantum Theoritical	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr.R. Kumar,Professor, SRMIST
Research, QpiAi, Bangalore		
2. Mr. Anuj Kumar, Program Delivery Manager, Nagarro	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai	
Software's Pvt Ltd	C . Same and the second s	1 11



Course Code	21ECE433T Course Name DEEP LEARNING								Cour Categ	se ory	E			PRO	ESSIC	DNAL	ELECT	IVE		;	L T 3 0	P 0	C 3
Pre-requi Course	site s	Nil		Co- requisite Courses		N	lil		Pi	ogres Cours	sive es						Nil	1					
Course (	Offering Departme	ent		ECE		Data Book	Codes /</td <td>Standard</td> <td>s</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>_</td> <td>Nil</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	Standard	s						_	Nil							
Course Le	arning Rationale	(CLR): Th	he purpo <mark>se o</mark>	o <mark>f learnin</mark> g this	course is	s to:	200	1		1			Progr	ram O	utcome	es (PO	)				P	rogra	m
CLR-1:	Know the basic n	nathematical	tools for mac	<mark>hine</mark> learning ML	L and its C	Concepts.			1	2	3	4	5	6	7	8	9	10	11	12	01	utcom	ies
CLR-2:	Understand vario	us technique:	s fo <mark>r better p</mark>	<mark>erf</mark> ormance of M	IL algorith	ims.	in the second	di lana				of	20	N.	1.6								
CLR-3:	Describe the Con	volutional Ne	eu <mark>ral Netwo</mark> rk	and its blocks.	1		1000	1000	adge		it of	ons o		ociel			Vork		JCe				
CLR-4:	<b>R-3:</b> Describe the Convolutional Neural Network and its blocks. <b>R-4:</b> Study the DNN Models for computer vision, time series, auto encoders and transfer learning method <b>R-5:</b> Acquire skill in the usage of libraries and tools for development of DL models through case studies								Knowle	alysis	lopmer	estigation	Usage	er and s	t & v		Team \	tion	& Final	arning			
CLR-5:	<i>LR-5:</i> Acquire skill in the usage of libraries and tools for development of DL models through case studies								leering	em An	gn/deve	uct inv	ern Too	enginee	onmen	S	dual &	nunica	ct Mgt.	ong Le	<del>.</del>	5	ņ
Course Ou	tcomes (CO):	A	t the end of	this course, lea	arners wil	Il be able to:	000		Engir	Probl	Desig	Cond	Mode	The	Envir	Ethic	ndivi	Com	Proje	-ife L	-OSc	-OSc	-OSC
CO-1:	Apply the linear a	algebra t <mark>o ma</mark>	<mark>chin</mark> e learnin	g and machine I	earning co	oncepts.	24.25	1247	3	2	-	-	-	<u> </u>	-	-	-	-	-	-	1	-	-
CO-2:	Apply improveme	ent techniques	<mark>s fo</mark> r enhance	ed ML algorithms	s performa	ance.		1 P	3	2			-	- 1	-	-		-	-	-	3	-	-
CO-3:	Apply the concep	t of con <mark>volutio</mark>	ion operation	in building CNN	model an	nd its blocks.	1. 5		-	- 1	3	-	-	-	-	-	-	-	-	3	2	-	-
CO-4:	Understand adva GoogleNet/Incep	nced ar <mark>chitec</mark> tionNet, <mark>Mob</mark> i	ctures of deep ileNetV1, Res	o learning - LeNI sNet, RNN, LST	ET,VGGN M and aut	let, toencoders.			ić.		S.	3	-		-	-	-	-	-	3	1	-	-
CO-5:	Develop DL mode	els for th <mark>e cas</mark>	<mark>se stu</mark> dies us	ing th <mark>e l</mark> ibraries.	R. d.				-	6-1	3	-	3	1.5	-	-	-	-	-	3	3	-	3
Unit-1 - Lin Matrices an	near Algebra for N ad Tensors, Identit	<i>IL and its Ba</i> y and inverse	asics e Matrices, L	inear Dependen	ice and Sp	pan, Norms, Sp	pecial Kind	ls of Matric	es an	d Vect	tors, E	igen de	ecompo	osition	and pr	oblem	solvin	g, Sing	ular Va	alue De	əcomp	<b>9</b> Dositio	<b>Hour</b> n and
Unit-2 - Te	chniques for Imp	roved Perfor	rmance	ionto Anarysio w		in solving, porot	cpironnea	ining algor		incur e	sopuru	onity, ii	iunnay		opii on	, buch	ριορα	gallon				9	Hour
Regularizat Dropout.Op	ion for Deep Learn timization for Train	ning: Paramete ning Deep Mo	ter Norm Pen odels: Challer	alties, Norm Pen I <mark>ges</mark> in Neural N	alties as C letwork Or	Constrained Opt ptimization, Bas	timization, sic Algorith	Regulariza ms, Param	ation a leter li	nd Uno nitializa	der-Co ation S	nstrain trategie	ed Pro es, Alg	blems orith <mark>m</mark>	Early S s with A	Stoppi Adaptiv	ng, Par re Lear	ramete rning R	r Tying ates	and Pa	aramet	ter Sh	aring,
Unit-3 - De	ep Neural Netwoi	rk			11.12			100			1											9	Hour
Deep Feed	forward network,	Convolutional	I Networks: C	convolution Oper	ration, bas	sic components	s of CNN a	nd unique	oropei	ties of	CNN,	archite	ctures	ofCNI	<mark>V, V</mark> aria	ants of	the Ba	isic Co	nvoluti	on Fun	ction		
Unit-4 - Ad LeNet, Alex Unit-5 - Ap	Vanced Deep Lea Net, GoogleNet, V Indications of Dee	rning Model /GGNet, Resl p Learning t	ls Net, Architec through Case	tur <mark>es, sequentia</mark> e Studies and 1	l models: <b>Fools</b>	RNN, bi-directio	ional RNN,	Challenge	of Lo	ng-Ter	m Dep	enden	cies, L	STM, a	autoend	coders	, its typ	oes and	l applic	ations,	, trans	9 fer lea 9	Hour arning Hour
Introduction	ntroduction to Keras, Classifying movie reviews: a binary classification, multiclass classification, Deep learning							rning for co	mpute	er visio	n, Dee	p learn	ing for	<sup>-</sup> text a	nd sequ	uences	6						

	1. IanGoodfellow, YoshuaBengio, AaronCourville, – DeepLearning, MITPress, 2016.	4. Navin Kumar Manaswi, -Deep Learning with Applications Using Python, Apress, ISBN-13 (pbk):
Learning	2. KevinP.Murphy, – MachineLearning: AProbabilisticPerspective, MITPress, 2012	978-1-4842-3515-7
Resources	3. Francois Chollet, - Deep Learning with Python, Manning Publications Co., ISBN	I 5. Daniel Graupe- Deep Learning Neural Networks- Design and case studies, World Scientific, ISBN
	9781617294433	978-0-00-098854-6(pbk)

		-	Continuous Learning	Assessment (CLA)		Sum	mativo				
	Bloom's Level of Thinking	Forr CLA-1 Avera (5	native age of unit test 0%)	Life-Long CL (10	y Learning A-2 )%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%		15%		15%	-				
Level 2	Understand	25%	1.12	20%		20%	-				
Level 3	Apply	30%	A State of the second	25%		20%	-				
Level 4	Analyze	30%		25%		30%	-				
Level 5	Evaluate	- 111 - 12		10%	1	10%	-				
Level 6	Create		A States	5%		5%	-				
	Total	10	00%	10	0%	10	0%				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Anuj Kumar, Program Delivery Manager, Nagarro     Software's Pvt Ltd	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr.S. Malarvizhi, SRMIST
2. Mr. Saivineeth, ML Accelerator Architect @ Google	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai	



Course Code	21ECE4341	21ECE434T Course Name WEB OF THINGS								C	Cours Catego	e ry	E			PROF	ESSIC	NAL E	ELECT	IVE			L T 3 0	P 0	C 3	
Pre-requis Course	site s	I	Nil		Co- requ Course	uisite es			Nil			Pr	ogres Cours	sive es						Nil						
Course C	Offering Depar	tment			ECE			Data	Book / Co	odes / Sta	Indard	S							Nil							
Course Lo	orning Potions				of loarnin	a this co	uree ie	to:		-	-11	4	1			Drogr	am ().	Itoomo	c /PO					P	roarai	n
Course Le	P.1: Obtain knowledge about Web of Things												-			Flogi			S (FU		10		40	s	pecifi	c
CLR-1:	Obtain knowle	edge ab	out Web o	of Things			<u> </u>		<u> </u>			1	2	3	4	5	6	1	8	9	10	11	12	Ou	itcom	es
CLR-2:	CLR-2: Learn the communication protocols and testbed								-	ge		of	is of	10	ciety			ork.		e						
CLR-3:	CLR-3: Identify various patterns and discovering things								wlec	6	hent	ation	ge	d so			М		nanc	p						
CLR-4:	Create insight	s abou	t integratio	on of device	s from vari	ious platfe	orms	14	Se	1.1.2		Kno	alysi	lopn	estig	Us	r an	~		Tear	ion	ъ В	arnir			
CLR-5:	Identify the se	curity r	nech <mark>anisn</mark>	<mark>ns and</mark> vario	us health	and socia	al imp <mark>ac</mark> t	t of WoT	3.02	51		ering	n Ana	deve	t inve	Tool	ginee	ment		al &	nicat	Mgt.	g Le			
					and the second s	1		100	-		1	ginee	blen	sign/	onpuc	dern	enç	viron stain	ics	vidu	nmu	ject	Lo	<u>-</u> 1	0-2	0-3
Course Ou	itcomes (CO):		At	<mark>t the</mark> end of	this cour	se, learn	ers will	be able	to:	A. Ger	100	Ēnç	Pro	Des	Sol	Mo	The	Sus	뛾	Indi	Š	Pro	Life	PS(	PS(	PS(
CO-1:	Gain knowled	ge abo	ut W <mark>oT</mark>		12			100	Cast	-113		3	÷.	1	-	3	-	-	-	-	-	-	-	-	-	-
CO-2:	Develop know	ledge o	of va <mark>rious</mark>	protocols ar	nd testbed		P.L.	100		Sec		3	2	12	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Distinguish an	d appr	ecia <mark>te vari</mark>	<mark>iou</mark> s pattern	S	-	1.1	22.5		3.1		3	2		-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Organize the	devices	s wo <mark>rking o</mark>	<mark>on</mark> heteroge	neous plat	form	100	200			1	3	2		-	2		-	-	-	-	-	-	-	-	-
CO-5:	Gain insight a	bout th	e se <mark>curity</mark>	<mark>and</mark> authen	tication as	pects of V	WoT and	d its socia	al effects			3		64	-	-	3	3	-	-	-	-	-	3	-	-
Unit-1 - Int Introduction of WoT, Or	roduction to T n to the concept ntology of WoT,	<b>he We</b> and hi Embeo	b Of Thin istory of th dded devic	gs le Internet o ces, Introdu	f Things (I ction to Re	oT), Purp aspberry F	ose of Ic Pi, Node	oT, Limita e.js on Ra	ations of tr aspberry P	raditional a Pi, Connect	approa ting se	ches to	o the I and ac	oT, Sig	gnificar s on Pl	nce of I i, Mode	Veb or ling R	f Things ESTful	s (WoT servic	<mark>), A</mark> pp es, Ma	licatior Ishup t	ns, Fea ools, N	atures a Iodel d	nd Sh riven e	<b>9</b> ortcon engine	Hour nings ering
for Wol, Co	omparing mash	up and bings	model dr	iven tools, N	lodeling of	RESTful	I service	s, Modeli	ing Wols	system with	h gene	ric RE	STful	operat	ions				-	_					0	Hour
Building ne protocol foi architecture Challenges	tworking for things things: Zigber Access, Find, of WoT, Testb	: Topol e, Blue WoT a eds of	logies, Clá tooth app architectui WoT and l	assification lication stat re: Share, C loT, Hardwa	nodels, N <mark>k,</mark> Applica ompose, E re of a Wc	etwork pr ation prote Building le oT testbee	rotocols ocol for oT with a d, Softwa	for things things: 7 Avatars: 7 are of Wo	is: spatial Apple hon Avatar ba: oT testbed	considera ne kit, Go sed IoT Pl 1	ations, l bogle w latform	nterne veave, , Disru	t prote Mess ption	ocols age C tolerar	and loi Dueuing at comr	T, IoT I Telen nunica	Persor netry tion, C	nal Area Transpo Context	a Netw ort (MC model	orks, QTT), ing and	loT Wi Constr d mana	de Are aint ap ageme	ea Netv oplicatio nt, Soc	vorks, on pro ial visi	Applic tocol, ton of	ation WoT WoT,
Web API's	for things: Devi	n N	sourcesT	hinas Princ	inles for w	oh API's	Publish	subscrib	o model li	Noh hooks	c Com	os and	woh	ockot	s Imple	monti		hinas	Conr	octina	dovica	e to th	o woh	Direct	<b>9</b> t integ	-tour ration
pattern, RE	ttern, REST on devices, Gateway integration pattern, CoAP, Cloud integration pattern, MQTT communication, Findability problem, Discovering																									
Unit-4 - Re	presentation a	nd Sto	orage								-						_								9	Hour
Automatic i Background Data storag	utomatic integration and querying of semantic rich heterogeneous data: introduction, Semantic WoT (SWoT), Semantic web as enabler of SWoT, Case study: smart application, Building entity graphs for WoT, ackground and methodology, DisCor-T: classification, DisCor-T: recommendation, Interoperability and cross domain Applications, Trends and evolution, Challenges in interoperability, Contributions, M3 framework, lata storage in WoT: framework, Methods and challenges, Data storage in cloud platform, Tendency for data storage technology, Future directions																									

#### Unit-5 - Security in WOT and Social and Health Impacts F WOT

Securing things, Open issues and challenges, Web of Topics (WoX) model, Design and implementation, Security from IoT to WoT, Existing models, Security in WoT: Encryption 101, TLS, Enabling HTTPS and WSS with TLS on Pi, Authentication and access control with REST and API tokens, OAuth, Social WoT authentication proxy, Implementing a social WoT authentication, Social impact and vulnerable populations, WoT and health, Potential positive implications for health, Challenges from health perspective, Unintended consequences for social health, Implications

	1.	Dominique Guinard and Vlad Trifa, Building the Web of Things: With examples in Node.js and	4.	Ning Zhong, Jianhua Ma, Jiming Liu, Runhe Huang, Xiaohui Tao, Wisdom Web of
		Raspberry Pi, Manning Publishers, 2016.		Things, Springer; 1st ed. 2016.
Looming	2.	Michael Sheng, Yongrui Qin, Lina Yao, Boualem Benatallah (Editors), managing the Web of Things	5.	Aarti Jain, Rubén González Crespo and Manju Khari (Editors), Smart Innovation of
Deseuress		Linking the Real World to the Web, Morgan Kaufmann publishers, 1st edition, 2017.		Web of Things, CRC Press Publishers, 1st edition, 2020.
Resources	3.	Shikha Mehta, Sanju Tiari, Patrick Siarry, M A Jabbar, (Editors), Tools, Languages, Methodologies	6.	https://www.w3.org/TR/2023/CR-wot-thing-description11-20230119/
		for Representing Semantics on the Web of Things, ISTE Ltd publishers, 1st edition, 2022.	7.	https://www.w3.org/WoT/
			8.	https://webofthings.org/

		a.	Continuous Learning	g Assessment (CLA)		Qum	motivo				
	Bloom's Level of Thinking	Forma CLA-1 Averag (50	ative je of unit test %)	Life-Long CL (10	g Learning "A-2 0%)	Final Examination (40% weightage)					
	the second second	Theory	Practice	Theory	Practice	<u>The</u> ory	Practice				
Level 1	Remember	15%		15%	· / · /	15%	-				
Level 2	Understand	25%	The Mar	20%		25%	-				
Level 3	Apply	30%		25%		30%	-				
Level 4	Analyze	30%		25%		30%	-				
Level 5	Evaluate	ALC: THE OWNER		10%		-	-				
Level 6	Create	1000		5%			-				
	Total	100	1%	10	0%	10	0%				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
<ol> <li>Mr. Anuj Kumar, Program Delivery Manager, Nagarro Software's Pvt Ltd.</li> </ol>	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University	1. Dr. Sudhanya P, SRMIST
2. Mr. Saivineeth, ML Accelerator Architect @ Google	2. Dr. Venkatesan, Sr. Scientist (Rtd.), NIOT, Pallikkaranai	

# ACADEMIC CURRICULA

# UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES (With exit option of Diploma)

(Choice Based Flexible Credit System)

**Regulations 2021** 

Volume - 14F (Syllabi for Elctronics and Communication Engineering w/s in Microelectronics System Design Programme Courses)



## SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

# ACADEMIC CURRICULA

Professional Core Courses

**Regulations 2021** 



## SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

### (Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Course Code	21ECC561P	Cat	ourse egory	C	;			PROF	ESSIC	NAL (	ORE			L 3	T 1	P 0	C 4			
Pre-requis Courses	site S	Nil	Co- requisite Courses	Nil		Prog Co	ressiv urses	e						Nil						
Course C	Offering Departme	ent	ECE	Data Book / Codes / Star	ndards	100							Nil							
Course Lea	arning Rationale (	CLR):	The purp <mark>ose of lear</mark> ning this o	course is to:	-	17	Ð	5		Progra	am Ou	itcome	es (PO	)				Pre	ograi	m
CLR-1:	Utilize basics of amplifiers	IC Biasing te	chniqu <mark>es and a</mark> nalysis of the	characteristic parameters of singl	e stage	1	2	3	4	5	6	7	8	9	10	11	12	Sp Out	ecifi com	c es
CLR-2:	Characterize the	basics of diffe	erential amplifier and knowledge	of various operational amplifiers		e		f	of	1	ety			¥						
CLR-3:	CLR-3: Understand and analyse different oscillator circuits and PLL							nto	ions	Ð	soci			Mol		ance				
CLR-4: Illustrate the basic architectures of Sampling and Quantization process and the Construction of the different types of filters								elopme	estigati	l Usag	er and	t & tv		Team	tion	& Fine	earning			
CLR-5:	CLR-5: Create insights into the operation of different types of D/A and A/D converters.								tinv	Toc	ine	nen		al &	nica	Mgt.	٦C			
					100	nee	oler	gn/	duct	ern	eng	ron	SS	/idu	nmu	ect I	Lon	-	2	e,
Course Out	tcomes (CO):		At the end of this course, lear	ners will be able to:		Eng	Prot	Desi	Con	Mod	The	Envi	Ethi	ndiv	Con	Proj	Life	PSC	SC	PSC
CO-1:	Analyse IC Biasin	g techn <mark>iques</mark>	and the characteristic paramete	rs of CMOS single stage amplifiers.	tree de	3	3	-	1	3	-	- 1	-	-	-	-		2	1	-
CO-2:	Demonstrate the	concepts of D	fferential Amplifiers and Op-am	p circuits		2	1.0	3	1	3	-	-	-	-	-	-	- 1	2	1	-
CO-3;	Construct various	oscillators an	d switched capacitors circuits			2		3	-	3	-	-	-	-	-	-	-	2	1	-
CO-4:	Illustrate compara amplifiers	ator de <mark>sign, v</mark>	arious sampling architectures a	and different types of analog Filters	s and SC	2	-	3		3		-	-	-	-	-	-	2	1	-
CO-5:	Describe the diffe	rent typ <mark>es of c</mark>	ligital to analog converters and a	Analog to digital converters	15	2		3	-	3	-	-	-	-	-	-	- 1	2	1	-
Unit-1 - IC	Biasing and Sing	le Stage Amp	lifiers			-1 \ / - 14 -		f	- Circu					6					121	lour
circuits usin flow, Analog Source Follo Case Study	nt mirror, Materni ng Resistor, BJT, M g Design Octagon ower, Common Ga v: Design of an an	MOS transisto MOS transisto Performanci te amplifier, C pplifier with ac	r, Zener diode, Band gap refere parameters, Common source ascode Amplifier, Foldedcasco tive load, operates for a freque	current minrors, Cascode Current r ance circuits, Supply Independent E Amplifier: Resistive load, Diode co de amplifier, Frequency response of ncv range 3-10GHz.	Biasing, 1 Dinnected CS, CD,	l volla Fempel load, ( CG, Ca	ge Re rature Curren ascode	indepe t-source ampli	ndent ce load fier, No	Refere , triode ise in a	erence ence c e load, amplifi	e circu ircuit, Comr ers.	Constant Con	ant –Gi ource a	nce Pa m bias amplifie	ing, Ai er with	alog l source	Design Jesign Ədege	i Proi nera	cess tion,
Unit-2 - Dif	ferential Amplifie	rs and Opera	tional Amplifiers		1.13			1.1	1	1									12 F	lour
Basic differe	ential pair, Qualitat	ive analysis o	<sup>f</sup> diffe <mark>rential amplifie</mark> r, Quantitati	ve analysis, Common-mode respon	se, CMR	R – De	erivatic	on, Diff	erentia	l pa <mark>ir v</mark>	vith M	<mark>OS</mark> loai	ds, Fre	equenc	y resp	onse o	f Diffei	rential	ampl	lifier,
Analysis of	Resistively loaded	r ,Perforr	nance	param	neters	of op-a	mp, B	lock D	iagram	of Op	o-amp,	one st	age op	)-amp,	Teles	copic	; ор-			
amp, Two S	tage op-amp, Gail	op-amp, I lieotione	Voise ii	n Op-a	imps.															
Unit-3 - Os	cillators and PI I	iysis lite perio	mance parameters for two stay	e op-amp imear and non-imear app	lications					-									121	Hour
Ring oscilla	tor. Two stage and	three stage rij	ng oscillator .LC oscillators: Colo	itt. Cross coupled oscillator. Voltage	controlle	d oscil	lators	Tunin	a range	of VC	Os. Pl	hase I d	ocked	Loop: I	Basic F	PLL ton	oloav	& Chai	racte	ristic
parameters Loops-Cont	,Phase detector, ( inuation, Application	Charge Pump	PLL, Problem of lock acquisition requency multiplication. Skew re	n, Non ideal effects in PLL: PFD/C eduction and jitter reduction.	P, Jitter	in PLL	s, Tra	nsient	respon	se of	PLL in	the lo	cked s	state, D	Delay L	.ocked	Loops	, Dela	y Lo	cked
Case Study	ase Study: Design of PLL for frequency multiplication and analyse its performance parameters																			

275

Unit-4 - Comparator . Sampling Architectures and Analog Filters	Unit-4 - Comparator	. Sampling	Architectures and Analog Filters
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Comparator Design, Basic building blocks, Pre-amplifier design, Post distortion amplifier design, Comparator analysis, Sampling theorem, Nyquist criteria, Aliasing Quantization Process, Quantization noise, multi-bit quantizers, Sampling Architectures: Characteristic parameters & Types, Unity gain sampler. Open loop architecture, closed loop architecture, Design of switched capacitor circuits, Ideal effects of SC circuits, Non-ideal effects in SC circuits, Switched Capacitor filter, Active RC Integrator, MOSFET-C Integrator, Transconductance- C integrator.

**Case Study:** Design a Dynamic comparator for DAC.

#### Unit-5 - Data Converters

12 Hour

12 Hour

Mixed Signal IC Performance metrics of D/A converter, D/A converter in terms of voltage division multiplication, Current division multiplication, Charge division multiplication, Resistor-Ladder architectures, Current mode R-2R DAC, Voltage mode R-2R DAC, Performance metrics of A/D converter, Successive approximation converters, Flash ADC, Two-step A/D converters, Interpolating A/D converters, Pipelined A/D converters, Time-Interleaved converters, Cyclic ADC.

Case Study: Demonstration of a project on design and verification of Analog and mixed signal circuit in any of the applications in IOT, Signal conditioning and Communication using EDA tools.

<ol> <li>Allen, Holberg, "CMOS analog circuit design", 3rd Edition, Oxford University Press, 2004</li> <li>Behzad Razavi, "Design of analog CMOS integrated circuits", 2nd Edition, McGraw F 2017.</li> <li>Gray, Meyer, Lewis, Hurst, "Analysis and design of Analog Integrated Circuits", 5th Editi Willey International, 2009.</li> <li>Adel S. Sedra, Kenneth C. Smith, "Microelectronic Circuits" 7th Edition, Oxford University Press, 2015</li> </ol>	<ol> <li>Jacob Baker, "CMOS Mixed-Signal circuit design", IEEE Press, 2009.</li> <li>Razavi, "Principles of data conversion system design", Wiley IEEE Press, 1st Edition, 1994</li> <li>Baker, Li, Boyce, "CMOS: Circuit Design, layout and Simulation", PHI, 2000.</li> <li>Jacob Baker, "CMOS circuit design simulation Layout,", IEEE press, 3<sup>rd</sup> Edition 2010</li> </ol>
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Learning Assessm	nent	Tank I and		Acres 64		100 C 100 C 100 C	1 1 m				
	Bloom's Level of Thinking	CLA-1 Avera	native age of unit test 0%)	Project Bas CL (6	sed Learning _A-2 0%)	Report and (2)	d Viva Voce 0%)	Final Examination (0% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	10%		-	10%		10%	-	-		
Level 2	Understand	15%		- 17.7	15%	- 7	15%	-	-		
Level 3	Apply	20%	-	-11.5	20%	- /	20%	-	-		
Level 4	Analyze	25%	-	- 110	25%	- 17	25%	-	-		
Level 5	Evaluate	10%		21.1	10%	12	10%	-	-		
Level 6	Create	5%	-		5%	- /	5%	-	-		
	Total	10	0%	10	0 %	10	0 %		-		

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Amrendra Kumar, Keysight Technologies.	1. Dr. Guru Prasad Subas Chandra Mishra, Associate professor, NIT Raipur.	1. Dr.J.Manjula, SRMIST
Email id: amrendra.kumar@keysight.com Mobile: 73378 96220	Email id: gpscmishra.etc@nitrr.ac.in, Mobile: 9437306597,	

Course Code	21ECC562J	C562J Course CHIP DESIGN VERIFICATION C				ourse egory	С				PROF	ESSIC	NAL (	CORE			L 3	T 0	P 2	C 4																	
Pre-requi Course	Pre-requisite Courses     Nil     Co- requisite Courses     Nil     Progressive Courses     Nil																																				
Course (	Course Offering Department ECE Data Book / Codes / Standards Nil																																				
Course Le	ourse Learning Rationale (CLR): The purpose of learning this course is to:									Progra	am Ou	itcome	s (PO	)				Pi	rogra	m																	
CLR-1:	Introduce chip de	sign flow pr	rocess	10 200		1	2	3	4	5	6	7	7 8 9 10 11 12					Outcomes																			
CLR-2:	Explains chip des	ign concep	ts	and the second second			5	of	SL							ee		•••																			
CLR-3:	System Verilog p	rogramming	a fe <mark>atures</mark>	A 1932.13	1994 L		s	nent	estigation	age	-			E		nan	бu																				
CLR-4:	Fundamentals on	chip Verific	cation		10. C		alysi	lopn		Usi	ir an	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		Tea	tion	& FI	arni																				
CLR-5:	Introduce chip Ve	rification m	ethodology		126	igineering owledge	ering	ering	ering	ering	ering	ering	ering	ering	ering	ering	ering	ering	ering	ering	ering	ering	ering	em An	/devel	ct inve	1 Too	ginee	ument abilit		ual &	unicat	: Mgt.	ng Le			
Course 01			At the and of this source, loss	and will be able to:	-		oble	esign	npuc	oder	le en cietv	Ivirol	hics	divid	um mm	ojeci	e Lo	SO-1	<u>\$0-2</u>	SO-3																	
CO-1.	Learning Verilog	programmin	At the end of this course, learn	the chin design	1.41	3	占 1	Å S	ŭ t	2		а Ш О	Ш	<u> </u>	ŭ	P	Ξ	с Ч	č	č																	
CO-2	Implement SOC of	lesian conc	ents		191-1	5	3	1		2					_	_	-	-	- 3																		
CO-3:	Apply the concept	ts of sy <mark>ster</mark>	1 Verilog for advanced learning			12	3	2	-	-	-	-	_	_	_	-	_	3	-	-																	
CO-4:	Evaluate the Veri	fication met	hodology		-	3	2	Ē	-	-	-	-	-	-	-	-	-	3		-																	
CO-5:	Analyse the signil	ficance <mark>of cl</mark>	hip verification domain		100	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-																	
					115	13.1																															
Unit-1 - Ch	nip Design Flow	vol Modolin	na Dataflow Modeling Rehavioral	Modeling, Test banch code simi	ulation and a	synthog	vic Int	roduc	ion to	Sustar	n Vor	iloa ba		ncont					15	Hour																	
Practice: 1	Fest bench code ge	eneration ar	nd synthesis using Verilog HDL	would will be a sind		synunes	515, III	rouuci		Syster	ii ven	llog- be		ncepis	5																						
Unit-2 - Ch	ip Primer									-									15	Hour																	
Chip introd	uction, chip charac	teristics, ch	i <mark>p interfac</mark> es, control status register	rs, Example SOC design																																	
Practice: S	OC programming i	using cypre	ss semiconductors	6	1.0	-	-	-		6-	-								45	Hour																	
Data types	Arrays Procedura	l Statomon	ts and flow control Processes Tax	k and Function Classes Rando	mization & (	Constra	inte I	PC A	sortio	ne and	Cove	rano							15	поиг																	
Practice: S	System Verilog proc	gramming, t	est bench development using sv, n	nailbox connections between cor	nponents lik	e gene	rator a	and dr	ver in	sv, Ch	ecking	Asser	tions																								
Unit-4 - De	sign Verification	,0,				0				,									15	Hour																	
Testing in c	chip making proces	s, checking	involved in the chip making flow, f	unctional verification, high level of	description o	of funct	ional v	rerifica	tion, v	erificat	ion pla	anning,	testbe	ench d	evelop	ment,	simula	ation, i	regres	ssion,																	
debug, cov	erage closure, Tes	t plan. Jan yaing al	hin yoult																																		
Practice: S	ynthesis of the des	lign using ci																	15	Hour																	
Design Ver	ification techniques	s based on a	simulation, analytical and formal ar	pproaches. Functional verification	n. Timina ve	rificatio	n. For	mal ve	erificati	on. Ba	sics o	f eauiv	alence	e checi	king ar	nd mod	lel che	ckina	. Harc	lware																	
emulation.					,		.,			, <b>2</b> 0				2.700																							
Practice: [	Design verification ι	using cypres	ss and chip vault																																		

		1.	Samir palnitkar,"Verilog HDL", Pearson education, Second Edition, 2003.	4.	A Practical Guide to Adopting Universal Verification Methodology (UVM) by
	Learning	2.	System Verilog For Verification: A Guide to Learning the Test bench Language Features by		Sharon Rosenberg & Kathleen A Meade (2nd Edition), 2013.
	Learning		Chris Spear & Greg Tumbush (3rd Edition)	5.	https://www.infineon.com/cms/en/design-support/tools/sdk/psoc-software/manual.
Resources	З.	System Verilog 3.1a – Language Reference Manual (Accellera Extensions to Verilog 2001), 2004.	6.	Ray Salemi," UVM Primer: A Step-by-Step Introduction to the Universal Verification	
					Methodology", second edition, October 2013,

		Sum	Summativa						
	Bloom's Level of Th <mark>inking</mark>	Form CLA-1 Avera (4)	native ige of unit test 5%)	Life-Lon Cl (1	g Learning LA-2 5%)	Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	the state of the s	15%	15%	-		
Level 2	Understand	25%			20%	25%	-		
Level 3	Apply 📃	30%		Long to the second	25%	30%	-		
Level 4	Analyze	30%	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1000	25%	30%	-		
Level 5	Evaluate				10%	-	-		
Level 6	Create				5%	-	-		
	Total	100 %		10	0 %	100 %			

Course Designers	A MARCH STREET & HER LIGT OF THE SECOND	And
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Raja K -Tech Lead (Verification Engineer) – L&T Technology Services	<ol> <li>Dr.J. Ramesh - Professor- ECE-PSG Institute of Technology, pelamedu Coimbatore.</li> </ol>	1. Dr.K. Suganthi, SRMIST
2. Govindan R – Design Verification Engineer – L&T Technology Services		2. Dr.J. Selvakumar, SRMIST



# ACADEMIC CURRICULA

Professional Elective Courses

**Regulations 2021** 



### SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India
Course Code	ourse Code         21ECE366T         Course Name         DIGITAL INTEGRATED CIRCUITS AND SYNTHESIS						urse egory	E			PI	ROFE	SSION	AL EL	ECTIV	Έ		L 3	T 0	P 0	C 3
Pre-requis Courses	site S	Nil		Co- requisite Course <mark>s</mark>	Nil		Progre	essive rses	e						Nil						
Course C	offering Departme	ent		ECE	Data Book / Codes / Stan	ndards								Nil							
Coursello	mine Detionale		The num	an of loomping this		1		-	-	_				a /DO					P	roara	m
Course Lea	arning Rationale	(GLR):	i ne purpo	ose of learning this	s course is to:			60	-		rogra		itcome	is (PU	)				s	pecifi	c
CLR-1:	Outline the funda	amentals of o	combination	<mark>al logi</mark> c design			1	2	3	4	5	6	7	8	9	10	11	12	Ou	tcom	es
CLR-2:	Illustrate the basi	ics of sequer	ential <mark>logic de</mark>	esign	and an and a second of				t of	Sus	1						ge				
CLR-3:	Introduce comple	ex design and	nd <mark>understan</mark>	d the finite state m	nachines	244		s	nen	jatic	age	q			Е		inar	bu			
CLR-4:	R-4: Understand the concept of PLD based designs							alysi	Iop	estiç	sn	r ar	< x x		Tea	tion	~ ⊗	arni			
CLR-5:	LR-5: Introduce the concepts of ASICs and SOC						ring	An	leve	inve	T00	nee	nen bilit		al &	nica	Agt.	g Le			
							nee vled	lem	gn/c	duct	em	eng	ronr	S	idu.	un u	ect N	Long	Ξ	2	က္
Course Ou	tcomes (CO):		At the end	l of this course, le	arners will be able to:	2075	Engi	Prob	Desi	Con	Mod	The	Envi	Ethio	ndiv Norl	Com	<sup>o</sup> roj	life	SC	SC	SC
CO-1:	Analyze the vario	us mod <mark>elling</mark>	g of combina	tional logic design			3	2	-	-	2	-	-	-	-		-		2	-	-
CO-2:	Explain the conce	epts of seque	ential logic d	esign	DE CASA	ter la	-	2	3	-	-	-	-	-	-	-	-	-	_	3	-
CO-3:	Interpret on comp	lex des <mark>ians</mark> a	and improve	the desian perform	nance of FSM		3	12	3	1	-	-	-	-	-	-	-	-	_	3	-
CO-4:	Illustrate the vario	ous EGPA ba	ased designs	3			3		3	1	_	-	-	-	-	-	-	-	-	2	-
CO-5:	Develop the conc	epts of RTL :	synthesis ar	nd optimization tech	niques	1	-	2	3	-	-	2	-	-	-	-	-	-	1	-	-
	mbinational Laui	. Decision				2.5	24														
Evolution of	f Logic Design Inte	c Design	uit Design a	nd Methodologies	Verilog HDL Verilog Design Descriptio	n Veriloo	a Arithr	notic	Onora	tors V	orilog	Logics	ol Onor	ators	Voriloo	a Faus	ality an	d Inor	uglity	Oper	nour ators
Multiplexers	. Decoders, Enco	ders.	an Design a	ia methodologics,	veniog hbe, veniog besign beschpild	n. venieg	<i>y</i>	nouo	Opera	<i>tors,</i> <b>v</b>	sniog	Logice	" Open	utors,	Voniog	j Lyuu	inty an	u mey	uanty	Opere	110/3.
Unit-2 - Se	quential Logic De	esign		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1																9	Hour
Sequential	Logic Design -Sea	quential Lo <mark>gi</mark>	i <mark>ic, Flip-Fl</mark> op,	Synchronous and	Asynchronous Reset. Design of JK F	<mark>-lip-flop,</mark> L	D Flip-f	lop ar	nd T F	lip-flop	, Syna	chrono	ous Col	unters	, Shift	Regis	ter. Til	ning a	ind Pe	ərform	ance
Evaluation,	Asynchronous Co	unter Design	n, <mark>Memory</mark> M	lodules and Design	, Sequential Design Guidelines -Use of	f Blocking	g Assigi	nmen	ts, No	nblocki	ng As	signm	e <mark>nts,</mark> U	se of I	f-Else	Versus	s Case	State	ments	:, Inter	mally
Generated	Clocks, Use of Pip	elining in De	esign. a <b>PTI</b>			1 m	-			-	-			-							Hour
ALLI Desig	Functions and	Silly verilog Tasks Paritv	y Generator	s and Detectors D	esion of parity generators Barrel Shit	fters Fini	te Stat	e Mai	chines	Moor	e vers		alv Ma	achine	s Des	ian of	ESM	ESM	Encod	ina S	tyles
Sequence L	Detectors Using FS	SMs. Improvii	ing the Desid	an Performance for	FSMs.	1010, 1 111	to otat	o ma		, 10001	0 000		July Mic	2011110	0. 200	igii oi	1 0111			ing of	.y100,
Unit-4 - Sin	nulation Concept	s and PLD-E	Based Desi	gns		-														9	Hour
Simulation	for Blocking and N	lon-blocking	Assignmen	ts, B <mark>locking Assig</mark> n	ments with Inter-assignment Delays, E	Blocking A	Assignn	nents	with I	ntra-as	signm	ent De	elays, I	Vonblo	cking	Assigr	nments	with i	Inter-a	issign	ment
Delays, Nor	blocking Assignm	ents with Intr	tra-assignme	ent Dela <mark>ys. Introduc</mark>	tion to PLD, FPGA as Programmable A	ASIC. FP	GA Des	sign F	low.												
Unit-5 - AS	IC RIL Synthesis		Coto Arroy A	SIC Coop study: T	unop of ASICo ASIC Dopign Flow AS	C Sunth		inthe		timizet	ion To	obnic	100 51	otom	on Chi	n /SO		ian C		9 I	Hour
SOC Desia	n Flow, SOC Desid	oen Asio, G an Challenge	es. SOC Des	sion Blocks.	ypes of ASICS, ASIC Design Flow, ASI	or Synthe	-sis, sj	mines	sis Op	umzal	UI I I I	unnd	103. JY	୬୮୯୮୮୮ (	on Grif	5 (300	c) Des	iyii, S	JU AI	UNITED	, ui e,

	1.	Jan M.Rabaey, Digital Integrated Circuits: A design perspective, Pearson education,	3.	Samir Palnitkar , Verilog HDL : A guide to digital design and synthesis, Prentice Hall PTR, Second
Learning		2016		edition,2003
Resources	2.	Vaibbhav Taraate, Digital Logic Design Using Verilog Coding and RTL Synthesis,	4.	Sunggu lee, Advanced Digital Logic Design Using VHDL, State Machines, and Synthesis for
		Springer, 2016		FPGA's, CL- Engineering, 2005

			Continuous Learning A	Assessment (CLA)			<i>"</i>			
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test )%)	Life-Long CL (10	Learning A-2 %)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%		15%		15%	-			
Level 2	Understand	25%		25%		25%	-			
Level 3	Apply	30%	Strate Same	30%		30%	-			
Level 4	Analyze	30%		30%		30%	-			
Level 5	Evaluate			1.11		-	-			
Level 6	Create			1910100		-	-			
	Total	100	) %	10	0%	10	0 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. KVN Savan kumar savan.k.k.v.n@intel.com	1. Dr. J. Ramesh , Professor , PSG ins of Tech , jr.ece@psgtech.ac.in	1. Dr.K. Vijayan, SRMIST



Course Code	Course Code         21ECE560T         Course Name         TESTING AND DIAGNOSIS OF VLSI CIRCUITS							E			PF	ROFE	SSION	AL EL	ECTIV	E		L 2	T 1	P 0	C 3
Pre-requi Course	site es	Nil	Co- requ Courses	isite	Nil		Progr Cou	essive rses	•						Nil						
Course	Offering Departmo	ent	ECE		Data Book / Codes / Sta	andards								Nil							
Course La	orning Dotionala			ing this cours	a in fat	1		1		-			teeme	a /DO	•				Pr	oara	n
Course Le			The purpose of learn	ing this cours		-	_	•			rogra		ilcome	S (PU	)	40		40	S	pecifi	c
CLR-1:	Introduce the con	icepts of testin	ng and its methods	1. 1.	and the second sec		1	2	3	4	5	6	1	8	9	10	11	12	Ou	tcom	es
CLR-2:	Illustrate the cond	cepts of combi	ina <mark>tional circu</mark> it testing		Concernance of the second	-		200	nt of	suo							nce				
CLR-3:	Analyze sequenti	ial circuit testin	n <mark>g and thei</mark> r testability r	neasures		124		sis.	mer	gati	sage	g			m	_	-ina	ing			
CLR-4:	Explain the conce	epts behind <mark>Me</mark>	<mark>emory a</mark> nd Fault testing	9			-	alys	elop	'esti prot	ŝ	er a	nt & tv		Tea	ation	8 F	earn			
CLR-5:	LR-5: Introduce the concepts of Built-In-Self-Test							۱An	dev	t inv	Toc	gine	mer abili		al &	nice	Mgt	ijГ			
							wle	blen	ign/	onpu	dern	ence	iron tain	S	vidu -k	nmu	ect	Lor	5	0-2	<u>-</u> 3
Course Or	utcomes (CO):		At the end of this cou	irse, learners	will be able to:	100	Enc	Pro	Des	of Cor	Mod	The	Env Sus	Ethi	Indi Wo	Cor	Pro.	Life	PS(	PS(	PS(
CO-1:	Introduce the con	ncepts in <mark>testin</mark>	<mark>ig fo</mark> r a better yield in IO	C design.			3	2	5-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	Apply the algorith	nms for t <mark>est pa</mark>	ttern generation of con	nbinational circ	uits.	2227	1	3	-	_	-		-	-	-	-	-	-	3		-
CO-3:	Analyse the desig	gn of se <mark>quentia</mark>	al circuits testing		See The ac	- Pr.	1	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-4:	Interpret the desi	gn of M <mark>emory</mark>	and Fault testing	1.00	2222 240		1	2	3	-	-	-	-	-	-	-	-	-	3	-	-
CO-5:	Utilize the concep	ots of BI <mark>ST for</mark>	test pattern generation	1			3	2	-	-	-		-	-	-	-	-	-	3	-	-
Unit-1 - B:	asics of Testing a	nd Fault		1000		10	1	24	<u> </u>				-							9	Hour
Introductio	n – Principle of tes	ting – types o	f testing – DC and AC	parametric tes	sts- fault modelling-Stuck-at-fa	ault- fault e	equivale	ence-f	ault co	llapsin	g-fault	domi	nance-	fault s	imulati	on					1001
Unit-2 - Te	stability of Comb	inational Circ	uits				1													9	lour
Test gener	ation basics- test g	eneration algo	<mark>prithms-</mark> path sensitizati	on-Boolean dif	ference-D-algorithm-PODEM	overview															
Unit-3 - Te	sting of Sequenti	al Circuits an	d Testability Measure	es	1	Constant lla	L !!!.			11			- 4 - 1- 11:4			<u></u>	DET -	0 .		91	lour
State table	verification-test ge	eneration base	a on circuit structure-D	esign of testal	ne sequential circuits- SCOAF	Controlla	dility al		servap	ility, Hi	gn Lev	/ei i e	stability	/ Meas	sures L	Jigitai	DFTa	na Sca	in Des	sign: a i	Hour
Testable n	nemory design-RAN	A fault models	-test algorithms for RA	Ms- Delav Fau	lts-Delav test						-									31	IUUI
Unit-5 - Bu	uilt-In-Self-Test (B	IST)				1.1.1		10	1.1.	T F										9	Hour
BIST archi	tectures –Test patt	ern generation	n- Logica <mark>l Level Dia</mark> gno	sis – Diagnosi	s by UUT reduction- Self-che	cking desi	gn – Sy	stem	Level	Diagno	sis.										
Learning Resource	1. M. L. Mixed 2. P.k. L 3. M. Al Publi	Bushnell and d-Signal VLSI .ala, "Digital C pramovici, M. A shing House, 2	I V.D. Agrawal, "Esser Circuits", Kluwar Acad Circuit Testing and Tes A. Breuer and A.D. Frie 2002.	ntials of Electr emic publisher tability", Acade dman, "Digital	onic Testing for Digital Memo rs, Springer, 2005. amic Press, 2002. systems and Testable Design	ory and ", Jaico	4. H. 5. Fa UL	Fujiwa brizio SI",KI	ara, Lo Lomb uwer A	ogi <mark>c Te</mark> ardi ai Academ	sting a nd Ma nic put	and D ariagic olishe	esign fe ovanna rs, Dore	or Tes Sami drecht	tability , " Te , Sprin	, MIT I sting ger 20	Press, and d 04	1985. iagnos	is of	VLSI	and

ning Assessm	nent										
			Continuous Learnin	g Assessment (CLA)		Sum	motivo				
	Bloom's Level of Thinking	Form CLA-1 Avera	native Ige of unit test 0%)	Life-Long CL (10	<mark>1 Learning</mark> A-2 )%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%	1	15%	A	15%	-				
Level 2	Understand	25%		20%		25%	-				
Level 3	Apply	30%	and the second se	25%		30%	-				
Level 4	Analyze	30%		25%		30%	-				
Level 5	Evaluate			10%		-	-				
Level 6	Create		States Land	5%		-	-				
	Total	10	0 %	10	0%	10	0 %				

Course Designers	10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mr. Nitin, Design Engineer, QualCom,	Provide the state of the state	1. Dr.K. Suganthi, SRMIST	
2. Mr. Vinoth Design Engineer, QualCom,		2. Dr.J. Selvakumar SRMIST	



Course Code	Course Code         21ECE561J         Course Name         HARDWARE DESIGN WITH MACHINE LEARNING         Course				Course Category	E			PF	ROFE	SSION	AL EL	ECTIV	E		2	Т 0	P 2	C 3
Pre-requis Course Course C	-requisite Nil Co- requisite Nil Courses Nil courses Nil ECE Data Book / Codes / Standard											Nil	Nil						
Course Le	course Learning Rationale (CLR): The purpose of learning this course is to:								Progra	am Ou	tcome	es (PO	)				Pr	rogran	n
CLR-1:	LR-1: Understand the basics of deep learning, deep learning frameworks						3	4	5	6	7	8	9	10	11	12	S Ou	pecifi	c es
CLR-2:	LR-2: Discussion on various aspects of hardware for machine learning,						it of	suc							гсе				
CLR-3:	Basic knowledge	on systolic <mark>a</mark>	array and FPGA Accelerator		14. C	<u>s</u>	mer	gatic	age	p			E		inaı	ing			
CLR-4:	Introduction to co-	-optimization	<mark>n of algorith</mark> ms and hardware, training	and inference.	100	alys	dole	esti	el Us	er ar	t & tv		Tea	tion	&F	earn			
CLR-5:	Fundamental of G	uantum co <mark>n</mark>	nputing and software 2.0	ALL PROPERTY IN	ering	n An	/deve	ct inv	1 Toc	gine	imen abili		lal &	unica	Mgt.	ng Le			
Course Ou	tcomes (CO):		At the end of this course, learners	will be able to:	Engine	Probler	Design	Conduction Conduction	Moderr	The en	Enviror Sustair	Ethics	<mark>Individı</mark> Work	Commu	Project	Life Loi	PSO-1	PSO-2	PSO-3
CO-1:	1: Basics of deep learning, deep learning frameworks, support for state-of-the-art deep learning networks					2	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Designed to help students come up to speed on various aspects of hardware for machine learning,				-	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	3: To impart knowledge on FPGA Accelerator and systolic array				1. 15	2	3	-	-	-		-	-	-	-	-	-	2	-
CO-4:	<b>D-4:</b> Introduction to hardware accelerators, co-optimization of algorithms and hardware, training and inference.				се	3	1	-	-	-	-	-	-	-	-	-	2	-	-
CO-5:	0-5: Basics of Quantum comp <mark>uting an</mark> d knowledge on software 2.0.			-	2	2	-	-	And the second	-	-	-	-	-	-	2	-	-	

# Unit-1 - Introduction to Deep Neural Network – DNN

Introduction to DNNs - Quantization slides recording - Integer-Arithmetic-Only Inference-Kernel Computation slides recording - Dataflow slides recording - Accelerator slides recording - The current state of Neural Network Quantization – Chipvard / FireSim Overview and Setup.

Practice: DNN Algorithm

# Unit-2 - Introduction to Systolic Array and Tensorization

Systolic arrays and MIMDs, CGRAs -Introduction to Spatial: Analyzing Performance and Energy with Spatial - Evaluating Performance, Energy efficiency, Parallelism, Locality -Memory hierarchy, Roofline model -Luigi Nardi: Design Space Optimization with Spatial Key Components of A Deep-Learning Accelerator

-Mapping slides recording - Data Orchestration slides recording - Sparsity slides recording - Co-Design slides recording Configurable Cloud-Scale Real-Time Deep Learning. Other Operators & Near-Data slides recording- Accelerating Software 2.0, Accelerator-Level Parallelism slides -Science to Fuel Neural Nets and TPU Design.

Practice: Benchmark: LeNet, Cifar-10 Full; Dataset: MNIST, Cifar-10, ILSVRC 2012 : Description : Hand-written Digit Recognition, Object Recognition, Network-in-Network(NiN) using DNNWeaver 1.0

### Unit-3 - FPGA Based Acceleration and AI Compute

Systolic Arrays-Architectures for ML in the cloud and at the edge-Memory systems for ML-In-memory or near-memory computing for ML-Temporal and spatial parallelism for machine learning-Energy aware architectures for ML-ASIC design for machine learning-GPU based acceleration for ML-FPGA based acceleration for ML-Hardware-software co-optimization for machine learning-Energy, area, delay trade-offs-Case study of ML chips: Google TPU, MIT Everiss, emerging AI chips-ML benchmarking (MLPerf)-HW/SW Co-design of AI Compute Systems.

Practice : FPGA Machine Learning Algorithm using open source software/Xilinx vivad0

12 Hour

12 Hour

 Unit-4 - Introduction- Software 2.0

 Introduction- Software 2.0 -Role of hardware accelerators in post Dennard and Moore era - Linear algebra fundamentals and accelerating linear algebra -BLAS operations - -Boris Ginsburg: Generalization and Regularization of Training Fast Implementation of Deep Learning Kernels-GPU Design Tradeoffs for Deep learning and MLPerf -Accelerating Natural Language Processing - Sparsity in Deep Learning-Machine Learning Systems and Software Stack- Basics of Machine Learning and Neural Networks-Computing need for machine learning- Overview of hardware platforms for training and inference (CPU, GPU, GPU+DSP, FPGAs, ASIC)

Practice: DNN/ML algorithm in sparsity.

### Unit-5 - Accerlator and Quantum Computing

Domain-Specific Computing- Vector Architectures, GPU Architectures, and Benchmarking Metrics - FPGA Accelerator Novel Post-Moore Computing Accelerators for ML - In-Memory Computing Accelerator Design - Hyperdimensional Computing Accelerators- ML Accelerators in Quantum Computing - Single and multi-Qubit System - Quantum Data Preparation & Processing – Quantum NAS Practice :Implementation of Gates, Combination Logic using quantum computing using open source software

	1. Deep Learning (Adaptive Computation and Machine Learning series) - Aaron Courville	3. H. T. Kung, C. E. Leiserson: Algorithms for VLSI processor arrays; in: C. Mead, L. Conway
Learning	(Author), Ian Goodfellow (Author), YoshuaBengio,2016	(eds.): Introduction to VLSI Systems; Addison-Wesley, 2008
Learning	2. Harware resources : : Jetson Nano- Coral Edge TPU- XilinxPYNQ-Z1- Chipyard, 2019	4. N. Petkov: Systolic Parallel Processing; North Holland Publishing Co, 2008
Resources		5. Quantum Computing - A Gentle Introduction - Leanor Rieffel and WolfgangPolak, MIT Press,
		Cambridge, 2011

Learning Assessm	nent	V.I.	0000000000									
	1		Continuous Learning	g Assessment (CLA)		Sum	motivo					
	Bloom's Level of Thinking	Form CLA-1 Avera (45	ative ge of unit test %)	Life-Lon Cl (1	g Learning _A-2 5%)	Final Examination (40% weightage)						
		Theory	Practice	Theory	Practice	Theory	Practice					
Level 1	Remember	15%	ALC: NOT THE OWNER OF	1.00	15%	15%	-					
Level 2	Understand	25%	1	and the second of	20%	<mark>2</mark> 5%	-					
Level 3	Apply	30%		-	25%	30%	-					
Level 4	Analyze	30%	- I.I.I.		25%	30%	-					
Level 5	Evaluate	- 1 C	- 11.14	-	10%	-	-					
Level 6	Create			-	5%	-	-					
	Total	100	)%	10	0 %	10	0%					

Course Designers	THE PERSON NEWSFILM	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Leela Krishna Thota, Sr. Solution engineer, Synopsys.	1. Dr.S. Meenakshi, Professor, AnnaUniversity	1. Dr.J. Selvakumar, SRMIST.

Course Code	ode 21ECE562J Course MODERN ASIC DESIGN C				Course ategory	E			P	ROFE	SSION	AL EL	ECTIV	Έ		L 2	T 0	P 2	C 3
Pre-requi Course	site es	Nil	Co- requisite Courses	Nil	Progr Cou	essiv Irses	e					A 1'1	Nil						
Course	Offering Departm	ent	ECE	Data Book / Codes / Standards								NII							
Course Le	arning Rationale	(CLR):	The purp <mark>ose of lear</mark> ning this co	urse is to:	1.4	1.1	12.	I	Progra	am Ou	<mark>itco</mark> me	es (PC	)				Pi	rogra	m
CLR-1:	-1: Gain Knowledge on entry-level industrial standard ASIC or FPGA designer					2	3	4	5	6	7	8	9	10	11	12	Ou	pecifi itcom	c ies
CLR-2:	R-2: Understand the basic FPGA Architectures						t of	suc							JCe				
CLR-3:	Familiarize issue	s and tools <mark>r</mark>	elated to ASIC design			<u>.</u>	men	gatic	age	p		-	E		inar	ing			
CLR-4:	Analyze the parti	tion and plac	ement issues			alys	Idole	estig	I Us	er ar	t &		Tea	tion	& F	arn			
CLR-5:	Understand the c	concept of clo	ock planning in ASIC design		edre	m An	v/deve	ict inv	n Toc	nginee	nmen		ual &	Iunica	t Mgt.	ng Le		0	_
Course Ou	utcomes (CO):		At the end of this course, learn	ers will be able to:	Engine	Proble	Design	Condu	Moder	The el	Enviro Sustai	Ethics	<mark>Indivic</mark> Work	Comr	Projec	Life Lo	PSO-`	PSO-2	PSO-3
CO-1:	Understand diffe	rent FPG <mark>A A</mark>	rchitecture and their interconnect m	echanism	3	-	5-	-	2		-	-	-	-	-	-	3	-	-
CO-2:	Familiarize the va	arious p <mark>rogra</mark>	ammable ASICs	A DE CARSACE	3	-	-	-		-	-	-	-	-	-	-	3	-	-
CO-3:	Summarize the o	ptimizat <mark>ion</mark> a	I <mark>gor</mark> ithms in ASIC and applying the	concept of portioning	1.5	1	3	2				-	-	-	-	-	3	-	-
CO-4:	CO-4: Illustrate floor planning and clock planning			3	2	-	-	-	-	-	-	-	-	-	-	-	-	2	
CO-5:	Analyze the vario	ous routi <mark>ng a</mark>	lgorithm			3	-	-	-	-	-	-	2	-	-	-	3	-	-

### Unit-1 - Introduction To ASIC

12 Hour

12 Hour

12 Hour

VLSI Design Flow-Types of ASIC-Programmable ASICs design type-Antifuse-.-SRAM-EPROM based ASICs-ASIC fusing based on EPROM-EEPROM based ASICs-FAMOS description-Programmable ASIC logic cells-ASIC I/O cells-Programmable interconnects – FPGA-Types of FPGA-Programmable FPGA-ASIC I/O Cells: DC Input- AC Input- ASIC I/O Cells-DC/AC output-Clock Input-Introduction to CPLD-CPLD architecture-Types of CPLD

Practice: Functional verification of a combinational circuit using GPDK library, Functional verification of a sequential circuit using GPDK library.

Unit-2 - Programmable ASIC Logic Cells

Actel ACT Architecture-Actel Interconnect delay analysis-Xilinx LCA -Architecture-Xilinx LCA internal architecture- -Xilinx EPLD Architecture-Xilinx EPLD Internal Architecture-Xilinx LCA Interconnect-Xilinx EPLD Interconnect-Altera MAX 7000, - Architecture-Altera Max 9000 : Architecture-Altera Max 9000 : interconnect mechanism-Altera Interconnect features-Altera MAX 5000 : Interconnect Delay analysis- ALTERA's FLEX 8000/10000: Architecture.

Practice: Generate RTL netlist for a digital circuit and analyze the performance, Implementation of KL algorithm in EDA environment

### Unit-3 - Optimization Methods and System Partitioning

Trade off issues at System Level-Solutions to the issues at system level-Optimization with regard to speed-Optimization with regard to area-Optimization with regard to power-Optimization trade off factor-ASIC physical design issues- Power Dissipation: Introduction-Problem - Derivation on power dissipation -System Partitioning Objectives-System partitioning Procedure-Partitioning methods-Measuring Connectivity-Problem on Constructive Partitioning-Constructive Partitioning-Iterative Partitioning Improvement-Problem on Iterative Partitioning Improvement-The Kernighan–Lin Algorithm **Practice**: Placement of Standard cells and timing report generation, Implementation of Non-slicing (B tree) floorplan in EDA environment

Unit-4 -	Floor	planning
<b>U</b> 1111 <b>U</b>	11001	piuning

ASIC floorplanning-Measurement of Delay in FloorPlanning-Channel Definition-I/O and Power Planning - Clock Planning-Placement-placement algorithms- Eigenvalue placement algorithm- Iterative placement improvement-Time driven placement methods- Problems on LEF algorithm

Practice: Implementation of Non-slicing O-tree floorplan in EDA environment, IR drop analysis in pre-placement stage.

Unit-5 - Routing

Introduction to Routing-single layer global routing-single layer detailed routing wire length- Global Routing Methods-Routing between blocks-inside flexible blocks-Timing driven methods- Detailed Routing- Algorithms-Left Edge algorithm-Area routing algorithm-Multilevel Routing-Timing driven detailed routing-Special routing Practice: IR drop analysis in post-placement stage, Generation of Clock tree for a target skew

	1. Smith, Michael. Application-Specific Integrated Circuits. United Kingdom,	4. Golshan, Khosrow. Physical Design Essentials: An Asic Design Implementation
	AddisonWesley Professional, 2008	Perspective. Ukraine: Springer Us, 2007.
Learning	2. Douglas J. Smith, Fundamentals of HDL Design: An	5. Sherwani, Naveed A. Sherwani, Naveed A. Algorithms for VLSI Physical DesignAutomat
Resources	EngineeringApproach. India: Pearson Education, 2010.	United States: Springer Us, 2013.
	3. Taraate, Vaibbhav. Asic Design and Synthesis: Rtl Design Using Verilog. Germany:	
	Springer Singapore, 2021.	A PLAN AND A

Learning Assessm	ent									
			Continuous Learning	g Assessment (CLA)	1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -	Sum	motivo			
	Bloom's Level of Thinking	Forn CLA-1 Avera (4:	native ge of unit test 5%)	Life-Long L CLA- (15%	earning 2 )	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	15%			15%	<mark>15</mark> %	-			
Level 2	Understand	25%	a la trans a desarra a ser		20%	25%	-			
Level 3	Apply	30%		and the second	25%	<mark>3</mark> 0%	-			
Level 4	Analyze	30%		-	25%	<mark>3</mark> 0%	-			
Level 5	Evaluate	2 N -	- 11	- ·	10%	-	-			
Level 6	Create		- ///	-	5%	-	-			
	T <mark>otal</mark>	10	0 %	100 9	6	10	0 %			

Course Designers	110-2-2-3-3-5-	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Leela Krishna Thota, Sr.Solution Engineer, Synopsys	1. Dr.S.Meenakshi, Professor, Anna University	1. Dr. K. Ferents Koni Jiavana, SRMIST

12 Hour

Course Code	21ECE563T	Course Name	LO	W POWER C	MOS VLSI DESI <mark>GN</mark>	C	Course ategory	E		PROFESSIONAL ELECTIVE							L T P C 2 1 0 3				
Pre-requi Course Course (	site s Offering Departm	Nil ent	Co- re Cour ECE	quisite ses	Nil Data Book / Coo	les / Standards	Progr Cou	essiv Irses	e					Nil	Nil						
						-11-4		-	-	_		•		(D0					D	oara	m
Course Le	arning Rationale	(CLR):	The purpose of lea	arning this co	ourse is to:	_		190	2	-	Progra	am Ol	itcome	es (PU	)		1	1	S	pecifi	C
CLR-1:	Learn the Low P	ower VLSI c	oncepts	1			1	2	3	4	5	6	7	8	9	10	11	12	Ou	itcom	es
CLR-2: Gain Knowledge on the Device modelling								344	it of	suc							ЭС				1
CLR-3:	CLR-3: Design of low power VLSI CMOS Circuits							.s	mer	gatio	age	p			m		inal	ing			1
CLR-4:	Understand the	concept Low	<mark>r power Te</mark> chniques a	nd Memories	1000			alys	dole	esti	ŝ	er al	it & tv		Tea	tion	. & F	earn			1
CLR-5:	CMOS Circuits.ii	n VLSI appli <mark>c</mark>	cations.		- 18 State	1	tering	mAn	/deve	ct inv	n Toc	ginee	nmen illider		ual &	unica	t Mgt.	ng Le			
Course Or	itcomes (CO):	-	At the end of this	course learn	ers will be able to:	-	ngine	roble	esign	ondu	loder	he er	nvirol ustaii	thics	laivid Iork	mmo	roject	ife Lo	SO-1	S0-2	SO-3
CO-1.	Manifest the Knr	wledge of L	ow power VLSI	oouroo, rourn		Contraction of the	3	3			2		а Ш О	ш		0	<u> </u>		2	Ч	
CO-2:	Design and Mod	el Low Volta			A DECEMBER OF THE OWNER	C	3	2											2	_	
CO-3·	Apply the Low P	ower technia	ues in CMOS circuits			10 A	3	3			-	-	-	-	-	-	-	-	2	-	-
CO-4:	Relate the low n	ower concen	ts and Memories		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	-	5	3			-	-	-	-	-	-	-	-	2	-	-
CO-5:	Estimate Power	and its impac	ct on CMOS Circuits	1000		1000		3					-	-		-			2	-	-
000.	Loumato i onor			1.11			1.5		1			1				_			2	_	
Unit-1 - Lo	w-Power VLSI D	esign: A <mark>n O</mark>	verview	1.	12322	11.0														9	Hour
Low-Power	r Applications, Lo	w-Power De	sign Methodology Lo	w-Voltage Pr	ocess Technology CMO	S Process Tech	nnology	Bipola	r Prod	cess T	echno	logy (	CMOS	and E	<mark>Bipo</mark> lar	Proce	esses	Conve	rgence	e BiC	MOS
l echnology	y Complementary	BICMOS Tec	chnology BiCMOS De	sign Rules Sili	icon On Insulator	1							-							0	Hour
MOSEET S	Structure and Oper	ration SPICE	Models of the MOS 1	Transistor CM	OS Low-Voltage Analytica	Model CMOS	Power S	vlaau	Voltad	e Scali	na Ma	delino	of the	Binola	ar Tran	sistor				9	1001
Unit-3 - Lo	w-Voltage Low-P	ower VLSI (	Cmos Circuit Design		oo zon vonago vinarjao		onor or	appij	ronag	o ooun	ing me	uoning	or the	Dipole	a man	010101				9	Hour
CMOS Inve	erter: Switching Ch	naracteristics	s Power Dissipation Ca	apacitance Es	timation CMOS static Log	ic Design Clock	ing Low-	Power	Circu	it Tech	niques	s Adial	batic Co	omput	ing						
Unit-4 - Lo	w-Power CMOS	Random Aco	cess Memory Circuit	ts	1. 3.16 3	IL DO IN					1									9	Hour
Low-Power	Low-Power Techniques Low-Voltage SRAM Operation and Circuitry Low-Voltage DRAM Operation and Circuitry Dynamic RAM																				
L P Physica	9 Hours 9 Hours 9 Prover VLSI Design International Parchitectures and International Provent ProventProvent Provent ProventProvent Provent Provent Provent Provent Prov																				
LP Physical Design LP Gate-Level Design LP Architecture-Level Design Algorithmic-Level Power Reduction Power Estimation Techniques         1. Roy, Kaushik, and Sharat C. Prasad. Low-power CMOS VLSI circuit design. John Wiley & Sons, 2009       3. Piguet, Christian. Low-power CMOS circuits: technology, logic design and CAD tools. CRC press, 2018.         Resources       2. Yeap, Gary K. Practical low power digital VLSI design. Springer Science & Business Media, 2012.       3. Piguet, Christian. Low-power CMOS circuits: technology, logic design and CAD tools. CRC press, 2018.																					

Learning Assessm	ent									
			Continuous Learning	Cum	mativa					
	Bloom's Level of Thinking	Form CLA-1 Avera (50	ative ge of unit test %)	Life-Long CL (1)	g Learning A-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	20%		20%	-	20%	-			
Level 2	Understand	20%		20%		20%	-			
Level 3	Apply	30%	1000	30%	A -	30%	-			
Level 4	Analyze	30%		30%	and the second s	30%	-			
Level 5	Evaluate	1.2.2	and the second second			-	-			
Level 6	Create					-	-			
	Total	100	)%	10	0%	100 %				
		N	A Contraction							

Course Designers							
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts					
1. Mr. Anuj Kumar, Bombardier Transportation,	1. Dr.S. Meenakshi, Professor, Anna University	1. Dr. P. Aruna Priya, SRMIST					
Ahmedabad, kumaranuj.anii@gmail.com							
2. Mr. Hariharasudhan - Johnson Controls, Pune,	「「「「「「「「」」」						
hariharasudhan.v@jci.com							



Course Code	21ECE564J	Course Name		RECONFI	IGURABLE	E SYSTEMS	Ca	ourse tegory	E			PI	ROFE	SSION	AL EL	ECTIV	Έ		L 2	Т 0	P 2	C 3
Pre-requis Courses	site S	Nil		Co- requisite Course <mark>s</mark>		Nil		Progr Cou	essiv Irses	e						Nil						
Course C	offering Departme	ent		ECE		Data Book / Codes / S	Standards								Nil							
Course Lea	arning Rationale (	CLR):	The purpo	se of learning th	is course	is to:	124	17	Ū.		F	Progra	am Ou	itcome	es (PC	))				P	rograr	m
CLR-1:	Outline the fundal	, mentals of R	Reconfigurabl	le computing.	10	1		1	2	3	4	5	6	7	8	9	10	11	12	S Ou	pecifi utcom	c es
CLR-2: Demonstrate the types of placement algorithms for Reconfigurable computing								344	of	SL	1						e					
CLR-3: Introduce the mapping methods for placement process								s	nent	atio	age	σ			E		nan	Б				
CLR-4:	Explain the workin	ng of sorting	g and searchi	ng algorithms for I	Reconfigu	rable computing	100 100		alysi	lopr	estig	Usi	r an	ø		Tea	ion	& E	arni			
CLR-5:	Introduce the con	cepts of sca	alability and ru	un time reconfigur	ration			ingineering	lem Ana	gn/deve	luct inve molex c	ern Tool	enginee	onment ainabilit	ş	idual &	municat	ect Mgt.	-ong Le	<del></del>	-2	က္
Course Out	tcomes (CO):		At the end	of this course, l	earners w	vill be able to:	100	ingi	Prob	Desi	Conc	Mod	The		Iti i	Nor	Com	<sup>2</sup> rojé	_ife	SO	SO	SO
CO-1:	Apply the concept	ts of va <mark>rious</mark>	s reconfigurat	ole computing arcl	hitectures		1.	-	2	3	2	-	-	-	-	-	-	-		3	-	-
CO-2:	Demonstrate the	fundam <mark>ental</mark>	als of reconfig	uration managem	nent	1 245N	12121		-	3	-	1		-	-	-	-	-	-	-	-	-
CO-3:	Acquire knowledg	e on di <mark>ffere</mark> r	ent types of re	configuration plac	cement me	thods		1.	2	2	2	-	2	-	-	-	-	-	_	-	-	2
CO-4:	Express the types	s of sele <mark>ction</mark>	n and sorting	procedures for re	configural	ble computing		1		2	-	2	-	-	-	-	-	-	_	-	-	-
CO-5:	Utilize the concep	ts of re <mark>conf</mark> i	figurable logic	; for hardware dev	/elopment		1000	1	1.	2	-	3		-	-	-	-	-	-	-	-	-
linit d inte	raduation to Daar	un finn um a la la	Commuting										-								401	
Introduction	to Reconfigurable		Reconfigur	rable Eabric - Co:	arse grain	ed and fine grain archited	tures - Inde	nender	t Rec	onfiau	ahle ar	chiter	tures.	RaP	ID stri	icture l	RPF ir	ntearat	ion wit	h trad	121 litional	I PF
architecture Reconfigura	– Loosely couple ation – Types – Sta Basic study of Xilin	d and tightly atic and Dyna v Vertex boo	ly coupled system namic Reconfi	stem design o iguration Partia	operating s al Reconfig	system support for recont guration – Evolution – Arti sample programs and P	ficial Evoluti	nputing on – Ev	- Con olvab	text ba le digit	ased FF al platfo	PGA a prms.	lesign Xilinx	– Sin	gle Co	ontext a	and M	lulti co	ntext F	PGA	systei	ms –
Unit-2 - Fui	ndamentals of Re	configurati	ion Manager	nes, Exploring ED		r sample programs and r	rograms bac			ciic op	cration	S WILLI	Amin	larger	bourd	15					12	Hour
Pipeline and switching - multithreade	d block based arc. Basic data model ed architectures	hitectures –I s – sequent	Reconfigurati tial , data par	ion management rallel – data centr	– Configu ric – multi	ration grouping – Configu threaded – System arch	itectures – s	ning – ( streami	Config ng - s	uration equen	Schea tial –bu	luling Ik syr	– Soft nchron	tware l lous pa	based aralleli	reloca sm, da	tion ai Ita par	nd defi rallel –	agmer cellula	ntatior ar aut	ı - Co omata	ntext a and
Practice - L	Design synthesis u	sing Vivado	i, Analysing a	and implementing	the design	n using vivado design flow	, Implement	ing a de	esign	floorpla	an for re	econfi	guratio	on							121	Hour
Mapping de complex log	signs into reconfig ic blocks – Mappir mplementation of a	purable platfo ng to Embed a static desid	form– Structu dded memory ian usina Xilir	ral – Area oriente / blocks – Macro c x boards Mapping	ed – Perfoi cell mappir	rmance driven - Power av ng – Generic FPGA Place d Implementing the static	vare and inte ment – Clus design / con	egrated tering – ofigurati	map Simu	oing m lated a	ethods annealir e target	—- M ng – V	lappinų 'PR an	galgori nnealin	thms i g	for hete	erogen	ieous :	structu	res - I	<u> </u>	ng to
Unit-4 - Ree	configuration Alg	orithms	gir doing rain		g typee an		uoolgii / ooli	inguruu		0 10 11	, target	boure									12	Hour
Reconfigura Graph algor <b>Practice -</b> S	tion algorithms – ithms – Euler tour Synthesis of Recon	Sorting algo - Minimum s figurable log	orithms opt spanning tree ogic or configu	timal, sub optimal -Algebraic path p Iration two on the	l and cons problem – target boa	tant time sorting – tradeo Acyclic graphs – Efficient rd, Mapping and swappin	ffs sorting list ranking L g procedure	three Determi s on the	dimen nistic e desi	<mark>sional</mark> and Ra red flo	R mesi andomiz orplan	h Basi zed aj	ics on oproac	the in ch - Lin	dexing nitatior	g and s ns	electio	on on a	in R m	nesh a	algorith	hm

# Unit-5 - Reconfiguration Scaling

Scaling simulation on a small model instance -- Scaling HVR- LR – FR – R mesh instances – Degrees of scalability – Case study - Matrix multiplication – Matrix vector multiplication – Equivalence of one dimensional models

Practice - Analysis and testing of the implemented configuration one and two using standard procedures, Case study- Relating PR and LR mesh- Run time reconfigurability

	1. Ramachandran Vaidhvanathan and Jerry. L. Trahan "Dvnamic Reconfiguration	n: 3.	Scott Hauck and Andre` DeHon. "Reconfigurable Computing: The Theory and Practice
Learning	Architectures and Algorithms", Kluwer Academic publishers, 2003.		of FPGA-Based Computation", Morgan Kaufmann, 2008
Resources	2. Clive Maxfield, "The Design Warrior's Guide to FPGAs Devices, Tools, and Flow	s", 4.	Pao-Ann Hsuing, Macro D.Santambrogio, Chun -Hsian Huang, "Reconfigurable System
	Elsievier Publications, 2004.		Design and Verification", CRC press, 2018.

Learning Assessm	ent										
			Continuous Learnin	Assessment (CLA)		Summative					
	Bloom's Level of Thinking	Forma CLA-1 Average (459)	e of unit test 6)	CLITE-LONG CL (1:	, Learning ,A-2 5%)	Final Examination (40% weightage)					
	2	Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%	2 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1000	15%	15%	-				
Level 2	Understand	25%	Sec 33,000		20%	25%	-				
Level 3	Apply	30%	How Bridde Will		25%	<mark>30</mark> %	-				
Level 4	Analyze	30%	A PAGE		25%	30%	-				
Level 5	Evaluate		No. 7 State March		10%		-				
Level 6	Create		A CONTRACTOR OF	-	5%	-	-				
	Total	100	%	10	0 %	10	0 %				

Course Designers	A CONTRACTOR OF	
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Leela Krishna Thota, Sr. Solution Engineer, Synopsys.	1. Dr.S. Meenakshi, Professor, AnnaUniversity	1. Dr.A. Ruhan Bevi, SRMIST.



B.Tech / M.Tech (Integrated) Programmes-Regulations 2021- Volume-14 - ECE - Higher Semester Syllabi-Control Copy

Course Code	21ECE566J Course Name	e P	ROCESS AND DEV	ICE MODELING USING	CAD Co	ourse tegory	E			PI	ROFES	SSION	IAL EL	.ECTIV	/E		L 2	. T 2 0	P 2	C 3
Pre-requi Course Course	site 21ECC201 s 21FCC201 Offering Department	J	Co- requisite Courses ECE	Nil Data Book / (	Codes / Standards	Progr Cou	ressive urses	e					Nil	Nil						
Course Le	arning Rationale (CLR):	The purpe	o <mark>se of learn</mark> ing this	course is to:		Program Outcomes (PO)									Program		m			
CLR-1:	Develop a firm foundation (CAD	in the use of	Computer-Assisted i	lechniques for ICdevice a	and process Design	1	2	3	4	5	6	7	8	9	10	11	12	Specific Outcomes		
CLR-2:	LR-2: Determine key indicators of device performance by linking process simulation to device simulation								1	×		ty								
CLR-3:	CLR-3: Generate two-dimensional (2D) or three-dimensional (3D) structures including doping profiles and electrical contacts							tof	ns of	0	ociety	ainabili		/ork		ce				
CLR-4:	R-4: Simulate numerically the electrical behavior of a single semiconductor device in isolation or several physical devices combined in a circuit						ysis	pment	stigatio	Jsage	and sc	& Susta		eam W	E	t Finan	rning			
CLR-5:	Understand the physics-based analytical modeling approach to predict device operation at specific conditions, environment and physical characteristics						gineering h blem Ana	gn/develo	uct inves lex pmbl	ern Tool (	engineer	onment 8	s	dual & T	municatio	ct Mgt. 8	ong Lea	- -	-2	3
Course Ou	Itcomes (CO):	At the end	d of this course, lea	arners will be able to:	ATT NOT STOLEN	Engir	Probl	Desig	Cond	Mode	The e	Invir	Ethic	ndivi	Com	<sup>o</sup> roje	_ife L	ÖSo	0Sc	-OSc
CO-1:	Understand the physics-ba	ased modelling	of semiconductor de	vices and their fabricatio	n process.	3	-	-	-	3	Ter lat	-	-	-	-	-	-	-	-	3
CO-2:	Design, analyze and optimodels	mize semicono	luctor technologies	and devices with funda	mental and accurate	9 3	3	-	-	3		-	-	-	-	-	-	-	-	3
CO-3:	Create a two-dimensional operations	I (2D) or three	+dimensional (3D) o	device with multiple reg	ions using geometrie	c 3		12	-	3	1	-	-	-	-	-	-	-	-	3
CO-4:	Compute terminal currents, the carrier distribution and	<mark>, voltage</mark> s, and conduction me	charges based on a echanisms	set of physical device equ	uations that describe:	s 3	-	-	-	3	<b>F</b> . 1	-	-	-	-	-	-	-	-	3
CO-5:	Apply numerical models in	v <mark>irtual envi</mark> ron	ment for device optir	nization.		3	-	-	-	3	-	-	-	-	-	-	-	-	-	3
Unit-1 - To	chnology, Oriented CAD		- f - 1		A COLOR			_	-	9									12	Hour
Process sin TCAD-base	mulation flow, Conventional ed electrical characterization	role of TCAD i n, Process sym 2D Structures	in IC processing, Pro thesis, TCAD and co	ocess steps involved in th ompact model, Paramete	he manufacturing of a r extraction, TCAD fo	an IC, s r Nano	Steps electro	involv onic, l	red in d Materia	levices Is used	imulati d in inte	ion, Hi egrate	istory ( d circu	of proc iits	ess si	mulatic	on, Evo	olutior	12 1 of T	CAD,
Unit-2 - IC	technology and TCAD tool	ls	12	(1)	- CHANGE			31				-							12	Hour
Process sil	mulation: Oxidation, Ion impl	lantation, Diffus	ion, Lithography, Etc	ching, Metallization, Syno	psys TCAD Tools, P	rocess-	-to-dev	vice si	mulatio	n: Dev	rice gel	neratic	on, Der	vice si	mulatio	n				
Unit-3 - Ge	enerating Geometric Struct	tures	Simulation								-								12	Hour
Introduction Areas for N <b>Practice</b> 2	n to Sentaurus Structure Edi lesh Refinement or Doping, D PN-Junction Structure, Se	itor, Modeling L Mesh Refinem entaurus Workt	Init and Modeling Ra ent Definition, Defini bench and Device Pl	inge, Creating a New Strung ng Doping Profiles: Cons hysics, Characteristics of	ucture, Basic 2D Sha tant Doping Profiles, PN Junction	pes, Ec Analyti	diting 2 ic Dop	2D Sh ing Pr	apes, S ofiles, I	Simplify Extern	/ing 2D al 2D a	) Struc and 3D	ctures, ) Dopir	Electri 1g Proi	ical an files, P	d Ther article	mal Co Dopin	ontact g Prof	is, Dei file	fining

### Unit-4 - Creating and Meshing Device Structure

Typical tool flow with device simulation using Sentaurus Device, Command File, Electrode Section, Physics Section, Plot Section, Math Section, Solve Section, Parameter File, and Example: Simulation of PN Junction diode and MOSFET, Abrupt and Graded Heterojunctions, Physical Models and the Hierarchy of Their Specifications - Region-specific and Material-specific Models, Interface-specific Models, Electrode-specific Models, Parameters for Composition-dependent Materials.

Practice: 2D MOSFET Structure, DC and AC Characteristics of MOSFET, 2D N-Type lightly doped drain (LDD) MOSFET

### Unit-5 - Physics in Sentaurus Device

Electrostatic Potential, Equilibrium Solution, Quasi-Fermi Potential with Boltzmann Statistics, Fermi Statistics, Carrier Transport Models, Numeric Parameters for Continuity Equation, Current Potential, Semiconductor Band Structure -Selecting the Bandgap Model, Effective Masses and Effective Density-of-States, Overview of Sentaurus Workbench, Mixed-Mode CMOS Inverter Simulation Practice: DC and AC Characteristics of N-Type lightly doped drain (LDD) MOSFET, 3D MOSFET Structure, DC and AC Characteristics of 3D MOSFET

	1. G.A. Armstrong, C.K. Maiti, "TCAD for Si, SiGe and GaAs Integrated Circuits", Published by	4.	Yogesh Singh Chauhan, Darsen Duane Lu, Vanugopalan Sriramkumar, Sourabh
	The Institution of Engineering and Technology, London, United Kingdom, 2007.		Khandelwal, Juan Pablo Duarte, Navid Payvadosi, Ai Niknejad, Chenming Hu, "FinFET
Learning	2. Robert W.Dutton, Zhiping Yu, "Technology CAD Computer Simulation of Processes and		Modeling for IC 'Simulation and Design: Using the BSIM-CMG Standard", AcademicPress -
Resources	Devices", Kluwer Academic Publishers, 1993.		Elsevier ,2015.
	3. Yung-Chun Wu • Yi-Ruei Jhan, "3D TCAD Simulation for CMOSNanoeletronic Devices",	5.	Synopsys Sentaurus TCAD Manual.
	Springer Nature Singapore Pte Ltd. 2018	-	

Learning Assessm	ient 📃 👘	- I I I I I I I I I I I I I I I I I I I										
		- 1	Continuous Learning	g Assessment (CLA)	200	Sum	motivo					
	Bloom's Level of Thinking	Form CLA-1 Avera (45	native ge of unit test %)	Life-Long CL (1)	g Learning A-2 5%)	Final Examination (40% weightage)						
		Theory	Practice	Theory	Practice	Theory	Practice					
Level 1	Remember	20%			20%	<mark>20</mark> %	-					
Level 2	Understand	20%	1	and the second	20%	<mark>2</mark> 0%	-					
Level 3	Apply	40%			40%	<mark>4</mark> 0%	-					
Level 4	Analyze	20%	-	-	20%	20%	-					
Level 5	Evaluate	- 11 M	•	-	1	-	-					
Level 6	Create		-	-	-	-	-					
	Total	100	)%	10	0 %	10	0 %					

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mr. Leela Krishna Thota, Sr.Solution Engineer, Synopsys.	1. Dr.S.Meenakshi, Professor, AnnaUniversity	1. Dr. Maria Jossy A, SRMIST	

12 Hour

Course Code	ourse Code         21ECE567J         Course Name         QUANTUM TECHNOLOGIES AND APPLICATIONS							Course ategory	E			Ρ	ROFE	SSION	JAL EL	ECTI	٧E		L 2	T 20	P 2	C 3
Pre-requis Courses	site s	Nil		Co- requisi Courses	te	Nil		Progr	essiv Irses	e						Nil						
Course C	Offering Departmo	ent		ECE		Data Book / Cod	es / Standards	1.00							Nil							
		(0) D)					- 14	1		-		_	•		(D(					D	roara	m
Course Lea	arning Rationale	(CLR):	i ne purp	ose of learning	j this cou	irse is to:	_			2.		rogr	am Ol	itcom	es (PC	<i>)</i>		1		S	pecifi	ic
CLR-1:	Learn about fund	lamentals of	quantum	<mark>mechan</mark> ics	- 10	10 200		1	2	3	4	5	6	7	8	9	10	11	12	0	itcom	ies
CLR-2:	Become familiar	with the fund	dam <mark>ental c</mark>	<mark>conce</mark> pts of quar	ntum circu	its and postulates	-		34	t of	suo							lce				
CLR-3:	LR-3: Learn the different insights behind basic quantum algorithms,								S	nen	jatic lem	age	g			E		inar	bu			
CLR-4:	CLR-3:       Learn the different insights behind basic quantum algorithms,         CLR-4:       Become acquainted with quantum cryptography and the supremacy of quantum computing         CLR-5:       Acquire knowledge on programming for quantum computers								alysi	lop	estiç	I Us	er ar	t &	-	Теа	tion	⊗ ⊥	arni			
CLR-5:	CLR-3:       Learn the different insights behind basic quantum algorithms,         CLR-4:       Become acquainted with quantum cryptography and the supremacy of quantum computing         CLR-5:       Acquire knowledge on programming for quantum computers         Course Outcomes (CO):       At the end of this course, learners will be able to:         CO-1:       Define the use of linear algebra in guantum computing							ring	Ani	leve	invi	T00	inee	nen		<u>a</u> 8	lica	dgt.	g Le			
	CLR-4:       Become acquainted with quantum cryptography and the supremacy of quantum computing         CLR-5:       Acquire knowledge on programming for quantum computers         Course Outcomes (CO):       At the end of this course, learners will be able to:         Co-1:       Define the use of linear algebra in quantum computing         Co-3:       Construe quantum computing Postulates and quantum circuits								lem	ign/c	duct	em	eng	ron	s S	vidu:	mu	ect [	Lon		-2	
Course Ou	tcomes (CO):		At the er	nd of this cours	e, learne	rs will be able to:		Eng	Prot	Des	Con	Mod	The	Envis	Ethi	Indiv Mor	Con	Proj	Life	PSC	PSC	PSC
CO-1:	Define the use of	<sup>r</sup> linear a <mark>lgebr</mark>	<mark>ra in</mark> quant	tum computing		10 - 10 - 10 - 10 - 10 - 10 - 10 - 10 -	Witten	3	2	60	-	-	1	-	-	-	-	-	-	2	- 1	-
CO-2:	Construe quantui	m comp <mark>uting</mark>	Postulate:	s and quantum o	circuits	2.45	1.1.2.1	3	2	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-3:	Examine quantur	n comp <mark>uter a</mark>	algorithms	1. 5		Sec. Sec.	No A	1.1	1	3	2	-	-	- 1	-	-	-	-	1	2	-	-
CO-4:	Investigate crypto	ography <mark>in qu</mark>	uantum cor	mputing	( <b></b>	25 A 4 4 4 4 4	5.00	1.5	2		3	-	-	-	-	-	-	-	1	1	-	-
CO-5:	Understand, Des	ign and <mark>Tes</mark> t	<mark>qua</mark> ntum o	circuits on IBMQ	1000		1.15	10.0	1.	3	-	2		-	-	-	-	-	1	1	-	-
-				Constant In Constant						1			-		-		,u			·		
Unit-1 - Qu	antum Mechanic	s-Fundamen	ntals										-			_	<u> </u>				12	Hour
Linear alge	bra basics, Vecto s and Measureme	r Spaces, Te	ensor proc	Jucts, inner and	outer pro	oduct, Hilbert space, N o	dimensional inn	er produ	ict, Inf	tinite a	imensi	onal i	nner p	produci	i, Schv	varz's	Inequa	ality, H	ilbert s	space	exam	nples,
inequalities	. Densitv operator	s Practice: be	ell states. r	mixed states.	entangien																	
Unit-2 - Qu	antum Circuits a	nd Postulate	es		1.00		14					15									12	Hour
Quantum C	omputing and its a	advantage, Po	Postulates o	<mark>of</mark> Quantum mec	hanics, Q	ubits and Dirac notation,	Bloch sphere, C	Quantum	Gates	s-Sing	e and	Multi-	qubit,	Quant	um cir	cuits-b	asic					
Practice: Si	ngle and multi qub	oits quantum	gates, bas	<mark>ic quantum circu ;</mark>	<u>iit designs</u>	3	the second second				- 1	-	_									
Unit-3 - Qu	Theorem Doutes	<b>S</b> h algorithm I	Doutooh k	azaa algorithm	Crover's S	Coarob algorithm Quantu	m Fourier Trans	form Cl	hor's f	ootorin	a alaa	ithm	Variati	iaabla	quanti	um ala	orithm	o ouch	00.04	04.1	12) /0E	Hour
Practice: D	eutsch-algorithm	Deutsch-Jozs	sa algorithi	m Grover's Sea	rch algorit	hm. Quantum Fourier Tr	ansform	sionn, Si	101 5 16	acionn	y aiyui	<i>iuiii</i> ,	vanau	Uable	quanti	iiii aiyi	JIIIIII	s such	as QA	UA, V	QE	
Unit-4 - Qu	antum Cryptogra	phy	ou uigonan		on algone				_		-										12	Hour
Quantum ci	ryptography-Introd	luction, Quan	ntum Key D	Distribution, BB8	<mark>4 Pr</mark> otocol	, B92 Protocol, EPR Pro	tocol, Quantum	Teleport	ation													
Practice: Q	uantum Key Distril	bution, Quant	tum Telepo	ortation																	- 10	
Chit-5 - En	tropy and Quantu	of ontropy W	ion theory	ann ontrony guo	ntum rolo	ive entrony basic propo	tios of Von Nou	mannar	trony	moor	uromo	nto Pr	actica	Mooo	urom	nts of	ontron	N/			12	Hour
Shannon ei	in opy, properties (		Un-INCUILLA	ппениору, циа		ive entropy, pasic proper	ues or von Neu	manın el	mopy,	meds	urente	no Fl	aciice.	MEds	urente	116 01	enu op	у				

	1	. Michael A. Nielsen and Issac L. Chuang, "Quantum Computation and Information,	5.	Ozaeta, W. van Dam, and P. L. McMahon, "Expectation values from the single-layer
		Cambridge (2002).		Quantum Approximate Optimization Algorithm on Ising problems," Quantum Sci.
	2	2. Quantum Computing, A Gentle Introduction, Eleanor G. Rieffeland Wolfgang H. Polak MIT		Technol., 2022.
Learning		press (2014)	6.	Peruzzo et al., "A variational eigenvalue solver on a photonic quantum processor," Nat.
Resources	3	David McMahon-Quantum Computing Explained-Wiley-Interscience, IEEE Computer		Commun., vol. 5, no. 1, p. 4213, 2014.
		Society (2008)	7.	www.quantum-computing.ibm.com
	4	. N. S. Yanofsky and M. A. Mannucci, Quantum Computing for Computer Scientists.		
		Cambridge, England: Cambridge UniversityPress, 2022.		A 8

Learning Assessmer	nt										
		N 1	Continuous Learning	Assessment (CLA)		Sum	motivo				
	Bloom's Level of T <mark>hinking</mark>	Form CLA-1 Averag (45	ative le of unit test %)	Life-Long CL (1-	g Learning _A-2 5%)	Final Examination (40% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	30%		Constant and	30%	30%	-				
Level 2	Understand	30%		10770 - March	30%	<mark>3</mark> 0%	-				
Level 3	Apply	40%		100 100	20%	<mark>4</mark> 0%	-				
Level 4	Analyze	- T- N	A Start Start		20%	-	-				
Level 5	Evaluate	and the second second	and the second second	1000		-	-				
Level 6	Create		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 - 1 - 2 - A			-				
	Total	100	%	10	0 %	10	0 %				

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Dr. Arun Sehrawat, Director of Quantum	1. Dr.S. Meenakshi, Professor, AnnaUniversity	1. Dr. Soumyaranjan Routray, SRMIST	
Theoritical Research, QpiAi, Bangalore			
		2. Mrs. GavathriSS. SRMIST	



Course Code         21ECE568J         Course Name         RF SYSTEM DESIGN								Co Cat	ourse egory	E			Ρ	ROFE	SSION	IAL EL	ECTIV	Έ		L 2	- T 2 0	P 2	C 3	
Pre-requi Course	site s	Nil		Co- rec Cours	luisite e <mark>s</mark>		Nil	1		Progr Cou	essiv Irses	e						Nil						
Course	Offering Departme	ent		ECE			Data Book /	/ Codes / Stand	ards								Nil							
Course Le	arning Rationale	(CLR)·	The nur	nose of lea	rnina this	course is	to:				10	-		Progr	am Oi	Itcome	es (PC	)				P	rogra	am
CLR-1:	Discuss the high	-frequency b	behavior o	f common c	ircuit com	ponents				1	2	3	4	5	6	7	8	9	10	11	12	S	pecif	ic
CI P_2:	List and identify t	ho challongo		high froguo	nev dovico		it dosign			-		of ,	s.				, ,	-		Ð		00	ilcon	les
CLR-2.	List and identity a	losian issuos	es in DE on	night nequel	re and Os		t uesigii					ent (	tion	ge				_		anc	Б			
CLR-3.	LR-4: Analyze the stability considerations and interference issues in RF design									ysis	mdc	stige	Usa	and	øð		ear	ы	Ĕ	min				
CLR-4.	<b>LR-5:</b> Learn RF circuit fundamentals for designing various circuit building blocks in a typical RF transceiver								bu e	Anal	evelo	nve:	8	leer	ent		& T	cati	gt. 8	Lea				
CLN-J.	LR-5: Learn RF circuit fundamentals for designing various circuit building blocks in a typical RF transceiver									hedr	em	p/uf	uct i	Lu	engir	onm	S	dua	unu	ct⊠	ong	<del></del>	2	က္
Course Outcomes (CO):       At the end of this course, learners will be able to:         Co-1:       Calculate basic radio specifications in terms of, gain, noise, signal-to-noiseratio, power									Engir	Probl	Desig	Cond	Mode	The e	Envir	Ethic	<u>Nork</u>	Comr	Proje	Life L	-OS-	-SO	-SO-	
CO-1:	Calculate basic ra	adio spe <mark>cifica</mark>	cations in te	erms of, gair	, noise, sig	gnal-to-noi	iseratio, powe	er		3	3	-	-	-		-	-	-	-	-	-	-	2	-
CO-2:	Apply mathematic	cal skill <mark>s and</mark>	d software	skills to des	gn and sin	nulate RF t	filters and ma	atching circuits	1	2	-	3	-	3	-	-	-	-	-	-	-	3	-	-
CO-3:	Identify and learn	the wo <mark>rking</mark>	g principle .	and charact	eristics of I	Radio frequ	uency device	IS	1	3	2		-	-	-	-	-	-	-	-	-	3	-	-
CO-4:	Perform stability	analysis <mark> on F</mark>	RF amplifie	er designs	100	1.1	100	1 m m - 1		-	-	3	3	2	1000	-	-	-	-	-	-	3	-	-
CO-5:	Design RF oscilla	ators an <mark>d mix</mark>	ixers		100	Sec. 1	100	111	2.5	-	3	3	-	2	-	-	-	-	-	-	-	3	-	-
				Second St.			1.			1.1					No.								1	
Unit-1 - Int	roduction to Rad	io Frequenc	cy Design							_					-	0.1						<u> </u>	12	Hour
– Noise fia	1 to passive compo ure computations -	Flectromage	, Definitioi netic Inter	1s – RF Unit ference in R	s, R⊢ para E circuits: ;	meters Pai Sources of	rallel and sen f FML Fleme	ies connection o	ot netwo	orks - A	BCD	and so	atterin	g para	meter	s, Smit	n cnar	t and it	s appi	ication	s, Noi	se in F	R⊢ sy:	stems
Practice: S	Smith chart, Noise f	igure calcula	ations in a	cascaded s	/stem, Tes	sting for EN	лі, шоліо Лі																	
Unit-2 - RF	Filters and Matci	hing Circuit	ts		1.11			1000						1									12	Hour
Filter config	gurations- LPF, HP	F,BPF,BSF,	, S <mark>pecial fil</mark>	ter realizatio	ns - Low p	ass prototy	ype, filter imp	lementation – Ri	ichards	Trans	format	tion, K	uroda l	dentity	y, Impe	edance	matcl	ning us	ing dis	screte	compo	onents	, micr	rostrip
line matchi	ng networks.					1																		
Practice: L	dio Froquency D	ION OF LPP II	nicrowave	liller, Desigr	i and simu	nation of in	ipedence ma	itening circuits u	sing iu	mpea e	erner	ns		1			-						12	Hour
RF diodes	Schottky PIN IM	PATT GUNN	N - RF B.IT		ET-Hiah El	lectron Mo	bility Transis	tors- Transistor	models	-Scatte	erina r	arame	eter de	vice ch	naracte	erizatio	n						12	noui
Practice: \	/-I characteristics of	of GUNN dio	de, Schott	ky diode, RF	BJT / ME	SFET	Sinty Transis	tore manoleter	nouore	ooune	ing p	aranne	itor do	100 01	iai aott	, Latio	,							
Unit-4 - RF	Amplifiers																						12	Hour
Amplifier c	lasses of operation	n, Character	ristics of a	nplifiers, an	nplifier pov	ver relatior	ns, stability c	ircle and conditi	ional s	tability,	stabi	lity tes	ting of	RF a	mplifie	rs, bro	adbar	id amp	lifiers.	High	power	<sup>.</sup> ampl	ifiers:	Gain
compressio	on, Intermodulation	distortion																						
Practice: L	vesign an K⊢ ampli	mer, Stability	y testing of	KE Amplifie	ers,																			

# Unit-5 - Radio Frequency Generation & Mixer

One-port and two-port microwave oscillator design, Crystal Oscillator, YIG tuned Oscillator, Analysis of phase noise in oscillators. Mixers: Characteristics, Various types of Mixers: FET mixers, Balanced mixers, Image reject mixers

Practice: Design One port and two port RF oscillator, Analyze Oscillator phase noise

	1.	David M. Pozar, "Microwave Engineering - Theory and Practice", Wiley India Pvt Ltd, 2020	4.	William F Egan, "Practical RF System Design", Wiley - IEEE Press, 1ed,2003
Learning	2.	Reinhold Ludwig, "RF circuit design, theory and applications" PavelBretchko, "Pearson Asia	5.	W. Prasad Kodali, Engineering Electromagnetic Compatibility: Principles,
Resources		Education", 2e,, 2009		Measurements, Technologies, and Computer Models, Wiley-IEEE Press, 2ndEdition,
	3.	Behzad Razavi, " RF Microelectronics", 2ed pearson Prentice Hall,2013		2001

Learning Assessm	ent	N 2 1									
		N	Continuous Learning	Assessment (CLA)		Gum	mativa				
	Bloom's Level of Thinking	Forma CLA-1 Averag (45)	ative le of unit test %)	Life-Long CL (1-	g Learning _A-2 5%)	Final Examination (40% weightage)					
	2	Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%	1	10/10/10	15%	15%	-				
Level 2	Understand	25%	100 - A 4 100	- 10 F	20%	25%	-				
Level 3	Apply	30%	Hard Street Vis	41.7 5.6 7	25%	30%	-				
Level 4	Analyze	30%	A REAGE		25%	30%	-				
Level 5	Evaluate	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	A THE NAME	1 1 1 1 2 4 A	10%		-				
Level 6	Create	7	1 C 1 C 1 C 1 C 1		5%		-				
	Total	100	%	10	0 %	10	0 %				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Leela Krishna Thota, Sr.Solution Engineer, Synopsys.	1. Dr,S.Meenakshi, Professor, AnnaUniversity	1. Dr.M.S. Vasanthi, SRMI <mark>ST</mark>



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Course Code	rse 21ECE569T Course Name VLSI SIGNAL PROCESSING TECHNIQUES										PI	ROFE	SSION	AL EL	ECTIV	Έ		L 2	T 1	P 0	C 3
Pre-requis	site s	Nil	Co- req Course	uisite es	Nil		Progr Cou	essiv Irses	e						Nil						
Course C	Offering Departmo	ent	ECE		Data Book / Coo	des / Standards								Nil							
Course Le	arning Rationale	(CLR):	The purpose of lear	ning this co	ourse is to:		1.2	10			Progra	am Ou	Itcome	s (PO	)				Pr	ograr	m
CLR-1:	Understand the tand low-power a	fundamental applications	lower bound on the s	ample period	l and the techniques use	ed for high-speed	1	2	3	4	5	6	7	8	9	10	11	12	Sı Ou	pecific tcom	c es
CLR-2:	Analyze retiming	and unfoldi	ing <mark>techniques</mark> to incre	ase the thro	ughput of the circuit	STATES.	je	-	of	s of	10	iety			¥		0				
CLR-3:	Explore reduction	n in hardw <mark>a</mark> l	re <mark>complexit</mark> y by use c	f substrate	sharing technique		ledç		ent o	tions	e	soci			Wo		ance	6			
CLR-4:	CLR-4: Demonstrate application of systolic architecture in VLSI Design							/sis	bme	tiga	Jsac	and			eam	Ę	Fin	ninç			1
CLR-5:	CLR-4:       Demonstrate application of systolic architecture in VLSI Design         CLR-5:       Emphasis on architecture design based on design methodologies for mapping algorithms to arithmetic architectures at bit-level								gn/develo	duct inves	ern Tool (	engineer	onment 8 ainability	Ş	idual & Te	municatio	ect Mgt. &	-ong Lear	5	-2	-3
Course Ou	tcomes (CO):		At the end of this co	ourse, learn	ers will be able to:	Contraction of the second	Engi	Prob	Desi	Conc	Mod	The	Envi	Ethic	ndiv	Com	Proje	-ife I	SO	So	SO
CO-1:	Compute the iter parallel processir	ation bo <mark>und</mark> 1g techn <mark>ique</mark>	using DSP algorithm a	and illustratio	n of low-power design u	sing pipelining and	d 3	2	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-2:	Apply retiming all of the circuit	gorithm <mark>to r</mark> e	educe the critical path o	lelay and un	folding algorithm to impro	ove the throughpu	t 2	2	2.1	5	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Examine algorith rank-order filters	mic stre <mark>ngt</mark> h	reduction transformati	on to design	fast parallel FIR filters,	DCTs, and paralle	3		-	2	-	0	-	-	-	-	-	-	-	-	3
CO-4:	Design regular ite	erative a <mark>lgori</mark>	<mark>ithm u</mark> sing linear mappi	ng technique	es	1. 6	3	2	-	-	-	-	- 1	-	-	-	-	-	-	-	3
CO-5:	Implement bit-lev	el arithmetic	<mark>c archit</mark> ectures and bit-p	arallel multip	oliers	1772	3	-	-	2	-	-	-	-	-	-	-	-	-	-	3
Unit-1 - Ite	ration Round Pi	nelining and	d Parallel Processing			<u></u>							-							91	Hour
Iteration Bo on LPM teo low power.	und, data flow gra hniques. Pipelinin Problems on low p	ph represen g and parall ower pipelin	ntations, loop bound, Ite el processing – Introdu ned and parallel system	ration bound ction, Pipelir s.	l. Problems on iteration b ing of FIR digital filters, p	ound techniques. barallel processing	Various , Parall	s mecl el pro	nanisn cessin	n for ite g of Fl	eration R Filte	bound r. Pipe	l comp elining p	utatior proces	i, long sing fa	est pat or low p	th mati bower,	rix algo Parall	orithm, Iel proc	Prob cessin	lems ng for
Unit-2 - Re	timing and Unfol	ding		200	1 March	TO DE LA				2	1									91	Hour
Introduction	n to Retiming – Re	timing Prope	erties, Retiming for cloc	k period min	imization, Problems on F	Retiming mechanis	m, Unfo	olding	– Intro	oductic	on, An a	algorit	hm for	unfold	ing, Pı	ropertie	es of u	nfoldir	ng, app	olicatio	on of
Unfolding -	sample period red	luction and F	Parallel Processing	la vina			-	-			-										Haur
Algorithmic	strength reduction	n <b>Reauctio</b> n – Introducti	ion Parallel FIR Filters	using Polyn	hase Decomposition Dis	crete Cosine Tran	sform (		and In	verse		Algorit	hm _ A	rchite	ture T	ransfo	rmatio	n Nur	nerica	<b>9 r</b> I nroh	lems
in N-point L	CT, Fast Convolu	tion – Introd	luction, Cook – To <mark>om a</mark>	gorithm, mo	dified Introduction, Cook	–Toom algorithm.	0101111 (	501)		10100	201,7	igoni		<i>i</i> oi iitot	nui o i	ranoro	indio	<i>n, nu</i>	nonou	1 0100	101110
Unit-4 - Sy	stolic Architectu	re																		91	Hour
Introduction	to systolic archite	ectures, Sys	tolic array design meth	odology, Sy	stolic arrays for FIR digita	al filters, Selection	of Sch	edulin	g Vec	tor, Pr	oblem	relate	d to sy	stolic	array o	lesign,	Matri	x Multi	iplicati	on an	d 2D
Systolic All	ay Design, Syston	c Design 101	space representations	containing d	eldys.																

### Unit-5 - Bit-Level Arithmetic Architecture

Bit-level architecture – Introduction, Parallel Multipliers, Parallel Multiplication with sign extension, Parallel Carry-ripple Array Multipliers, Parallel Carry-Save Array Multipliers, Baugh-Wooley Multipliers, Parallel Multipliers with Modified Booth Recoding, Interleaved Floor-plan and Bit-plane based Digital Filters, Design of Bit-Serial Multipliers using Systolic Mappings

Learning Resources	<ol> <li>Keshab K.Parhi, "VLSI Digital Signal Processing systems, Design and implementation", Wiley, Inter Science, 1999.</li> <li>Gary Yeap, "Practical Low Power Digital VLSI Design", Kluwer Academic Publishers, 1998.</li> <li>Mohammed Ismail and Terri Fiez, "Analog VLSI Signal and Information Processing", Mc Graw-Hill, 1994.</li> </ol>	<ol> <li>S.Y. Kung, H.J. White House, T. Kailath, "VLSI and Modern SignalProcessing", Prentice Hall, 1985.</li> <li>Jose E. France, Yannis Tsividis, "Design of Analog &amp; Digital VLSI Circuits for Telecommunication and Signal Processing ", Prentice Hall, 1994</li> </ol>

Learning Assessm	ent										
			Continuous Learning	Assessment (CLA)		Cum	mativa				
	Bloom's Level of Thinking	Forma CLA-1 Average (50%	tive e of unit test 6)	Life-Long CL (10	g Learning _A-2 0%)	Final Examination (40% weightage)					
	2	Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%	2	15%		15%	-				
Level 2	Understand	25%	10. 10 A. 10. 10	25%		25%	-				
Level 3	Apply Tar	35%	ALL DESCRIPTION	35%		<mark>35</mark> %	-				
Level 4	Analyze	25%	the second second	25%		<mark>25</mark> %	-				
Level 5	Evaluate		N 1997 MA	1 A			-				
Level 6	Create	1	A & 1 & 1 & 1		-	-	-				
	Total	100	%	10	0 %	10	0 %				

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Leela Krishna Thota, Sr.Solution Engineer, Synopsys.	1. Dr.S. Meenakshi, Professor, AnnaUniversity	1. Dr. Maria Jossy A, SRMI <mark>ST</mark>



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Course Code	21ECE570T	S Ca	ourse tegory	E			PI	ROFE	SSION	IAL EL	ECTI	/E		L 2	. T ! 1	P 0	C 3						
Pre-requi Course	site 21EC	C205T		Co- requisi Courses	ite		Nil		Progr Cou	essive Irses	•						Nil						
Course (	Offering Department			ECE		Data	Book / Codes	s / Standards								Nil							
Course Le	arning Rationale (CL	R):	The purpo	o <mark>se of learn</mark> in	g this cou	urse i <mark>s t</mark> o:		-12-4	17	ŧ.	5.	I	Progra	am Ou	itcome	es (PC	))				P	rogra	m
CLR-1:	Outline the use of CA	ADs for hig	gh speed cl	hip packaging	- 12	$\mathbf{v} \geq$	<		1	2	3	4	5	6	7	8	9	10	11	12	0.	pecifi utcom	ic ies
CLR-2:	Elaborate different e	lectrical cl	hall <mark>enges i</mark>	in packaging	1	1			Θ	344	f	of		ety	-		¥						
CLR-3: Explore the basics of transmission lines and their types						ledg		into	ions	θ	soci			Mol		ance	_						
<b>CLR-4:</b> Develop different AC and DC models for the simulations of interconnects and power distribution network						Nou	'SiS	pme	tigat	lsag	pue			am	c	Fina	ning						
CLR-5:         Deduce fundamental numerical models using partial element equivalent circuit for electrical characterization							ineering K	lem Analy	ign/develo	duct inves	ern Tool L	engineer a	ronment 8	S	vidual & Te	Imunicatio	ect Mgt. &	Long Lear	-1	)-2	-3		
Course Ou	itcomes (CO):		At the end	d of this cours	se, learne	ers will be al	ble to:	10. Sec.	Eng	Prot	Desi	Con	Mod	The	Envi	Ethi	Indiv	Con	Proj	Life	PSC	PSC	PSC
CO-1:	Illustrate the use of C	CAD <mark>s and c</mark>	different pa	arameters for h	nigh speed	d chip packa	ging	129-11	2	-	10	- 1	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Identify electrical cha	allen <mark>ges er</mark>	<mark>nco</mark> untered	l during high sp	beed pack	kaging	1000		2	-	1	-	2	-	-	-	-	-	- 1	2	2	-	-
CO-3:	Correlate different tra	ansm <mark>issior</mark>	<mark>n lines, time</mark>	e and frequenc	cy domain	analysis	- 992 C		2	2	2		-	-	-	-	-	-	- 1	-	1	-	-
CO-4:	Develop AC and DC	mod <mark>el fo</mark> r	2.5D elect	rical characteri	ization	1.00	State 1	1. 1. 1. 1.	2	2	2	-	-	-	-	-	-	-	-	-	1	-	-
CO-5:	Apply partial element	t equ <mark>ivaler</mark>	<mark>nt c</mark> ircuit co	ncept to mode	el 3D elect	trical charact	erization	100	2	2	2	-	-	-	-	-	-	-	_	-	1	-	-
Unit-1 - CA	AD for High-Speed C	Chip-Pack	kage-Syste	ems: An Over	rview			1	-			_	-	-								9	Hour
Function of low L, therr	f packages: power an mal performance, mech	nd sign <mark>al o</mark> hanical pe	distribution offormance.	, heat dissipation past trends, 3	tion, mech 3D integrat	hanical stab tion today	ility, types of p	packages and	PCBs,	desire	d pac	kage p	roper	ties: ei	lectrica	al perfo	ormand	се, рои	ver dist	tributio	n with	1 low F	२ and
Unit-2 - Ele	ectrical Challenges			- E.									18									9 /	Hour
Review of e	electromagnetic and ci	ircuit basic foronco ar	c <mark>s, on-chi</mark> p nd electron	signal integrity	/, noise an	nd timing and	alysis, high free	quency aspect,	skin efi	fect, p	ower ii	ntegrity	, simu	ltaneo rs	ous swi	itching	noise	, A.C. J	oower l	integri	ty, imp	portan	ice of
Unit-3 - 2D	, electromagnetic inter ) Electrical Character	ization			aubility, re	eview of SFIC	JE DASICS, IUIII	peu mouers, un	sinbule	u RLG	0, 3/1	/Z pare	amete	15		-						9	Hour
Transmissi ground pla frequency a	on line basics, TEM m ne, co-axial cable, two and time domain analy	ode and its conducto sis, 2D an	ts pro <mark>pertie</mark> or transmis nalysis: MT	s, Stokes' and sion line frequ L channel simu	Gauss's ti lency dom ulation	theorem, Ma nain analysis	xwell's equatio s, losses, A, B,	ns, two conduc , C, D,Z, Y par	tor tran ameters	smissi s, 2D /	on line Analys	and p is: mul	er unii ticond	t lengti luctor	h parai transm	meters iission	s, cylin lines	drical v (MTL)	vires o extrac	f differ tion, 2	ent ra D ana	idii, wi alysis:	re on MTL
Unit-4 - 2.5	5D Electrical Characte	erization																				9 /	Hour
Power deli	very, power distribution method (M-EDM) 2.50	n network Danalvsis <sup>.</sup>	(PDN) mo	deling: DC and	<mark>d AC</mark> anal	lysis, DC int	ernal resistanc	e (DCIR) drop	solver, vitching	multig	rid ba	sed so	lvers:	algebr	raic mu	ıltigrid	(AMG	), 2.5E	) analy	rsis: m	ultilay	rered f	finite-
Unit-5 - 3D	Electrical Character	ization	. yap unu n	ingo con collor	i, accoupi			intalancous sw	noning	10130	(00/1)											9	Hour
Partial elen	nent equivalent circuit	(PEEC) m	nethod: qua	sistatic conduc	ctor, full-w	vave conduct	tor, dielectric, r	non-orthog <mark>onal</mark> ,	surface	e, and	fast co	ompres	sed P	EEC, a	advant	ages (	of PEE	C, frec	juency	deper	ndenc	e in P	EEC,
near and fa	ar field radiation, compa	arison of 2	2D, 2.5D, 3	D, through-silie	con-via mo	odeling																	

Leonier	1. Stephen H. Hall and Howard. L. Heck, Advanced Signal Integrity for High Speed	3. Eric Bogatin, Signal and Power Integrity-Simplified, Second Edition, Prentice Hall, 2010
Learning Resources	Digital Designs, IEEE Computer Society Press, 2009 2 Howard W Johnson and Martin Graham High Speed SignalPropagation:	<ol> <li>Magnavan Swaminathan and Ege Engin, Power Integrity Modelling and Design for Semiconductors and Systems First Edition Prentice Hall 2007</li> </ol>
Resources	Advanced Black Magic, Prentice Hall, 2003	5. HSPICE, Signal Integrity User Guide, Version A-2007.12, December 2007, Synopsys

		1	Continuous Learnin	g Assessment (CLA)		Cum	mativa			
	Bloom's Level of Thinking	Forn CLA-1 Avera (50	native ge of unit test 1%)	Life-Long CL (10	g Learning "A-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	20%	100 million 100	20%		20%	-			
Level 2	Understand	30%	States and	30%		30%	-			
Level 3	Apply	30%		30%		30%	-			
Level 4	Analyze	20%		20%		20%	-			
Level 5	Evaluate		Contraction of the second	- 17 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1		-	-			
Level 6	Create					-	-			
	Total	10	0%	10	0%	10	0 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Leela Krishna Thota, Sr, Solution Engineer, Synopsys.	. 1. Dr.S.Meenakshi, Professor, Anna University.	1. Dr. Aditya Nath Bhatt, SRMIST
		2. Dr. Rajesh Agarwal, SRMIST



Course Code	21ECE571T	Course Name	HARDWARE ACCELERA		Course Category	E			P	ROFE	SSION	IAL EI	_ECTI\	/E		L T P C 2 1 0 3							
Pre-requ Cours	uisite ses	Nil	Co- requisite Courses	Nil	Progr	ressiv urses	e						Nil										
Course	Offering Departme	ent	ECE	Data Book / Codes / Standard	ls							Nil											
Course L	earning Rationale	(CLR): Th	e pu <mark>rpose of lea</mark> rning this cou	ırse is to:		v	17		Progra	am Ou	utcom	es (PC	<b>)</b> )				Pr	rogra	m				
CLR-1:	To study mm-wav	e device modelir	ng second	1000	1	2	3	4	5	6	7	8	9	10	11	12	S Ou	pecifi Itcom	C es				
CLR-2:	Understands mm-	-Wave Device Or	otimization				of	SU (							e								
CLR-3:	.R-3: Analyze mm-Wave CMOS Noise Analysis							jatio	age	ъ			E		inan	bu							
CLR-4:	Observe Unilater	alization	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	State State State	2	alysi	alopr	estic	I Us	er an	t &	~	Tea	tion	ъ К Г	arni							
CLR-5:	Understand Teral	hertz CM <mark>OS Devi</mark>	ces, Circuits, and Systems		ering	n An	deve	t invi	Too	ginee	men		lal &	inica	Mgt.	ng Le							
Course C	Outcomes (CO):	At	the end of this course, learne	rs will be able to:	Engine	Probler	Design	Conduction of Comit	Moderr	The en	Enviror Sustain	Ethics	Individu Mork	Commu	Project	Life Lor	PSO-1	PSO-2	PSO-3				
CO-1:	Infer mm-Wave D	evice M <mark>odelling</mark>		like Cours With	3	2		-	-		-	-	-	-	-	-	-	-	-				
CO-2:	Predict mm-Wave	) Device Optimiza	ation		1	3	2	-	-	-		-	-	-	-	-	-	- <sup> </sup>	-				
CO-3:	Estimate mm-Wa	ve CMO <mark>S Noise</mark> .	Analysis		1	3		2	-		-	-	-	-	-	-	-	-	1				
CO-4:	Examine Unilatera	alization <mark> Techniq</mark> i	ues		196	2	3	-	-	-	-	-	-	-	-	-	-	-	-				
CO-5:	Explain Terahertz	: CMOS <mark>Devices,</mark>	Circuits, and Systems		1	2	3	-	-	1	-	-	-	-	-	-	-	-	2				
<b>Unit-1 - N</b> The Teral	//M-Wave Device M hertz Gap-Shift of Pa	l <b>odelling</b> aradigm in t <mark>he</mark> IC	Design-The Importanceof Mode	lling in mm-Wave-High Frequency Mo	deling Pro	cedur	e-Mea	sureme	ent and	d De-e	mbed	ding.						9	Hour				
Unit-2 – I	MM wave Device Op	otimization																9	Hour				
Device Performance Metrics-Layout Effect on Device Performance- Round-Table Structure-mm-Wave Power Device							_	1	7.														
Unit-3 - N	JNIT-3 - MM Wave CMOS Noise Analysis						_	_	-									9	Hour				
Unit-4 - L	nit-4 - Unilaterization						-											9	Hour				
Theory of	heory of Unilateralization-Mason Gain as a Ma <mark>ximum Gain-</mark> 2-Port Unilateralization Techniques-N-Port Unilateraliza						sistor l	Unilater	alizati	io <mark>n-S</mark> ir	nulate	d Resi	ults and	d Imple	ementa	tion.							
Unit-5 - 1	erahertz CMOS De	vices, Circuits a	and Systems			1.1												9	Hour				
Ultra-Hial	h Speed CMOS Devi	ices-Ultra-High S	peed CMOS Circuits- Ultra-Higl	h-Speed Systems			_																

Skew Tolerant Dominio Design , IEEE Journal of Solid-State Circuits, 200
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			Continuous Learning A	Assessment (CLA)		Cum	mativa			
	Bloom's Level of Thin <mark>king</mark>	Forn CLA-1 Avera (50	native ge of unit test 0%)	Life-Long CL (1)	g Learning _A-2 0%)	Final Examination (40% weightage)				
		Theory	Practice	Theory	Practice	Theory	Practice			
Level 1	Remember	35%		35%		25%	-			
Level 2	Understand	35%	States Server	30%		35%	-			
Level 3	Apply	30%	1 2 3 S S S S S	35%		40%	-			
Level 4	Analyze	SW/ - 54		1.		-	-			
Level 5	Evaluate			17 C		-	-			
Level 6	Create				1 - N	-	-			
	Total	10	0%	10	0%	10	0%			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Leela Krishan Thota, Sr.Solution Engineer, Synopsys,	1. Dr.S. Meenaskshi, Professor, AnnaUniversity	1. Dr.S. Yuvarai, SRMIST



Course Code	21ECE572T	PGAS Ca	ourse tegory	E			PI	ROFE	SSION	AL EL	ECTIV	′E		L 3	T 0	P 0	C 3				
Pre-requi Course	site s	Nil	C	o- requisite Courses	Nil		Progr Cou	essive Irses	9						Nil						
Course	Offering Departme	ent	E	CE	Data Book / Co	des / Standards								Nil							
Course Le	arning Rationale (	CLR):	The purp <mark>ose c</mark>	of learning this c	ourse is to:	-	17	10	6	F	Progra	am Ou	itcome	es (PO	)				Pr	rogra	m
CLR-1:	Understand the b	asic concep	pts hardware soft	ware and dataflow	w modeling		1	2	3	4	5	6	7	8	9	10	11	12	S Ou	pecifi utcom	c
CLR-2:	Study FPGA hard	dware synth	esis tools and So	C tool flows that	integrate custom hardwa	re		Sec.	of	SU .							g				
CLR-3: Highlight the characteristics of system models and representation							S	nent	atio	age	σ			۶		nan	ور				
CLR-4: Study the performance of real time embedded system							alysi	lopr	estig	Usi	r an	~		Tea	lion	8 E	arni				
CLR-5:	CLR-4:     Study the performance of real time embedded system       CLR-5:     Design FPGA with self-replicating properties						neering	lem Ana	gn/deve	luct inve molex p	ern Too	enginee	onment ainabilit	ş	idual &	municat	ect Mgt.	-ong Le	5	-2	ကု
Course Ou	tcomes (CO):		At the end of t	this course, learn	ers will be able to:	1.07	Engi	Prob	Desi	Conc	Mode	The	Envii	Ethic	Nork	mo	Proje	life I	0Sc	So	SO
CO-1:	Implement data fl	ow in ha <mark>rdw</mark>	vare software		100 C		3		-	-	-	-	-	-		-	-	   -	2	-	-
CO-2:	Integrate SoC too	ls on c <mark>ustor</mark>	m hardware	ei	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	S. NOTHING	3	2	-	-	-	-	-	-	-	-	-	-	2	_	-
CO-3:	Apply the concep	ts of m <mark>odeli</mark>	ing in system des	ign		Sec N	12-1	3	-	-	-	-		-	-	-	-	-	2	-	-
CO-4:	Analyze the perfo	rmance of e	embedded softwa	re system		3.1	3			-	-	-	-	-	-	-	-	-	2	_	-
CO-5:	Analyze reconfigu	ırable c <mark>omp</mark>	<mark>outing</mark> platforms u	sing FPGA		1000		3	2	-	-	-	-	-	-	-	-	2	2	-	-
llnit-1 - He	ordwara Softwara	Basic Con	cents		-	_			<u> </u>			-								0	How
Nature of I	nardware software,	Hardware s	software code sig	n, Energy efficien	cy, Relative performance	e, H <mark>ardwar</mark> e softw	are cod	e sign	space	e, Duali	ism of	hardv	vare al	nd Sof	ftware	design	i, Mode	əling, (	concu	rrency	/ and
Unit-2 - De	sign Space of Cu	stom Arch	itecture		in in natuwate soltware.	120							-							9	Нош
Finite state	machine with data	path, Cycle	e based bit parall	el and hardware,	wires and registers, prec	isi <mark>on</mark> and sign, Ha	rdware i	mappi	ng of	express	sion, F	lardwa	are mo	dules,	and F	inite st	tate ma	achine	s with	data	path,
Micro prog	rammed architectur	re, and Gen	eral-purpose emb	bedded core.	<u></u>	1.1-1		_	-	-	0										
Unit-3 - Mo	odeling and Hardw	vare Descri	iption						_							<u> </u>				91	Hour
Data flow p	process network, to o reactive and real-	rmal models time system	s, Validation, Syn	thesis, Paradigm i	or hardware software sys	stem design, VHD	L genera	ation fi	rom Si	DL spe	cificat	ion, De	evelopi	ment c	of comp	olex re	active	systen	ns, Sy	nchro	nous
Unit-4 - Ar	alvsis and Estima	ation of Har	rdware Software	System		110.01	10	110	N.											9	Hour
Performan	ce of embedded so	oftware with	instruction cache	e modeling, Sche	duling algorithm for multi	programming har	d real ti	me sy	stem,	Perform	mance	e estirr	nation (	of real	time e	əmbed	lded di	stribut	ed sy:	stem,	Rate
analysis for	r embedded system	n, Power and	alysis for embedd	led software, Des	ign for system level powe	r management, P	ower est	timatic	on for e	embeda	ded sy	stem									Harri
Programm	able active memori	es reconfig	uurahle systems T	ogic emulation wi	th virtual wires Embryon	ics. Design field n	roaramn	nable	nate a	rravs w	ith se	lf-rena	ir and	self-re	nlicatir	יח חרח	nerties			91	nour
				segie onnanauon m			~ gi (ai i ii i		yalo u						~	- PICK					

<ol> <li>A Practical Introduction to Hardware/Software Codesign", Patrick Schaumont, Spring</li> </ol>	3. Handbook of hardware/software codesign, Jürgen Teich, Soonhoi Ha, Spr
Learning 2010, ISBN 978-1-4614-3736-9	Netherlands, 2017
Resources 2. De Micheli, Giovanni, et al. Readings in hardware/software co-design. MorganKaufma	4. The Codesign of embedded systems, James H. Aylor, Barry W. Johnson, WM A
publisher, 2002.	Kluweracademic publishers, 1995

			Continuous Learning A		Quin	mativa			
	Bloom's Level of Thinking	Form CLA-1 Avera (50	native ge of unit test 0%)	Life-Lon CL (1	g Learning _A-2 0%)	Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%		15%		15%	-		
Level 2	Understand	25%		20%		25%	-		
Level 3	Apply	30%	States Land	25%		30%	-		
Level 4	Analyze	30%		25%		30%	-		
Level 5	Evaluate	51/ - 55		10%		-	-		
Level 6	Create			5%		-	-		
	Total	10	0%	10	0%	10	0%		

Course Designers	and the second second second second		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Dr. N.R. Shanker Managing Director Chase Research	1. Dr.S. Meenakshi, Professor, Anna University	1. Mrs. M.K. Srilekha, SRMIST	
and development Centre, Chennai		Contraction Contraction Contraction	



Course Code	21ECE573J	Course         BOARD DESIGN PRACTICE         Course           Name         PART-I: ELECTRONICS SYSTEM DESIGN AND ANALYSIS         Car				ourse egory	E		PROFESSIONAL ELECTIVE					. T 0	P 2	C 3				
Pre-requisite Nil Co- requisite Nil Courses							essive Irses	e						Nil						
Course (	Offering Departme	ent	ECE	Data Book / Codes / Stan	dards								Nil							
Course Learning Rationale (CLR): The purpose of learning this course is to:							17	5.	F	orogra	am Ou	tcome	es (PO	)				Pi	rograi	n
CLR-1:	1: Utilize basics models of the devices- diodes, BJT and MOSFET and analysis its characteristic parameters						2	3	4	5	6	7	8	9	10	11	12	S Ou	peciti itcom	c es
CLR-2:	LR-2: Characterize the basics of operational amplifiers and its applications							of	s of		iety			rk		e				
CLR-3:	Understand and a	analyze the	typ <mark>es of feed</mark> back and its applicat	ion circuits	dan.	led		ento	tion	ge	soc			Wo		anc	5			
CLR-4:	Illustrate the cond	cepts of digit	t <mark>al subsys</mark> tem and its functional e	lements	1.0	Non	/sis	bmg	tiga	Jsac	and	~*		eam	Ľ	Fin	'nin			
CLR-5:	Create insights in design.	to the opera	ation of different types of D/A and	A/D converters and electronics sub	system	eering K	m Analy	n/develo	ict inves ex probl	n Tool (	ngineer	nment 8 nability		lual & To	iunicatic	t Mgt. &	ong Leai		01	~
Course Ou	tcomes (CO):		At the end of this course, lear	ners will be able to:		Engine	Proble	Design	Condu	Moder	The er	Enviro Sustai	Ethics	Individ	Comm	Projec	Life Lo	PSO-1	PSO-2	PSO-3
CO-1:	Analyze the chara	acteristi <mark>c par</mark>	r <mark>ame</mark> ters of diodes, BJT and MOS	FET.	1.1	3	-	2	-	3	-	-	-	-	-	-	-	-	2	-
CO-2:	Demonstrate the concepts of Op-amp circuits						1.0	2	-	3	-	-	-	-	-	-	-	-	2	-
CO-3:	Illustrate the various circ <mark>uits using</mark> different feedback concepts.						-	2	-	3	-	-	-	-	-	-	-	-	2	-
CO-4:	0-4: Construct various digital subsystem and its functional elements						100	2	-	3	-	-	-	-	-	-	-	-	2	-
CO-5:	Describe the different types of digital to analog converters and Analog to digital converters						-	2	-	3	-	-	-	-	-	-	-	-	2	-

### Unit-1 - Device Models

Overview; PN Junction as a Diode, Diode Models and Circuits;: Half and Full Wave Rectifiers with C/ LC/ Pi Filters, Voltage Regulation, Limiting Circuits, Diodes, Level Shifters and Switches, Diode as a switch, Diode Switching Time Parameters, Interpreting diode data sheets. Bipolar Junction Transistor Review and BJT Amplifiers: BJT I - V Characteristics - CB, CE and CC Configurations and Device Ratings of Interest; BJT Amplifiers, Biasing Techniques, Bias Stability, BJT Small Signal DC and AC Models, CE Amplifier with an Emitter Degenerate Resistor, Frequency Response, Input/ Output Impedances, The Emitter Follower, and the CB Amplifier; BJT as a switch - Switching time parameters, Interpreting the BJT datasheets, MOSFET Review and Discrete MOSFET Amplifiers: MOSFET Device Principle of Operation and I - V Characteristics Review; MOSFET Discrete Amplifiers -CS, CG and the Source Follower, Biasing Techniques and Circuits, MOSFET Small Signal DC and AC Models, Review; Current Mirrors and The Differential Amplifier

Practice on Design and verification of Diode application circuits: Rectifiers, voltage regulators, Level shifting circuits, Design and analysis of CE,CB and CC configurations of BJT amplifiers, Design and analysis of CS, CD and CG configurations of MOSFET amplifiers

### Unit-2 - Op-Amp Circuits

OPAMP Review - OPAMP Linear and Nonlinear Application Circuits: The Ideal OPAMP, Practical OPAMP Characteristics (OPAMP 741 as example): Large Signal Gain, Input Bias Current, Input Offset Voltage, CMRR, PSRR, Common Mode and Differential Input Resistances, Interpretation of the datasheet, OPAMP Large Signal and Small Signal Linear Model; OPAMP Linear Applications: Virtual Short and Virtual Ground Concept, Inverting, Non-Inverting Amplifiers, I2V/V2I converters, Summing Amplifier, Instrumentation Amplifier, OPAMP Integrator and Differentiator - Gain and BW limitations; OPAMP Nonlinear Applications: Analog Comparator, ZCD, the Schmitt Trigger, Comparator Applications – ZCD, Phase Meter, Window Comparator, Comparator Wired OR function, Precision Diode and Rectifier Circuits, OPAMP Log and Antilog Amplifiers Practice on Verification of OP-AMP operation and characteristics, Design and Analysis of Summer, Integrator and Differentiator using op-amp

12 Hour

Unit-3 - Feedback Circuits	12 Hour
Feedback Concepts, FB Amplifiers and Waveform Generators - Review and Circuits: Basic Amplifier Topologies, Conc	ept of FB and Basic FB Topologies – Review; FB Amplifier Analysis and Design - Frequency
Response and Stability; Frequency Compensation Techniques; OPAMP Filters – Butterworth, Chebyshev Polynomials	, Sallen – Key Filters, Oscillators and Multivibrators - Review, OPAMP RC and Wein Bridge
Oscillator Design, Hartley and Colpitts Oscillators, Automatic Gain Control, OPAMP Astable Multivibrator and VCO.	
Practice on Design and analysis of Feedback amplifiers: voltage series, voltage shunt, Current series and current shur	t amplifiers, Design and analysis of Butterworth and Chebyshev filters using op-amp, Design
and analysis of RC and LC oscillators	
Unit-4 - Digital Subsystem Design	12 Hour
Digital Subsystem Design: Review of Digital Logic Functions and Combinational Circuits, Interpreting Datasheets; Logic	Synthesis of Combinational
Functional Blocks – Arithmetic Functions - FA, 4 Bit Parallel Adder/ Subtractor, Adder topologies – CLA, Carry Skip Adv	Jers, Multiplier topologies – Wallace Tree and Booth Multipliers, MUX, Decoders and Demux,
Encoders, Parity Check and Generation; Sequential Digital Functional Elements - D Latch and D Flop, Applications - S	witch Debounce Circuit; Design and Logic Synthesis of Binary and Non-Binary Synchronous
Counters, FSM – Introduction; Memory types and Memory Interface – Review	
Practice on Design of Combinational circuits: Adders, Subtractors, Multipliers, Parity generators and Synchronous cour	nters
Unit-5 – Data Converters	12 Hour
Data Converter Topologies: The Sample and Hold - Topologies, Key Specifications, the Sampling Theorem, Effect of Ali	asing, Digital – to - Analog Converters – Principle, DAC topologies – R – 2R, Current Steering,
Charge Sharing DAC, DAC Key Specifications; Analog – to – Digital Converter topologies – Counting Type, Dual Slope,	SAR ADC, Oversampling, Sigma – Delta ADC, Pipeline ADC, Key Performance Specifications
- Resolution, ENOB, SNR, SNDR, Conversion Time Electronic Subsystem Design : Linear Voltage Regulators and	LDO Topologies; Key Specifications; The PLL and DLL – Clock recovery circuits, the Data
Acquisition Signal Chain – Design of a 4-1/2 Digit Auto Ranging Digital Multi Meter with AC/DC I/ V measurements, Te	emperature, Humidity sensor interfaces and LCD display, Design of a Complete Audio Signal
Chain – Microphone to Speaker involving, data acquisition, DSP, and the speaker amplifier, Signal Interface Protocols –	SPI, I2C
Practice on Simulation of R-2R DAC circuit	
1. Ronals A. Reis, 'Electronics Project Design and Fabrication' 4 <sup>th</sup> Edition, Pearson, 1998.	6. Adel S. Sedra, Kenneth C. Smith, "Microelectronic Circuits" 7 <sup>th</sup> Edition, Oxford
<ol> <li>Walter C Bosshart, Printed Circuit Boards: Design and Technology, McGraw Hill Education, 1983.</li> </ol>	University Press, 2015
3. R. Khandpur, 'Printed Circuit Boards: Design, Fabrication, and Assembly', McGraw-Hill Electronic	7. Jacob Baker, "CMOS Mixed-Signal circuit design", IEEE Press, 2009.
Decourses Engineering, 2005	8. Razavi, "Principles of data conversion system design", Wiley IEEE Press, 1st Edition,
Allon Holborg "CMOS analog airquit design" 210 Edition Oxford University Proce 2004	1001

- Allen, Holberg, "CMOS analog circuit design", 3<sup>rd</sup> Edition, Oxford University Press, 2004.
   Behzad Razavi, "Design of analog CMOS integrated circuits", 2<sup>nd</sup> Edition, McGraw Hill, 2017.
- 1994 Baker, Li, Boyce, "CMOS: Circuit Design, layout and Simulation", PHI, 2000.
   Jacob Baker, "CMOS circuit design simulation Layout,", IEEE press, 3<sup>rd</sup> Edition 2010

Learning Assessn	nent											
		Continuous Learning Assessment (CLA)										
	Blo <mark>om's</mark> Level of Thinking	Formative CLA-1	Average of unit test 5%)	Life-Long Le	earning CLA-2 5%)	(40% weightage)						
		Theory	Practice	Theory	Practice	Theory	Practice					
Level 1	Remember	25%	1 mil 1 mil		25%	25%	-					
Level 2	Understand	30%	ALC: A DEPUT	1. 1	25%	30%	-					
Level 3	Apply	30%	-		30%	30%	-					
Level 4	Analyze	15%	-	and the second s	15 <mark>%</mark>	15%	-					
Level 5	Evaluate		-	-	5%	-	-					
Level 6	Create	-	-	-		-	-					
	Total 1			10	0%	10	0 %					

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Venugopal D Kulkarni, Consultant, Entuple Technologies Mail ID: vdk@entuple.com	1. Dr.S. Meenakshi, Professor, Anna University	1. Dr.J. Manjula, SRMIST

Course Code	21ECE574J	Course Name	BOARD DESIGN PRACTICE PART-II: PCB DESIGN, FABRICATION & TESTING Categ		Course ategory	E		PROFESSIONAL ELECTI			ECTIV.	CTIVE		2	Т 0	P 2	C 3			
Pre-requisite         Nil         Co- requisite         Nil           Courses         Nil         Courses         Nil								e					Nil	Nil						
Course	Unering Departme	int			Data Book / Codes / Standards								INII							
Course Learning Rationale (CLR): The purpose of learning this course is to:							1.9	100		Progra	am Ou	<mark>itco</mark> me	es (PO	))				Pr	ogra	m
CLR-1:	Apply the design	and other c	consideration	involved in PCB design	2 2 K	1	2	3	4	5	6	7	8	9	10	11	12	S Ou	pecifi	c es
CLR-2:	Understand the o	lesign of Fle	exibl <mark>e PCB d</mark>	esign consideration	La martine and		34.	t of	Sus							ge				
CLR-3:	Explore various F	PCB manufa	act <mark>uring tech</mark> i	niques			s.	men	gatic	age	p	-		E		inar	ing			
CLR-4:	Understand the t	esting and o	q <mark>uality con</mark> tro	ol of PCB			alys	elop	/esti	ŝ	er ar	tt &		Tea	ation	«Ε	earn			
CLR-5:	Address the pollu	ition control	l and recyclin	g in PCB Fabrication		eering	am An	n/dev	uct inv	n Too	ngine	onmer inabili		lual &	unica	t Mgt	ong Le	_		~
Course Ou	itcomes (CO):		At the end	l of this course, learner	s will be able to:	Engin	Proble	Desig	Condu	Mode	The el	Enviro	Ethics	Indivic Work	Comn	Projec	Life Lo	-OS4	PSO-2	PSO-(
CO-1:	Apply the design	rules in <mark>des</mark>	signing PCB			2	1.	3	-	-	1	-	-	-	-	-	-	1	-	-
CO-2:	Explore the requi	red PC <mark>B Fa</mark> l	abrication Pro	cess and technology	The State State	1		-	-	3	-	-	-	-	-	-	-	1	-	-
CO-3:	3: Identify the construction and advantages of Flexible PCBs						-	2	-	-	-	-		-	-	-	-	-	-	-
CO-4:	: Explore the required testing, Quality control and Recycling in PCB Design						-	-	-	-	-	2	-	-	-	-	-	-	-	-
CO-5:	-5: Develop a PCB layout us <mark>ing mod</mark> ern CAD tool						2	-	-	3		- 1	-	-	-	-	-	-	2	-
llnit-1 - la	vout Planning an	d Design				Page 1	1	1			-								12	Hour

General PCB Design Considerations: Important design elements and performance parameters, Fabrication and Assembly Considerations, Environment Factors: Thermal consideration, contamination and shock and vibrations, Cooling Requirements: Heat sink and packaging Density, Layout Design Rules:Grid system, Layout Scale, Sketch/Design, Layout consideration, materials and aids, Land requirements, Layout methodology, Layout Design Checklist, Documentations, Useful Standards, Practice: Schematic and Layout Design of Combinational and sequential Circuit

### Unit-2 - Etching Techniques

Etching solutions and Chemistry, etching arrangements: Simple batch production etching, continuous feed etching, open loop and close loop regeneration, Etching Parameters, etching equipment and Techniques: immersion etching, Bubble etching, Splash etching, Spray etching, Etching Equipment selections, Optimizing Etching Economy, Problems in Etching, Facilities for Etching Areas, Electrochemical etching, Mechanical Etching, Practice: Etching process in the PCB design and Fabrication

### Unit-3 - Flexible Printed Circuit Boards

Flexible Printed Circuit Boards, Construction of Flexible Printed Circuit Boards: Films, Foils and Adhesives, Design Considerations in Flexible Circuits and step by step Approach to design Flex circuit, Manufacturing of Flexible Circuits, Rigid Flex Printed Circuit Boards, Designing for flexibility and Reliability Terminations, Advantages of Flexible Circuits, Special Applications of Flexible Circuits, Useful Standards **Practice:** Schematic and Layout Design of Combinational and sequential Circuit using PCB Design Tool

### Unit-4 - Quality Reliability and Acceptability Aspects

Quality Assurance: classifications of defects and defectives, Acceptability Quality Level, Quality control program, Testing for Quality Control, Designing of QA methods, Incoming QA, Traceability, Quality Control Methods, Testing of Printed Circuit Boards, Testing of Assembled board, Reliability Testing, Applicability of PCBs: Acceptance criteria, Inception of assembled PCB, Inception techniques, Acceptability criteria, Useful Standards, **Practice**: Schematic and Layout Design of Combinational and sequential Circuit using PCB Design Tool

12 Hour

12 Hour

# Unit-5 - Environment concerns in the PCB Industry

Pollution Control in PCB Industry, Polluting agents, Recycling of Water, Recovery Techniques, Air pollutions, Recycling of Printed Circuit Boards: Present approach to PCB scrap disposal, characteristics of PCB scraps, Dis-assembly of equipment, Technologies of recycling of PCBs, Environmental Standards, Safety Precautions for the Personnel, Toxic Chemicals in Printed Circuit Board Fabrication, Useful Standards **Practice**: Schematic and Layout Design of Combinational and sequential Circuit using PCB Design Tool

	1.	R. S. Khandpur, Printed Circuit Boards: Design, Fabrication, Assembly and Testing, 0-07-146420-	5.	Mark I. Montrose "Printed Circuit Board Design Techniques for EMCCompliance: A
		4, McGraw-Hill, 2006.		handbook for designers" Wiley, 2 Edition, 2015.
Learning	2.	Charles A. Harpe, "High Performance Printed Circuit Boards", McGraw Hill Professional, 2000.	6.	Esim open-source tool: http://esim.fossee.in/
Resources	З.	9Bruce R. Archambeault, James Drewniak, "PCB Design for Real-World EMI Control", Volume	7.	TINA/Orcad User manual
		696 of The Springer International Series in Engineering and Computer Science,	Sec.	
	4.	Springer Science & Business Media, 2013.		

			Continuous Learning	Summativa					
	Bloom's Level of Thinking	Forn CLA-1 Avera (4)	native ge of unit test 5%)	Life-Long CL (15	Learning A-2 5%)	Final Examination (40% weightage)			
		Theory	Practice	Theory	Practice	<u>Theory</u>	Practice		
Level 1	Remember	30%	and the second sec		15%	15%	-		
Level 2	Understand	30%			20%	25%	-		
Level 3	Apply	20%	1	ALL STATE	25%	<u>30</u> %	-		
Level 4	Analyze	10%			25%	30%	-		
Level 5	Evaluate	and the second second		and the second second	10%	-	-		
Level 6	Create			Sector Sector	5%	-	-		
	Total	10	0%	100	0 %	10	0 %		

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Exper <mark>ts</mark>
<ol> <li>Mr. Vikas Verma, Physical design Engineer, Mediatek, vikas verma@mediatek.com</li> </ol>	1. Dr. G. P.S. Mishra, Associate Professor,NIT Raipur, Chhattisgarh	1. Dr. Manish Verma, SRMIST
2. Mr. Mahesh Malewale Tanaji, Physical DesignEngineer, mahesh.tanaji.malewale@intel.com	2. Dr. Shivendra Yadav, Assistant Professor, SVNIT, Surat, Gujrat	2. Dr. P. Eswaran, SRMIST

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