

SRI CHANDRASEKHARENDRA SARASWATHI VISWA MAHAVIDYALAYA

(University established under section 3of UGC Act 1956) (Accredited with 'A' Grade by NAAC)



CURRICULUM FOR FULL TIME BE - ELECTRONICS AND COMMUNICATION ENGINEERING HONS./MINOR DEGREE IN EMERGING AREAS(OPTIONAL)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING





B.E /B.TECH-Hons./Minor Degrees in Emerging Areas (Optional)

Emerging Areas	Offered as Hons., for the following Major Disciplines*	Offered as Minor Degrees for the following Major Disciplines**
5G COMMUNICATION SYSTEMS	Electronics and Communication Engineering / Computer Science and Engineering / Information Technology/ Electrical and Electronics Engineering	Electronics and Instrumentation Engineering/ Mechatronics / Mechanical Engineering / Civil Engineering
VLSI DESIGN	Electronics and Communication Engineering / Computer Science and Engineering / Information Technology/ Electrical and Electronics Engineering	Electronics and Instrumentation Engineering/ Mechatronics / Mechanical Engineering / Civil Engineering
IMAGE PROCESSING AND COMPUTER VISION	Electronics and Communication Engineering / Computer Science and Engineering / Information Technology	Electrical and Electronics Engineering /Electronics and Instrumentation Engineering/ Mechatronics/ Mechanical Engineering / Civil Engineering

Note: The "Minor Degree or Hons. will cumulatively require additional 18 to 20 credits in the specified area in addition to the credits essential for obtaining the Under Graduate Degree in Major Discipline.

* Under Graduate Degree Courses in EMERGING AREAS shall be allowed as specialization from the same Department. The minimum additional Credits for such Courses shall be in the range of 18-20 and the same shall be mentioned in the degree, as specialization in that particular area.

** Minor specialization in EMERGING AREAS in Under Graduate Degree Courses may be allowed where a student of another Department shall take the minimum additional Credits in the range of 18-20 and get a degree with minor from another Department.

ELECTRONICS AND COMMUNICATION ENGINEERING WITH HONS./MINOR DEGREES

5G COMMUNICATION SYSTEMS



CURRICULUM & SYLLABUS

For B.E. (Hons.) Electronics and Communication Engineering with Specialization in

S.N o	Year	Sem	Cour se Code	Course Name	L	Т	Р	С	IA	EA	ТМ
1	п	IV		INTRODUCTION TO COMMUNICATION AND NETWORKING	3	0	0	3	40	60	100
2	III	V		ADVANCED WIRELESS COMMUNICATION	3	0	0	3	40	60	100
3	III	V		WIRELESS COMMUNICATION LAB	0	0	2	2	40	60	100
4	III	VI		WIRELESS BROADBAND NETWORKS	3	0	0	3	40	60	100
5	IV	VII		5G COMMUNICATIONS	3	0	0	3	40	60	100
6	IV	VII		5G COMMUNICATION LABORATORY	0	0	2	2	40	60	100
7	IV	VIII		SMART ANTENNAS FOR 5G COMMUNICATION	3	0	0	3	40	60	100
			Total	Credits		1	1	1	19		

5G COMMUNICATION SYSTEMS



Course C	Code		L	Т	Р	C	IA	EA	TM							
Course N	lame	INTRODUCTION TO	3	0	0	3	40	60	100							
		COMMUNICATION AND														
		NETWORKING														
Course		PROFESSIONAL		Sylla	ous Re	vision		V	.1.0							
Category	,	SPECIALIZED COURSE														
Pre-requ	isite	Digital Communication														
Course C) bjectives:															
The cours	se should er	hable the students														
1. To	o understan	d basic knowledge of networking	g.													
2. To	o demonstra	ate knowledge of OSI and TCP M	Iodels	5.												
3. To	o Evaluate a	Evaluate and compare the performance of the various digital modulations schemes.														
4. To	o understan	understand the concept of Information Theory.														
5. To	Acquire the skills to generate and detect Wireless digital modulation schemes.															
	To require the skins to generate and detect is neless digital modulation schemes.															
Course C)utcomes:															
On comp	letion of the	e course, the student will be able	to													
Course		Description	n					Hi	ghest							
Outco								Blo	oom's							
mes								Tax	onomy							
CO1	Understar	nding of networking systems.							K2							
CO2	Understar	nding the concept of different lay	vers in	the ne	etworks	5.			K3							
CO3	Demonstr	rate proficiency in the generation	n and	d detec	tion of	f digit	al		K5							
	modulate	d signals.														
CO4	Gain a c	omprehensive understanding of	info	rmatio	n theo	ory an	d		K2							
	channel c	oding to improve communication	n relia	ability.												
CO5	Explore t	he practical applications of wi	reless	digit	al mod	lulatio	n		K5							
	technique	S.														
Correlati	ion betwee	n Course Outcomes (COs) and	Prog	ram (Outcom	nes (P	Os):									
							Prog	ram S	Specific							
		Program Outcomes (F	POs)				Ou	tcomes								

				P	rogra	m Ou	tcome	es (PO	s)				(PSOs)				
COs	РО	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PS	PS	PS		
	1	2	3	4	5	6	7	8	9	10	11	12	0	02	03		
													1				
CO1	Μ	-	-	-	-	-	-	-	-	-	-	-	L	-	-		
CO2	Μ	Μ	L	-	-	-	-	-	-	-	-	-	L	-	-		
CO3	S	-	-	L	L	-	-	-	-	-	-	-	-	L	L		
CO4	Μ	-	L	-	-	-	-	-	-	-	-	-	L	-	-		
CO5	S	Μ	Μ	L	Μ	-	-	-	-	-	-	-	-	М	L		



UNI'.	Г-І	INTRODUCTION TO DATA COMMUNICATION	9 Hours
Data	Commu	nication, Networks – Distributed Processing, Network Criteria, Applica	tions; Protocols
and S	Standards	s, Standard Organization, Line Configuration – Point to Point, Multi Po	int; Topology –
Mesh	n, Star, 7	Tree, Bus, Ring, Hybrid; Transmission mode, Categories of Network	K – LAN, MAN,
WAN	N, Inter M	Networks.	
UNI	T-II	OSI AND TCP/IP MODEL	9 Hours
ISO o	organiza	tion, The model – Layered architecture, functions of the layers -Physica	al layer, Data Link
layer	, Networ	k layer, Transport layer, session layer, Presentation layer, Application	layer. The TCP/IP
refere	ence mo	del, comparison of TCP/IP & OSI, Introduction to Internet – ARPAN	JET, Architecture
of In	ternet. (Client server model, www. IP Address Classes, Protocols; IP, HTTP,	TCP. FTP. ARP.
-		,	
UNI	T-III	DIGITAL MODULATION TECHNIOUES	9 Hours
Dhase	a shift K	aving techniques using coherent detection: generation detection and	error probabilities
of Bl	DSK and	OPSK Mary DSK M ary OAM Frequency shift keying technique	enter probabilities
dataa	tion: D	ESK generation detection and error probability. Spread Spectrum	Communication
Susta	\mathbf{D}	rsk generation, detection and error probability. Spread Spectrum	d Speatrum
Syste	enis - D	neet sequence spread spectrum systems, Frequency hopped sprea	u spectrum.
UNI	T-IV	INFORMATION THEORY	9 Hours
Infor	mation-t	heoretic limits and Channel Coding, The capacity of AWGN Chann	el: modelling and
geom	netry, Sł	nannon theory basics: entropy, mutual information, and divergence	, channel coding
theor	em, the	capacity of standard constellations, parallel Gaussian channels and wat	er filling Channel
codes	s: Binar	y convolutional codes, Turbo codes and iterative coding, LDPC of	codes, bandwidth-
effici	ient code	ed modulation.	
UNI	Г-V	WIRELESS DIGITAL MODULATION	9 Hours
Wire	less Dig	ital Modulation Physical modelling for wireless channels, Fading and	l diversity, OFDM,
CDM	IA, MIŇ	IO- linear array, Beam-steering, MIMO-OFDM, Spatial Multiplexing,	Space-time coding.
		Total Hours	45 Hours
Text	Book(s)		
1.	Behrou	z A. Forouzan, Data Communications And Networking, Mc Graw Hil	l, 2017.
2.	Upama	nyu Madhow, Fundamentals of Digital Communication, Cambridge	University Press,
	2012		,
3	Saniav	Sharma, Communication Systems (Analog and Digital), SK Kataria So	ons. 2013.
Refe	rence B	ook(s)	,
1.	B. P. L	athi, Modern Digital and Analog Communication Systems, Oxford.	
2.	J.R.B	arry, E. A. Lee, and D. G. Messerschmitt, Digital Communication	n, Kluwer
	Academ	nic Publishers, 2004.	



Course	e Code				A 1	EA	TM									
Course	Name		ADVA	ANCE	D WI	[REL]	ESS	3	0	0	3	3 4	0	60	100	
			СОМ	MUN	ICAT	ION										
Course	e Categ	ory	PROF	ESSI	DNAL	,			Syll	abus	Revisi	ion		V.1	.0	
			SPEC	IALIZ	ED C	OURS	SE									
Pre-ree	quisite		Wirel	ess C	ommu	inicati	ion Te	echnic	lues							
Course	e Objec	tives:														
The cou	urse sho	ould er	hable t	he stu	dents											
1.	To unc	lerstar	nding o	of the	capaci	ity lim	itatior	ns of v	vireles	s chai	nnels.					
2.	To Exp	plore t	he pri	nciple	s of M	IMO	systen	ıs.								
3.	To Ana	lyse tl	he cap	acity o	of MIN	MO sy	stems	under	diffe	rent cl	nannel	cond	itions	•		
4.	To Stu	dy rad	lio wa	ve pro	pagati	on an	d its e	ffects	on wi	reless	comm	nunica	tion.			
5.	To Inve	estigat	e diffe	erent s	pace-t	ime co	oding	techni	ques.							
Course	e Outco	mes:														
On con	npletion	of the	e cours	se, the	stude	nt will	l be ab	ole to								
Cour	se					De	script	ion						High	nest	
Outcor	nes													Bloo	m's	
		Тахо													omy	
CO1	A	nalyz	e chan	nel ca	pacity	of wi	ireless	chan	nels.					K.	3	
CO2	A	nalyse	e MIN	IO sys	stem.									K3		
CO3	A	apply t	the pri	nciple	s of N	/IMO	system	ms to	enhan	ce the	capa	city ar	nd	K	4	
	re	eliabili	ity of v	wirele	ss con	nmuni	cation									
CO4	U	Inderst	tand th	ne prir	nciples	s of rad	dio wa	we pr	opaga	tion.				K	2	
CO5	D	Design	and d	ecodir	ng of v	various	s space	e-time	codir	ig tech	nnique	s.		K	5	
Correl	ation b	etwee	n Cou	rse O	utcon	nes (C	Os) a	nd Pr	ogran	n Out	comes	s (POs	5):			
													I	Progra	ım	
				Du	ognon	a Out	00m 00		.)				S	pecifi	c	
				Pr	ogran		comes		<i>s</i>)				C	outcon	nes	
COs														(PSO	s)	
	PO1	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PS	PS	PS	
		2	3	4	5	6	7	8	9	10	11	12	0	02	03	
													1			
CO1	М	L	L	-	-	-	-	-	-	-	-	-	L	-	-	
CO2	М	L	L	-	Μ	-	-	-	-	-	-	-	-	L	-	
CO3	S	М	М	-	Μ	-	-	-	-	-	-	-	Μ	-	-	
CO4	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO5	L	Μ	М	S	S	-	S L -									



UNI	T-I	CAPACITY OF WIRELESS CHANNELS	9 Hours
The	crowded s	spectrum, need for high data rate, MIMO systems - Array Gain, Div	versity Gain,
Data	Pipes, Sp	atial MUX, MIMO System Model. MIMO System Capacity - chann	nel known at
the T	ſX, Chann	el unknown to the TX – capacity of deterministic channels, Random c	channels and
frequ	lency sele	ctive channels.	
UNI	T-II	RADIO WAVE PROPAGATION	9 Hours
Radi	o wave p	ropagation - Macroscopic fading- free space and out door, small s	scale fading
Fadi	ng measu	rements - Direct pulse measurements, spread spectrum correlati	on channel
soun	ding frequ	ency domain channel sounding, Antenna Diversity – Diversity com	bining
meth	nods.		
UNI	T-III	SPACE TIME BLOCK CODES	9 Hours
Dela	y Diversit	y scheme, Alamoti space time code - Maximum likelihood decodin	g maximum
ratio	combinin	g. Transmit diversity space time block codes for real signal const	ellation and
com	plex signal	l constellation - decoding of STBC.	
UNI	T-IV	SPACE TIME TRELLIS CODES	9 Hours
Spac	e time co	ded systems, space time code word design criteria, design of space	time T C on
slow	fading ch	annels, design of STTC on Fast Fading channels, performance anal	lysis in slow
and	fast fadin	g channels, effect of imperfect channel estimation and Antenna co	orrelation on
perfo	ormance, c	comparison of STBC & STTC.	
UNI	T-V	LAYERED SPACE TIME CODES	9 Hours
LST	transmitte	er – Horizontal and Vertical LST receiver – ML Rx, Zero forcing Rx;	MMSE Rx,
SIC	Rx, ZF V-	blast Rx- MMSE V-blast Rx, Iterative Rx - capacity of MIMO – OFI	DM systems
- cap	pacity of N	AIMO multi user systems.	
		Total Haura	45 Hours
Text	Book(s)	Total Hours	45 Hours
1.	Mohinde	r Jankiraman, "Space Time Codes and MIMO Systems", Artech Hou	se. Boston".
	London.	www.artechhouse.com, 2004.	<i>se, Besten</i> ,
2.	Paulraj	Rohit Nabar, Dhananjay Gore, "Introduction of Space Tim	e Wireless
	Commun	nication Systems", Cambridge University Press, 2003.	
Refe	erence Boo	ok(s)	
1.	David T	se and Pramod Viswanath, "Fundamentals of Wireless Comm	nunication",
2	Cambrid Sergio V	ge University Press, 2005.	
2. 3	Andro V	iterbi "Principles of Spread Spectrum Techniques" Addison Waslaw	1005
<i>J</i> .	Voltor L	when "Wireless communication over MIMO channels". John Wilder	177J.
4.	Ltd., 200	b.	



Course	e Cod	e						L	Т	P) (L	A	EA	TM		
Course	e Nam	e	WIRI	ELES	S			0	0	2	2 2	2 4	0	60	100		
			COM	MUN	ICAT	ION											
			LAB(DRAT	ORY												
Course	9		PROF	ESSI	DNAL		~		Syll	abus	Revis	ion		V .:	1.0		
Catego	ory		SPEC	IALIZ	ZED C	OUR	SE										
Pre-re	quisit	e	Digita	l Con	imuni	cation											
Course	e Obje		s:	.1	c		c	1			<i>.</i> .						
1.	To st	udy &	t meas	ure th	e peri	orman	ice of	digital		nunic	ation	systen	18.				
2. 3	To su	uay u wida	e prac	ucal a	know	s of Da ladge	of Wi	ia sysi	Com	sign.	ation						
3. 4	To de	esion :	a con	nduct	exper	iment	s for	dioital	com	nunic	ation.						
	10 40	51511		muuet	exper	mont	5, 101	uigitu	com	nume	ation.						
Course	e Outo	comes	:														
On con	npletio	on of	the co	urse, t	he stu	dent w	vill be	able t	0								
Cours	e					De	script	tion						Hig	hest		
Outco	m													Bloc	m's		
es														Taxonomy			
C01	G	enera	te and	detec	t digit	al con	nmuni	cation	signa	ls				K4			
CO2	E	Evaluate cellular mobile communication technology and													K4		
	pi	propagation mode.															
CO3	A	pply	mathe	matica	al form	nulatio	on to	analys	e spec	ctrum	estim	ation	of	K	3		
<u> </u>	a A	signa	l.	norfor	monor		atimia	otion	alacri	thma	for ag	uolizi	na	V	5		
004	A th	narys e cha	nnel o	r nois	e/echc	cance	ellatio	alloll	aigon	unns	lor eq	uanzi	ng	N	.5		
C05		esion	svnc	hroniz	ation	algoi	rithm	for	Digita		mmiir	nicatio	m	K	5		
005	S	/stem	5yne. 5.	monnz	auton	uigoi		101	Digita		iiiiiui	neun	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	13			
Correl	ation	betw	een C	ourse	Outco	omes	(COs)	and]	Progr	am O	utcon	nes (P	Os):				
														Progr	am		
				р	raara	m Au	teom	ng (P (e)				S	Specifi	ic		
				I	rugra	in Ou	com		5)				(Dutco	mes		
COs													Da	(PSO	s)		
	РО	P	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PS	PS	PS		
	1	02	3	4	5	6	7	8	9	10	11	12	0	02	03		
													1				
CO1	S	S	-	-	S	-	-	-	S	S	Μ	Μ	L	L	-		
CO2	S	S	L	Μ	S	-	-	-	S	S	Μ	Μ	-	L	-		
CO3	S	S	Μ	Μ	S	-	-	-	S	S	Μ	Μ	L	-	-		
CO4	S	S	Μ	Μ	S	Μ	Μ	L	S	S	Μ	Μ	-	L	М		
CO5	S	S	L	Μ	S	L	Μ	L	S	S	Μ	Μ	Μ	Μ	Μ		



	LIST OF EXPERIMENTS
1.	Communication link simulation
2.	Pseudo random binary sequence generation Baseband DSSS
3.	Performance analysis of simulated CDMA system
4.	OFDM design
5.	Channel equalizer design
6.	Design and Analysis of Spectrum Estimators
7.	BER performance Analysis of M-ary digital Modulation Techniques
8.	Noise / Echo cancellation
9.	Study of synchronization
10.	Wireless channel characterization.
Tools : N	MATLAB, LABVIEW



Course	Cod	e			I) (C I	A	EA	TM						
Course	Nam	ie	WIRF	ELES	S BRO	DADB	AND	3	0	()	3 4	-0	60	100	
			NETV	VORI	KS											
Course			PROF	FSSI	<u>DNAI</u>				Svll	ahus	Revis	ion		V	1.0	
Catego	rv		SPEC	IALIZ	ZED C	OURS	SE		byn	abus		IUII		••	1.0	
Pre-ree	- J auisit	e	Comp	uter N	letwor	ks. W	ireless	s Com	munic	cation			l			
Course	e Obje	ectives:	1			,										
The cou	urse sl	hould e	nable	the stu	udents											
1.	To le	arn the	basic	archit	ecture	of a n	next g	enerat	ion ne	twork	(NGI	N) wit	h ref	erence	e.	
2.	To ur	nderstar	nd nex	t gene	eration	netwo	ork se	rvices								
3.	To le	arn the	e role	of P]	Multir	nedia	Sub-S	System	n (IMS	S), ne	twork	attac	hmer	nt and		
	admis	ssion co	ontrol	functi	ons.											
4.	To le	arn and	d com	pare 1	the va	rious	metho	ods of	provi	iding	conne	ction-	orier	nted se	ervices	
	over	NGN.														
G	0 (
Course	e Oute	comes:		no th	o atud	ont mil	11 ha a	bla to								
Cour			Description Highest													
Outoor	se					Des	script	1011						Bloor	nest n's	
Outcol	nes															
CO1	1	Underst	and th		lution	of wir	reless	netwo	orks					1 a.v.	110111y 72	
CO2		Analyze	e the r	protoc	ols use	ed in w	vireles	s netv	vorks.					K	3	
CO3	1	Evaluat	e the	featur	es an	d com	poner	nts of	4G a	nd be	vond	wirele	ess	K	<u> </u>	
000	1	network	KS.	ieutui	us un	u v om	poner		10 4	na oc	<i>j</i> ona			-		
CO4		Analyze	e the I	LTE-A	techi	nology	and r	networ	k arcl	nitectu	ire.			k	K 3	
CO5		Analyze	e layer	r-level	funct	ions ir	n wire	less n	etworl	ks.				k	K 3	
		`														
Correl	ation	betwee	en Co	urse (Jutco	mes (C	COs) a	and P	rogra	m Ou	tcom	es (PC) s):			
														Progr	am	
				Pı	norai	n Out	come	s (PO	c)				5	Specif	ïc	
					051 01	n Out	come	5 (I O	3)					Outco	mes	
COs							DO							(PSC)s)	
	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PS	PS	PS	
	1	2	3	4	5	6	7	8	9	10	11	12	0	02	03	
													1			
CO1	Μ	-	-	-	-	-	-	-	-	-	-	-	L	-	-	
CO2	S	М	-	L	Μ	-	-	-	-	-	-	-	-	Μ	-	
CO3	S	-	Μ	L	-	-	-	-	-	-	-	-	L	M	-	
CO4	S	-	Μ	-	Μ	-	_	-	_	-	-	-	-	-	-	
CO5	S	-	Μ	Μ	-	-	-	-	-	-	-	-	-	-	-	
												-	-			



TINTE			
UNI	Г-І	EVOLUTION OF WIRELESS NETWORKS	9 Hours
Revi	ew of ce	llular standards, migration and advancement of GSM architecture a	and CDMA
arch	itecture, V	WLAN – IEEE 802.11and HIPERLAN, Bluetooth.	
UNI	Г-II	WIRELESS PROTOCOLS	9 Hours
Mob	ile netwo	rk layer- Fundamentals of Mobile IP, data forwarding procedures in	mobile IP,
IPv4	, IPv6, IP	mobility management, IP addressing - DHCP, Mobile transport layer	-Traditional
TCP,	, congesti	on control, slow start, fast recovery/fast retransmission, classical TCP)
impr	ovements	- Indirect TCP, snooping TCP, Mobile TCP.	
UNI	Г-III	3G EVOLUTIONS	9 Hours
IMT-	-2000 - W	V-CDMA, CDMA 2000 - radio & network components, network struct	ure, packet-
data	transpor	t process flow, Channel Allocation, core network, interference	e-mitigation
techr	niques, U	MTS-services, air interface, network architecture of 3GPP, UTRAN -	-
archi	tecture, H	ligh Speed Packet Data-HSDPA, HSUPA.	
UNI	Г-IV	4G AND BEYOND	9 Hours
Intro	duction t	o LTE-A - Requirements and Challenges, network architectures -	– EPC, E-
UTR	AN archi	tecture - mobility management, resource management, services, chan	nel -logical
and	transport	channel mapping, downlink/uplink data transfer, MAC control elements	ment, PDU
pack	et formats	s, scheduling services, random access procedure.	
UNI	Γ-V		
		LAYER-LEVEL FUNCTIONS	9 Hours
Char	acteristics	LAYER-LEVEL FUNCTIONS s of wireless channels - downlink physical layer, uplink physical la	9 Hours ayer, MAC
Char scher	acteristics ne - fran	LAYER-LEVEL FUNCTIONS s of wireless channels - downlink physical layer, uplink physical late structure, resource structure, mapping, synchronization, reference	9 Hours ayer, MAC signals and
Char scher chan	acteristics me - fran nel estima	LAYER-LEVEL FUNCTIONS s of wireless channels - downlink physical layer, uplink physical late structure, resource structure, mapping, synchronization, reference ation, SC-FDMA, interference cancellation –CoMP, Carrier aggregation	9 Hours ayer, MAC signals and on,
Char scher chan Servi	acteristics me - fran nel estima ices - mul	LAYER-LEVEL FUNCTIONS s of wireless channels - downlink physical layer, uplink physical late structure, resource structure, mapping, synchronization, reference ation, SC-FDMA, interference cancellation –CoMP, Carrier aggregation timedia broadcast/multicast, location-based services.	9 Hours ayer, MAC signals and on,
Char scher chan Servi	acteristics me - fran nel estima ices - mul	LAYER-LEVEL FUNCTIONS s of wireless channels - downlink physical layer, uplink physical late structure, resource structure, mapping, synchronization, reference ation, SC-FDMA, interference cancellation –CoMP, Carrier aggregation timedia broadcast/multicast, location-based services.	9 Hours ayer, MAC signals and on,
Char scher chan Servi	acteristics me - fran nel estima ices - mul	LAYER-LEVEL FUNCTIONS s of wireless channels - downlink physical layer, uplink physical la ne structure, resource structure, mapping, synchronization, reference ation, SC-FDMA, interference cancellation –CoMP, Carrier aggregation timedia broadcast/multicast, location-based services. Total Hours	9 Hours ayer, MAC signals and on, 45 Hours
Char scher chan Servi	acteristics me - fran nel estima ices - mul Book(s)	LAYER-LEVEL FUNCTIONS s of wireless channels - downlink physical layer, uplink physical la ne structure, resource structure, mapping, synchronization, reference ation, SC-FDMA, interference cancellation –CoMP, Carrier aggregation timedia broadcast/multicast, location-based services. Total Hours	9 Hours ayer, MAC signals and on, 45 Hours
Char scher chan Servi	acteristics me - fran nel estima ices - mul Book(s) KavehPa	LAYER-LEVEL FUNCTIONS a of wireless channels - downlink physical layer, uplink physical layer be structure, resource structure, mapping, synchronization, reference ation, SC-FDMA, interference cancellation –CoMP, Carrier aggregation timedia broadcast/multicast, location-based services. Total Hours ahlavan, "Principles of wireless networks", Prentice-Hall of India, 200	9 Hours ayer, MAC signals and on, 45 Hours 8.
Char scher Servi Text 1. 2.	acteristics me - fran nel estima ices - mul ices - mul Book(s) KavehPa Vijay K	LAYER-LEVEL FUNCTIONS a of wireless channels - downlink physical layer, uplink physical layer and the structure, resource structure, mapping, synchronization, reference ation, SC-FDMA, interference cancellation –CoMP, Carrier aggregation timedia broadcast/multicast, location-based services. Total Hours ahlavan, "Principles of wireless networks", Prentice-Hall of India, 200 .Garg, "Wireless Network Evolution- 2G & 3G" Pearson, 2013.	9 Hours ayer, MAC signals and on, 45 Hours 8.
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Char scher Chan Servi Text 1. 2. Refe 1.	acteristics me - fran nel estima ices - mul Book(s) KavehPa Vijay K rence Bo Clint Sr Hill, 200	LAYER-LEVEL FUNCTIONS s of wireless channels - downlink physical layer, uplink physical layer the structure, resource structure, mapping, synchronization, reference ation, SC-FDMA, interference cancellation –CoMP, Carrier aggregation timedia broadcast/multicast, location-based services. Total Hours ahlavan, "Principles of wireless networks", Prentice-Hall of India, 200 .Garg, "Wireless Network Evolution- 2G & 3G" Pearson, 2013. ok(s) nith,P.E, Dannel Collins, "3G Wireless Networks" 2nd edition, Tata 08.	 9 Hours ayer, MAC signals and on, 45 Hours 8. 8.
Char scher Servi Text 1. 2. Refe 1. 2.	acteristics me - fran nel estima ices - mul Book(s) KavehP Vijay K rence Bo Clint Sr Hill, 200 JochenH	LAYER-LEVEL FUNCTIONS s of wireless channels - downlink physical layer, uplink physical late the structure, resource structure, mapping, synchronization, reference ation, SC-FDMA, interference cancellation –CoMP, Carrier aggregation timedia broadcast/multicast, location-based services. Total Hours ahlavan, "Principles of wireless networks", Prentice-Hall of India, 200 Garg, "Wireless Network Evolution- 2G & 3G" Pearson, 2013. ok(s) nith,P.E, Dannel Collins, "3G Wireless Networks" 2nd edition, Tata 08. I.Schiller, "Mobile Communications", 2/e, Pearson, 2014.	 9 Hours ayer, MAC signals and on, 45 Hours 8. 8. a McGraw-
Char scher Servi Text 1. 2. Refe 1. 2. 3.	acteristics me - fran nel estima ices - mul Book(s) KavehPa Vijay K rence Bo Clint Sr Hill, 200 JochenH Sassan	LAYER-LEVEL FUNCTIONS s of wireless channels - downlink physical layer, uplink physical layer the structure, resource structure, mapping, synchronization, reference ation, SC-FDMA, interference cancellation –CoMP, Carrier aggregation timedia broadcast/multicast, location-based services. Total Hours ahlavan, "Principles of wireless networks", Prentice-Hall of India, 200 .Garg, "Wireless Network Evolution- 2G & 3G" Pearson, 2013. ok(s) nith,P.E, Dannel Collins, "3G Wireless Networks" 2nd edition, Tata 08. I.Schiller, "Mobile Communications", 2/e, Pearson, 2014. Ahmadi, "LTE-Advanced – A practical systems approach to underst	 9 Hours ayer, MAC signals and on, 45 Hours 8. 8. a McGraw- tanding the



Course	Code	e						L	Т	P) (A]	EA	TM	
Course	Nam	e	5G C	OMM	UNIC	CATIO	ONS	3	0	0	3	3 4	0	60	100	
Course				ESSI					Svll	ahue	Povisi	ion		V	1.0	
Course	rv		SPEC	IALIZ	ZED C	OURS	SE		Syn	abus .	NEVISI	UII		۷.	1.0	
Pre-rec	- J quisite	e	Digita	l com	munic	ations	, Mob	ile Co	mmui	nicatio	on Sys	tems,	Wire	less		
			Netwo	orks												
Course	Obje	ectives	5:													
The cou	ırse sl	nould	enable	e the s	tudent	S			с т	a .	1					
1. 2	To un	dersta	and the	e requi	iremer	nts and	l regul	lations	$\frac{1}{5}$ for 5	G net	works					
2. 3	To Ib	umiliai ndorst	nze ru	nction	an arc	nitecti	re or	5G ne	twork	S.						
3. 4.	To an	alvse	differe	e desig	gn pri work	deploy	vment	types	in 5G	ogy.						
	10	ar) se				<u>aepro.</u>)	-JPS		•						
Course	Outo	comes	:													
On con	pletic	on of t	he cou	ırse, tl	ne stuc	dent w	ill be	able to)							
Cours	e					De	script	ion						Higl	hest	
Outco	n													Bloom's		
es CO1	I	ndara	26	Taxonomy K2												
COI	fc	for 5G. K2														
CO2	A	Analyze use of MIMO in 5G and its techniques														
CO3	U	inderst	and	devic	e to	dev	vice	(D2D) co	mmur	nicatio	n a	nd	K2		
	st	andar	dizatio	on.					,							
CO4	S	tudv tl	he in-o	lepth	functio	oning	of 5G	radio	acces	s tech	nologi	es.		K	3	
CO5	U	nderst	and in	nterfer	ence	manag	gemen	nt, mo	bility	mana	ageme	nt an	d	K	2	
	se	ecurity	' issue	s in 50	G.				•		C					
					-											
Correl	ation	betwe	en Co	ourse	Outco	omes ((COs)	and I	Progra	am Ou	utcom	es (Po	Os):			
														Progra	am	
				P	rogra	m Ou	tcome	es (PO	s)					pecili	C MOS	
COg														(PSO	s)	
COS	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PS	PS	PS	
	1	2	3	4	5	6	7	8	9	10	11	12	0	02	03	
													1			
CO1	Μ	-	-	-	-	-	-	-	-	-	-	-	L	-	-	
CO2	S	L	L	-	-	-	-	-	-	-	-	-	L	-	-	
CO3	Μ	-	-	-	-	-	-	-	-	-	-	-	-	L	-	
CO4	Μ	L		-	-	-	-	-	-	-	-	-	-	-	-	
CO5	Μ	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
1																



S CSVM1
UNIT-I5G BROADBAND WIRELESS COMMUNICATIONS9 Hours
. An Overview of 5G requirements, Regulations for 5G, Spectrum Analysis and Sharing fo
5G. Channel modeling requirements, propagation scenarios and challenges in the 5G
modeling, Channel Models for mmWave MIMO Systems.
UNIT-IITHE 5G ARCHITECTURE9 Hours
Introduction, NFV and SDN, Basics about RAN architecture, High-level requirements for the
5G architecture, Functional architecture and 5G flexibility, Functional split criteria, Functional
split alternatives, Functional optimization for specific applications, Integration of LTE and
new air interface to fulfill 5G Requirements, Enhanced Multi-RAT coordination features,
Physical architecture and 5G deployment.
UNIT-IIIDEVICE-TO-DEVICE (D2D) COMMUNICATIONS9 Hours
D2D: from 4G to 5G, D2D standardization: 4G LTE D2D, D2D in 5G: research challenges
Radio resource management for mobile broadband D2D, RRM techniques for mobile
broadband D2D, RRM and system design for D2D, 5G D2D RRM concept: an example, Multi-
hop D2D communications for proximity and emergency, services, National security and public
safety requirements in 3GPP and METIS, Device discovery without and with network
assistance.
UNIT-IV 5G RADIO-ACCESS TECHNOLOGIES 9 Hours
Access design principles for multi-user communications, Orthogonal multiple-access systems
Spread spectrum multiple-access systems, Capacity limits of multiple-access methods, Sparse
code multiple access (SCMA), Interleave division multiple access (IDMA), Radio access for
dense deployments, OFDM numerology for small-cell deployments, Small-cell sub-frame
structure, Radio access for V2X communication, Medium access control for nodes on the
move, Radio access for massive machine-type communication.
UNIT-V INTERFERENCE MANAGEMENT, MOBILITY 9 Hours
MANAGEMENT, AND SECURITY FOR 5G
Network deployment types, Ultra-dense network or densification, Moving networks
Heterogeneous networks, Interference management in 5G, Interference management in UDN
Interference management for moving relay nodes, Interference cancelation, mobility
management in 5G, User equipment-controlled versus network-controlled handover, Mobility
management in heterogeneous 5G networks.
Total Hours 45 Hours
1 ext BOOK(S)
Patrick Marsch Second Edition 2011
2 5G NR: The Next Generation Wireless Access Technology Erik Dahlman Stafan

Parkvall, Johan Sko¹d, Elsevier, First Edition, 2016.



3.	Fundamentals of 5G Mobile Networks, Jonathan Rodriguez, Wiley, First Edition, 2010
Refe	rence Book(s)
1.	Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock
	"Millimeter Wave Wireless Communications", Prentice Hall Communications.
2.	Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, "New
	Directions in Wireless Communication Systems from Mobile to 5G", CRC Press.
3.	Amitabha Ghosh and RapeepatRatasuk "Essentials of LTE and LTE-A", Cambridge
	University Press.



Course C	ode		L	Τ	Р	C	IA	E A	TM						
Course N	ame	5G COMMUNICATION	0	0	2	2	40	6	100						
		LABORATORY						0							
Course		PROFESSIONAL		Sylla	bus Re	visio	1	V.1.0							
Category		SPECIALIZED COURSE													
Pre-requi	site	5G Communication													
Course O	Course Objectives:														
The course	The course should enable the students														
1. To	1. To Understand the working of cellular networks.														
2. To	o analys	e the performance of LTE netwo	ork.												
3. To	3. To analyse the performance of 5G communication.														
4. To	design	and analyse 5G waveform gener	ration.												
Course O	utcome	S:													
On comple	etion of	the course, the student will be a	ble to												
Course		Descript	ion					Highest							
Outcom								Blo	om's						
es								Ta	xonomy						
CO1	Design	n and analysis of cellular networ	k.						K4						
CO2	Design	n and analyse the 5G network.							K4						
CO3	Under	stand the fundamentals of ra	ay tra	cing	as a	simul	ation		K3						
	techni	que for analysing communicatio	n link	s in 50	3 netwo	orks.									
CO4	Evalua	ate the performance and capabili	ties of	f WLA	N tech	nolog	ies in		K5						
	the co	ntext of 5G.													
CO5	Design	n and optimize beamforming a	lgoritł	nms ar	nd con	figura	tions		K5						
	for 5C	systems.													



Correlation between Course Outcomes (COs) and Program Outcomes (POs):																	
COs				Р	rogra	m Ou	tcome	es (PC) (s)				Program Specific Outcomes (PSOs)				
	РО	P	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PS	PS	PS		
	1	02	3	4	5	6	7	8	9	10	11	12	0	02	03		
													1				
CO1	S	S	-	-	S	-	-	-	S	S	Μ	Μ	-	L	-		
CO2	S	S	L	Μ	S	-	-	-	S	S	Μ	Μ	-	L	-		
CO3	S	S	Μ	Μ	S	-	-	-	S	S	Μ	Μ	L	-	-		
CO4	S	S	Μ	Μ	S	L	Μ	-	S	S	Μ	Μ	-	L	-		
CO5	S S L M S L M - S S M M M M M																
					LIS	ST OF	F EXP	ERIN	IENT	S							
1.	Call	establ	ishme	nt in o	cellula	r netw	vork.										
2.	Hand	lover	in cell	lular n	etwor	k.											
3.	Thro cond	ughpu itions	it perf , traffi	ormar	ice for files in	vario LTE	ous tern netwo	rain m ork.	odels,	trans	missic	on moo	des, lo	oading	,		
4.	5G C	Comm	unicat	tions I	Link A	nalysi	is with	n Ray	Tracin	ıg.							
5.	Wire	less C	Connec	ctivity	in the	5G E	ra for	WLA	N.	C							
6.	MIM	O Wi	reless	Syste	m Des	sign fo	or 5G.										
7.	5G V	Vavef	orms	- genera	tion.	U											
8.	5G B	Beamf	ormin	g Des	ign.												
9.	Fram	e Stru	icture	of 5G	techn	ology	•										
		F				- /											
Tools :	MAT	LAB															

Ζ



Course	e Cod	e						L	Т	P			A []	EA	TM			
Course	Nam	e	SMAI	RT AI	NTEN	NAS	FOR	3	0	0	3	3 4	0	60	100			
		:	5G C	OMM	UNIC	CATIC	DN											
Course	•		PROF	ESSIC	DNAL				Syll	abus	Revisi	ion		V.	1.0			
Catego	ry		SPEC.	IALIZ	ED C	OURS	<u>SE</u>											
Pre-ree	quisit	e	Electr	omagr	netic F	field I	heory	, Ante	nna a	nd Wa	ive Pr	opaga	tion					
Course	e Obje	ectives	5 : 1. 1 -	41		_												
	To U	ndorati	enable	e the s	lamon	S tala of	amort	onton	200 01	nd tha	ir arak	itaatu	ro					
1.	To et	udv th	anu ui 9 diffe	e Iulio	mart a	ntenn	sillari	iourati	lias a	ia the		mectu	ie.					
2.	To an	uuy m alvse	variou	is Ano	le of a	arrival	estim	ation	metho	ds								
4.	To an	nalvse	the M	IIMO	and m	mWa	ve ante	enna d	lesign	reauii	remen	ts for	5G					
	comn	nunica	tion.		una m	iii v u	ve une			requi	emen							
Course	e Outo	comes	:															
On con	npletio	on of t	he cou	ırse, tł	ne stuc	lent w	vill be	able to)									
Cours	e					De	script	ion						Highest				
Outcon	nes													Bloom's				
001							1							Taxo	nomy			
COL	T	To Familiarize with smart and adaptive antennas.													2			
CO2	A	pply c	liffere	nt ada	ptive :	algorit	thms t	or 5G	anten	$\frac{na.}{1}$	1	1	6	<u>K3</u>				
CO3	U	nderst	andin	g the	conce	pt of	direc	tion of	of arr	ival a	and an	igle c	of	K2				
<u>CO4</u>		rival.	ofort			malaita	ot	to ma	at 5C			4		T/	- 1			
C04		vesign	$\frac{01 \text{ and}}{\text{milling}}$	enna a	uray a		unicat	to me		requi	remen	ι.		N	.4 `2			
005		iscuss	11111111	netei	wave	comm	lumca	.1011.						N	3			
Correl	ation	hetwe	en Co	mrse	Outco	mes (COs)	and F	Progra	m Oi	itcom	es (PC)s):					
		beene		Juise	outeo		(005)	unu I	1051		atcom		1	Progr	am			
				_		-		-					S	bpecif	ic			
				P	rogra	m Ou	tcome	s (PO	s)				Č	Jutco	mes			
COs														(PSC	s)			
005	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PS	PS	PS			
	1	2	3	4	5	6	7	8	9	10	11	12	0	02	03			
													1					
CO1	S	L	L	-	-	-	-	-	-	-	-	-	L	-	-			
CO2	S	М	М	L	М	-	-	_	-	_	-	-	-	-	-			
CO3	Μ	L	L	-	-	-	-	-	-	-	-	-	Μ	-	-			
CO4	S	S	S	Μ	М	-	-	-	-	_	-	-	-	Μ	-			
CO5	Μ	L	L	-	L	-	-	-	-	-	-	-	-	Μ	L			
	1																	



UNIT	-I	INTRODUCTION TO SMART ANTENNA	9 Hours
Intro	duction	to Smart Antennas, Architecture of a Smart Antenna System: Trans	smitter and
Recei	ver, Ty	pes of Smart Antennas, Benefits and Drawbacks of Smart Antennas, A	pplications
of Sm	nart Ant	ennas.	
			<u>.</u>
UNIT	-II	SMART ANTENNA CONFIGURATIONS	9 Hours
Fixed	Sidelo	be Cancelling, Retrodirective Arrays, Beamforming, Adaptive Arr	ays, Butler
Matri	x, Spati	al Filtering with Beamformers, Switched Beam Systems, Multiple F	Fixed Beam
Syster	m. Up	link Processing, Diversity Techniques, Angle Diversity, Maxin	num Ratio
Comb	oining,	Adaptive Beamforming, Fixed Multiple Beams versus Adaptive Bea	amforming,
Down	nlink Pr	ocessing.	
			T
UNIT	-III	ANGLE-OF-ARRIVAL ESTIMATION	9 Hours
Funda	amental	s of Matrix Algebra, Array Correlation Matrix, AOA Estimation	Methods:
Bartle	ett AOA	A Estimate, Capon AOA Estimate, Linear Prediction AOA Estimate,	, Maximum
Entro	py AOA	A Estimate, Pisarenko Harmonic Decomposition AOA Estimate, Min-N	Norm AOA
Estim	ate, MU	JSIC AOA Estimate, ESPRIT AOA Estimate.	
UNII	'-IV	MIMO ANTENNAS	9 Hours
Introd	luction,	Multiple-Antenna MS Design, RAKE Receiver Size, Mutual Coupli	ing Effects,
Dual-	Antenn	a Performance Improvements, Downlink Capacity Gains, Principles	of MIMO
syster	ns: SIS	O, SIMO, MISO, MIMO, Hybrid antenna array for mm Wave massi	ve MIMO:
Massi	ive Hyb	rid Array Architectures, Hardware Design for Analog Subarray.	
TINIT	X 7		0.11
UNII	L - V	mm waves	9 Hours
Millin Commission	neter-w	ave Communications – spectrum regulations, deployment scenar	10s, beam-
Tormi	ng, pny	sical layer techniques, interference and mobility management, Mass	sive MIMO
propa	gation	L Multi Call Massive MIMO, Dilat Cantomination, Spatial Mathematic	IIMO with
Imper	riect CS	n, Multi-Cell Massive MIMO, Phot Contamination, Spatial Modulation	1 (SM).
		Total Harra	45 Houng
Tovt	Rook(e)	1 otal Hours	45 Hours
1	Ahmed	El Zooghby Smart Antenna Engineering" ARTECH HOUSE INC	2005
2.	Frank 1	B. Gross, "Smart antenna with MATLAB", 2nd Edition, McGraw-Hill.	2005.
3.	Lal Ch	and Godara . "SMART ANTENNAS" . CRC PR ESS. 2004.	
Refer	ence B	ook(s)	
1.	Shahid	Mumtaz, Jonathan Rodriguez, Linglong Dai mmWave Massive I	MIMO: A
	Paradig	gm for 5G.	





CURRICULUM & SYLLABUS

For B.E. (Hons.) Electronics and Communication Engineering with

Specialization inVLSI DESIGN

S.N o	Year	Sem	Cour se Code	Course Name	L	Т	Р	С	IA	EA	TM
1	Π	IV		ANALOG AND DIGITAL IC DESIGN	2	1	0	3	40	60	100
2	III	V		MIXED-SIGNAL AND ARCHITECTURE DESIGN	2	1	0	3	40	60	100
3	III	VI		VLSI SIGNAL PROCESSING	2	1	0	3	40	60	100
4	III	VI		VLSI SIGNAL PROCESSING LABORATORY	0	0	2	2	40	60	100
5	IV	VII		MACHINE LEARNING IN VLSI	2	1	0	3	40	60	100
6	IV	VIII		DEVELOPMENT OF MACHINE LEARNING ALGORITHMS IN VLSI	0	0	2	4	40	60	100
		18									



Course	e Cod	e						L	Т	F		C	IA EA TM							
Course	e Nan	ne	ANAI	LOG	AND	DIGI	TAL	3	0	C)	3	40	60	100					
			IC DI	ESIGN	N															
Course	e		PROF	ESSI	ONAL	,			Syll	abus	Revi	ision		V	.1.0					
Catego	ory		SPEC	IALIZ	ZED C	OUR	SE													
Pre-ree	quisit	e	Digita	l Syst	em De	esign,	Micro	proces	ssor &	Mic	ocor	ntrolle	ers							
Course	e Obj	ectives	5:																	
The co	urse s	hould	enable	e the s	tudent	S														
1.	To le	arn co	mbina	tional	and s	equen	tial cir	cuits i	in CM	OS de	esigr	1.								
2.	To le	arn an	d desi	gn usi	ng PL	Ds.	1		• •	лла	т 1.									
3. 4		ndersta	and the $C \wedge d$	e basic	CS OI V	arious	s anaio	g circ	uits in	VLS	I des	sign.								
4.	10 16	alli ff	'UA u	esign	now.															
Course	Out	00000	•																	
On con	mpletion of the course, the student will be able to The provide the provide the student will be able to The provide the provide the student will be able to The provide the provide the student will be able to The provide the provide the student will be able to The provide the provide the student will be able to The provide the provide the student will be able to The provide the provide the student will be able to The provide the providet the provide the p																			
Cours	e					De	script	ion						Hi	ghest					
Outco	m														om's					
es														Tax	onomy					
CO1	I in	Design of the combinational and sequential building blocks used K3 indigital CMOS VLSI circuits.													K3					
CO2	A	Analyze and Implement the simple design with PLDs. K3													K3					
CO3	U	Inderst	tand t	he sig	nifica	nce of	f diffe	rent a	nalog	devie	ces a	and a	pply		K3					
	t	hem ap	otly fo	r diffe	erent c	ircuits	5.		-											
CO4	Ι	Design	all ba	isic bi	uilding	g bloc	ks like	e sour	ces, si	nks, 1	mirro	ors, u	p to	•	K3					
	1	ayout l	evel.																	
CO5	U	Inders	tand F	PGA	design	flow.									K2					
Correl	ation	betwe	en Co	ourse	Outco	omes ((COs)	and F	Progra	m O	utco	mes (POs)	:						
														Prog	am					
				Dr	oaron	n Aut	comos		.				:	Specif	ïc					
				11	Ugi al		comes	(I Os	9				(Outco	mes					
COs		T	[I	I									(PSC)s)					
	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	P	PO	PSC) PS	PSO3					
	I	2	3	4	5	6	7	8	9	10	0	12	1	02						
CO1	м	T	М								11		м	м						
	M		M	-	-	-	-	-	-	-	-	-			-					
CO2	M	L	M	M	-	-	-	-	-	-	-	-	M	M	-					
CO3	M	L	M	M	-	-	-	-	-	-	-	-	M	M	-					
CO4	M	L	M	M	-	-	-	-	-	-	-	-	M	S	-					
CO5	-	L	Μ	Μ	-	-	-	-	-	-		-	Μ	S	-					



UNI	Г-І	COMBINATIONAL AND SEQUENTIAL LOGIC CIRCUITS	9 Hours								
Dyna	mic Log	ic Gates, Pass Transistor Logic, Power Dissipation, Static Latches and	l Registers,								
Dyna	mic Late	hes and Registers.									
UNI	T-II	DESIGN EXAMPLES USING PLDs	9 Hours								
Desi	gn of Un	iversal block, Memory, Floating point, multiplier, Barrel shifter.									
UNI	T-III	INTRODUCTION TO FPGAs	9 Hours								
Evol	ution of	programmable devices, FPGA Design flow, Applications of FPGA.									
UNI	T-IV	MOS DEVICES	9 Hours								
MOS	5 FET d	evice I/V characteristics, second order effects, Capacitances, body	bias effect,								
Biasi	Biasing Styles, MOS small signal Model, NMOS verses PMOS devices.										
UNI	T-V	CURRENT MIRROR CIRCUITS	9 Hours								
Basi	e buildir	g blocks and basic cells-Switches, active resistors, Current sources	and								
sinks	,Current	mirrors: Basic current mirror, cascode current mirror, low voltage cu	irrent								
mirro	or,Wilson	n and Widlar current mirrors, voltage and current references.									
		Total Hours	45 Hours								
Text	Book(s))	1								
1.	Pr Gray	and Rg Meyer, Analysis and Design of Analog Integrated Circuits, 5 ^t	ⁿ Edition,								
	Wiley,	2009.									
2.	Design	of Analog CMOS Integrated Circuit, Behad Razavi McGraw Hill Edu	cation,								
	2nd Ed	ition, 2017.									
Refe	eference Book(s)										
1.	John V. Old Field, Richrad C. Dorf, Field Programmable Gate Arrays, Wiley, 2008.										
2.	D.A, Patterson And J.L. Hennessy, Computer Organization and Design: Hardware										
	/Softwa	re Interface, 4th Edition, Elsevier, 2011.									
3.	Geiger,	Allen and Stradder, VLSI Design Techniques for Analog and Digital	Circuits,								
	Tata M	cGraw-Hill Education, 2010.									



								L	Т	P		C	IA	EA	ТМ		
Course	Code							_	_	_		J					
Course	Nam	e	MIXE	ED-SI	GNAI	L AN	D	3	0	0)	3	40	60	100		
			ARCI	HITE	CTUR	RE											
Course			DESI	GN ESSIC					Syll	obuc	Dovi	ision		I	710		
Course Categor	۰v		SPEC	IALIZ	ZED C	OUR	SE		Syn	abus	NEV	SIOII		``	.1.0		
Pre-req	uisite		Analo	g and	Digita	l IC I	Design	, Micı	oproc	essor	& N	licroc	ontro	llers			
Course	Obje	ctives	:	0	0		0	,	1								
The cou	rse sł	nould	enable	the st	tudent	S											
1. 7	Го un	dersta	ind mi	xed si	gnal s	pecifi	cation	s usin	g op-a	mp.							
2. 7	Го an	alyze	the co	mpara	ators c	ircuits	s and i	ts requ	uireme	ent in	VLS	I circ	uits.				
3. 7	Го un	dersta	and the	e basic	es of v	arious	s archi	tectur	e (RIS	C/FP	GA).						
4. 7	Го un	dersta	and the	e build	ling bl	ocks	of FPC	GA/CF	PLDs.								
0	0.4	outcomes:															
Course On com	Outc pletic	Jutcomes: letion of the course, the student will be able to															
Course		Description Highest															
Outcon	n	•															
es															Taxonomy		
CO1	D	esign	basic	cell	s like	e Op	Amp	to n	neet	the n	nixe	d sig	gnal		K4		
	sp	specifications.															
CO2	D	circuitry K4															
CO3		esign	$\frac{y}{0}$ of RI	SC are	hitect	ure ar	nd con	troller	for a	speci	fic ii	ostruc	tion		K5		
003	se	et.			meet	uic ai		uonei	101 a	speer		istiuc	uon		IX.J		
CO4	U	nderst	and	the	buildi	ng b	locks	of	comn	nercia	lly	avail	able		K2		
	F	PGA/0	CPLD	s.		<u> </u>											
CO5	D	evelop	o mod	lels a	ind sy	ynthes	size ta	argetir	ig foi	r Ver	tex,	Spar	rtan		K6		
	F	PGAs.															
Correla	tion	betwe	en Co	ourse	Outco	mes ((COs)	and I	Progra	am O	utco	mes (POs)	:			
														Prog	ram		
				Pr	noran	n Out	comes		3					Spec	ific		
GO					051 ali		come		,					Outco	omes		
COs	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO	D	DO	DS		JS		
	1	2	3	4	5	го 6	7	8	РО 9	10	r O	12	1		1505		
	-	-	C	-		Ŭ	-	Ū	-		11			0			
CO1	Μ	L	Μ	-	S		-	-	-	-		-	Μ	Μ	-		
CO2	Μ	L	Μ	Μ	S	-	-	-	_	-	-	-	Μ	Μ	-		
CO3	Μ	L	Μ	Μ	S	-	-	-	-	-	-	-	Μ	Μ	-		
CO4	Μ	L	Μ	Μ	S	-	-	-	-	_	-	-	Μ	S	-		
CO5	-	L	Μ	Μ	S	-	-	-	-	-	-	-	Μ	S	-		



UNI	T-I	OP-AMP CIRCUITS	9 Hours
Basi	c Build	ling Blocks, OpAmp, Capacitors, Switches, Non-overlapping	g Clocks,
Basi	cOperation	on and Analysis, Resistor Equivalence of a Switched Capacitor	, Parasitic-
Sens	itiveInte	grator, Parasitic-Insensitive Integrators, Signal-Flow-Graph Analysis	s, Noise in
Swit	ched-Caj	pacitor Circuit.	
UNI	T-II	A/D CONVERTERS	9 Hours
Mult	i-Bit Su	ccessive-Approximation, Algorithmic (or Cyclic) A/D Converter, Ra	tio
Inde	pendent .	Algorithmic Converter, Pipelined A/D Converters, One-Bit-Per-Stage	Pipelined
Conv	verter, 1.5	5 Bit Per Stage Pipelined Converter, Pipelined Converter Circuits.	
UNI	T-III	RISC/CISC	9 Hours
Over	view of	the features of Instruction set architectures of CISC, RISC processo	r- Building
datap	oath and	Control, multicycle implementation.	
UNI	T-IV	FPGAs/CPLDs	9 Hours
Prog	ramming	g Technologies, Commercially available FPGAs: Xilinx's Vertex and	nd Spartan,
Acte	l's FPG	A, Altera's FPGA/CPLD, Building blocks of FPGAs/CPLDs, Configu	rable Logic
bloc	k functio	nality, Routing structures, Input/outputBlock, Impact of logic block fu	unctionality
on F	PGA per	formance, Model for measuring delay.	-
UNI	T-V	CASE STUDY	9 Hours
Appl	ications	using Kintex-7, Virtex-7, Artix-7-Zynq7000 Architecture.	
		Total Hours	45 Hours
Text	Book(s)		
1.	David A	A Johns, Ken Martin: Analog IC design, Wiley 2008.	
2.	John V	. Old Field, Richrad C. Dorf, Field Programmable Gate Arrays, Wiley,	2008.
3.	D.A, P. /Softwa	atterson And J.L. Hennessy, Computer Organization and Design: are Interface, 4th Edition, Elsevier, 2011.	Hardware
Refe	rence B	ook(s)	
1.	Amano	, Hideharu, Principles and Structures of FPGAs, First Edition, Springe	r, 2018.
2.	Xilinx	Inc, Vivado Design Suite User Guide, 2021.	
3.	Data sh	neets of Artix-7, Kintex-7, Virtex-7.	



Course	e Code	e						L	Т	P		C	IA	EA	TM	
Course	e Nam	e	VLSI	SIGN	AL PR	OCESS	SING	3	0	0)	3	40	60	100	
Course	•		PROF	ESSI	DNAL	,			Syll	abus	Revi	ision		V	7.1.0	
Catego	ry	1	SPEC	IALIZ	ZED C	OURS	E									
Pre-ree	quisite	e	Digita	l Sign	al Pro	cessing	g, Mix	ked-Si	gnal a	and ar	chite	cture	e Desig	gn		
Course	e Obje	ectives	5 :													
The co	urse sl	nould	enable	the s	tudent	S	• •			1 110	01					
1.	To an	alyze	variou	is VL	SI- DS	SP algoi	rithm	s in Fl	IR and	I IIR I	filter	s.				
2.	To an	alyze	algori	thm fo	or itera	ation.	סמת	A	4 4							
5 .	To an	alyze	the clo	DCKINE	g conce orithm	epts in	DSP	Archi	tectur	es.						
4.	10 111	ipieme		or algo	Jium		201.									
Course	ourse Outcomes:															
On con	ompletion of the course, the student will be able to															
Cours	e	<u>, , , , , , , , , , , , , , , , , , , </u>			ie stat	Des	crinti	ion						Hi	ghest	
Outco	m					205								Bl	om's	
es														Tax	onomy	
CO1	A	Analyze the critical path, iteration bound using LPM and MCM K4														
	al	algorithm.														
CO2	A	Analyze Digital filters. K4														
CO3	A	Apply Retiming, Folding and Unfolding Techniques and Synthesize K4														
	sy	/stolic	arran	gemer	nts.											
CO4	A	pply (Cook	Toom	and V	Winogr	ad al	gorith	m and	d desi	gn 1	ooka	head		K4	
-	aı	nd clu	ster pi	pelini	ng.											
CO5	A	bility	to mo	dify tl	he exis	sting or	r new	DSP	archit	ecture	es su	itabl	e for		K6	
	V	LSI.														
Correl	ation	betwe	en Co	ourse	Outco	omes (C	COs)	and P	rogra	am O	utco	mes	(POs)	:		
														Prog	ram	
				Pr	ooran	n Outc	omes	(POs)					Spec	ific	
GO					051 011		omes)					Outco	omes	
COs	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO	n	DO	DC		Js)	
	PO 1	PO 2	2 PO		PO 5	PO	PO 7	PO o	PO	10 PO	P	PO	PSC		PS03	
	1	4	3	-	3	U	'	o	9	10	11	12	1	02	·	
CO1	S	М	М	S	S	-	-	-	_	_	-	-	S	S	_	
CO2	S	M	M	S	S	-	-	-	-	-	-	-	S	S	-	
CO3	S	Μ	Μ	S	S	-	-	-	-	_	-	-	S	S	-	
CO4	S	Μ	Μ	S	S	-	-	-	-	-	-	-	S	S	-	
CO5	S	Μ	М	S	S	-	-	-	-	-	-	-	S	S	-	
	•	•	•	•	•						•					



UNIT-I	INTRODUCTION TO DSP SYSTEMS	9 Hours
Introductio	n; representation of DSP algorithms: Block Diagram, signal flow graph	, data flow
graph, dep	endence graph.	
UNIT-II	ITERATION BOUND	9 Hours
Introduction	- Loop Bound and Iteration Bound - Algorithms for Computing Iteration Bou	nd: Longest
Path Matrix	and Multiple Cycle Mean algorithms - Iteration Bound of Multi-rate Data Flow	Graphs.
UNIT-III	PIPELINING AND PARALLEL PROCESSING	9 Hours
Pipelining	and parallel processing of FIR digital filters, pipeline interleaving in dig	gital filters:
signal and	multichannel interleaving.	
UNIT-IV	RETIMING, UNFOLDING AND FOLDING	9 Hours
Retiming t	echniques; algorithm for unfolding, Folding transformation, systolic a	rchitecture
design, sys	tolic array design methodology.	
UNIT-V	FAST CONVOLUTION, FILTERS AND TRANSFORMS	9 Hours
Cook-toon	algorithm, modified cook-toom algorithm, Winogard algorithm	n, iterated
convolutio	Algorithm strength reduction in filters and transforms.	
	Total Hours	45 Hours
Text Book	(s)	
1. Kesh Impl	ab k. Parhi, "VLSI Digital Signal Processing Systems: Dementation", Wiley, inter science.	esign and
Reference	Book(s)	
1. John	G. Proakis, Dimitris K Manolakis, Digital Signal Processing:	Principles,
Algo	rithms and Applications, Prentice Hall, Fourth Edition, 2015.	
2. Moh	ammed Ismail and Terri Fiez, Analog VLSI Signal and I	nformation
Proc	essing,McGraw-Hill, 2014.	



Course		5		aras					1	P	,	0		EA	1.00				
Course	e Nam	e	VLSI	SIGN	AL			0	0	2		2	40	60	100				
			PRO	CESSI	ING														
			LABO)RAT	ORY														
Course	è		PROF	ESSI	DNAL	,			Syll	abus	Revi	sion		V	.1.0				
Catego	ory		SPEC	IALIZ	ZED C	OUR	SE		-										
Pre-ree	quisite	e	Digita	l Sign	al Pro	cessin	ıg Lab	, CAS	D Lat)									
Course	e Obje	ectives	5:																
The co	urse sl	nould	enable	the s	tudent	S													
1.	To pr	ovide	design	conce	pts on	imple	ementa	tion of	f DSP	algori	thms	in FP	GA.						
2.	To pr	provide insights into design and implementation of image processing.																	
3.	To pr	provide insight on communication protocols used in FPGA domain.																	
9	0 1	Jutcomos																	
Course	e Outo	Jutcomes:																	
On con	ipieuc	letion of the course, the student will be able to													1 4				
Cours	e	Description													gnest				
Outcol																			
CO1	Δ	Ability to interface external peripherals with a programmable platform.													75				
CO2	A	Ability to design and implement DSP algorithms into FPGA													K5 K6				
CO3	A	Ability to design and implement DSF algorithms into FFGA. Ability to analyze and optimize the HDL Code from MATLAB													K4				
CO4	Ir	Interpret the ethical principles in engineering practice													<u>x</u> 3				
CO5	E	Express the Engineering activities with effective presentation and													K5				
000	re	report.																	
CO6	A	nalyse	e and	l de	velop	innc	ovative	fine	dings	with	aj	pprop	riate	K6					
	te	chnol	ogical	/ resea	urch cit	tation.					-								
		. .	~		<u> </u>														
Correl	ation	betwe	en Co	ourse	Outco	omes ((COs)	and I	rogra	am Ou	itcoi	mes (POs):						
														Progr	am				
				Pr	ogran	n Out	comes	s (POs	5)					specifi	IC				
					-									Juicol (DSC)	mes				
COs	PO	PO	PO	PO	PO	D	PO	PO	ΡΛ	ΡΛ	D	ΡΛ	DS		DSO				
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	L	2	5	4	5	00		o	9	10		14	01		5				
											I			0					
											I			2					
CO1	M	S	S	S	S	-	-	-	-	-	-	-	S	S	-				
CO2	S	S	S	S	S	_	L	_	_	_		-	S	S	-				
CO3	S	S	S	S	S	-	L	-	-	-	-	-	S	S	-				
CO4	-	-	-	-	-	-	-	S	S	М	-	Μ	-	-	S				
CO5	-	-	-	-	-	-	-	S	S	Μ	-	Μ	-	-	S				
CO6	-	-	-	-	-	-	-	S	S	М	-	Μ	-	-	S				
	1												1		1				



	LIST OF EXPERIMENTS										
1.	Implementation of sampling of input signal and display in FPGA.										
2.	Implement on DCT, FFT using FPGA.										
3.	Synthesize and implement FIR filter and IIR filter Verilog /VHDL.										
4.	Experiments on Multirate processing, Bus architectures using FPGA.										
5.	Implementation of Application Platforms in FPGA boards.										
6.	Image Processing – Image Enhancement, Edge detection.										
Too	ls										
1	MATLAB/HDL										



Course	Cod	e			•	С	IA	EA]	٢M						
Course	Nam	ie	MAC	HINE	LEA	RNIN	G IN	3	0	0)	3	40	60	1	00
			VLSI													
Course			PROF	ESSI	ΟΝΔΙ				Svll	ahue	Povi	sion			J 1 (<u>)</u>
Cotogo	; rx 7		SPEC	LOSK I A I 17	FD C	OURS	SF		Syn	abus	Nevi	51011			v.1.(J
Pre-rec	nnisit/	e	VLSI	Desig	n	oon										
Course	Obi	ectives		Desig												
The cou	irse s	hould	 enable	the s	tudent	S										
1.	To pr	ovide	a con	cise in	troduc	ction to	o the f	undar	nental	conce	epts	of M	achine	e Lea	ming	g.
2.	Toex	plore	the di	fferen	t Deep	learn	ing te	chniqu	ies ind	cludin	g ens	semb	le me	thods		2
3.	To ga	in the	know	ledge	of ma	chine	learni	ng to a	apply	in VL	SI de	esign				
4.	To fo	ocus o	n the	backe	end de	esign o	challe	nges,	incluc	ling n	nask	synt	hesis	and	phys	sical
	verifi	cation	•													
5.	To st	udy ho	w ma	chine	learni	ng can	help	in phy	vsical	desigr	ì .					
		tcomes:														
Course	Out	tion of the course, the student will be able to														
On con	pletio	tion of the course, the student will be able to														
Cours	e	Description Highest Rights													st	
Outcor	n	Bloom's Toyonom													1´S	
es CO1	T	Taxonomy Understand basic applications and issues of Machine Learning V2														
		nolvz		asic aj	oplication ($\frac{10115}{2}$ a L out	ning	and Γ	an I		earn	mg. Johni	allos			
02	A a	Analyze various Machine Learning and Deep Learning techniques K4														
CO3		nnlv t	he kno	wled	re of 1	machir	ne lear	ning i	n VL	SI fiel	d				K4	
CO4	A	nnlv t	he m	achine	lear	ning	in nh	vsical	verif	icatio	n ar	nd m	nask		K4	
001	S	vnthes	is.	aemin	o icui	11115	in pi	ysicai	vern	louio	ii ui	10 11	luon			
CO5	P	redict	the m	achin	e lear	ning 1	model	for 1	ohysic	al de	sign	such	as		K4	
	p	laceme	ent and	d rout	ing.	0		. 1	J		0					
Correla	ation	betwe	en Co	ourse	Outco	omes (COs)	and I	Progra	am O	utco	mes ((POs)	:		
														Prog	ram	1
				Pr	oaran	n Aut	comes		9					Speci	fic	
				11	ogran		comes		'					Outc	ome	S
COs										-				(PS	Os)	
	PO 1	PO	PO	PO	PO -	PO	PO 7	PO	PO	PO	P	PO	PSC		S P	'SO3
	1	2	3	4	5	0	7	8	9	10	11	12	1	0	2	
CO1	S	S	М	М	c		-			_	-	_	c	6		
	I	с С	C 141	C 141	с С						<u> </u>		2	с С		
		<u>с</u>	<u>ь</u>	<u>ь</u>	<u>ь</u>	-	-	-	-	-	-	-	<u> </u>	2		-
		5	<u></u> З	<u> </u>	<u>ہ</u>	-	-	-	-	-	-	-	5			-
CO4	M	M	M	M	S	-	-	-	-	-	-	-	S			-
CO5	Μ	Μ	Μ	Μ	S	-	-	-	-	-	-	-	S	S		-



UNIT-I	INTRODUCTION TO MACHINE LEARNING	9 Hours
Basics of ma	chine learning Applications of Machine Learning, processes involved	in Machine
Learning S	upervised Learning Unsupervised Learning and Reinforcement	I earning
Evaluation N	Jeasures: confusion matrix precision recall E-Score ROC-Curve	Cross-
Validation	reasures. confusion matrix, precision, recan, 1-5core, ROC-Curve,	C1085-
v andation.		
IINIT_II	DEED LEARNING: CONVOLUTIONAL NEURAL	0 Hours
011111	NETWORKS	
Feed forward	l networks, Activation functions, back propagation in CNN, optimi	zers, batch
normalizatior	a. convolution layers, pooling layers, fully connected layers, dropout	. Examples
of CNNs.	, · · · · · · · · · · · · · · · · · · ·	,F
UNIT-III	MACHINE LEARNING IN VLSI DESIGN	9 Hours
A Taxonomy	for Machine Learning in VLSI Design Energy-Efficient Design of	Advanced
Machine Lea	rning Hardware.	
UNIT-IV	MACHINE LEARNING APPLICATIONS IN IC VERIFICATION	9 Hours
ML in Physic Synthesis, M Clock Optimi Patterning Pr	cal Verification, Layout Feature Extraction and Hotspot Detection, M fask Synthesis Flow, Mask Synthesis and Verification, Machine L fization, Decision tree induction algorithm, Importance of Lithographic ocess. Machine Learning for Lithography.	IL in Mask earning for
	MACHINE LEADNING ADDI ICATIONS IN IC DIVSICAL	0 Houng
UNII-V	MACHINE LEARNING APPLICATIONS IN IC PHYSICAL DESIGN	9 Hours
Machine Lea	arning for Physical Design: Modern VLSI Layouts, Placement a	nd Routing
Example, Co	prrelation between Placement and Routing, Machine Learning for	Placement,
Routing, Ma	sk Synthesis and Verification, VLSI Placement and Algorithm, Cha	allenges for
VLSI Design	, Routability-Driven Placement, Prediction of Routing Congestion, C	hallenges
of Routing C	ongestion, Application Specific ML.	
	Total Hours	45 Hours
Text Book(s)		
1. Ethem	Alpaydin, Introduction to Machine Learning, PHI.	
2. Elfadel Compu	, Ibrahim M., Duane S. Boning, and Xin Li, eds. Machine Learnin ter-Aided Design, Springer, 2019.	g in VLSI
Reference B	ook(s)	
1. Bishop	. C. (2006). Pattern Recognition and Machine Learning. Berlin: Spring	er-Verlag.



Course	cod	e						L	Т	P)	C	IA	EA	TM			
Course	Nan	ne	DEVI	ELOP	MEN	Т	OF	0	0	2		4	40	60	100			
			MAC	HINE	I	EAR	NING											
			ALG	ORIT	HMS	IN VI	LSI											
Course			PROF	ESSI	DNAL	,			Syll	abus	Revi	sion		V	.1.0			
Catego	ry		SPEC	IALIZ	ED C	OUR	SE											
Pre-ree	quisit	e																
Course	Obj	ectives	S:															
The cou	arse s	hould	enable	e the s	tudent	S												
1. To c	carry	out re	search	/ inv	estiga	tion a	nd dev	velopn	nent v	vork a	nd t	o sol	ve pra	actical				
prob	olems	ite and present a substantial technical report / document in the field of VLSI.																
2. To V	Write	and p	resent	a subs	tantia	l techi	nical r	eport /	docu	ment	in the	e fiel	d of V	LSI.				
3. 101	Jemo	nstrate	e the R	lesearc	ch find	lings	the VL	LSI are	ea.									
Commo	04	utcomes:																
On con	onleti	utcomes: etion of the course, the student will be able to																
Cours		tion of the course, the student will be able to Description Highest																
Outcor	t n			Highest Bloom's														
															Taxonomy			
COl	S	Synthesize knowledge and skills previously gained and apply to an in-													K3			
cor	d	depth study and execution of new technical problems in the area of																
	V	LSI.							- r									
CO2	Γ	Define	specifi	cation	, adop	ot new	VLS	I meth	odolo	gies a	nd a	nalyz	e to		K5			
	р	roduce	e a suit	able re	esearci	n desig	gn and	justify	the d	esign.		-						
CO3	Γ	Demon	strate t	he re	search	findi	ngs th	nrough	hard	ware	and	softv	vare		K5			
	to	ools.																
CO4	P	resent	the fir	dings	of the	ir tech	nical s	olution	n in a	writte	ı rep	ort.			K6			
CO5	P	ublish	the wo	ork in	repute	d jour	nals ar	nd Inte	rnatio	nal Co	onfere	ences			K6			
		• •	0		0 /													
Correla	ation	betwe	een Co	ourse	Outco	omes ((COs)	and I	rogra	am O	utco	mes (POs)	<u> </u>				
														Prog	am			
				Pr	ogran	n Out	comes	(POs	5)					Spec	ific			
COa					U									Outco	mes			
COS	PO	PO	DO	PO	PO	PO	DO	PO	PO	PO	D	PO	DSC		JS) DSO3			
	1	2	3	4	5	6	7	8	9	10	0	12	1	$\begin{vmatrix} 1 \\ 0 \end{vmatrix}$	1303			
	•												-	02				
CO1	S	S	S	S	S	-	-	_	_	_	-	Μ	S	S	-			
CO2	S	S	S	S	S	S	S	-	-	-	-	S	S	S	-			
CO3	-	-	S	S	S	S	S	_	-	-	S	Μ	S	S	-			
CO4	-	- 1	-	-	_	-	-	S	S	Μ	-	S	-	- 1	S			
CO5	-	<u>_</u> <u>S</u> <u>S</u> <u>M</u> _ <u>M</u> <u>S</u>																
			•	•											•			



PRACTICAL	SYLLABUS:

The project topic should be selected to ensure the satisfaction need to establish a direct link between education, national development and productivity and reduce the gap between the world of work and the world of study.

The project should have the following

- 1. Relevance to social needs of society.
- 2. Relevance to value addition to existing facilities in the institute.

3. Relevance to industry need.

4. Problems of national importance.

5. Research and development in various domain.

The student should complete the following for Mini Project

1	Literature survey and Problem Definition.

- 2 Motivation for study and Objectives.
- 3 Preliminary design approaches.
- 4 Development and Verification.

5 Report and presentation.

6 Presenting the work in Reputed journals / International Conferences.

Examples

1	Design and	Development	of	a	Bayes	Classifier	for	Two-Class	and	Multi-Class
	Classification	n.								

2 Design and Development of a Deep Learning Classifier Model.

- 3 Design and Development of Clustering Algorithms.
- 4 Develop the algorithms using Raspberry Pi.

ELECTRONICS AND COMMUNICATION ENGINEERING WITH HONS./MINOR DEGREES IMAGE PROCESSING AND COMPUTER VISION



CURRICULUM & SYLLABUS

For B.E. (Hons.) Electronics and Communication Engineering with Specialization in IMAGE PROCESSING ANDCOMPUTER VISION

S.N o	Year	Sem	Cour se Code	Course Name	L	Т	Р	С	IA	EA	TM
1	II	IV		MULTIDIMENSIONAL DIGITAL SIGNAL PROCESSING	3	0	0	3	40	60	100
2	III	V		DIGITAL IMAGE PROCESSING	3	0	0	3	40	60	100
3	III	V		COMPUTER VISION	3	0	0	3	40	60	100
4	III	VI		IMAGE ANALYSIS	3	0	0	3	40	60	100
5	IV	VI		DEVELOPMENT TOOLS FOR IMAGE AND VIDEO PROCESSING LABORATORY	0	0	2	2	40	60	100
6	IV	VII		PATTERN RECOGNITION AND MACHINE LEARNING	3	0	0	3	40	60	100
7	IV	VII		DIGITAL IMAGE PROCESSING LABORATORY	0	0	2	2	40	60	100
Total Credits							-	1	19	<u> </u>	



CSVM																
Course	e Code	e						L	Т	P	· (C 1	[A	EA	,	ТМ
Course	e Nam	e	MUL'	TIDI	MENS	SIONA	4L	3	0	0		3 4	40	60]	100
			DIGI	TAL S	SIGN	AL										
			PRO	CESSI	ING											
Course	•		PROF	ESSI	ONAL	4			Syll	abus	Revis	ion			V.1.	0
Catego	ry		SPEC	IALIZ	ZED C	OUR	SE									
Pre-ree	quisite	e	Basic	Engin	neering	g Matł	nemati	cs, Sig	gnals a	and Sy	vstem,	Digi	tal S	ignal		
			proces	ssing												
Course	e Obje	ectives	5:													
The cou	urse sl	nould	enable	e the s	tudent	S										
1.	To un	dersta	and on	e-dim	ensior	nal and	d two-	dimen	sional	signa	ls.					
2.	To g	ain a	bette	r und	erstan	ding	of the	e sam	pling	theore	em ai	nd re	econs	struct	ion,	it's
	impor	tant t	o con	sider	both	down	samp	oling a	and u	p sam	pling	, whi	ich i	nvol	ve i	using
	differ	ent sa	mpling	g tech	niques											
3.	To ga	in kno	owledg	ge of a	a disci	rete sp	bace tra	ansfor	m for	Fouri	er trai	nsfori	n an	d fast	t Fo	urier
	transf	orm.														
4.	To un	dersta	ind an	d anal	lyze w	vavelet	t trans	format	tions a	ind 2D) Z tra	ansfo	rmati	ions.		
5.	To ac	quire	knowl	edge	and co	omprel	hend the	he des	ign of	FIR a	and II	R filt	ers.			
Course	Outo	comes	:													
On con	npletic	on of t	he cou	ırse, tl	he stud	dent w	vill be	able to	O							
Cours	e					De	escript	ion						Η	ighe	est
Outcom	nes													Bloom's		
														Ta	xon	omy
CO1	A	pply t	he kr	nowled	dge of	f one	dime	nsiona	al and	l two	dime	ensio	nal		K2	
<u>CO2</u>		$\frac{1}{nnly}$	oncer	ts of	samnli	ing th	eorem	and re	econst	ructio	n				K3	
$\frac{\text{CO2}}{\text{CO3}}$	E	vnlain	the 1	hasic	conce	nts of	f Fouri	er tra	nsforr	n and	fact	Four	ier		K2	
005	tr	ansfor	m	Jasie	conce	pts of	1 J Juli		1151011	ii anu	Tast	Tour			182	
CO4		escrib	nn. e diffe	erent v	wavele	t tran	sform	and 7	trans	forms					КЛ	
C04		estion	and ir	nnlem	entati	$\frac{1}{2}$ on of	FIR at	nd IIR	filter	, ,					K/	
005		esign	und m	npiem	lentati		I IIX ui		men						124	
Correl	ation	betwe	en Co	ourse	Outco	mes ((COs)	and I	Progra	am Oi	utcom	nes (F	POs)	:		
														Pro	grai	m
				п		0								Spec	rific	
CO.				Р	rogra	m Ou	tcome	es (PO	S)					Out	com	es
COs														(P S	SOs)
	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	P	SI	PS	PS
	1	2	3	4	5	6	7	8	9	10	11	12	0	1 ()2	03
CO1	S	Μ	М	S	L	L	M	-	-	-	L	Μ	S	5	L	М
CO2	Μ	S	Μ	-	-	-	-	-	-	-	S	Μ	N	1 1	M	L



CO3	S	Μ	Μ	-	-	-	-	-	L	Μ	L	М	Μ	S	L
CO4	Μ	S	S	-	М	L	Μ	-	-	-	L	L	S	М	L
CO5	Μ	Μ	Μ	-	L	-	S	-	-	-	Μ	М	S	М	Μ
UNIT	I	INT	RODI	UCTIO	ON									9 Ho	urs
One D	imens	ional	and T	wo D	imens	ional	Signa	ls and	l Syst	ems-	Separa	able S	ignal	s- Peri	odic
Signal	s - Ge	neral	Period	licity -	- 1D a	& 2-D	Disc	rete S	pace S	Systen	ns. 1	D & 2	2D C	onvolu	tion.
Contin	uous S	Space 1	Fourie	er Tran	sform	l .									
UNIT	II	SAN	IPLIN	IG IN	ONE	ANI) TWO) DIN	IENS	IONS				9 Ho	urs
Ideal H	Ideal Rectangular Sampling – Sampling Theorem. General Case – Change of Sampling Lattice – Reconstruction – Down compling and Up compling by integers														ate -
Sampling Lattice – Reconstruction – Down sampling and Up sampling by integers.															
UNIT	III	DIS	CRET	E SP.	ACE	TRAN	NSFO	RMS						9 Ho	urs
1D &	2D Discrete Fourier Series - 1D & 2-D Discrete Fourier transform- Pr												opertie	es –	
Discre	Discrete Time Fourier Transform- Short Time Fourier Transform – Fast Fourier Transform												nsform	1.	
UNIT-IV WAVELET TRANSFORM 9 Hours															
Gabor	Trans	form.	Two	Dimer	nsiona	l Syst	tems a	nd Z-	Trans	forms	- 2D	Spati	al Sy	stems	– Z-
Transf	orms -	Regio	ons of	Conve	ergenc	e - Li	near N	/lappir	ng of V	Variab	les - I	nverse	e Z-Tı	ransfor	m.
UNIT	V	FIL	FER 1	DESI	GN FI	UNDA	MEN	TAL	5					9 Ho	urs
Ideal	and fir	nite or	der Fi	ilters -	Two	Dime	ension	al Filt	er De	sign -	FIR a	and II	R filt	er desi	ign -
Windo	w Fun	ctions	- Rec	tangul	ar and	l Rota	ited wi	ndow	s.						
											To	tal H	ours	45 H	ours
Text E	look(s))													
1.]	Dan E.	Dudg	eon ai	nd Rus	ssell N	1. Me	rserea	u, "Mı	ıltidin	nensio	nal Di	gital 3	Signal	1	
]	Process	sing",	Prenti	ce-hal	1, 198	4.									
2.	ohn W	V. Wo	ods, "]	Multid	limens	sional	Signal	l, Ima	ge, an	d Vide	eo Pro	cessin	ig and	l Codin	ıg",
	Second	l Editi	on, Ac	cadem	ic Pre	ss, Els	sevier	Inc. 2	012.						
3.	Steven	W. Sı	nith, ʻ	'Digita	al Sigr	nal Pro	ocessii	ng – A	Pract	ical G	luide f	or En	gineer	rs and	
	Scienti	sts", N	Jewne	s Else	vier S	cience	e, 2013	3.							
Refere	ence B	ook(s)													
1.	Alan V	⁷ Oppe	enhein	n and	Schaf	er Ro	nald V	V, "D	igital	Signal	Proc	essing	", Pre	entice 1	Hall,
	2008.														
2.	Sanjit	K Mi	tra, "	Digita	l Sig	nal P	rocess	ing: 7	A Co	mpute	r-Base	ed Ap	proa	ch", T	hird
]]	Edition	n, McC	Braw-I	Hill Co	ompar	ies, 2	005.								



CSVM															
Course	e Cod	e						L	Т	P	· (A [EA	TM
Course	e Nam	ie	DIGI	TAL]	IMAG	E		3	0	0		3 4	0	60	100
			PRO	CESSI	ING										
Course	9		PROF	ESSI	ONAL				Syll	abus	Revisi	ion		V.1	.0
Catego	ory		SPEC	IALIZ	ZED C	OUR	SE								
Pre-ree	quisit	e	Basic	Digita	al Elec	ctronic	s, Sig	nals a	nd Sy	stem, I	Digita	l Sign	al Pr	ocessii	ng
Course	e Obje	ectives	5:												
The co	urse sl	hould	enable	the s	tudent	S									
1.	To ac	quire	knowl	edge	about	image	repre	sentati	ion an	d ima	ge dig	itizati	on.		
2.	Gain	insigh	t into	the fu	ndame	ental p	orincip	les of	imag	e trans	forma	tion, s	smoo	thing,	and
	restor	ation.													
3.	To ex	amine	e diffe	rent ir	nage s	egmei	ntatior	and g	graph	cut alg	gorithi	ns.			
4.	To ac	quire	knowl	edge	and id	entify	differ	ent ty	pes of	color	image	e proce	essin	g.	
5.	To st	udy va	rious	color	transfo	ormati	ons.								
Course	e Outo	comes	:												
On con	npletio	on of the course, the student will be able to													
Cours	e	Description Highest													
Outco	m	Bloom's													
es		Тахопоту													
CO1	A	pply t	he kno	owled	ge of i	image	repres	sentati	on, in	nage d	igitiza	tion.		K	3
CO2	A	pply o	concep	ots of	imag	ge tra	nsforn	nation	, smo	othing	g and	imag	;e	K	3
	re	estorat	ion.												
CO3	E	xplain	the l	oasic	conce	pts of	imag	e seg	menta	tion a	ind gr	aph c	ut	K	2
	a	lgorith	m.												
CO4	A	pply a	and ide	entify	color	image	proce	essing.						K	4
CO5	D	escrib	e and	imple	ment	color	transfo	ormati	on.					K	4
Correl	ation	betwe	en Co	ourse	Outco	omes ((COs)	and I	Progra	am O	utcom	es (P	Os):		
]	Progra	am
				D	roare	m ()11	tooma	а (Р О	c)				S	Specifi	с
				1	rugra	in Ou	tcome	5 (1 0	5)				(Dutcor	nes
COs														(PSO	s)
	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PS	PS	PS
	1	2	3	4	5	6	7	8	9	10	11	12	0	02	03
													1		
CO1	Μ	S	Μ	-	-	-	-	L	L	-	L	Μ	М	L	М
CO2	Μ	L	L	Μ	-	L	Μ	-	Μ	-	M	Μ	M	L	S
CO3	M	M	M	-	L	-	-	L	-	-	S	L	S	M	S
<u>CO4</u>	S	S	L	-	M	-	M	-	M	-	L		S	M	
005	3	L	IVI	-	L	-	L	-	L	-	L	IVI	M	IVI	L



UNI	T-I	IMAGE REPRESENTATION AND PROPERTIES	9 Hours						
Intro	duction -	- Image Representation - Image Digitization - Digital Image Properties	– Discrete						
Four	ier Trans	form - Image Pre-Processing in Spatial and Frequency Domain.							
UNI	T-II	IMAGE TRANSFORMATION	9 Hours						
Pixe	l Brightn	ess Transformation - Geometric Transformations - Local Preprocessi	ng - Image						
Smo	othing –	Edge Detectors - Corner Detectors - Image Restoration.							
UNI	T-III	IMAGE SEGMENTATION	9 Hours						
Thre	sholding	- Edge- Based Segmentation - Region Based Segmentation, Mean	shift						
segm	nentation	, Graph cut algorithm- Matching - Evaluation Issues in Segmentation,	,						
Wate	ersheds.								
UNI	T-IV	COLOR IMAGE PROCESSING	9 Hours						
Colo	r Fundar	nentals - Color Models - Pseudocolor Image Processing - Basics of	Full Color						
Imag	ge Proces	sing.							
UNI	T-V	COLOR TRANSFORMATIONS	9 Hours						
Smo	oothing a	nd Sharpening – Color Segmentation – Noise in Color Images.							
		Total Hours	45 Hours						
Text	: Book(s)								
1.	Rafael Pearsor	C. Gonzalez and Richard E. Woods, "Digital Image Processing", Third 1 Education, 2009.	1 Edition,						
2.	2. Milan Sonka, Vaclav Hlavac and Roger Boyle, "Image Processing, Analysis and								
D. A	Machine Vision", Third Edition, Cengage Learning, 2007.								
Kefe	rence B	ook(s)							
1.	Willian	n K. Pratt, "Digital Image Processing", Fourth Edition, Wiley Interscie	nce, 2007						
2.	Anil K Jain, "Fundamentals of Digital Image Processing", Prentice Hall, 1989.								



Course	Code	e						L	Т	Р			\	EA	ТМ
Course	Nam	e	СОМ	PUTE	ER VI	SION		3	0	0	3	3 40	0	60	100
Course	•		PROF	ESSIC	DNAL	,			Svll	abus]	Revisi	ion		V.	1.0
Catego	ory		SPEC	IALIZ	ED C	OURS	SE		v						
Pre-ree	quisite	e 1	Engin	eering	Math	ematio	cs, Kn	owled	ge, D	igital I	Electro	onics,	Digi	tal Im	age
			Proces	ssing.											
Course	e Obje	ectives	:												
The cou	urse sl	nould	enable	the s	tudent	s									
1. 1	l'o Ga	in kno	owled	ge on	how	image	es are	forme	d req	uires	under	standu	ng h	ow th	ey are
f	ormed	1.													
2. 7	Fo ana	lyze t	he ide	a of c	amera	mode	ls and	calibr	ation.						
3. 7	Го le	arn a	and u	inders	tand	the d	liffere	nt ty	pes o	of Loo	cal F	eature	De	tector	rs and
I	Descri	ptors.													
4. 7	Го асс	luire k	ire knowledge of multiplane methods in pose Estimation.												
5. 7	Го lea	rn and	n and understand the Stereo and Multi-view Geometry.												
Course	e Outo	Outcomes:													
On con	completion of the course, the student will be able to														
Cours	se Description Highest														
Outcor	m	Bloon											n's		
es														Taxo	nomy
CO1	A	pply t	he kno	owledg	ge of i	mage	forma	tion.						<u> </u>	3
CO2	A	pply c	oncep	ts of o	camera	a mod	els and	d calib	pration	l.				<u> </u>	2
<u>CO3</u>	A	pply t	he kno	owledg	ge of I		Featur	$\frac{1}{1}$	ectors	and L	escrip	otors.			3
C04 C05		pply a	ind ide		calibra	ation 1	metho	ds.	14:	Car		-			4
05	D	escrib	e and	imple	ment	for Ste	ereo ar	ia Mu	iti-vie	ew Geo	ometry	/.		K	4
Correl	ation	hotwo	on Co	MIRCO	Outco	mag	$\overline{(\mathbf{CO}_{\mathbf{C}})}$	and F	Progra	m Oi	itcom	05 (P	Jeje		
Correla	ation	Detwe		Juise	Outco	mes ((005)	anu i	Tugra		ncom	C5 (1 (Js). 1	Drogr	om
													S	necifi	am ic
				P	rogra	m Ou	tcome	es (PO	s)				\mathbf{C}	Jutco	mes
COs														(PSC)s)
005	PO	PO P										PS	PS		
	1	2	3	4	5	6	7	8	9	10	11	12	0	02	03
													1		
CO1	S	М	S	Μ	L	Μ	М	-	L	Μ	М	Μ	S	M	М
CO2	Μ	L	Μ	-	L	L	-	_	_	Μ	_	L	M	L	L
CO3	S	Μ	S	Μ	Μ	L	-	Μ	-	L	L	Μ	S	Μ	М
CO4	Μ	Μ	L	Μ	L	Μ	-	-	-	-	М	-	L	S	М
CO5	S	L	L	S	Μ	L	-	L	-	Μ	L	-	Μ	L	L
			-												



3 CS	VMV								
UNI	T-I	IMAGE FORMATION	9 Hours						
Geor	netric in	nage formation, Photometric image formation.							
UNI	T-II	CAMERA MODELS AND CALIBRATION	9 Hours						
Cam	era Proje	ection Models - Orthographic, Affine, Perspective, Projective models.	Projective						
Geor	netry: Ti	ransformation of 2D and 3D, Internal Parameters, Lens Distortion Mod	lels.						
UNI	T-III	LOCAL FEATURE DETECTORS AND DESCRIPTORS	9 Hours						
Hess	ian corn	er detector, Harris Corner Detector, LOG detector, DOG detector, S	IFT, PCA-						
SIFT	, GLOH	, SURF, HOG, Pyramidal HOG, PHOW.							
UNI	T-IV	CALIBRATION METHODS	9 Hours						
Line	ar, Direc	t, Indirect and Multiplane methods - Pose Estimation.							
UNI	Г-V	STEREO AND MULTI-VIEW GEOMETRY	9 Hours						
Epip	olar Geo	metry, Rectification and Issues related to Stereo, General Stereo wit	h E Matrix						
Estin	nation, S	tratification for 2 Cameras, Extensions to Multiple Cameras, Self-Cali	bration						
with	Multiple	e Cameras, 3D reconstruction of cameras and structures, Three View G	eometry.						
		Total Hours	45 Hours						
Text	Book(s)								
1.	Forsyth	and Ponce, "Computer Vision - A Modern Approach", Second Edition	on, Prentice						
	Hall, 20	011.							
2.	Emanu	ele Trucco and Alessandro Verri, "Introductory Techniques for 3-D	Computer						
	Vision'	', Prentice Hall, 1998.							
Refe	rence B	ook(s)							
1.	Olivier	Faugeras, "Three Dimensional Computer Vision", MIT Press, 1993.							
2.	Richard	d Szeliski, "Computer Vision: Algorithms and Applications", Springer,	, 2011.						
3.	Milan S	Sonka, Vaclav Hlavac and Roger Boyle, "Image Processing, An	alysis and						
	Machine Vision", Third Edition, CL Engineering, 2013.								



Course	e Code	e						L	Т	P			4	EA	ТМ
Course	e Nam	e	IMAC	GE AN	NALY	SIS		3	0	0		3 4	0	60	100
Course	9		PROF	ESSI	ONAL	,			Syll	abus 1	Revisi	ion		V	.1.0
Catego	ory	1	SPEC	IALIZ	ED C	OURS	SE		·						
Pre-ree	quisite	e	Signal	s and	System	m, Dig	gital S	ignal I	Proces	sing, i	Digita	l Imag	ge Pr	rocess	sing.
Course	e Obje	ectives	:												
The cou	urse sl	nould	enable	the s	tudent	S									
1.	To lea	arn an	d unde	erstand	d the i	mage	morph	ology	and s	egmei	ntation	1.			
2.	To an	alyze	the pe	rform	ance c	of featu	ure ex	tractio	n and	measu	ureme	nt.			
3.	To un	dersta	nd va	rious i	mage	repres	sentati	ons an	d des	criptio	ns.				
4.	To lea	arn an	d unde	erstand	the T	exture	e repre	esentat	tion ar	nd ana	lysis				
5.	To be	ecome	famil	iar im	age ur	ndersta	anding	.			-				
Course	e Outo	zomes:													
On con	npletic	on of the course, the student will be able to													
Cours	e	Description Highest													
Outco	m	Bloom's													
es		Тахопоту													
CO1	A	Analyze given images and identify image morphology and K3													
	se	egmen	tation.												
CO2	A	pply t	he cor	icepts	of fea	ture e	xtracti	ion an	d mea	surem	ent.				<u><u><u>K</u>2</u></u>
CO3		escrib	e vari	ous in	nage r	eprese	ntatio	ns and	l desci	iption	IS.	.1 1			<u><u> </u></u>
CO4	A	pply t	he cor	icepts	of tex	ture d	lescrip	$\frac{100}{c}$	nd rec	ogniti	on me	thods			<u> </u>
C05	A	nalyze	e the p	oint d	listribi	ition r	nodels	s of in	nage u	nderst	andin	g.		J	\$4
Correl	ation	hater	on Co		Outor		$\overline{\mathbf{CO}}$	and I)		-+	og (D (\mathbf{a}		
Correl	ation	Detwe	en Co	burse	Outco	omes (CUS)	and F	rogra	im Ot	itcom	es (P	JS):	Dere	
														Prog.	ram Sfie
				P	rogra	m Ou	tcome	es (PO	s)					Spec	mes
CO														(PS	nics Os)
COs	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PS		S PS
	1	2	3	4	5	6	7	8	9	10	11	12	0	0	2 03
	-	-	J	-	2	Ū	,	U		10		12	1		
C01	S	S	М	м	Т		М		T	М	м	T	1 S	м	м
CO1	M	M	S	S	M	T	-	T	M	111	M	M	M	S	IVI
CO2	S	M	L	M	I.	-	_	M	-	L	L	L	M	L	S
CO4	M	S	L	M	L	М	М	-	L	-	L	M	L	M	M
CO5	M	M	L	S	M	-	L	-	L	-	M	L	S	M	M
			1 -	1	=	1	1 -	1	_		=		<u> </u>		



UNI	Г-І	IMAGE MORPHOLOGY	9 Hours							
Binar	ry and g	ray scale Morphological analysis - Dilation and Erosion - Skeletons	and Object							
Mark	Marking – Granulometry – Morphological Segmentation.									
UNI	Г-II	FEATURE EXTRACTION	9 Hours							
Glob	al image	measurement, feature specific measurement, characterizing shape	es, Hough							
Trans	sform.									
UNI	Γ-III	REPRESENTATION AND DESCRIPTION	9 Hours							
Regio	on Ident	ification - Contour Based and Region Based Shape Represent	tation and							
Desc	ription –	- Shape Classes. Flexible shape extraction: active contours, Flexible s	shape							
mode	els: activ	e shape and active appearance.								
UNI	Γ-ΙV	TEXTURE REPRESENTATION AND ANALYSIS	9 Hours							
Statis	stical Te	xture Description – Syntactic Texture Description Methods – Hybr	rid Texture							
descr	iption M	lethods – Texture Recognition Method Applications.								
UNI	Г-V	IMAGE UNDERSTANDING	9 Hours							
Cont	rol Strat	egies -RANSAC - Point Distribution Models - Scene Labeling and	Constraint							
Propa	agation.	Image Data Compression: Predictive Compression Methods	– Vector							
Quan	tization,	DCT, Wavelet, JPEG.								
			·							
		Total Hours	45 Hours							
Text	Book(s)		1							
1.	Milan Machin	e Vision", Third Edition, Cengage Learning, 2007.	alysis and							
2.	Tinku A	Acharya, Ajoy K Ray,"Image Processing- Principles and Application	ns", Wiley,							
	2005.									
3.	John C	Russ, "The Image Processing Handbook", Sixth Edition, CRC Press,	2007.							
Refe	rence Bo	pok(s)								
1.	Mark S	. Nixon, Alberto S. Aguado, "Feature Extraction and Image Processin	g", Second							
	Edition	, Academic Press, 2008.								



								-				<u> </u>	•		
Course	e Code	e						L	Т	ł	, (A	EA	TM
Course	Nam	e	DEVE	ELOP	MEN	T TO	OLS	0	0	2	2 2	2 4	0	60	100
			FOR	IMA(JE AI	ND VI	IDEO								
				JESSI	ING										
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Course			PROF	ESSI	JNAL				Syll	abus	Revis	ion		V	.1.0
Catego	<u>ry</u>		SPEC	IALIZ	ED C	OUR	SE								
Pre-ree	quisite	2													
Course	e Obje	ectives	S:			6.6	~ ~ ~	-	T 1	c		D			
1.	To un	dersta	and th	e imp	ortanc	e of (Open S	Source	e Tool	s for	Image	Proc	essin	g and	1
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3.	To stu	idy ar	nd imp	lemer	nt NI	Vision	Syste	m Ca	mera v	with L	ab Vie	W.			
4.	To lea	arn an	id und	erstan	d the	IKODO	t for N	latiab	progr	ammi	ng for	· Navi	gatio	n sce	enario.
5.	10 De	esign	sign and implement Lego windstorm Simple Robot Frogramming.												
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CO2		Computer vision.													V 6
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CO5	Μ	Μ	Μ	S	S	-	Μ	-	S	L	Μ	Μ	S	Μ	M



	LIST OF EXPERIMENTS
1	Open Source Tools for Image Processing and Computer Vision
2	BeagleBoard XM and BeagleBone Black
	- Application Development using OpenCV/Java for Image Processing concepts
3	NI Vision System Camera with LabView
	- Data Acquisition
	- Basic Image Processing concepts
4	iRobot - Matlab programming for Navigation scenario
	Lego Mindstorm
5	iRobot
	- Simple Robot Programming
	- Object



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5.	To lea	arn the	conc	ept of	deep	learnii	ng and	l Deep	Archi	itectur	e.		uno	1110	uu 15.					
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CO5	C	ategor	izes d	eep le	arning	g and l	Deep 4	Archit	ecture	•]	K4					
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UNI	T-I	INTRODUCTION	9 Hours							
Patte	rn recog	mition systems - The design cycle - Learning and adaptation -Linear	models for							
class	ification	- Discriminant functions (Two and multiple classes) - Lea	st squares							
class	classification functions - Fisher's discriminant analysis for two and multiple classes -									
Prob	abilistic	generative models - Maximum likelihood solution.								
UNI	T-II	KERNEL METHODS	9 Hours							
Cons	structing	kernels - Kernel density estimators - Nearest neighbor methods - Gaus	ssian							
proce	esses and	d classification - Sparse kernel machines - Support vector machines -	Maximum							
marg	in classi	fiers - Multi-class support vector machines.								
UNI	T-III	GRAPHICAL MODELS	9 Hours							
Baye	esian ne	etworks - Generative models - Linear Gaussian models - C	Conditional							
indep	pendence	e. Mixture models and Expectation maximization: K-means clustering	- Mixtures							
of Ga	aussian -	Expectation maximum for Gaussian mixtures.								
UNI	T-IV	CONTINUOUS LATENT VARIABLES	9 Hours							
Princ	cipal con	nponent analysis - Applications of principal component analysis - PCA	for higher							
dime	nsional	data - Factor analysis. Sequential data: Markov models - Hidden Marl	kov models							
- Ma	ximum	likelihood for HMM - Forward-backward algorithm. Combining mo	dels - Tree							
based	d models	s - Decision trees - Classification and regression trees (CART).								
UNI	T-V	DEEP LEARNING FOR HIGH-LEVEL VISION	9 Hours							
Intro	duction	to Deep Learning, main types of Deep Architectures, Application	of Deep							
Lear	ning Arc	hitecture to Computer Vision.								
		Total Hours	45 Hours							
Text	Book(s)		2007							
1.	Dichor	ppner IVI. BISNOP, "Pattern Recognition and Machine Learning", Spring	er, 2006.							
۷.	Edition	Job Duua, Feler E. Hart and David G. Slork, Fattern Classification	n, second							
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	Analys	is, Prenuce Hall of India, 2002.								



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Course	Obje	ctives	5:												
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]	proces	ssing.													
2. '	To un	dersta	and the	e Disp	lay of	an Im	lage, N	Vegati	ve of a	an Ima	age (B	inary	& Gr	ay Sca	ale).
3. '	To im	mplement the various techniques of image enhancement, reconstruction,													
	compr	ression and segmentation.													
4. '	To im	plement sampling and reconstruction procedures.													
5. '	To dea	sign image processing systems.													
Course	Outc	comes:													
On com	pletio	ion of the course, the student will be able to													
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Outcon	n	Bloom's													m's
es		Taxonomy													
CO1	A	ble to understand the image fundamentals, mathematical K4													
001	tra	ransforms necessary for image processing.													
CO2	D	emon	strate	knowl	edge	about	the	Contra	ast sti	retchir	ng of	a lov	w	K	6
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CO3	A	ble to	ider	ntify	form	ilate	and	solve	imag	e sm	oothir	lg an	d	K	6
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CO5	Μ	S	S	Μ	S	-	Μ	-	S	-	Μ	Μ	S	Μ	S
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	LIST OF EXPERIMENTS
1.	To study the Image Processing concept.
2.	Simulation and Display of an Image, Negative of an Image (Binary & Gray Scale).
3.	Implementation of Relationships between Pixels.
4.	Implementation of Transformations of an Image.
5.	Contrast stretching of a low contrast image, Histogram, and Histogram Equalization.
6.	Computation of Mean, Standard Deviation, Correlation coefficient of the given
	Image.
7.	Implementation of Image Smoothing Filters (Mean, Median filtering of an Image).
8.	Implementation of image sharpening filters and Edge Detection using Gradient
	Filters.
9.	Image Compression by DCT, DPCM, HUFFMAN coding.
10.	Implementation of image restoration techniques.