

ISO 9001:2015 Certified | DST-FIST Supported Institution Recognized under Section 2(f) & 12(B) of the UGC Act, 1956 Vannarpettai, Tirunelveli - 627003, Tamil Nadu

Department of Electronics and Communication Engineering

M.E – Communication Systems

R 2024 - Curriculum and Syllabi -PG CHOICE BASED CREDIT SYSTEM AND OBE

Vision of the Department

To develop Electronics and Communication Engineers by permeating with proficient morals, to be recognized as an adroit engineer worldwide and to strive endlessly for excellence to meet the confronts of our modern society by equipping them with changing technologies, professionalism, creativity research, employability, analytical, practical skills and to excel as a successful entrepreneur.

Mission of the Department

- To provide excellence through effective and qualitative teachinglearning process that equips the students with adequate knowledge and to transform the students' lives by nurturing the human values to serve as a precious resource for Electronics and Communication Engineering and nation.
- To enhance the problem solving and lifelong learning skills that will enable by edifying the students to pursue higher studies and career in research.
- To create students with effective communication skills, the abilities to lead ethical values in order to fulfill the social needs

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PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Core Competence: To demonstrate core competence in mathematics, basic sciences and engineering concepts, that apply to communication systems engineering knowledge and/or also to pursue advanced study or research.

PEO2: Design and Analysis: To demonstrate good skills to comprehend communication engineering trade-offs, forecast, analyse, design, and synthesize data and technical concepts to create novel solutions for real life problems.

PEO3: Develop multi skills & Professionalism:

To have a successful career by meeting the demand driven needs of communication systems industries/ profession, with multi-disciplinary projects, adhering to ethical standards with social responsibility

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1:The ability to apply basic mathematics and sciences to analyse, design and implement application specific systems for complex engineering problems, pertaining to analog and digital domains in communication systems engineering and its allied fields.

PSO2: The ability to adapt to latest industrial sophistications, tools and technology in communication systems engineering and its allied fields.

PSO3: Excellent compliance to function in multi-disciplinary environment, exhibiting good interpersonal and leadership skills with an understanding of societal and ecological issues, adhering to ethical engineering practice.

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PROGRAMME OUTCOMES (POS)

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one"s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. **12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PO	PEO1	PEO2	PEO3	PS01	PSO2	PSO3
1		Н		Н		
2		Н		М		
3		L	Н			Н
4	Н	L			Н	
5			М	Н		
6			L			М
7			L		Н	
8	L				Н	
9	L			М		М
10	М			М		М
11	М				Н	
12	L	М	Н			М

Mapping with PO Vs PEO, PSO

Contribution L: Low / Reasonable M: Medium / Significant H:High / Strong

FRANCIS XAVIER ENGINEERING COLLEGE M.E. – COMMUNICATION SYSTEMS - REGULATIONS 2024 Choice Based Credit System and Outcome Based Education

SUMMARY OF CREDIT DISTRIBUTION

S.No	Category		Credits Pe	er Semester	•	Total	Credits in
0.110	cutegory	Ι	II	III	IV	Credits	%
1	ES	3				3	4.2%
2	РС	17	11	3		31	43.6%
3	PE	3	9	6		18	25.3%
4	EEC		0	7	12	19	26.7%
	Total	23	20	16	12	71	100%

Minimum Number of Credits to be Acquired: 71

ES - Engineering Sciences

PC - Professional Core

PE - Professional Elective

EEC - Employability Enhancement Courses

FRANCIS XAVIER ENGINEERING COLLEGE

M.E. – COMMUNICATION SYSTEMS - REGULATION 2024

Choice Based Credit System and Outcome Based Education

I- IV Semester Curriculum and Syllabi 2024

SEMESTER I

S.No	Course Code	Course Name	Catego ry	Contact Periods	L	Т	Р	С
Theory	Courses	·						
1	24MA1256	Applied Mathematics for Communication Engineers	ES	3	3	0	0	3
2	24CS1601	Advanced Radiation systems	PC	3	3	0	0	3
3	24CS1602	Advanced Wireless Communication	PC	3	3	0	0	3
4	24CS1603	Advanced Digital Signal Processing	PC	3	3	0	0	3
5	24CS1604	Advanced Digital Communication Techniques	PC	3	3	0	0	3
6	24CS1605	Research Methodology for Engineers	PC	3	3	0	0	3
7		Professional Elective I	PE	3	3	0	0	3
Practic	al Courses							
1	24CS1611	Communication Systems Laboratory I	PC	4	0	0	4	2
			Total	25	21	0	4	23

SEMESTER II

S.No	Course Code	Course Name	Catego ry	Contact Periods	L	Τ	Р	С
Theory	Courses							
1	24CS2601	Optical Communication Networks	PC	3	3	0	0	3
2	24CS2602	MIC and RF Transceiver Design	PC	3	3	0	0	3
3	24CS2603	5G Networks	PC	3	3	0	0	3
4		Professional Elective II	PE	3	3	0	0	3
5		Professional Elective III	PE	3	3	0	0	3
6		Professional Elective IV	PE	3	3	0	0	3
Practic	al Courses					•		
1	24CS2611	Communication Systems Laboratory II	PC	4	0	0	4	2

Francis Xavier Engineering College | Dept of ECE | M.E- CS | Curriculum and Syllabi R 2024 Total 22 18 0 4 20 **SEMESTER III** С S.No Course **Course Name** Catego Contact L Т Р Code Periods ry **Theory Courses** Machine Learning in Communication 24CS3607 1 PC 3 3 0 0 3 Networks Professional Elective V 2 PE 3 3 3 0 0 Professional Elective VI 3 PE 3 3 0 0 3 **Practical Courses** Dissertation I 12 1 24CS3901 EEC 0 0 12 6 2 24CS3902 Term paper writing EEC 0 0 2 1 1 22 Total 9 0 14 16

SEMESTER IV

S.No	Course Code	Course Name	Catego ry	Contact Periods	L	Τ	Р	С
Pract	ical Courses							
1	24CS4901	Dissertation II	EEC	24	0	0	24	12
	•		Total	24	0	0	24	12

Minimum Number of Credits to be acquired: 71

S.No	Course Code	Course Name	Seme ster	L	Т	Р	С
Profes	sional Electiv	e I	Ster				<u> </u>
1	24CS1701	Communication Network Security	Ι	3	0	0	3
2	24CS1702	Advanced Multimedia Compression Techniques	Ι	3	0	0	3
3	24CS1703	Advanced Digital Image Processing	Ι	3	0	0	3
4	24CS1704	VLSI Design for Signal Processing	Ι	3	0	0	3
5	24CS1705	High performance FPGA System Design	Ι	3	0	0	3
Profes	sional Electiv	e II					
1	24CS2701	Advanced Wireless Sensor Networks and WBAN	II	3	0	0	3
2	24CS2702	Massive MIMO and Millimeter Wave Communication	II	3	0	0	3
3	24CS2703	MIMO OFDM Systems	II	3	0	0	3
4	24CS2704	High Performance Analog IC Design	II	3	0	0	3
Profes	sional Electiv	e III					•
1	24CS2705	Advanced Integrated SOC Design Techniques	II	3	0	0	3
2	24CS2706	Modern IOT	II	3	0	0	3
3	24CS2707	Real Time Embedded Systems	II	3	0	0	3
4	24CS2708	Smart Antennas	II	3	0	0	3
Profes	sional Electiv	e IV					
1	24CS2709	VLSI Circuit Test and Verification Techniques	II	3	0	0	3
2	24CS2710	Modern Satellite Systems	II	3	0	0	3
3	24CS2711	Network Routing Algorithms	II	3	0	0	3
4	24CS2712	Remote Sensing	II	3	0	0	3
Profes	sional Electiv	e V	1				
1	24CS3701	Embedded Wireless Sensor Networks	III	3	0	0	3
2	24CS3702	DSP Processor Architecture and Programming	III	3	0	0	3
3	24CS3703	RF And Radiation System Design	III	3	0	0	3
4	24CS3704	High Speed Communication Networks	III	3	0	0	3
Profes	sional Electiv	e VI					
1	24CS3705	Cooperative Communication	III	3	0	0	3

List of Professional Electives Courses

2	24CS3706	VLSI Architecture for Image and Video Processing	III	3	0	0	3
3	24CS3707	Mobile Robotics	III	3	0	0	3
4	24CS3708	Advanced Radar and Navigational AIDS	III	3	0	0	3

Semester I

S.No	Course Code	Course Name	Catego ry	Contact Periods	L	Τ	Р	С
Theory	Courses		I			1		
1	24MA1256	Applied Mathematics for Communication Engineers	ES	3	3	0	0	3
2	24CS1601	Advanced Radiation systems	PC	3	3	0	0	3
3	24CS1602	Advanced Wireless Communication	PC	3	3	0	0	3
4	24CS1603	Advanced Digital Signal Processing	PC	3	3	0	0	3
5	24CS1604	Advanced Digital Communication Techniques	PC	3	3	0	0	3
6	24CS1605	Research Methodology for Engineers	PC	3	3	0	0	3
7		Professional Elective I	PE	3	3	0	0	3
Practic	al Courses							
1	24CS1611	Communication Systems Laboratory I	PC	4	0	0	4	2
			Total	25	21	0	4	23

<u>Francis Xavier</u>	Engineering Colleg	e Dept of ECE M.E- CS Curricu	lum and Sy	<u>rllabi</u>	<u>R 202</u>	<u>24</u>	
24MA1256	APPLIED MAT	HEMATICS FOR COMMUNIC	ATION	L	T	Р	C
		ENGINEERS		3	L T P 0 0 0 0 e Numerical e experience winnering. n engineering. using mathemat le in communic 9 porization-Gener Paroblem-Assig 9 Problem-Assig 9 om variables- 1 Random variables- 1 Random variables- 1 Random variables- 45	3	
• The pre	for the course -requisite knowledge s, Probability and Ra	e required by the Students to study andom Processor.	this Course	are N	umer	rical	
Objectives							
 To iden tools. To dem enginee To iden 	tify, formulate, abstr onstrate various num ring.	and logical thinking applicable in act and solve problems in electrical nerical solutions of Differential equ nd Random process variable applic model	l engineerin ation applic	ıg usir	ng ma	them	atical
UNIT I	j ucout the Quounig	LINEAR ALGEBRA				9	
UNIT II Formulation-Gr models		NEAR PROGRAMMING mplex Method-Big M Method-Tr	ransportatic	on Pro	oblem	-	gnme
UNIT III		CAL SOLUTION OF ORDINAR ERENTIAL EQUATIONS	Y			9	
	nethod of fourth or	der for system of IVPs-Numerica d-shooting method BVP- Finite I					
UNIT IV	PROBABII	LITY AND RANDOM VARIABL	ES			9	
•	Marginal and condit	Probability function- Two dime ional distributions- Function of tw					
UNIT V		QUEUEING MODELS				9	
Poisson proces analysis	s- Markovian queu	es- Single and Multi –server mod		's for	mula		dy sta
<u> </u>	sessment Method		l Periods			43	
	ssessment Test	5 Formative Assessment Test (10 Marks)	End Sem (60M			ns	
1.Description 2.Formative M questions	Questions Multiple choice	1.Assignment 2.Online Quizzes 3.Problem solving Activities		tive M	-		

Outcomes

Upon completion of the course, the students will be able to:

- CO256.1 To be able to analyze the fundamental of Linear algebra
- CO256. 2 To be able to analyze the linear programming.
- CO256. 3 To be able to design numerical solution
- CO256. 4 To be able to analyze the performance of Probability and Random variable.
- CO256.5 To be able to analyzeQueuing model.

Text Books

- 1. Bronson, R. and Costa, G. B., "Linear Algebra", 2nd Edition, Academic Press, 2007.
- 2. Burden, R. C. and Faires, J. D., "Numerical Analysis ", 9th Edition, Cengage Learning, 2016.
- 3. Gross, D., Shortle, J.F., Thompson, J. M. and Harris, C. M., "Fundamentals of Queueing Theory ", 4th Edition, Wiley, 2014.

Reference Books

- 1. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
- 2. Sastry, S. S., "Introductory Methods of Numerical Analysis ", 5th Edition, PHI Learning, 2015..

Web Resources

- https://nptel.ac.in/courses/111/105/111105124/
- https://nptel.ac.in/courses/111/105/111105035/
- https://nptel.ac.in/courses/108/108/108108109/

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2			1				2	3	3	1	2	
2	3	2	2	1	2				2		3	3			1
3	3	1	1		2					2	1	3	1		
4	3	3	2		2			1		2	2	3		2	1
5	2	3	2	1						2	3	3	3	1	2

24CS1601	ADVANCED RADIATON SYSTEMS	L	T	Р	C
		3	0	0	3
Prerequisites	for the course			•	•
1	requisite knowledge required by the Students to study this Cours Antenna and Amplifiers.	e are R	F and	l Micr	owave
Objectives					

- 1. To understand the antenna fundamentals.
- 2. To understand about the antenna elements
- 3. To understand the various components that constitute an antenna array.
- 4. To know the basic patch techniques needed for evaluating the performance antenna.
- 5. To know the concepts electromagnetic radiation and antenna design.

UNIT I	AN	FENNA FUNDAMENTALS		9		
bandwidth, po	olarization, radiation	Radiation pattern, power density, r n efficiency, effective aperture. ansformer, Introduction to numeric	Reciproci	ty theorem, Matching		
UNIT II	1	ANTENNA ELEMENTS		9		
Reflector anter	1	le, dipole. Micro-strip patch ante ge, and design consideration, Pract				
UNIT III	ANTI	ENNA ARRAY		9		
Yagi-uda anten	ina array.Smart anter	linear antenna arrays, General stru na for Mobile stations		oadside, end-fire array,		
UNIT IV		ERFORMANCE ENHANCEME		9		
		bading of antenna, Meandering				
-	-	e antenna,Excitation techniques;R	-			
Micro-strip dip	ole Radiation Mecha	nism from patch Application of M	icro-strip ar	ray antenna.		
UNIT V	ANTENNA	MEASUREMENTS AND DESIG	ΓN	9		
	imulation with CST	entation – Gain, Impedance and an Microwave studio, Antenna Prot	otype deve			
		Tota	l Periods	45		
Suggestive As	ssessment Method	S				
Continuous A (30 Mai	ssessment Test rks)	Formative Assessment Test (10 Marks)	End Sem (60 M	ester Exams arks)		
1.Description 2.Formative questions	a Questions Multiple choice	1.Assignment 2.Online Quizzes 3.Problem solving Activities	-	ption Questions itive Multiple choice is		
Outcomes						
Upon comple	tion of the course,	the students will be able to:				
CO601. 1	To be able to analy	ze the fundamental of antenna syst	tem			
CO601. 2	To be able to analy	ze the antenna elements.				
CO601. 3	To be able to desig	gn antenna array				
CO601. 4	To be able to analy	ze the performance of Micro-strip	antenna and	l its characteristics.		
CO601.5	To be able to analy	ze antenna measurements and desi	gn.			
Text Books						

1. Hubregt.J.Visser "Antenna Theory and Applications" 1st Edition, John Wiley & Sons Ltd, Newyork, 2012.

2. Zhijun Zhang" Antenna Design for Mobile Devices" 1st Edition, John Wiley & Sons (Asia) Ltd, Newyork, 2011.

Reference Books

- Xavier Begaud, "Ultra Wide Band Antennas", 1st Edition, ISTE Ltd and John Wiley & Sons 1. Ltd, Newyork, 2013.
- 2. Balanis.A, "Antenna Theory Analysis and Design", John Wiley and Sons, New York, 1982.
- 3. Krauss.J.D, "Antennas", II edition, John Wiley and sons, New York, 1997.
- 4. I.J. Bahl and P. Bhartia," Micro-strip Antennas", Artech House, Inc., 1980
- 5. W.L.Stutzman and G.A.Thiele,"Antenna Theory and Design", 2nd Edition, John Wiley & Sons Inc., 1998.
- 6. S.Drabowitchet.al.:,"Modern Antennas", 2nd Edition Springer science business Media, Inc.2005.

Web Resources

- https://interferencetechnology.com/antenna-fundamentals/
- https://www.antenna-theory.com/basics/main.php •
- https://www.3ds.com/products-services/simulia/products/cst-studio-suite/

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2			1				2	3	3	1	2	
2	3	2	2	1	2				2		3	3			1
3	3	1	1		2					2	1	3	1		
4	3	3	2		2			1		2	2	3		2	1
5	2	3	2	1						2	3	3	3	1	2

24CS1602	ADVANCED WIRELESS COMMUNICATION	L	Т	Р	C				
		3	0	0	3				
Prerequisites	for the course								
• The pre-requisite knowledge required by the Students to study this Course is basic knowledge in Wireless Communication.									
Objectives									

- 1. Understand the basics of propagation of EM signals and its mechanisms in Wireless channels.
- 2. Learn the capacity equations of wired and wireless channels.
- 3. Study the various diversity and equalization techniques.
- 4. Explore the fundamentals of spatially diversified Communication systems.
- 5. Realize the concepts of Multi-user systems

UNIT I	WIRELESS PROPOGATION CHANNELS AND	9
	MODELS	

Propagation Mechanisms – reflection, diffraction, scattering indoor and outdoor propagation models, Small –scale fading, Multipath fading distributions, Rayleigh, Rician, Nakagami distribution, Clarkes's fading model ,Link power budget analysis,Propagation of EM signals in wireless channel,Reflection, diffraction and Scattering, Free space model,Two ray propagation model,Channel classification-channel models, COST-231 Hata model, Longley-Rice Model,NLOS Multipath Fading Models:Rayleigh, Rician, Nakagami, Composite Fading, Shadowing Distributions and Link power budget Analysis

UNIT II	CAPACITY OF WIRELESS CHANNELS	9								
Capacity in AWGN, Capacity of flat fading channel, Channel and System Model, Channel Distribution										
Information (C	CDI) Known, Channel Side Information at Transmitter and Re	eceiver.Capacity with								
Receiver Dive	ersity, Capacity Comparisons, Capacity of frequency selective fa	ading channels, Time-								
Invariant Chan	nels, Time-Varying Channels.									

UNIT III	DIVERSITY AND EQUALIZATION	9
Realization of	independent fading paths, Receiver Diversity: Introduction, Recei	ver Diversity: System

model,Selection Combining, Threshold Combining,Maximum-ratio Combining,Equal gain Combining,Transmitter Diversity :Introduction,Channel known at transmitter,Channel unknown at the transmitter: Alamouti scheme and Equalization.Directly linear and non linear equalizers in communication Receiver,Algorithms for Adaptive Equalization, timing and tracking.

UNIT IVMIMO COMMUNICATIONS9Fundamentalsof MIMO,NarrowbandMIMOModel,andParallelDecompositionoftheMIMOchannel,MIMOchannelcapacity,StaticChannels,FadingChannels,MIMODiversityGain,BeamformingandDiversity-Multiplexingtrade-offs,SpacetimeModulationandcoding,MLDetectionandPairwiseErrorProbability,RankandDeterminantCriterion,Space-TimeTrellis,BlockCodes,SpatialMultiplexingandBLASTArchitectures.Architectures.ArchitecturesArchitectures

UNIT V	MULTI USER SYSTEMS	9								
Review of Multiple Access Techniques-FDMA, TDMA, CDMA, Space-Division, Hybrid Techniques,										
Scheduling, Po	Scheduling, Power control, Downlink (Broadcast) Channel Capacity: Channel Model, Channel Capacity									
in AWGN,Cor	nmon Data, Capacity in fading, capacity with multiple antennas a	and uplink (Broadcast)								
Channel Cap	acity, Channel Capacity in AWGN, Capacity in fading, cap	acity with multiple								
antennas, Uplink/Downlink Duality, multiuser diversity and MIMO-MU systems										

		Total	Periods	45						
Suggestive As	ssessment Method	ls								
Continuous A (30 Ma	ssessment Test rks)	Formative Assessment Test (10 Marks)	End Semester Exams (60 Marks)							
1.Description 2.Formative questions	n Questions Multiple choice	1.Assignment 2.Online Quizzes 3.Problem solving Activities	1.Description Question 2.Formative Multiple choice questions							
Outcomes		1	•							
Upon comple	tion of the course	, the students will be able to:								
CO602. 1	Use the various fac systems.	e various fading models for performance analysis of wireless communication								
CO602. 2	Design a wireless of	Design a wireless communication system of desired capacity								

CO602. 3 Design the equalization techniques in advanced algorithms for automation of wireless receivers.

CO602. 4 Analyze the applications involving multi antenna systems.

CO602. 5 Interpret the Multiuser transceiver concepts.

Text Books

1. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2007.

2. Rappaport. T.S., "Wireless Communication", Pearson Education, 2003.

Reference Books

- 1. Andreas.F. Molisch, "Wireless Communication" John Wiley, India, 2006..
- 2. Arogyaswami Paulraj, et al, "Introduction to Space-Time Wireless Communications", Cambridge University Press, 2003.
- 3. Simon Haykin& Michael Mohar, "Modern Wireless Communications" Pearson Education, 2007.
- 4. Gordon L. Stuber, "Principles of Mobile Communication", Springer International Ltd., 2001.

Web Resources

- http://www.nptelvideos.in/2012/11/advanced-3g-and-4g-wireless-mobile.html
- https://www.egr.msu.edu/~tongli/Introduction-WCN.pdf

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3										3	1	2	
2	3		3									3	2		3
3				3								3			
4	3				3	3						3		2	1
5				3	3	3	3					3	3	1	2

0.4001.600		L	Τ	Р	C	
24CS1603	ADVANCED DIGITAL SIGNAL PROCESSING					
		3	0	0	3	
Prerequisites	s for the course					
• The pre	-requisite knowledge required by the students to study this Course	e is ba	sic k	nowle	dge in	
Signal I	Processing.					
Objectives	-					
1. The stu	dent understands mathematical description and modelling of discre	ete tim	ne rai	ndom		
signals.						
2. The St	udent will be able to understand the spectral estimation					
3. The stu	dent is conversant with important concepts in various types of filte	ers.				
	dent learns various adaptive filters and its applications.					
	dent is familiar with multirate concepts, techniques and wavelet tra	ansfor	ms			
	dent is furnitur with multifule concepts, teeningdes and wavefet at	ansioi	1115			
UNIT I	UNIT I DISCRETE RANDOM SIGNAL PROCESSING					

Discrete Random Processes- Ensemble Averages, Stationary processes, Bias and Estimation, Auto covariance, Autocorrelation, Parseval's theorem, Wiener-Khintchine relation, White noise, Power Spectral Density, Spectral factorization, Filtering Random Processes, Special types of Random Processes – ARMA, AR, MA –Harmonic Process

UNIT II	SPECTRAL ESTIMATION	9
Estimation of	spectra from finite duration signals, Nonparametric methods - P	eriodogram, Modified
periodogram, E	artlett, Welch and Blackman-Tukey methods, Parametric methods	– ARMA, AR and MA
model based sp	ectral estimation, Solution using Levinson-Durbin algorithm	

UNIT III		LINEA	R ES	TIM	ATIC)N AND	PREDIC	TION		9	
	· _						~		-		-

Linear prediction – Forward and Backward prediction, Solution of Prony's normal equations, Least mean-squared error criterion, Wiener filter for filtering and prediction, FIR and IIR Wiener filters, Discrete Kalman filter

UNIT IV	JNIT IV ADAPTIVE FILTERS					
FIR adaptive filters - adaptive filter based on steepest descent method- Widrow-Hoff LMS algorithm,						
Normalized LMS algorithm, Adaptive channel equalization, Adaptive echo cancellation, Adaptive noise						
cancellation, RLS adaptive algorithm.						

UNIT V	MULTIRATE DIGITAL SIGNAL PROCESSING AND	
	WAVELET TRANSFORM	

9

45

Multirate system –Decimator, Interpolators – Polyphase structure - Multistage implementation of multirate system – Wavelet transform: Discrete Wavelet transform one dimension (Haar Wavelet transform) - wavelet packets - Application to subband coding

I otal Periods	Total	Periods
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Suggestive Assessment Methods							
Continuous Assessment Test	Formative Assessment Test	End Semester Exams					
(30 Marks)	(10 Marks)	(60 Marks)					
1.Description Questions	1.Assignment	1.Description Questions					
2.Formative Multiple choice	2.Online Quizzes	2.Formative Multiple					
questions	3.Problem solving Activities	choice questions					

Outcomes

Upon completion of the course, the students will be able to:

- CO603.1 To understand the various special types of Random Processes in communication receiver
- CO603. 2 To understand the Power Spectrum
- CO603. 3 To design optimum filters in various applications of signal processing
- CO603.4 To design adaptive filters
- CO603. 5 To understand multirate systems and wavelet transforms.

Text Books

1. 1.Monson H. Hayes, 'Statistical Digital Signal Processing and Modeling, Wiley India (P) Ltd. 2008

2. P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Prentice Hall, 1992.

Reference Books

- 1. Simon Haykin , Telagarapu Prabhaka "Adaptive Filter Theory" Prentice Hal,2014
- 2. Saeed V. Vaseghi "Advanced digital signal processing and noise reduction: fourth edition, Wiley, 2008
- 3. John.G.Proakis, Dimitris.G.Manolakis "Digital signal Processing-Prinicples, Algorithms and Applications" Pearson, 2014

Web Resources

- <u>https://nptel.ac.in/courses/117/101/117101001/</u>
- <u>http://www.nptelvideos.in/2012/12/advanced-digital-signal-processing.html</u>

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	1								3	3	1	2	
2	3	3	1								3	3			3
3	3	3	1								3	3	3	2	
4	3	3	1								3	3			1
5	3	3	1								3	3	3	1	2

24CS1604

ADVANCED DIGITAL COMMUNICATION TECHNIQUES

L	Т	Р	С
3	0	0	3

Prerequisites for the course

• The pre-requisite knowledge required by the students to study this Course is basic knowledge in Digital Communication.

Objectives

- 1. To extend the theory of Constant envelope modulation to M-ary schemes and to familiarize the concept of Spread Spectrum.
- 2. To develop the mathematical and algorithmic foundations of the error detecting and error correcting codes used in modern communications systems.
- 3. To demonstrate the concept of Convolution coding in form of Tree diagram and trellis code.
- 4. To study about the Viterbi algorithm in Turbo coding
- 5. To develop the spread spectrum signal concept in Digital communication.

· · · · · · · · · · · · · · · · · · ·					
UNIT I	DETECTION	9			
Pass band Tran	smission model - Gram Schmidt orthogonalization procedure, Ge	cometric Interpretation			
of signals, Response of bank of correlators to a noisy input-Detection of Known signals in noise - correlation Receiver- Matched Filter Receiver - Detection of signals with unknown phase- Probability of					
error.					

Advantages of Constant Envelope Modulation - Minimum Shift Keying- Gaussian Minimum Shift Keying- M-ary Pulse Amplitude Modulation - M-ary Quadrature Amplitude Modulation – M-ary Phase Shift Keying- M-ary Frequency Shift Keying, Non Coherent modulation Techniques.

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UNIT III	CO	NVOLUTIONAL CODING		9		
		olynomial- State diagram- Tree di				
Maximum likelihood Decoding - Distance properties - Sequential decoding. Coded modulation for						
bandwidth-constrained channels-Trellis coded modulation- Set Partitioning, Four state trellis-coded						
	-	tellation, Eight-state trellis code for c	oded 8-P	SK modulation, Eight-		
	rectangular QAM sig	TURBO CODING		0		
UNIT IV			- 1. T	<u>9</u>		
		S Turbo Code- cdma2000 Turbo C		,		
		cations of the MAP Algorithm-The				
		ormance over Gaussian channels, T	urbo Cod	ing Performance over		
Rayleigh Chan			. . .			
UNIT V	SPREAD SPI	ECTRUM SIGNALS FOR DIGIT	AL	9		
Model of sprea	d Spectrum Digital (COMMUNICATION Communication System-Direct Sequ	ience Spre	ad Spectrum Signale_		
-		· Generation of PN Sequences and its	-			
-		nce of FH Spread Spectrum Signals				
	•					
system based o	II FH spiead spectru	n signals- Synchronization of Spread	-	-		
<u>C</u>	N/		Periods	45		
	ssessment Method					
(30 Ma	ssessment Test	Formative Assessment Test (10 Marks)	End Sei (60 Ma	mester Exams		
	2		ì	2		
1.Description	•	1.Assignment		ription Questions		
questions	Multiple choice	2.Online Quizzes 3.Problem solving Activities		2.Formative Multiple choice questions		
-		5.1 roblem solving Activities	choice			
Outcomes						
		the students will be able to:				
CO604. 1		t and non coherent detection in detail		a of owner note and		
CO604. 2	spectral efficiency	ce of a pass band digital communication syst	tem in terms	s of error rate and		
CO604. 3	1 *	lasses of error detecting and error co	rrecting c	odes and how they		
	are used in practice.		-			
CO604. 4	Explain the concepts of	Turbo coding.				
CO604. 5 To Apply Spread Spectrum Techniques in Wireless Communication Technologies						
Text Books						
1 (1) 11						
ť	, 0	unications", John Wiley, 2006.	T	0010		
-		unication System", Wiley Student				
		unications", Pearson Education, s	econd edi	tion, 2001		
Reference Bo	OKS					

1. John G. Proakis., "Digital Communication", McGraw Hill Publication, 4th edition, 2001

- 2. S.Lin&D.J.Costello, Error Control Coding (2/e) Pearson, 2005.
- 3. L. Hanzo, T.H. Liew&B.L. Yeap, "Turbo Coding, Turbo Equalization & Space-Time Coding", Wiley, 2002.
- 4. Theodore S.Rappaport., "Wireless Communications", Pearson Education, 2nd edition 2002.
- 5. Stephen G. Wilson., "Digital Modulation and Coding", Pearson Education, First Indian Reprint, 2003.
- 6. 9. Rodger E. Ziemer, Roger L. Peterson, David E. Borth , "Introduction to Spread Spectrum Communications", Prentice Hall, 1995.

Web Resources

- https://onlinecourses.nptel.ac.in/noc17_ee17/
- https://eprints.soton.ac.uk/271238/2/Turbo-coding-equalization-chapter-1-3-13-18.pdf

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	1								3	3	1	2	
2	3	3	1							2	1	3			3
3	3	3	1								2	3	3	2	
4	3	3	1							2	3	3			1
5	3	3	1								3	3	3	1	2

24081605		L	Τ	Р	C
24CS1605	RESEARCH METHODOLOGY FOR ENGINEERS	3	0	0	3
Prerequisites for	the course		Ŭ	v	
NIL					
Objectives					
1. To understa	nd some basic concepts of engineering research and its method	ologie	s.		
2. To identify	various sources of information for literature review.				
3. To familiar	ze the various procedures for analysis and optimization of rese	arch te	chniq	ues	
4. To understa	nd report writing and presentation skills.			-	
5. To understa	nd about intellectual property rights				
UNIT I	INTRODUCTION TO RESEARCH METHODOLOGY			9	
Research –types of	research-research process, engineering research- objectives, mo	tivatio	n, typ	es, res	earcl
question, formulat	ing a research problem		•••		
UNIT II	LITERATURE REVIEW			9	
		•			

New and Existing Knowledge, Analysis and Synthesis, Types of Publications, Bibliographic Databases, Measures of Research impact, keywords, Types of Plagiarism, Software Used for Identifying Plagiarism Techniques to Avoid Plagiarism, ethics in engineering research

UNIT III

ANALYSIS AND OPTIMIZATION

Research tools, Statistics-one dimensional, two dimensional, multidimensional, Optimization Methods –

Two parameter, multi parameter, cost function. Survey research methods

UNIT IV	TECHNICALWRITING /PRESENTATION	9
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Technical writing – attributes and reasons, writing strategies, Journal Paper: Structure and Approach, Language Skills, Writing Style, and Editing, Rules of Mathematical Writing, Attributions and Citations, Acknowledgments, patents.

UNIT V	INTELLECTUAL PROPERTY RIGHTS	9

Introduction, Significance, Requirements for Patentability, Application Preparation and Filing, Forms of IPR, IPR and Licensing, patent – examples

Total Periods

45

9

Suggestive Assessment Methods		
Continuous Assessment Test	Formative Assessment Test	End Semester Exams
(30 Marks)	(10 Marks)	(60 Marks)
1.Description Questions	1.Assignment	1.Description Questions
2.Formative Multiple choice	2.Online Quizzes	2.Formative Multiple
questions	3.Problem solving Activities	choice questions

Outcomes

Upon completion of the course, the students will be able to:

- CO605.1 Demonstrate the concepts of engineering research and its methodologies.
- CO605.2 Understand the various methods used to collect the data for research.
- CO605.3 Formulate appropriate research problem and conduct the experiments using analysis and optimization
- CO605.4 Write quality research in engineering.
- CO605.5 Understand the concepts of intellectual property rights.

Text Books

1. Dipankar Deb, Rajeeb Dey, Valentina E. Balas."Engineering Research Methodology A Practical Insight for Researchers",Springer.2019

2. David V. Thiel, "Research Methods for Engineers", Cambridge university press, 2014

 Vinayak Bairagi Mousami V. Munot ,"Research Methodology A Practical And Scientific Approach", CRC Press, 2019

Reference Books

1. Ranjit Kumar, "Research Methodology a step-by-step guide for beginners" SAGE publications, Fifth edition, 2019

Web Resources

- <u>https://nptel.ac.in/courses/107/108/107108011/</u>
- https://onlinecourses.swayam2.ac.in/cec20 hs17/preview

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	1								3	3	2	1	1
2	3	3	1								3	3	2	1	1
3	3	3	1								3	3	2	1	1
4	3	3	1								3	3	2	1	1
5	3	3	1								3	3	2	1	1

$1 \rightarrow Low 2 \rightarrow Medium 3 \rightarrow High$

		L	Т	P	C
24CS1611	COMMUNICATION SYSTEMS LABORATORY - I	4	0	4	2
Dronoguicitos	for the course				

Prerequisites for the course

• The pre-requisite knowledge required by the Students to study this Course is basic knowledge in Digital Communication lab.

Objectives

- 1. To analyze the performance of error control codes and spectral estimation
- 2. To design and test LMS, RLS algorithm and BER
- 3. To analyze lossless coding techniques and OFDM transceiver design..
- 4. To design the radiation pattern of antenna.
- 5. To design and estimate the cancellation and fractal structure of antenna

S.No	List of Experiments	CO
1	Design and performance analysis of error control encoder and decoder (CRC and Convolution Codes)	1
2	Design and Analysis of Spectrum Estimators (Bartlett, Welch) .	1
3	Channel equalizer design (LMS, RLS algorithms)	2
4	BER performance Analysis of M-ary digital Modulation Techniques (coherent & non coherent) in AWGN Environment .	2
5	Design and performance analysis of Lossless Coding Techniques - Huffman Coding and Lempel Ziv Algorithm	3
6	OFDM transceiver design .	3
7	Design 2D Radiation Pattern of the antenna.	4

	8	Desig	n 3D R	adiatio	on Pat	tern of	f the ai	ntenna	l .					4	
	9	Const	ruction	and si	mulati	on of a	n Fracta	al Struc	cture					4	
	10	Noise	/ Echo	cance	llation	.(LMS	S / RLS	algori	thms)					5	
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	ıtcom														
U]	pon c	omple	tion o	f the c	ourse	, the s	tuden	ts wil	l be al	ole to:					
	CO61	1.1	To ana	alyze tl	he perf	orman	ce of e	rror co	ntrol c	odes and	1 spectr	al estim	ation		
	CO61	1.2		•	-		RLS a				-				
	CO61	1.3								FDM tra	nsceive	r design			
	CO61	1.4	To des	sign the	e radia	tion pa	ttern o	f anten	na the	desired	frequer	ncies			
	CO61	1.5	To des	sign an	d estin	nate th	e cance	ellatior	and fi	actal str	ucture	of anten	na		
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UNIT III WAVELENGTH ROUTING NETWORKS 9	Prere 1. Objec 1. 2. 3. 4. 5. UN Light products Amplie UN Introd	equisite The pr Advan Enable Enable Enable Comm Make UIT I propaga al Netw fiers, Sv IT II uction t	re-requise students the students the stude the stude the stude the stude tion in o ork Correst witches,	to learn the dents to ider dents to ider dents to desi lents to appl n and analyz ents to mana OPTI optical fibers mponents – Wavelength OPTICA al Networks	ge require basic of tify an ign Opt ly the l ze the t age the CAL S Coupl n Conve L NE s: SON	uired b ion and optical nd forn tical N basic	by the St d Comr l compo nulate d letwork Network ivision r al netwo EM CO ndwidth solators RK AR SDH s	tudents nunicat onents f lifferent Routin king kn nultiple orks in i DMPO h, Dispe & Cin CHITI tandarc	to study the tion System for realizing t networking ag Algorith nowledge to exing in op its configur NENTS ersion effect rculators, 1 ECTURES ds, Metrop	his Course ns Laborate g any optic ng topologi ms. tical doma ration, faul ts, Non-Li Multiplexe	3 is bas ory I. cal fun ies. ny so in. t and near of rs & a Ne	0 sic k nctic ort o perf effec Filt	0 cnow f en form 9 cts; \$ 9 rks,	d to nance Solito	end end e. ons- tica	
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Optical layer, Node Designs, Routing and Wavelength Assignment, Virtual topology design problem,Regular virtual topology design- Predetermined Virtual topology and Light path routes-Architectural variations.

UNIT IV	PACKET SWITCHING AND ACCESS NETWORKS	9
Photonic Packe	et Switching - OTDM, Multiplexing and Demultiplexing, Syncl	nronisation, Broadcast
OTDM networ	ks, Switch-based networks- Access Networks – Network Architec	ture overview, OTDM
networks- Opti	cal Access Network Architectures- Future Access Networks, FTTH	I Scenario in India and
Foreign Countr	ies.	

UNIT V	NETWORK DESIGN AND MANAGEMENT	9
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Transmission System Engineering – System model, Power penalty - transmitter, receiver, Optical amplifiers, crosstalk, dispersion- Wavelength stabilization; Overall design considerations- Control and Management – Network management functions, Configuration management, Performance management, Fault management, Optical safety.

	Total	Periods	45
Suggestive Assessment Method	S		
Continuous Assessment Test	Formative Assessment Test	End Ser	mester Exams
(30 Marks)	(10 Marks)	(60 Ma	rks)
1.Description Questions	1.Assignment	2.Form	ription Questions
2.Formative Multiple choice	2.Online Quizzes		ative Multiple
questions	3.Problem solving Activities		questions

Outcomes

Upon completion of the course, the students will be able to:

- CO601.1 Apply knowledge of basic optical components for realizing any optical function.
- CO601. 2 Identify and formulate different networking Topologies.
- CO601. 3 Design Optical Network Routing Algorithms.
- CO601.4 Apply the basic Networking knowledge to realize any sort of end to end communication and Analyze the Time division multiplexing in optical domain.

CO601. 5 Manage the optical networks in its configuration, fault and performance.

Reference Books

- 1. Rajiv Ramaswami, Kumar N. Sivarajan and Galen H. Sasaki "Optical Networks : A Practical Perspective", Harcourt Asia Pvt. Ltd., Third Edition 2010.
- 2. Mohammad Ilyas, Hussein T. Mouftah, "Handbook of Optical Communication Networks", Taylor and Francis, First edition, 2007.
- 3. C.Siva Ram Moorthy and Mohan Gurusamy, "WDM Optical Networks :Concept, Design and Algorithms", Prentice Hall of India, First Edition, 2002.
- 4. Biswanath Mukherjee, "Optical Communication Networks", McGrawHill Revised Edition 2006.
- 5. P.E. Green, Jr., "Fiber Optic Networks", Prentice Hall, NJ, 1993. 6. Rajiv Ramaswami and Kumar N. Sivarajan, "Optical Networks : A Practical Perspective", Harcourt Asia Pvt. Ltd., First Edition 1997.
- 6. Rajiv Ramaswami, Kumar N. Sivarajan and Galen H. Sasaki "Optical Networks : A Practical Perspective", Harcourt Asia Pvt. Ltd., First Edition 2005.

Web Resources

- <u>www.nextgenerationoptical.com</u>
- <u>http://www.lightwaveonline.com</u>
- http://aicte-stream/Nptel Lecture by Dr. MukundaRao.

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1	1		1				2	1	2	1	2	
2	3	2	1	1						2	1	2	2		3
3	3	2	2	1		1				2	1	2		2	
4	3	2	1	1						2	1	2			1
5	3	2	2	1		1				2	1	2	3	1	2

24CS2602	MIC AND RF TRANSCEIVER DESIGN	L	T	Р	C
		3	0	0	3
Prerequisite	s for the course	•			•
1. The	pre-requisite knowledge required by the Students to study this Cou	irse is	basic	c knov	wledge
in N	Aicrowave Engineering				
Objectives					
1. To desi	gn and analyze different microwave components				
2. To use	SMITH chart to analyze the region of stability and instability for de	esignii	ng an	nplifie	ers and
oscillat	ors.				
3. Design	of RF circuits and RFIC system				
4. Design	passive and active microwave Circuits and MIC Systems				
5. Deign t	he system using MMIC Technologies.				
UNIT I	MICROWAVE TRANSISTOR AND AMPLIFIER DESIGN			9	
Power Gain Ec	uations- Stability Considerations- Constant gain circles:Unilateral	case-	Uni	ateral	Gain
Constant Gain	circles:Bilateral case- Operating and Available Power Gain Circles	8- DC	Bias	Netw	vorks
UNIT II	MICROWAVE HIGHPOWER AMPLIFIER AND OSCILLTOR DESIGN			9	
Noise in Two	port Network- Constant Noise Figure Circles- Broadband Amplifi	er De	sign-	High	powe
Amplifier Des	ign, Two stage amplifier design- One Port Negative-Resistance	Oscil	lator	s- Tw	o Por
Nagativa Dasi	tance Oscillators- Oscillator design using large signal mea	suren	nents	- Oso	cillato
negative-kesis					

UNIT III	TRAN	SCEIVER ARCHITECTURES		9	
Noise Figure,	Effects of Nonlinea	rity, Harmonic Distortion, Gain Co	mpressio	n, Cross Modulation,	
Intermodulatio	n, Cascaded Nonlin	ear Stages AM/PM Conversion, Se	nsitivity	and Dynamic Range	
Transceiver A	Architectures-Genera	l Considerations, Heterodyne Rec	eivers,	, Direct Conversion	
Receivers, Ima	ge Reject Receivers,	Low-Receivers, Transmitter Architec	tures - Ge	eneral Considerations	
	o Step up conversion				
UNIT IV		OWAVE PASSIVE CIRCUITS		9	
Overview of P	lanar Transmission L	ines- Design Parameters for Strip line	es and Mi	crostrips - Realization	
		Impedance method and STUB metho		-	
•	Rat-Race Coupler, Po	-	,	C	
	-	SIGN USING MMIC TECHNOLO	GY	9	
-		icro Machined Antennas - Micro Elec		-	
-	•••	Array Radar- Satellite Transponder -I		•	
	Avionic Systems Int	•	integrated		
171C modules		Total P	eriods	45	
Suggestive A	ssessment Method		ciiuus	тJ	
22	ssessment Test	Formative Assessment Test	End So	mester Exams	
(30 Ma		(10 Marks)	(60 Ma		
1.Description		1.Assignment		ription Questions	
	Multiple choice	2.Online Quizzes		rmative Multiple re questions	
questions	-	3.Problem solving Activities	choice		
Outcomes					
Upon comple	tion of the course,	the students will be able to:			
CO602. 1	Perform transistor	analysis and be able to design an	nplifiers	and oscillators at	
	microwave frequen	cies			
CO602. 2	Perform gain analy	sis and be able to design amplifiers a	nd oscill	ators at microwave	
	frequencies.				
CO602. 3	•	d for the required performance.			
CO602. 4	Design an MIC circ	cuit for the required performance.			
CO602. 5	Design application	specific MIC Systems.			
Text Books					
1. Jia Sh	eng Hong, M. J. L	ancaster, "Microstrip Filters for F	RF/Micro	wave Applications"	
John V	Viley & Sons, 2001				
2. Guiller	mo Gonzalez, "Mic	rowave Transistor Amplifiers – Ana	alysis and	d Design", II Edition	
Prentie	ce Hall, New Jersy				
3. Thoma	is H.Lee, "Planar M	licrowave Engineering", Cambridge	e Univer	sity Press, 2004	
4. Reinho	d.Ludwig and Pav	elBretshko, "RF Circuit Design", P	earson E	ducation, Inc., 2006	
5. B.Raza	vi,"RF Micro elect	ronics", Pearson Education, Second	Edition	, 2012	
Reference Bo	oks				
1. Jia Sh	eng Hong, M. J. L	ancaster, "Microstrip Filters for F	RF/Micro	wave Applications"	
John V	Wiley & Sons, 2001	_			
	rmo Gonzalez, "Mic	erowave Transistor Amplifiers – An	alysis and	d Design", II Edition	
2. Guille	,	*	-	- /	
	ce Hall, New Jersy				

- 4. Reinhold.Ludwig and PavelBretshko, "RF Circuit Design", Pearson Education, Inc., 2006
- 5. B.Razavi,"RF Micro electronics", Pearson Education, Second Edition, 2012

Web Resources

- http://www.analog.com/library/.../archives/.../EDCh%204%20rf%20if.pdf
- <u>http://www.highfrequencyelectronics.com/Archives/Aug11/HFE0811_Maloratsky.pdf</u>
- http://adsabs.harvard.edu/abs/1987maa..agar....D

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1	1		1				2	1	2	1	2	
2	3	2	1	1						2	1	2			3
3	3	2	2	1		1				2	1	2	3	2	
4	3	2	1	1						2	1	2			1
5	3	2	2	1		1				2	1	2	3	1	2

24CS2603	
24CS2003	

5G NETWORKS

L	Т	Р	С
3	0	0	3

9

9

Prerequisites for the course

• The pre-requisite knowledge required by the Students to study this Course is basic knowledge in Computer Networks and Wireless Communication

Objectives

- 1. To study about advanced wireless network, 5G and Evolutions.
- 2. To study about Physical Architecture and 5G Network architecture,
- 3. To study about multi-carrier waveforms FBMC and GFDM.
- 4. To study about Multiple Access Techniques in 5G.
- 5. To study about the MTC and D2D communication

INTRODUCTION TO 5G AND BEYOND

5G characteristics and requirements, Applications, Case studies, 5G channel models: METIS channel models, Map-based model, stochastic model, Comparison of Models

UNIT II

UNIT I

5G ARCHITECTURE

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 III	MULTI-CARRIER WAVE FORMS FOR 5G	9
	UNIT III	UNIT III MULTI-CARRIER WAVE FORMS FOR 5G

Filter-bank based multi-carrier (FBMC)- Principles, Transceiver block diagram, Frame structure, Resource structure, allocation, mapping.Universal filtered multi carrier (UFMC)- Principles, Transceiver structure, Frame and Resource structure, allocation, mapping. Generalized frequency division multicarrier (GFDM) –Principles, Transceiver Block diagram, Frame structure, Resource structure, allocation, mapping, MIMO-GFDM

UNIT IV	MULTIPLE ACCESS TECHNIQUES IN 5G 9						
Challenges in OFDM- NOMA – Principle- Superposition Coding, Successive Interference Cancellation,							
Power Domain	Power Domain NOMA, Sparse Code NOMA - types, Power Domain Sparse Code NOMA, Cooperative						
NOMA – Benefits and Challenges							
UNIT V	COOPERATIVE COMMUNICATION	9					

Machine Type Communication (MTC), Device to Device Communication (D2D), 5G Narrowband IoT, Cloud Computing architecture and Protocols, Relaying: Cooperative NOMA- Benefits and Challenges, Half duplex relaying, Full duplex relaying, Amplify and forward relaying, Decode and forward relaying, Decode and forward relaying with PLNC, BER Analysis, Capacity Analysis.

Total Periods

45

	IUtal	renous	43					
Suggestive Assessment Methods								
Continuous Assessment Test (30 Marks)	Formative Assessment Test (10 Marks)	End Se (60 Ma	mester Exams rks)					
1.Description Questions 2.Formative Multiple choice questions	1.Assignment 2.Online Quizzes 3.Problem solving Activities	2.Form	ription Questions ative Multiple questions					
<u>.</u>								

Outcomes

Upon completion of the course, the students will be able to: Able to analyze the performance of different channel models adopted in 5G wireless CO603.1 systems CO603. 2 Able to design a transceiver for Multicarrier waveforms. CO603.3 Able to analyze multiple access techniques in 5G networks CO603.4 Able to design a pilot, estimate channels and analyze capacity for single cell and multi cell Massive MIMO. CO603.5 Able to analyze different types of cooperative communications **Text Books** 1. AfifOsseiran, Jose.F.Monserrat and Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016.

- Robert W. Heath Jr., Nuria González-Prelcic, SundeepRangan, WonilRohand Akbar M. Sayeed, "An Overview of Signal Processing Techniques for Millimeter Wave MIMO Systems", IEEE Journal of Selected Topics in Signal Processing, Vol. 10, No. 3, April 2016.
- 3. Min ChulJu and Il-Min Kim, "Error Performance Analysis of BPSK Modulation in PhysicalLayer Network-Coded Bidirectional Relay Networks", IEEE Transactions on Communications, Vol. 58, No. 10, October 2010.

Reference Books

1. Shengli Zhang, Soung-Chang Liew, Patrick P.Lam, "Physical Layer Network Coding", Mobicom _06, Proceeding of the 12th International Conference on Mobile Computing and Networking, pp.358-365, Los Angeles, CA, USA, Sep.23-29,2006.

- 2. ThomasL. Marzetta, ErikG. Larsson, HongYang, HienQuocNgo, "Fundamentals of Massive MIMO", Cambridge University Press, 1stEdition, 2016
- 3. AfifOsseiran, Jose F. Monserrat, Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2nd edition, 2011
- 4. Erik Dahlman, Stefan Parkvall, Johan Sköld, "5G NR: The Next Generation Wireless Access Technology", Elsevier, 1stEdition, 2016.
- 5. Jonathan Rodriguez." Fundamentals of 5G Mobile Networks", Wiley, 1stEdition, 2010.

Web Resources

- <u>https://nptel.ac.in/courses/117/104/117104099/</u>
- https://nptel.ac.in/courses/117/102/117102062/
- https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-cs09/

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	2						2	2	1	2	
2	3	3	3	3	2						2	2			3
3	3	3	3	3	2						2	2	3	2	
4	3	3	3	3	3						2	2			1
5	3	3	3	3	2						2	2	3	1	2

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COMMUNICATION SYSTEMS LABORATORY - II	4	0	

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2

Prerequisites for the course

• The pre-requisite knowledge required by the Students to study this Course is basic knowledge in Communication Systems lab I.

Objectives

- 1. To simulate the performance of EZW and Characterization of wireless communication signals
- 2. To analyze Additive Correlated / Uncorrelated White Noise and Estimation techniques
- 3. To design and determine the characteristics of CDMA system and SPIHT.
- 4. To design and simulate dipole and horn antenna
- 5. To design and simulate patch antenna and Audio and speech compression algorithms.

S.No	List of Experiments	СО
1	Simulation of Wavelet Transform Based Image Coding Algorithm- EZW.	1
2	Study the Spectral Characterization of wireless communication signals.	2
3	Simulation of spatially separated Signal in the presence of Additive Correlated / Uncorrelated White Noise	2

4	Analysis of performance of the Estimation techniques - MLE, MMSE, Bayes Estimator, MAP Estimator, Expectation Maximization (EM) algorithm .	2
5	Simulation and performance evaluation of a CDMA System .	3
6	Simulation of Wavelet Transform Based Image Coding Algorithm- SPIHT.	3
7	Design and simulate the Dipole antenna.	5
8	Design and simulate the Horn antenna.	5
9	Design and simulate the Patch antenna.	4
10	Simulation of Audio and speech compression algorithms a) Companding techniques. b) Linear Predictive Coding techniques.	4

Total Periods :60

Suggestive Assessment Methods						
Lab Components Assessments (50 Marks)	End Semester Exams (50 Marks)					
1.Experiment 2.Model lab exam	1.End semester lab exam					

Outcomes

Upon completion of the course, the students will be able to:

- CO611. 1 Analyze the performance of EZW and Characterization of wireless communication signals
- CO611. 2 Analyse Additive Correlated / Uncorrelated White Noise and Estimation techniques
- CO611. 3 Design characteristics of CDMA system and SPIHT.
- CO611. 4 Design and simulate dipole and horn antenna.
- CO611. 5 Design and simulate patch antenna and Audio and speech compression algorithms.

Laboratory Requirements

Software Requirement:

- CST Studio
- SCILAB

Reference Books

- 1. J.G.Proakis, M.Salehi, —Fundamentals of Communication Systems^{II}, Pearson Education 2014.
- 2. Simon Haykin, —Communication SystemsI, 4th Edition, Wiley, 2014
- 3. B.P.Lathi, —Modern Digital and Analog Communication Systems^{II}, 3rd Edition, Oxford University Press, 2007.

Web Resources

- <u>https://nptel.ac.in/courses/108/101/108101112/</u>
- <u>https://nptel.ac.in/courses/108/102/108102420/</u>
- https://nptel.ac.in/content/storage2/courses/117105083/pdf/ssg_m9l29.pdf

СО	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1		2							2			1	2	
2	2									2			2		3
3		2												2	
4	1		2							1				2	1
5		2	1										3	1	2

SEMESTER III

S.No	Course Code	Course Name	L	Τ	Р	C		
Theory	Courses		_					
1	24CS3607	Machine Learning in Communication Networks	PC	3	3	0	0	3
2		Professional Elective V	PE	3	3	0	0	3
3		Professional Elective VI	3	3	0	0	3	
Practical Courses								
1	24CS3901	Dissertation I	EEC	12	0	0	12	6
2	24CS3902	Term Paper Writing	EEC	1	0	0	2	1
			Total	18h + 8 weeks	6	0	14	16

		L	T	Р	C
24CS3607	MACHINE LEARNING IN COMMUNICATION		0	0	
	NETWORKS				3
Prerequisites	s for the course				
• The pre	-requisite knowledge required by the students to study this Course is	s bas	ic kr	nowle	dge in
Artifici	al Intelligence.				
Objectives					
1. To und	erstand the concepts of Supervised and Unsupervised Learning.				
2. To expl	ore the different supervised learning techniques including ensemble r	netho	ods		
3. To lear	n different aspects of unsupervised learning and reinforcement learning	ıg			
4. To lear	the role of probabilistic methods for machine learning				
5. To und	erstand the basic concepts of neural networks and deep learning				
UNIT I			9		

Supervised and Unsupervised learning, Capacity, Over fitting and Under fitting, Cross Validation, Linear regression, Logistic Regression, Regularization, Naive Bayes, Principle Component Analysis, Support Vector Machines (SVM), Decision tree, Random forest, K-Means Clustering, k nearest neighbor.

NEURAL NETWORKS 9 **UNIT II** Feed forward Networks, Back propagation, Convolutional Neural Networks-LeNet, AlexNet, ZFNet, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Back propagation, Recurrent Neural Network (RNN). DISTRIBUTED ML AND REINFORCEMENT LEARNING 9 UNIT III Distributed optimization in resource-constrained systems, Communication-Efficient Distributed Edge Learning, Federated learning, Decentralized learning, Low-latency and on-device AI; Reinforcement Learning - Markov decision processes, Q-learning and Policy Optimization methods, Deep Reinforcement Learning (DRL), Multi-agent systems ML IN WIRELESS PHYSICAL LAYER SYSTEM DESIGN 9 **UNIT IV** Machine Learning in Channel Estimation, Feedback, and Signal Detection-Compressive sensing and pilot Estimation. Physical layer communications-Use of auto encoders for data transmission, Modulation, Channel coding, Modulation / Signal and Constellation classification, Localization, Spectrum Sensing using Deep Learning. **ML IN WIRELESS SYSTEMS AND SECURITY** UNIT V 9 LOS and NLOS channel classification, Water-filling power allocation for 5G systems, Optimization for OFDM and MIMO-OFDM systems. Optimization in beamformer design – Robust receive beamforming, Transmit downlink beamforming. IoT Application: MCU-Net, Radar for target detection, Array Processing, MUSIC, ML in Side channel analysis. **Total Periods** 45 **Suggestive Assessment Methods End Semester Exams Continuous Assessment Test Formative Assessment Test** (60 Marks) (30 Marks) (10 Marks) **1.Description Questions 1.Description Questions 1.Assignment 2.**Formative Multiple 2.Formative Multiple choice 2.Online Quizzes **3.Problem solving Activities** questions choice questions **Outcomes** Upon completion of the course, the students will be able to: Familiar with the different machine learning techniques and their use cases. CO603.1 CO603.2 In a position to formulate Neural Network based problems corresponding to different applications. CO603.3 In a position to formulate reinforcement learning concepts based problems corresponding to wireless applications. Able to evaluate machine learning techniques that are useful to solve wireless CO603.4 physical layer problems. CO603.5 In a position to read current research papers, understand the issues and implement the machine learning based real time solution approaches. **Text Books** 1. Ian Good fellow, Yoshua Bengio, and Aaron Courville, "Deep learning", Cambridge, MA", MIT Press, 2017.

- 2. Tom M. Mitchell, "Machine Learning", McGraw Hill, 1997.
- 3. Ethem Alpaydın, "Introduction to machine learning", MIT Press, 3rd Edition, 2014.

Reference Books

- 6. Richard S. Sutton, Andrew G. Barto, "Reinforcement Learning, An Introduction", 2018
- 7. Xu Wang , Sen Wang, Xingxing Liang , Dawei Zhao, Jincai Huang, XinXu , Bin Dai , and Qiguang Miao , "Deep Reinforcement Learning: A Survey", IEEE Transactions On Neural Networks And Learning Systems, 2017

Web Resources

- <u>https://nptel.ac.in/courses/106106139</u>
- https://nptel.ac.in/courses/106106184
- https://nptel.ac.in/courses/106105152

TERM PAPER WRITING

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In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

- 1. Selecting a subject, narrowing the subject into a topic
- 2. Stating an objective.
- 3. Collecting the relevant bibliography (atleast 15 journal papers)
- 4. Preparing a working outline.
- 5. Studying the papers and understanding the authors contributions and critically analysing each paper. 6. Preparing a working outline
- 7. Linking the papers and preparing a draft of the paper.
- 8. Preparing conclusions based on the reading of all the papers.
- 9. Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained. Activities to be carried out

Activity	Instructions	Submission week	Evaluation
Selection of area of	1	2 nd week	3 % Based on clarity of
interest and Topic	interest, topic and state an objective		thought, current
Stating an Objective			relevance and clarity in
			writing
Collecting	1. List 1 Special Interest Groups or	3 rd week	3% (the selected
Information about	professional society		information must be
your area & topic	2. List 2 journals		area specific and of
	3. List 2 conferences, symposia or		international and
	workshops 4. List 1 thesis title		national standard)
	5. List 3 web presences (mailing lists,		
	forums, news sites)		

	6. List 3 authors who publish regularly in		-
	your area		
	7. Attach a call for papers (CFP) from your		
	area.		
Collection of	• You have to provide a complete list of	4 th week	6% (the list of standard
Journal papers in	references you will be using- Based on your		papers and reason for
the topic in the	objective -Search various digital libraries		selection)
context of the	and Google Scholar		
objective - collect	• When picking papers to read - try to:		
20 & then filter	• Pick papers that are related to each other in		
	some ways and/or that are in the same field		
	so that you can write a meaningful survey		
	out of them,		
	• Favour papers from well-known journals		
	and conferences,		
	• Favour "first" or "foundational" papers in		
	the field (as indicated in other people's		
	survey paper),		
	• Favour more recent papers,		
	• Pick a recent survey of the field so you can		
	quickly gain an overview,		
	• Find relationships with respect to each		
	other and to your topic area (classification		
	scheme/categorization)		
	• Mark in the hard copy of papers whether		
	complete work or section/sections of the		
	paper are being considered		
Reading and notes	Reading Paper Process	5 th week	8% (the table given
for first 5 papers	• For each paper form a Table answering the	5 WEEK	should indicate your
1 1	following questions: • What is the main		understanding of the
	topic of the article?		paper and the evaluation
	• What was/were the main issue(s) the		is based on your
	author said they want to discuss?		conclusions about each
	• Why did the author claim it was important?		paper)
	• How does the work build on other's work,		
	in the author's opinion?		
	• What simplifying assumptions does the		
	author claim to be making?		
	• What did the author do?		
	What did the author do?How did the author claim they were going		
	• How did the author claim they were going to evaluate their work and compare it to		
	others?		
	• What did the author say were the		
	• what did the author say were the limitations of their research?		
	• What did the author say were the important		
	directions for future research? Conclude		
	unections for future research? Conclude		

	with limitations/issues not addressed by the		
	paper (from the perspective of your survey)		
Reading and notes for next5 papers	Repeat Reading Paper Process	6 th week	8% (the table given should indicate you understanding of the paper and the evaluation is based of your conclusions abou each paper)
Reading and notes for final 5 papers	Repeat Reading Paper Process	7 th week	8% (the table given should indicate you understanding of the paper and the evaluation is based on your conclusions abou each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8 th week	8% (this componen will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	9 th week	6% (Clarity, purpose and conclusion) 6% Presentation & Vive VoceIntroduction Background
Introduction Background	Write an introduction and background sections	10 th week	5% (clarity)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11 th week	10% (this component will be evaluated base on the linking and classification amon the papers)
Your conclusions	Write your conclusions and future work	12 th week	5% (conclusions clarity and your ideas)
Final Draft	Complete the final draft of your paper	13 th week	10% (formatting English, Clarity an linking) 4% Plagiarism Chec Report
Seminar	A brief 15 slides on your paper	14 th week	10% (based of presentation and Viva

SEMESTER IV

S.No	Course Code	Course Name	Catego ry	Contact Periods	L	Τ	Р	C
Practic	al Courses							
1	24CS4901	Dissertation II	EEC	24	0	0	24	12
			Total	24	0	0	24	12

List of Professional Electives Courses

S.No	Course	Course Name	Seme	L	Т	Р	С
Drofo	Code ssional Electiv	• I	ster				
Profes	ssional Electiv					· · · · · · ·	
1	24CS1701	Communication Network Security	Ι	3	0	0	3
2	24CS1702	Advanced Multimedia Compression Techniques	Ι	3	0	0	3
3	24CS1703	Advanced Digital Image Processing	Ι	3	0	0	3
4	24CS1704	VLSI Design for Signal Processing	Ι	3	0	0	3
5	21CS1705	High Performance FPGA System Design	Ι	3	0	0	3
Profes	ssional Electiv	e II					
1	24CS2701	Advanced Wireless Sensor Networks and WBAN	II	3	0	0	3
2	24CS2702	Massive MIMO and Millimeter Wave Communication	II	3	0	0	3
3	24CS2703	MIMO OFDM Systems	II	3	0	0	3
4	24CS2704	High Performanc Analog IC Design	II	3	0	0	3
Profes	ssional Electiv	e III					
1	24CS2705	Advanced Integrated SOC Design Techniques	II	3	0	0	3
2	24CS2706	Modern IOT	II	3	0	0	3
3	24CS2707	Real Time Embedded Systems	II	3	0	0	3
4	24CS2708	Smart Antennas	II	3	0	0	3
Profes	ssional Electiv	e IV	1			1	
1	24CS2709	VLSI Circuit Test and Verification Techniques	II	3	0	0	3
2	24CS2710	Modern Satellite Systems	II	3	0	0	3

3	24CS2711	Network Routing Algorithms	II	3	0	0	3
4	24CS2712	Remote Sensing	II	3	0	0	3
Profes	ssional Electiv	e V					
1	24CS3701	Embedded Wireless Sensor Networks	III	3	0	0	3
2	24CS3702	DSP Processor Architecture and Programming	III	3	0	0	3
3	24CS3703	RF and Radiation System Design	III	3	0	0	3
4	24CS3704	High Speed Communication Networks	III	3	0	0	3
Profes	ssional Electiv	e VI					
1	24CS3705	Cooperative Communication	III	3	0	0	3
2	24CS3706	VLSI Architecture for Image and Video Processing	III	3	0	0	3
3	24CS3707	Mobile Robotics	III	3	0	0	3
4	24CS3708	Advanced Radar and Navigational AIDS	III	3	0	0	3

List of Professional Electives I

S.No	Course Code	Course Name	Seme ster	L	Т	Р	C
1	24CS1701	Communication Network Security	Ι	3	0	0	3
2	24CS1702	Advanced Multimedia Compression Techniques	Ι	3	0	0	3
3	24CS1703	Advanced Digital Image Processing	Ι	3	0	0	3
4	24CS1704	VLSI Design for Signal Processing	Ι	3	0	0	3
5	21CS1705	High Performance FPGA System Design	Ι	3	0	0	3

24CS1701	COMMUNICATION NETWORK SECURITY	L	T	Р	C
		3	0	0	3
Prerequisites	s for the course				
• The pre	-requisite knowledge required by the Students to study this Course	e is ba	sic k	nowle	edge in
Networ	k security.				
Objectives					

- 1. To learn security mechanisms and techniques to provide security services.
- 2. To be exposed to symmetric & asymmetric key algorithms and key management aspects.
- 3. To be aware of the need for security in different layers and wireless network security.
- 4. To study the various network and Web security.
- 5. To be aware about the wireless network security.

UNIT I SECURITY SERVICES AND MECHANISMS

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Security Goals, Types of Attacks: Passive attack, active attack, attacks on confidentiality, attacks on Integrity and availability. Security services – Confidentiality, Integrity, Authentication, Non repudiation& Access control and Mechanisms- Encipherment, Data Integrity, Digital Signature, Authentication Exchange, Traffic Padding, Routing Control, Notarization & Access Control.

UNIT II	SYMMETRIC & ASYMMETRIC KEY ALGORITHMS	
---------	---------------------------------------	--

Substitutional Ciphers, Transposition Ciphers, Stream and Block Ciphers, Data Encryption Standards (DES), Advanced Encryption Standard (AES), RC4, Principle of Asymmetric key algorithms, RSA Cryptosystem.

UNIT III	INTEGRITY, AUTHENTICATION AND KEY	9
	MANAGEMENT	

Message Integrity, Hash functions: SHA, Digital signatures: Digital signature standards, Authentication: Entity Authentication: Biometrics, Key management Techniques.

UNIT IV	NETWORK SECURITY , FIREWALLS AND WEB	
	SECURITY	

Introduction on Firewalls, Types of Firewalls, Firewall Configuration and Limitation of Firewall. IP Security Overview, IP security Architecture, authentication Header, Security payload, security associations, Key Management. Web security requirement, secure sockets layer, transport layer security.

UNIT V	WIRELESS NETWORK SECURITY	9
Sagurity Attacl	risques analific to Winslass systems; Warm hals Tunnalling Das	WED for W: E

Security Attack issues specific to Wireless systems: Worm hole, Tunnelling, DoS. WEP for Wi-Fi network, Security for 4G networks: Secure Ad hoc Network, Secure Sensor Network.

Total Periods

Suggestive Assessment Methods **Continuous Assessment Test Formative Assessment Test End Semester Exams** (30 Marks) (10 Marks) (60 Marks) **1.Description Questions** 1.Assignment **1.Description Questions** 2.Formative Multiple choice 2.Online Quizzes 2.Formative Multiple **3.Problem solving Activities** questions choice questions

Outcomes

Upon completion of the course, the students will be able to:

CO701. 1 Identify and differentiate security attacks.
CO701. 2 Apply various Encryption, Authentication and Digital Signature Algorithms
CO701. 3 Configure firewalls based on the security requirements and secure the perimeter.
CO701. 4 Deal with different general purpose and application specific Security Protocols and Techniques.
CO701. 5 Provide security services at different layers for various network architectures.

Text Books

- 1. Behrouz A. Forouzan , Debdeep Mukhopadhyay,"Cryptography and Network security", Tata McGraw- Hill, Second Edition, 2011.
- 2. William Stallings, "Cryptography and Network security: Principles and Practice", Prentice Hall of India, New Delhi, Sixth Edition, 2013.
- 3. AtulKahate , "Cryptography and Network security", Tata McGraw- Hill, Third Edition, 2008

Reference Books

- 1. R.K.Nichols and P.C. Lekkas ," Wireless Security Models, Threats and Solutions", Tata McGraw- Hill, First Edition, 2006.
- 2. H. Yang et al., "Security in Mobile Ad Hoc Networks: Challenges and Solution", IEEE Wireless Communications, Feb. 2004.
- 3. L. Zhou and Z. J. Haas , "Securing Ad Hoc Networks", IEEE Network Magazine, vol. 13, no. 6, pp. 24-30, December 1999.
- 4. David Boyle and Thomas Newe, "Securing Wireless Sensor Networks Security Architecture", Journal of networks, Vol.3. No. 1. pp. 65 -76, Jan 2008
- 5. Perrig, A., Stankovic, J. And Wagner, D., "Security in Wireless Sensor Networks", Communications of the ACM, Vol. No.47, Issue. 6, pp 53-57, 2004

Web Resources

- http://highered.mcgraw-hill.com/sites/0072870222/student_view0/
- <u>http://williamstallings.com/Crypto/Crypto4e.html</u>

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2							2	2	3	1	2	
2	3	3	2	1	2						2	3	2		1
3	3	3	3		2					2	2	3		2	
4	3	3	2		2					2	2	3			1
5	3	3	2	1						2	2	3	3	1	2

24CS	4CS1702 ADVANCED MULTIMEDIA COMPRESSION TECHNIQUES	L	T	Р	C
	TECHNIQUES	3	0	0	3
Prere	quisites for the course			•	
٠	The pre-requisite knowledge required by the Students to study this Co	ourse is ba	sic k	nowle	dge in
	Multimedia compression.				
Objec	tives				
1.	To get familiarized with the multimedia concepts				
2.	To get acquainted with various compression techniques for text.				
	To study the various compression techniques in audio,				

- **4.** To understand the various compression techniques in image
- **5.** To get familiarized with various video compression methods.

UNIT I	M	ULTIMEDIA CONCEPTS		9
Special features	of Multimedia – G	raphics and Image Data Representatio	ns – Fur	ndamental Concepts in
Video and Digit	al Audio – Storage	requirements for multimedia applicat	tions -Ne	eed for Compression
Taxonomy of co	mpression techniq	ues - Overview of source coding, sou	urce mod	dels, scalar and vecto
quantization the	ory – Evaluation tee	chniques – Error analysis and methodo	ologies.	
UNIT II		TEXT COMPRESSION		9
Compaction tecl	niques – Huffman	coding – Adaptive Huffman Coding	– MNPS	5-Adaptive Arithmetic
coding — Dictio	nary techniques – l	LZW –WINRAR – exe compressors		
UNIT III	A	AUDIO COMPRESSION		9
Audio compress	ion techniques - µ	- Law and A- Law companding. Free	quency d	lomain and filtering -
Basic sub-band	coding -speech co	oding standard – G.722 – Audio codi	ing stand	lard- MPEG 4 audio
speech compress	ion techniques – Fe	ormant and CELP VocodersAAC- D	olby AC	23
UNIT IV	Ι	MAGE COMPRESSION		9
Lapped transfor	ms – LOT-LBT-	Transform based image compression	ı –JPEG	E-Embedded zero tre
coding - fractal	based image com	pression – partitioned IFS- Design of	Filter b	anks – Wavelet base
compression: Im	plementation using	; filters – EZW, SPIHT coders – JBIG	, JBIG2	standards.
UNIT V	Ţ	IDEO COMPRESSION		9
Video compress	ion techniques and	standards -MPEG - 4 and 7 - Motion	n estimat	ion and compensation
techniques - H.	261 Standard – DV	/I technology - PLV performance -	DVI rea	al time compression -
Packet VideoF	ractal based video o	compression – Quadtree PIFS.		
		Total P	eriods	45
Suggestive Ass	essment Method	S		
Continuous As	sessment Test	Formative Assessment Test	End Se	mester Exams
(30 Marl	ks)	(10 Marks)	(60 Ma	rks)
1.Description	Questions	1.Assignment	1.Desc	ription Questions
2.Formative M	ultiple choice	2.Online Quizzes	2.Form	ative Multiple
questions		3.Problem solving Activities	choice	questions
Outcomes				
Upon complet	on of the course,	the students will be able to:		
CO702. 1	To analyze the requ	uirement of compression in different r	eal time	applications.
CO702. 2	To Apply various of	compaction techniques for text compre	ession.	
CO702. 3	Fo understand the p	performance of audio compression tech	hniques.	
	Γo study the perfor	mances of various algorithms for imag	ge compi	ression
CO702. 4		erent standards applicable for video co	ompressi	ion.
CO702. 4 CO702. 5	To analyze the diff			
CO702. 5	To analyze the diff			
CO702. 5 Text Books	-	Compression – The Complete Refere	ence", S	pringer Verlag, Nev
CO702. 5 Text Books 1. 1.David	-		ence", S	pringer Verlag, Nev
CO702. 5 Text Books 1. 1.David York Inc	Salomon, "Data C c., Fourth Edition,			

Reference Books

- 1. K.R.Rao, P.C.Yip, "The transform and data compression handbook" CRC Press ,2018
- 2. Yun Q.Shi and Huifang Sun,"Image and Video Compression for Multimedia Engineering - Fundamentals,
- 3. Algorithms & Standards", CRC press, Second Edition, 2008
- 4. Mark S.Drew and Ze-NianLi, "Fundamentals of Multimedia", Prentice Hall, 2009.

Web Resources

- https://www.pearsonhighered.com/assets/ sample Chapter/0/1/3/2/ 0132406426.pdf
- <u>https://book.systemsapproach.org/data/multimedia.html</u>

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	1								3	3	1	2	
2	3	3	1								3	3			3
3	3	3	1								3	3	3	2	
4	3	3	1								3	3			1
5	3	3	1								3	3	3	1	2

24CS1703

ADVANCED DIGITAL IMAGE PROCESSING

L	Т	Р	С
	0	0	3

9

3

Prerequisites for the course

The pre-requisite knowledge required by the Students to study this Course is basic knowledge in Digital Image Processing.

Objectives

•

- 1. To understand the image fundamentals.
- 2. To understand the various image segmentation techniques.
- 3. To extract features for image analysis.
- 4. To introduce the concepts of image registration and image fusion.
- 5. To illustrate 3D image visualization

UNIT I FUNDAMENTALS OF DIGITAL IMAGE PROCESSING

Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, 2D image transforms-DFT, DCT, KLT,SVD. Image enhancement in spatial and frequency domain, Review of Morphological image processing

UNIT IISEGMENTATION9Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour
models, Texture feature based segmentation, Graph based segmentation, Wavelet based Segmentation -
Applications of image segmentation.

UNIT III	F	EATURE EXTRACTION		9
First and second	d order edge detection	n operators, Phase congruency, Localiz	zed featur	e extraction - detecting
		igh transform, shape skeletonization, I		
Texture descrip	otors- Autocorrelatio	n, Co-occurrence features, Runlengtl	h features	, Fractal model base
	filter, wavelet featur			
UNIT IV		RATION AND IMAGE FUSION		9
Registration -	Preprocessing, Fe	ature selection - points, lines, re	gions ar	nd templates Featur
		natching, Line matching, Region 1		
		ty transformation and Affine Transfo		
		ge Fusion - Overview of image fusion		
fusion -region	_		· •	
UNIT V		IMAGE VISUALIZATION		9
Sources of 3D	Data sets, Slicing the	Data set, Arbitrary section planes, Th	ne use of o	color, Volumetric
	e	g, Reflection, Surfaces, Multiple conr		
	D, Measurements on		Secon Bul	
processing in 5) a mi a si	4 5
			Periods	45
	ssessment Methods		T	
	ssessment Test	Formative Assessment Test	End Ser	mester Exams
(30 Ma)	rks)	(10 Marks)	(60 Ma	rks)
1.Description	Questions	1.Assignment	1.Desci	ription Questions
-	Multiple choice	2.Online Quizzes		ative Multiple
questions		3.Problem solving Activities		questions
•			chioree	questions
Outcomes				
		the students will be able to:		
CO703. 1		nentals digital image processing.		
CO703. 2	Describe image var	rious segmentation for image analysis		
CO703. 3	Describe image var	ious feature extraction techniques for	image an	alysis.
CO703.4	Discuss the concep	ts of image registration and fusion.		
CO703.5	Explain 3D image			
Text Books	Explain DD inlage			
	laghin Caghtaghr (2D and 2D Image registration for	Madiaal	Domoto Consing on
	•	2D and 3D Image registration for ",John Wiley and Sons,2005.	wiedical,	Remote Sensing and
	11	·- ·	Doorson L	ducation Inc. 2002
Reference Bo		ntals of Digital Image Processing', H	rearson r	Autation, mc., 2002
		Image Processing Handbook", CRG		
	,	o Aguado, "Feature Extraction and	Image P	rocessing", Academic
	Press,2008.	az Dishard F Woods Digital	Imaga D	magaging! Deeman
	Education, Inc., Sec	ez, Richard E. Woods, Digital	illiage r	rucessing, rearson
	, ,	g Liu, "Multisensor image fusion a	nd its An	nlications" Taylor&
	Francis,2006.	g Liu, Multisensoi iniage iusion a	nu ns Ap	plications, rayiore
	/			
	00			
Web Resourc		tol ac in /noc10 ooEE /neroview		
Web Resourc	//onlinecourses.np	otel.ac.in/noc19_ee55/preview		
Web Resourc <u>https:/</u> <u>https:/</u>	/ <mark>/onlinecourses.np</mark> / <mark>/en.unisi.it/ugov/</mark>	otel.ac.in/noc19_ee55/preview /degreecourse/89770 abama.ac.in/coursematerial_stag		

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3								2	2	1	2		1
2	3	3	2							1	3			3	2
3	3	2	3							2	2	3	2		
4	3	3								2	2			1	
5	3	3	2							1	3	3	1	2	3

24CS1704	VLSI DESIGN FOR SIGNAL PROCESSING	L	Τ	Р	C
		3	0	0	3
Prerequisites	s for the course				
• The pre	-requisite knowledge required by the Students to study this Course	is ba	sic k	nowle	dge i
VLSI D	besign.				
Objectives					
1. To f	amiliarize various representation methods of DSP algorithms, und	erstar	d the	;	
	ificance of the iteration bound and to calculate the same for a give	n sing	gle-ra	te and	l/or
	ti-rate DFG.				
	understand retiming and pipelining and parallel processing. Inderstand algorithms unfolding and folding on a given DFG.				
	inderstand algorithms unfolding and folding on a given DFO.	proc	essin	o for	FIR
	IIR filters	proc	035111	5 101	
5. To s	signify and calculate the effects of numerical strength reduction, sc	aling	and 1	ound	-off
nois	e for a given digital filter with limited word length.				
UNIT I	INTRODUCTION TO SIGNAL PROCESSING			9	
Typical DSP A	lgorithms – DSP Application Demands and Scaled CMOS Technology	ogies ·	- Rep	resen	tatior
of DSP Algorit	hms - Data-Flow Graph Representations. Introduction -Loop Bour	nd and	l Iter	ation	Bour
-Algorithms for	r Computing Iteration Bound: Longest Path Matrix and Multiple C	ycle	Meaı	ı algo	rithn
- Iteration Bour	nd of Multi-rate Data Flow Graphs				
UNIT II	PIPELINING, PARALLEL PROCESSING AND RETIMING			9	
Pipelining, Par	allel processing and Retiming- Introduction to Retiming -Defini	tions	and	Prope	erties
Solving Syster	ns of Inequalities - The Bellman-Ford Algorithm - The Floyd	War	shall	Algo	rithn
Retiming Tech	niques.				
UNIT III	UNFOLDING AND FOLDING			9	
Introduction, A	An Algorithm for Unfolding, Properties of Unfolding, Critical	Path,	Unf	oldin	g, ar
Retiming, App	lications of Unfolding, Introduction, Folding Transformation, F	Regist	er M	linim	izatio
Techniques, Re	gister Minimization in Folded Architectures.				
UNIT IV	FAST CONVOLUTION, PIPELINING AND PARALLEL			9	
	PROCESSING FOR FIR AND IIR FILTERS		1	1	11
	on – Cook-Toom algorithm, modified Cook-Toom algorithm, I s – Look-Ahead pipelining in first-order IIR filters, Look-Ahead pip				

UNIT V		STRENGTH REDUCTION, SCA	LING	9	
Introduction N		AND ROUNDING NOISE eduction – subexpression elimination	multiple cor	nstant	
	e	ing Noise, State Variable Description			
-	-	unding Noise in Pipelined IIR Filters	-	tions, searing and	
110 0110 110 110			Periods	45	
Suggestive A	ssessment Metho				
	ssessment Test	Formative Assessment Test	End Seme	ster Exams	
(30 Ma	rks)	(10 Marks)	(60 Marks	s)	
1.Description	1 Questions	1.Assignment	1.Descrip	tion Questions	
	Multiple choice	2.Online Quizzes	2.Formative Multiple		
questions		3.Problem solving Activities	choice qu	estions	
Outcomes					
Upon comple	tion of the course	e, the students will be able to:			
Text Books					
	,	SI Digital Signal Processing System	s: Design and	d Implementation	
Kei	print, Wiley, Inter	Science, 2014.			
-					
2. Joh	· · · · · ·	Dimitris K Manolakis, Digital S	0	ssing: Principle	
2. Joh Alg	orithms and Appli	Dimitris K Manolakis, Digital S cations, Prentice Hall, Fourth Edit	0	ssing: Principle:	
2. Joh Alg Reference Bo	orithms and Appli	cations, Prentice Hall, Fourth Edit	ion, 2015.		
2. Joh Alg Reference Bo 3. Mo	orithms and Appli ooks hammed Ismail ar		ion, 2015.		
2. Joh Alg Reference Bo 3. Mo Mc	orithms and Appli ooks hammed Ismail an Graw-Hill, 2014.	cations, Prentice Hall, Fourth Edit nd Terri Fiez, Analog VLSI Signa	ion, 2015. Il and Inforn	nation Processing	
2. Joh Alg Reference Bo 3. Mo Mc 4. S.Y	orithms and Appli ooks hammed Ismail ar Graw-Hill, 2014. 7. Kung, H.J. Whit	cations, Prentice Hall, Fourth Edit	ion, 2015. Il and Inforn	nation Processing	
2. Joh Alg Reference Bo 3. Mo Mc 4. S.Y 201	orithms and Appli ooks hammed Ismail an Graw-Hill, 2014. 7. Kung, H.J. Whit 0.	cations, Prentice Hall, Fourth Edit nd Terri Fiez, Analog VLSI Signa re House, T. Kailath, VLSI and M	ion, 2015. Il and Inforn Iodern Signal	nation Processing	
2. Joh Alg Reference Bo 3. Mo Mc 4. S.Y 201 5. S. I	orithms and Appli ooks hammed Ismail an Graw-Hill, 2014. 7. Kung, H.J. Whit 0. K. Mitra, Digital S	cations, Prentice Hall, Fourth Edit nd Terri Fiez, Analog VLSI Signa	ion, 2015. Il and Inforn Iodern Signal	nation Processing	
2. Joh Alg Reference Bo 3. Mo Mc 4. S.Y 201 5. S. I Mc	orithms and Appli ooks hammed Ismail an Graw-Hill, 2014. 7. Kung, H.J. Whit 0. K. Mitra, Digital S Graw-Hill, 2010.	cations, Prentice Hall, Fourth Edit nd Terri Fiez, Analog VLSI Signa re House, T. Kailath, VLSI and M	ion, 2015. Il and Inforn Iodern Signal	nation Processing	
2. Joh Alg Reference Bo 3. Mo Mc 4. S.Y 201 5. S. I Mc Web Resource	orithms and Appli ooks hammed Ismail an Graw-Hill, 2014. 7. Kung, H.J. Whit 0. K. Mitra, Digital S Graw-Hill, 2010.	cations, Prentice Hall, Fourth Edit nd Terri Fiez, Analog VLSI Signa re House, T. Kailath, VLSI and M	ion, 2015. Il and Inforn Iodern Signal	nation Processing	
2. Joh Alg Reference Bo 3. Mo Mc 4. S.Y 201 5. S. I Mc Web Resource • <u>https://</u>	orithms and Appli ooks hammed Ismail an Graw-Hill, 2014. 7. Kung, H.J. Whit 0. K. Mitra, Digital S Graw-Hill, 2010. ces nptel.ac.in/courses/1	cations, Prentice Hall, Fourth Edit nd Terri Fiez, Analog VLSI Signa re House, T. Kailath, VLSI and M ignal Processing –A Computer Bas	ion, 2015. Il and Inforn Iodern Signal	nation Processing	

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3													
2	3	3	2										2		
3	3	3												1	
4	3	2	1										2		
5	3	2													

24CS1705	HIGH PERFC	ORMANCE FPGA SYSTEM DESI	GN	L 3	Т 0	P 0	С 3
Prerequisites	for the course						
	requisite knowledge Logic Design, VLSI D	required by the Students to study th DESIGN	is Cours	e is ba	isic l	knowl	edge in
Objective							
Underst	and and critically co	ompare state-of-the-art design auto	omation	metho	odol	ogies.	
	puter aided design m for execution on a	tools to synthesize a design writte an FPGA.	n in VHD	L and	gen	erate	а
-	-	several levels in the design flow.					
		d application of different optimizat computer aided design tools.	tion tech	nique	s, an	d thei	r.
	vantage of pre-exist otimal results.	ing intellectual property to reduce	design t	ime a	nd p	roduc	e
UNIT I	OVERVIEW O	F ASIC TYPES, DESIGN FLOW, MOS CIRCUIT DESIGN	AND			9	
Types of ASICs		CMOS transistors- CMOS Design ru	ules –Co	mbina	ation	al log	gic Cel
		as Resistors - Transistor parasitic					
Library cell des	sign – Library archit						
UNIT II	INTEGRATED SY	YSTEM-ON-CHIP DESIGN FOR OVER IP	VOICE			9	
Voice over IP S	OC - Intellectual Pro	operty – SOC Design challenges- Me	thodolog	gy and	d des	sign-F	PGA to
ASIC conversio	n – Design for integ	ration-SOC verification-Set top box	SOC.				
UNIT III	MODERN PHY	YSICAL DESIGN AND LOW POV TECHNIQUES	VER			9	
Over view of p	hysical design flow	- tips and guideline for physical d	esign- m	oderr	ı phy	/sical	design
· ·	wer dissipation-low guideline for low po	v power design techniques and me ower design.	thodolog	gies-lo	ow p	ower	desigr
UNIT IV	ESSENTIAL PRIN	NCIPLES OF VHDL AND FPGA I	DESIGN			9	
		interface, Architecture, Process, V		types	an	d ope	rators
	-	cal design – Debugging models: A				-	
	-	aries – Synthesis – Place and route					
UNIT V	FPGA INT	ERFACE DESIGN TECHNIQUES	5			9	
		mera Link Interface - ADC interfac - PS/2 Mouse Interface – PS/2 Key	-	-			
		Total	Periods			45	
Suggestive As:	sessment Methods						
	ssessment Test (30 Marks)	Formative Assessment Test (10 Marks)	End Sen	neste (60			
1.Description 2.Form choice o	Questions	 1.Assignment 2.Online Quizzes 3.Problem solving Activities 	1.Descr • 2	iption 2.Form	n Qu nati	estio	ultiple
Outcomes							
	· · · · · ·	the students will be able to:					
CO1 Exp	lain the need for pr	ogrammable devices.					

CO2 Express the IC fabrication techniques vis-à-vis CMOS switch.

CO3 Explain the low power design techniques and methodologies.

CO4 Write VHDL programs for optimised system design using FPGA

CO5 Interface basic devices to FPGA in designing digital systems.

Text Books

- 1. M.J.S. Smith, "Application Specific Integrated Circuits", Pearson Education, 2020 [Unit- I-III]
- 2. Peter Wilson, "Design Recipes for FPGAs: Using Verilog and VHDL", Elsevier (Newnes), 2015 (Second Edition). [Unit- IV- V]

Reference Books

- 1. Wayne Wolf, —FPGA-Based System Design, Prentice Hall PTR, 2019.
- 2. Farzad Nekoogar and Faranak Nekoogar, —From ASICs to SOCs: A Practical Approach, Prentice Hall PTR, 2003

Web Resources

- 1. <u>www.vhdl.org/rassp/vhdl/guidelines/DesignReq.pdf</u> [Unit- I- V]
- 2. <u>https://nptel.ac.in/courses/117/108/117108040/#</u>[Unit- I- V]

CO Vs PO Mapping and CO Vs PSO Mapping

С О	P0 1	P0 2	PO 3	P0 4	РО 5	P0 6	P0 7	P0 8	РО 9	PO1 0	P01 1	P01 2	PS0 1	PSO 2
1	3	3		2	2						1	1	3	
2	3	2	2	2							1	1	3	
3	3	2	2	2	3						1	1	3	
4	3	3	3	2							1	1	3	
5	3	3	3	2							1	1	3	

List of Professional Electives II

S.No	Course	Course Name	Seme	L	Т	Р	С
	Code		ster				
1	24CS2701	Advanced Wireless Sensor Networks and WBAN	II	3	0	0	3
2	24CS2702	Massive MIMO and Millimeter Wave Communication	II	3	0	0	3
3	24CS2703	MIMO OFDM Systems	II	3	0	0	3
4	24CS2704	High Performance Analog IC Design	II	3	0	0	3

24CS2701	ADVANCED WIRELESS SENSOR NETWORKS AND	L	Τ	Р	С				
	WBAN	3	0	0	3				
Prerequisites for the course									

The pre-requisite knowledge required by the Students to study this Course is basic knowledge in Wireless networks, computer networks, Networking. **Objectives** 1. To understand the overview of Wireless Sensor Network 2. To analyse the MAC and Routing methods. 3. To Design the Architecture of MAC protocol. 4. To analyse the infrastructure establishment and Data Management. 5. To identify the necessity of WBAN. **OVERVIEW OF WIRELESS SENSOR NETWORKS** UNIT I 9 Challenges for Wireless Sensor Networks-Characteristics requirements-required mechanisms, Difference between mobile ad-hoc and sensor networks, Applications of sensor networks- case study, Enabling Technologies for Wireless Sensor Networks **UNIT II** MAC AND ROUTING 9 Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts. Physical Layer and Transceiver Design Considerations UNIT III ARCHITECTURES 9 MAC Protocols for Wireless Sensor Networks, IEEE 802.15.4, ZigBee, Low Duty Cycle Protocols and Wakeup Concepts - S-MAC, The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy Efficient Routing, Geographic Routing. **UNIT IV** INFRASTRUCTURE ESTABLISHMENT AND DATA 9 MANAGEMENT Topology Control, Clustering, Time Synchronization, Localization and Positioning-Data management in WSN, Storage and indexing in sensor networks, Query processing in sensor, Data aggregation. UNIT V WIRELESS BODY AREA NETWORK 9 Introduction to WBAN Standard-Architecture-WBAN layers- Network and MAC Protocol Design for WBAN-Energy Management in WBAN-Performance Analysis of WBAN- Miniaturized Antennas Implanted Antennas- PHY layer for UWB WBAN. Case study using Simulation Tools. **Total Periods** 45 Suggestive Assessment Methods **Continuous Assessment Test Formative Assessment Test End Semester Exams** (30 Marks) (10 Marks) (60 Marks) **1.Description Questions 1.Description Questions 1.Assignment** 2.Formative Multiple choice 2.Online Quizzes **2.Formative Multiple 3.Problem solving Activities** choice questions questions Outcomes Upon completion of the course, the students will be able to: CO701.1 Ability to demonstrate an understanding of the different components of WSN and WBAN CO701.2 Ability to demonstrate an understanding of the different implementation challenges and the solution approaches

- CO701.3 Ability to design and implement protocols suitable to sensor communication scenario using design tools and characterize them
- CO701.4 Ability to appreciate the need for designing energy efficient sensor nodes and protocols for prolonging network lifetime.
- CO701.5 Ability to understand the practical design issues and find out different implementation tools for improving the overall performance of body area network.

Text Books

1. Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks".John Wiley, 2005.

2. Ian F. Akyildiz, Mehmet Can Vuran, "Wireless Sensor Networks" John Wiley, 2010 **Reference Books**

- 1. Yingshu Li, My T. Thai, Weili Wu, "Wireless Sensor Networks and Applications" Springer, 2008.
- 2. Huan-Bang Li, Kamya Yekeh Yazdandoost Bin-Zhen, "Wireless Body Area Networks", **River Publishers. 2010.**
- 3. Kasun Maduranga Silva Thotahewa(Author), Jean-Michel Redoute (Author), Mehmet RasitYuce, "Ultra Wideband Wireless Body Area Networks", Springer, 2016.

Web Resources

- https://nptel.ac.in/courses/106/105/106105160/
- https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-cs09/

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3			1				3	3	3	1	2	
2	3	3	3	1	3				3		3	3	2		3
3	3	1	1		3					3	1	3		2	
4	3	3	3		3			1		3	3	3			1
5	3	3	3	1						3	3	3	3	1	2

24CS2702	MASSIVE MIMO AND MILLIMETER WAVE	L	Τ	Р	C			
	COMMUNICATION	3	0	0	3			
Prerequisites for the course								

The pre-requisite knowledge required by the Students to study this Course is basic knowledge in Advanced Wireless Communication.

Objectives

- 1. To understand the principles and challenges involved in the design of Massive MIMO systems.
- 2. To understand the propagation aspects of Millimeter wave signals and the fundamentals of Millimeter wave devices and circuits.
- 3. To understand the various components of Millimeter wave MIMO systems.
- 4. To understand the Millimeter wave communication systems.

5. To understand the Millimeter wave MIMO systems.

UNIT I		INTRODUCTION		9		
MIMO wirele	ss communication- N	MIMO channel and signal model- A	fundame	ental trade-off- MIMO		
transceiver de	sign- MIMO in wirel	ess networks- Large MIMO system	s: Opportu	unities in large MIM		
systems- Chan	nel hardening in larg	e dimensions- Technological challer	nges and s	olution approaches.		
UNIT II	MIMOI	ENCODING AND DETECTION		9		
Spatial multip	lexing- Space-time c	oding: Space-time block codes, Hi	gh-rate No	O-STBCs, NO-STBC		
from CDAs,	Spatial modulation:	SM, SSK, GSM- MIMO detection	on- Optim	um detection- Linea		
detection- Inte	rference cancelation-	LR-aided linear detection				
UNIT III	mr	mWAVE PROPAGATION		9		
Millimeter wa	ave characteristics- n	nillimeter wave wireless, implement	ntation ch	allenges, Radio wav		
		ale propagation channel effects, sma		-		
	-	ing applications of millimeter wave				
UNIT IV	mmWAVI	E COMMUNICATION SYSTEMS	5	9		
Modulations f	or millimeter wave c	communications: OOK, PSK, FSK,	QAM, OF	DM, Millimeter wav		
link budget, Tr	ransceiver architectur	e, Transceiver without mixer, Receiv	ver withou	t Oscillator, millimete		
wave calibration	on, production and m	anufacture, Millimeter wave design	considerat	tions		
UNIT V mmWAVE MIMO SYSTEMS						
Massive MIM	O Communications,	Spatial diversity of Antenna Array	ys, Multip	le Antennas, Multip		
Transceivers.	Noise coupling in M					
	Noise coupling in r	MIMO system, Potential benefits t	for mm w	vave systems, Spatia		
		MIMO system, Potential benefits f Dynamic spatial, frequency and mod				
Temporal and	Frequency diversity,	-	lulation all	ocation, Beamformin		
Temporal and	Frequency diversity,	Dynamic spatial, frequency and mod alogbeamforming, digital beamform	lulation all	ocation, Beamformin		
Temporal and for MmWave of Suggestive A	Frequency diversity, 2 communications: Ana ssessment Method	Dynamic spatial, frequency and mod alogbeamforming, digital beamform Total	lulation all ing and hy Periods	ocation, Beamformin brid Beamforming. 45		
Temporal and for MmWave Suggestive A Continuous A	Frequency diversity, communications: Ana ssessment Method Assessment Test	Dynamic spatial, frequency and mod alogbeamforming, digital beamform Total s Formative Assessment Test	ulation all ing and hy Periods End Se	ocation, Beamformin brid Beamforming. 45 mester Exams		
Temporal and for MmWave of Suggestive A Continuous A (30 Ma	Frequency diversity, communications: Ana ssessment Method Assessment Test arks)	Dynamic spatial, frequency and mod alogbeamforming, digital beamform Total s Formative Assessment Test (10 Marks)	lulation all ing and hy Periods End Se (60 Ma	ocation, Beamformin /brid Beamforming. 45 mester Exams arks)		
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Temporal and for MmWave of Suggestive A Continuous A (30 Ma 1.Description 2.Formative questions Outcomes	Frequency diversity, communications: Ana ssessment Method Assessment Test arks) n Questions Multiple choice	Dynamic spatial, frequency and mod alogbeamforming, digital beamform Total s Formative Assessment Test (10 Marks) 1.Assignment 2.Online Quizzes 3.Problem solving Activities	End Se (60 Ma 2.Form	ocation, Beamformin brid Beamforming. 45 mester Exams arks) ription Questions native Multiple		
Temporal and for MmWave of Suggestive A Continuous A (30 Ma 1.Description 2.Formative questions Outcomes Upon comple	Frequency diversity, communications: Ana ssessment Method Assessment Test arks) n Questions Multiple choice	Dynamic spatial, frequency and mod alogbeamforming, digital beamform Total s Formative Assessment Test (10 Marks) 1.Assignment 2.Online Quizzes 3.Problem solving Activities	lulation all ing and hy Periods End Se (60 Ma 1.Desc 2.Form choice	ocation, Beamformin /brid Beamforming. 45 mester Exams arks) ription Questions native Multiple questions		
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- 2. Ezio Biglieri, Robert Calderbank, Anthony Constantinides, Andrea Goldsmith, Arogyaswami Paulraj, Vincent Poor, "MIMO Wireless Communications", Cambridge University Press, 2006.
- 3. T.S. Rappaport, R.W. Heath Jr., R.C. Daniels and J.N. Murdock, "Millimeter Wave Wireless Communications: Systems and Circuits", 2015.

Reference Books

- 1. I. Robertson, N. Somjit and M. Chongcheawchamnan, "Microwave and Millimetre-Wave Design for Wireless Communications", 2016.
- 2. AlxelJantsch, "Modeling Embedded Systems and SOC's. Concurrency and Time in Models of Computation", MK, 2004.
- 3. K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, 2011.
- 4. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock,"Millimeter Wave Wireless Communication", Prentice Hall, 2014.

5. Xiang, W; Zheng, K; Shen, X.S; "5G Mobile Communications", Springer, 2016

Web Resources

- <u>https://nptel.ac.in/courses/117/105/117105139/</u>
- <u>https://onlinecourses.nptel.ac.in/noc24_ee12/preview</u>

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3							1	3	1		
2	3	3	3	3							1	3			3
3	3	3	3	3							1	3	3	2	
4	3	3	3	3							1	3		2	1
5	3	3	3	3							1	3	3		2
6	3	3	3	3							1	3	1	2	

24CS2703	MIMO OFDM SYSTEMS	L	Τ	Р	С
		3	0	0	3
Prerequisites	s for the course				

• The pre-requisite knowledge required by the Students to study this Course is basic knowledge in Wireless Communication.

Objectives

- 1. To describe the concepts of MIMO OFDM Wireless communication systems.
- 2. To determine the capacity of MIMO OFDM system for a given power delay profile of the MIMO channel
- 3. To study the SISO and MIMO channel model
- 4. To Estimate the channel impulse response using least square, MMSE and Robust MMSE estimation algorithms

Francis Xavier Engineering College| Dept of ECE | M.E- CS | Curriculum and Syllabi R 2024 5. To Estimate and correct the timing and frequency offset in the signal received in the MIMO OFDM receivers and Analyze the performance of MIMO OFDM physical channel in Wi-Max/LTE wireless standards. ST CHANNEL AND SIGNAL MODELS UNIT I 9 Introduction-physical scattering model for ST channels, Extended channel models, Statistical properties of H, Sampled Signal model for SISO, SIMO, MISO and MIMO, ST multiuser and ST interference channels. ST channel estimation **CAPACITY OF WIRELESS CHANNELS** UNIT II 9 AWGN channel capacity-Resources of AWGN Channel, Linear time invariant guassian channels, Capacity of fading channels. SISO AND MIMO CHANNEL MODELS **UNIT III** 9 SISO channel models-Indoor and outdoor models. MIMO channel models-Statistical MIMO model, 1-METRO MIMO, SCM MIMO channel model. OFDM AND ITS SYNCHRONIZATION UNIT IV 9 Single Carrier Vs Multi Carrier Transmission, Basic principle of OFDM, OFDMA, Effect and Estimation Techniques for STO and CFO. **CHANNEL ESTIMATION** UNIT V 9 Pilot structure, Training symbol based channel estimation, DFT based and Decision directed Channel estimation. Advanced channel estimation techniques. **Total Periods** 45 **Suggestive Assessment Methods Continuous Assessment Test Formative Assessment Test End Semester Exams** (60 Marks) (30 Marks) (10 Marks) **1.Description Questions** 1.Assignment **1.Description Questions** 2.Formative Multiple choice 2.Online Quizzes **2.Formative Multiple** questions **3.Problem solving Activities** choice questions Outcomes Upon completion of the course, the students will be able to: CO703.1 The student would be able to analyze the complexity of MIMO OFDM spatial multiplexing receivers. CO703.2 The student would be able to study the channel capacity of SISO and SIMO systems. CO703.3 The student would be able to analyze the SISO and MIMO models. CO703.4 The student would be able to fundamentals of OFDM and Its synchronization. CO703.5 The student would be able to analyse the channel estimation techniques. Text Books 1. Chockalingam and B. Sundar Rajan, "Large MIMO Systems ", Cambridge University Press, 2014. 2. Ezio Biglieri, Robert Calderbank, Anthony Constantinides, Andrea Goldsmith, Arogyaswami Paulraj, Vincent Poor, "MIMO Wireless Communications", Cambridge University Press, 2006.

T.S. Rappaport, R.W. Heath Jr., R.C. Daniels and J.N. Murdock, "Millimeter Wave Wireless Communications: Systems and Circuits", 2015.

Reference Books

- 1. Robertson, N. Somjit and M. Chong cheawchamnan, "Microwave and Millimetre-Wave Design for Wireless Communications", 2016.
- 2. Alxel Jantsch, "Modeling Embedded Systems and SOC's. Concurrency and Time in Models of Computation", MK, 2004.
- 3. K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, 2011.
- 4. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock,"Millimeter Wave Wireless Communication", Prentice Hall, 2014.
- 5. Xiang, W; Zheng, K; Shen, X.S; "5G Mobile Communications", Springer, 2016

Web Resources

- <u>https://nptel.ac.in/courses/117/104/117104115/</u>
- https://nptel.ac.in/noc/courses/noc17/SEM2/noc17-ee19/

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3							1	3	1	2	
2	3	3	3	3							1	3	2		3
3	3	3	3	3							1	3	3		
4	3	3	3	3							1	3		2	1
5	3	3	3	3							1	3	3		

24CS2704	HIGH PERFORMANCE ANALOG IC DESIGN	L	Т	Р	C
24032704	HIGH FERFORMANCE ANALOG IC DESIGN	3	0	0	3

Prerequisites for the course

The pre-requisite knowledge required by the Students to study this Course is basic knowledge in Analog Electronics

Objectives

1. To learn about the characteristics and model of MOS devices

2. To familiarize the concepts of analog CMOS circuits, switches and current mirrors

3. To gain knowledge on CMOS amplifiers, Op Amps and their characteristics

4. To analyze the frequency response of amplifiers, representation of noise and effect of feedback

5. To learn the concepts of switched capacitor circuits

UNIT I	FUNDAMENTALS AND ADVANCED CONCEPTS IN	
	MOS ANALOG DESIGN	

9

Introduction to Analog Design - General consideration of MOS devices – MOS IV Characteristics – Second Order Effects-MOS Device Model – MOS device layout - Device capacitance- Small signal model- Spice models- NMOS versus PMOS devices – Long channel versus short channel devices

<u>Francis Xavie</u>	<u>r Engineering Colle</u>	ge Dept of ECE M.E- CS Curricul	um and S	Syllabi R 2024
UNIT II		D MOS DEVICES AND CURREN ERENCE CIRCUIT DESIGN	Т	9
MOS Transistor	- nMOS and pMOS	S Transistor – MOS Switch- MOS D	iode- Cui	rrent Sinks and Sources -
Basic current m	irrors - Cascode cur	rent mirrors -Active current mirrors	- Current	and voltage references -
Bandgap referen	ices			
UNIT III		OS AMPLIFIER AND OP-AMP D INIQUES	DESIGN	9
		nplifiers – Current amplifiers – Outp		
		DpAmps- Design of two stage OpA		
speed/frequency voltage OpAmp		tial output OpAmps - micropower Op	pAmps- L	ow noise OpAmps – Low
UNIT IV		STAGES, NOISE ANALYSIS, AN CK EFFECTS IN CMOS DESIGN	ND	9
followers - Com - Representation	mon gate stage - Cas	et and Association of Poles with Not code stage - Differential pair - Noise - Noise in single stage amplifiers - ffect of loading - Effect of feedback	- Statistic Noise in	al characteristics of noise differential pairs - Noise
UNIT V		CAPACITOR CIRCUITS AND CM DCESSING TECHNOLOGY	IOS	9
		hed capacitor amplifiers - Switched		
		acitor circuits – First order switche	-	
switched capaci	tor circuits- CMOS p	processing technology – Layout and I		
Currentine An	a a gree a set Mathada		Periods	45
	sessment Methods		D 10	
		Formative Assessment Test	End Sen	nester Exams
· · · · · · · · · · · · · · · · · · ·	30 Marks)	(10 Marks)	4 D	(60 Marks)
1.Description	•	1.Assignment 2.Online Quizzes		iption Questions
	estions	3.Problem solving Activities	2.1011	ative Multiple choice questions
Qutcomes	23110113	5.1 Toblem Solving Activities		questions
	ion of the course t	the students will be able to:		
	· · · · · · · · · · · · · · · · · · ·	and model of MOS devices		
		nalog CMOS circuits, switches and	current n	nirrors
	4	OS amplifiers and OpAmps		
	ine of the frequency	y response of amplifiers, represent	ation of n	oise and effect of
CO5 Design	various levels of sw	itched capacitor circuits		
Text Books				
	Razavi, "Design of 2016 [Unit I-V].	Analog CMOS Integrated Circuits	", Tata M	cGraw Hill, 2001, 33rd
Reference Bo	nks			

1. Phillip Allen and Douglas Holmberg "CMOS Analog Circuit Design" Second Edition, Oxford University Press, 2004.

2. R. Jacob Baker, "CMOS: Circuit Design, Layout, and Simulation", Wiley – Blackwell, 2019.

3. A.B.Bhattacharyya, "Compact MOSFET Models for VLSI Design", John Wiley & Sons Ltd., 2009.

4. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, Analysis and Design of Analog Integrated Circuits, 5th Edition, Wiley, 2009

5. <u>Mikael Sahrling</u>, "Analog Circuit Simulators for IC Designers", Springer, 2020.

Web Resources

1. https://nptel.ac.in/courses/117/101/117101105/

2. <u>https://onlinecourses.nptel.ac.in/noc21ee51/preview</u>

CO Vs PO Mapping and CO Vs PSO Mapping

CO	P0 1	P0 2	PO 3	P0 4	РО 5	P0 6	P0 7	PO 8	P0 9	P0 10	P0 11	PO 12	PSO 1	PSO 2
1	2	3	3	2	2								3	
2	2	3	3	2									3	
3	3	3	2	2			2	1					3	
4	2	3	2	2			2	1					3	
5	1	3	3	2	2		1	1					3	

List of Professional Electives III

S.No	Course Code	Course Name	Seme ster	L	Т	Р	С
1	24CS2705	Advanced Integrated SOC Design Techniques	II	3	0	0	3
2	24CS2706	Modern IOT	II	3	0	0	3
3	24CS2707	Real Time Embedded Systems	II	3	0	0	3
4	24CS2708	Smart Antennas	II	3	0	0	3

24CS2705	ADVANCED INTEGRATED SOC DESIGN	L	Т	P	С
	TECHNIQUES	3	0	0	3
Prerequisites for	the course			1	
• Basics of I	Digital System Deign				
Objectives					

- 1. Exploring Design Strategies for ASICs.
- 2. Understanding NISC Approaches in SoC Design.
- 3. Integrating HDL Coding Techniques.
- 4. Optimizing SoC Architectures for Low Power.

5. Applying Advanced Synthesis and Verification Methods.

UNIT I ASIC TYPES AND SOC DESIGN METHODOLOGIES

9

9

45

Overview of ASIC types, design strategies, CISC, RISC and NISC approaches for SOC architectural issues and its impact on SoC design methodologies, Application Specific Instruction Processor (ASIP)concepts.

UNIT II MODELING NISC ARCHITECTURES AND SYSTEMS 9

NISC Control Words methodology, NISC Applications and Advantages, Architecture Description Languages (ADL) for design and verification of Application Specific Instruction- set Processors (ASIP), No-Instruction-Set-computer (NISC)- design flow, modelling NISC architectures and systems, use of Generic Netlist Representation - A formal language for specification, compilation and synthesis of embedded processors.

UNIT III	ADVANCED SIMULATION AND DESIGN	9
	TECHNIQUES FOR VLSI AND SOC SYSTEMS	

Different simulation modes, behavioural, functional, static timing, gate level, switch level, transistor/circuit simulation, design of verification vectors, Low power FPGA, Reconfigurable systems, SoC related modelling of data path design and control logic, Minimization of interconnects impact, clock tree design issues.

UNIT IV LOW POWER SOC DESIGN AND DIGITAL SYSTEMS

Design synergy, Low power system perspective- power gating, clock gating, adaptive voltage scaling (AVS), Static voltage scaling, Dynamic clock frequency and voltage scaling (DCFS), building block optimisation, building block memory, power down techniques, power consumption verification.

UNIT V	ADVANCED CONCEPTS IN VLSI DESIGN AND	9
	OPTIMIZATION	

Role and Concept of graph theory and its relevance to synthesizable constructs, Walks, trails paths, connectivity, components, mapping/visualization, nodal and admittance graph. Technology independent and technology dependent approaches for synthesis, optimisation constraints, Synthesis report analysis, Single core and Multi core systems, dark silicon issues, HDL coding techniques for minimization of power consumption, Fault tolerant designs.

Total Periods

Suggestive Assessment Methods

Continuous Assessment Test	Formative Assessment Test	End Semester Exams (60 Marks)
(30 Marks) (30 Marks) 1.Description Questions	(10 Marks) 1.Assignment 2.Online Quizzes	1.Description Questions

2.Formative Multiple choice	3.Problem solving Activities	2.Formative Multiple choice
questions		questions

Outcomes

Upon completion of the course, the students will be able to:

CO1: Analyze and apply various design strategies in ASIC development, optimizing for performance, area efficiency, and power consumption.

CO2: Gain a comprehensive understanding of No Instruction Set Computer (NISC) approaches and their implications in System-on-Chip (SoC) design.

CO3: Acquire proficiency in integrating advanced Hardware Description Language (HDL) coding techniques.

CO4: Apply techniques to optimize System-on-Chip (SoC) architectures for low power consumption.

CO5: Apply advanced synthesis and verification methods to ensure the correctness, functionality, and timing closure of VLSI and SoC designs.

Text Books

1. Hubert Kaeslin, "Digital Integrated Circuit Design: From VLSI Architectures to CMOS Fabrication", Cambridge University Press 2008.

2. B. Al Hashimi, "System on Chip-Next Generation Electronics", The IET 2006

Reference Books

1. RochitRajsuman, "System-on- a-chip: Design and Test", Advantest America R & D Centre, 2000

2. P Mishra and N Dutt, "Processor Description Languages", Morgan Kaufmann 2008

3. Michael J. Flynn and Wayne Luk, "Computer System Design: System-on-Chip". Wiley, 2011

Web Resources

1. <u>https://youtu.be/PRQXzjTrCJY?feature=shared</u>

2. <u>https://youtu.be/YQwU30mptYg?feature=shared</u>

3. <u>https://youtu.be/2MM8mmTXi08?feature=shared</u>

CO Vs PO Mapping and CO Vs PSO Mapping

C	PO	PO1	PO1	PO1	PSO	PSO								
O	1	2	3	4	5	6	7	8	9	0	1	2	1	2
1	3	3		2	2						1	1	3	

2	3	2	2	2				1	1	3	
3	3	2	2		3			1	1	3	
4	3	3	3	2				1	1	3	
5	3	3	3	2				1	1	3	

24CS2706	MODERN IOT	L	Τ	Р	C
		3	0	0	3
Prerequisites	s for the course				
• The pre-	-requisite knowledge required by the Students to study this Course	e is ba	sic k	nowle	edge ir
Embedd	led Systems.				
Objectives					
1. Asso	ess the genesis and impact of IoT applications, architectures in real	l worl	d.		
2. Illus	strate diverse methods of deploying smart objects and connect then	n to n	etwo	rk.	
3. Con	npare different Application protocols for IoT.				
4. Infe	r the role of Data Analytics and Security in IoT.				
5. Iden	tify sensor technologies for sensing real world entities and unders	stand	the ro	ole of	IoT in
varie	ous domains of Industry.				
UNIT I	INTRODUCTION TO IOT ARCHITECTURES			9	
Genesis of IoT	, IoT and Digitization, IoT Impact, Convergence of IT and IoT	, IoT	Cha	llenge	es, Io]
Network Arch	itecture and Design, Drivers Behind New Network Architect	ures,	Con	nparin	g Io]
Architectures A	A Simplified IoT Architecture, The Core IoT Functional Stack, IoT	Data	Man	aama	ent and
i nemicectures, i	Tompinied for Mienteeture, The core for Tunetional Stack, for	Data	wiana	ageme	one an
Compute Stack		Data	wan	agenic	iii uii
		Data	Iviana	<u>9</u>	
Compute Stack UNIT II	•			9	
Compute Stack UNIT II Smart Objects:	IOT SENSORS AND ACTUATORS			9	
Compute Stack UNIT II Smart Objects:	IOT SENSORS AND ACTUATORS The "Things" in IoT, Sensors, Actuators, and Smart Objec			9	
Compute Stack UNIT II Smart Objects: Connecting Sm UNIT III	IOT SENSORS AND ACTUATORS The "Things" in IoT, Sensors, Actuators, and Smart Object art Objects, Communications Criteria, IoT Access Technologies.	ets, S	ensoi	9 Net 9	
Compute Stack UNIT II Smart Objects: Connecting Sm UNIT III IP as the IoT	IOT SENSORS AND ACTUATORS The "Things" in IoT, Sensors, Actuators, and Smart Objec art Objects, Communications Criteria, IoT Access Technologies. IOT COMMUNICATION PROTOCOLS	ets, S	ensor ptim	9 Net 9 izing	
Compute Stack UNIT II Smart Objects: Connecting Sm UNIT III IP as the IoT IP for IoT, Pr	IOT SENSORS AND ACTUATORS The "Things" in IoT, Sensors, Actuators, and Smart Object art Objects, Communications Criteria, IoT Access Technologies. IOT COMMUNICATION PROTOCOLS Network Layer, The Business Case for IP, The need for Optimization	ets, S	ensor ptim	9 Net 9 izing	
Compute Stack UNIT II Smart Objects: Connecting Sm UNIT III IP as the IoT IP for IoT, Pr	IOT SENSORS AND ACTUATORS The "Things" in IoT, Sensors, Actuators, and Smart Object art Objects, Communications Criteria, IoT Access Technologies. IOT COMMUNICATION PROTOCOLS Network Layer, The Business Case for IP, The need for Optimization ofiles and Compliances, Application Protocols for IoT, The Transported	ets, S	ensor ptim	9 Net 9 izing	
Compute Stack UNIT II Smart Objects: Connecting Sm UNIT III IP as the IoT IP for IoT, Pr Application T UNIT IV	IOT SENSORS AND ACTUATORS The "Things" in IoT, Sensors, Actuators, and Smart Object art Objects, Communications Criteria, IoT Access Technologies. IOT COMMUNICATION PROTOCOLS Network Layer, The Business Case for IP, The need for Optimization ofiles and Compliances, Application Protocols for IoT, The Transport Transport Methods	on, O	ensor ptim .ayer	9 Net 9 izing , IoT 9	works
Compute Stack UNIT II Smart Objects: Connecting Sm UNIT III IP as the IoT IP for IoT, Pr Application T UNIT IV Data and Anal	IOT SENSORS AND ACTUATORS The "Things" in IoT, Sensors, Actuators, and Smart Object art Objects, Communications Criteria, IoT Access Technologies. IOT COMMUNICATION PROTOCOLS Network Layer, The Business Case for IP, The need for Optimization ofiles and Compliances, Application Protocols for IoT, The Transport Transport Methods IMPACT OF IOT ON DATA ANALYITICS	on, O port I ne Le	ensor ptim _ayer arnin	9 7 Net 9 izing , IoT 9 g, Big	works
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Compute Stack UNIT II Smart Objects: Connecting Sm UNIT III IP as the IoT IP for IoT, Pr Application T UNIT IV Data and Analy Analytics Tools History of OT	IOT SENSORS AND ACTUATORS The "Things" in IoT, Sensors, Actuators, and Smart Object art Objects, Communications Criteria, IoT Access Technologies. IOT COMMUNICATION PROTOCOLS Network Layer, The Business Case for IP, The need for Optimization ofiles and Compliances, Application Protocols for IoT, The Transport Methods IMPACT OF IOT ON DATA ANALYITICS ytics for IoT, An Introduction to Data Analytics for IoT, Machin s and Technology, Edge Streaming Analytics, Network Analytics,	on, O port I ne Le Secur	ensor ptim Layer arnin ring	9 7 Net 9 izing , IoT 9 g, Bi IoT, A ractic	g Dat B Brie es and
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Systems on RaspberryPi, Configuring RaspberryPi, Programming RaspberryPi with Python, Wireless Temperature Monitoring System Using Pi, DS18B20 Temperature Sensor, Connecting Raspberry Pi via SSH, Accessing Temperature from DS18B20 sensors, Remote access to RaspberryPi, Smart and Connected Cities, An IoT Strategy for Smarter Cities, Smart City IoT Architecture, Smart City Security Architecture, Smart City Use-Case Examples.

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24CS2707	REAL TIME EMBEDDED SYSTEMS	L	T	Р	C
		3	0	0	3
Prerequisite	s for the course				
• The pre	-requisite knowledge required by the Students to study this Course	e is ba	sic k	nowle	edge i
Microp	rocessors & Microcontrollers.				
Objectives					
1. To	gain knowledge on popular embedded processors				
2. To	understand the Networking in Embedded systems.				
3. To	acquire essential skills for developing an embedded system.				
4. To	understand the RTOS concepts in depth				
5. To	develop skills in working with µc/OS–II RTOS				
UNIT I	EMBEDDED PROCESSORS			9	
Embedding C	omputers- Characteristics of Embedded Computing Applicat	tions-	- Ch	allen	ges i
Embedded Co	nputing System-Performance in Embedded Computing- ARM pr	rocess	sor f	undan	nenta
	re-Registers-CPSR-Pipelining- Exceptions, Interrupts, and the				
	LPC 244x Family ARM processor- Block diagram & Features -Per				
to ARM 9, AR	• • •	- r			
UNIT II	EMBEDDED NETWORKING			9	
interfacing: Int protocols: PCI	concepts- Port and Bus-based I/O – Memory mapped I/O & Standar errupts, DMA - Arbitration - Serial protocols: I ² C, CAN, Ethernet, F ARM bus – Wireless protocols – IrDA, Bluetooth, IEEE 802.11- I pment and Debugging-System-Level Performance Analysis-Des	Fieldb Memo	us, U ory h	ISB- H ierarc	Paralle hy an
UNIT III	EMBEDDED PROGRAM DESIGN AND ANALYSIS			9	
	n – Model of programs – Assembly and Linking – Basic compilation on of program level & software performance, execution time, powe				
and optimization					
and optimization	validation and testing – Design example : Software Modem RTOS CONCEPTS AND μC/OS-II			9	
and optimizations size – Program UNIT IV Foreground/Batime priority ba – Exclusion –	validation and testing – Design example : Software Modem	st Sc to μC	hedu	ulers Iling -	Kern
and optimizations size – Program UNIT IV Foreground/Batime priority ba – Exclusion –	validation and testing – Design example : Software Modem RTOS CONCEPTS AND μC/OS-II ckground process – Resources – Tasks – Multitasking – Priorities sed scheduling – Rate Monotonic Scheduling, Earliest Deadline Fir Intertask communication – Interrupts – Clock ticks – Introduction	st Sc to μC	hedu	ulers Iling -	Kerne

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Outco	mes													
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CO	707.1	Unde	erstand	the co	oncept	of em	bedded	l syste	ms in p	opular	embedd	led ARM	M famil	у
		proce	essors											
	707.2		• •		• •				g embec	-				
CO	707.3	Unde	erstand	how e	mbedd	ed prog	grams c	can be	designe	d and a	nalysed	for perf	ormance	e.
CO	707.4	Learı	n the re	eal time	e opera	ting sy	stem co	oncept	s and he	ow to ap	ply the	m in μC	/OS-II	
CO	707.5	Learı	n to per	rform t	ask, tii	ne and	memo	ry mai	nagemei	nt in µC	/OS-II			
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24CS270	SMART ANTENNAS					l

3 0 0 3 Prerequisites for the course The pre-requisite knowledge required by the Students to study this Course is basic knowledge in RF and Microwave System, Antenna and Amplifiers. **Objectives** 1. To give insight of basics of physics and radiation phenomena 2. To give a thorough understanding of the radiation characteristics and antenna parameters 3. To create awareness about propagation of radio waves. 4. To select appropriate antenna applications 5. To design dipole, Yagi and patch antenna for a small application ANTENNA FUNDAMENTALS 9 **UNIT I** Definition of antenna parameters -Radiation pattern, Gain, Directivity, Effective aperture, Radiation Resistance, Band width, Beam width, Input Impedance, Polarization Radiation power density and intensity, Solid angle and beam width. Polarization mismatch, Antenna noise temperature. ARRAYS 9 **UNIT II** Linear array, Pattern multiplication, Broadside and End fire array - Concept of Phased arrays, Adaptive array, Binomial array. **UNIT III** SPECIAL ANTENNAS 9 Huygens's principle, Uniqueness theorem, Field Equivalence principle and Duality theorem, Babinet's Principle - Slot antenna. Horn Antennas, Spiral antenna, helical antenna, LPDA. - Reconfigurable antenna. UNIT IV **ANTENNA MEASUREMENTS** 9 Antenna Measurements - Gain, Radiation pattern, Polarization, VSWR, directivity measurement, Microstrip antenna measurement and calculation UNIT V SMART ANTENNA SYSTEMS AND PROPAGATION 9 Switched beam antenna: Single beam directional antenna, multi beam directional antenna, Single user beam forming, Multi- user beam forming, Modes of propagation, Structure of atmosphere, Ground wave propagation , Tropospheric propagation , Duct propagation, Troposcatter propagation ,Sky wave propagation. **Total Periods** 45 **Suggestive Assessment Methods Continuous Assessment Test Formative Assessment Test End Semester Exams** (30 Marks) (10 Marks) (60 Marks) **1.Description Questions** 1.Assignment **1.Description Questions** 2.Formative Multiple choice 2.Online Quizzes **2.Formative Multiple 3.Problem solving Activities** choice questions questions **Outcomes** Upon completion of the course, the students will be able to: CO708.1 Students able to determine the characteristics Impedance and Propagation constant of transmission lines and to explain the process of radiation CO708.2 Students able to calculate various matching impedance and losses in transmission lines, explain the behavior of an antenna in terms of its parameters CO708.3 Students able to determine the radiation fields of antennas and Compute the fields

- CO708.4 Students able to analyze the nature of the wave propagation in various layers of atmosphere
- CO708. 5 Students able to Study the measurement of antenna parameters using various methods

Text Books

- 1. Edward C.Jordan and Keith G.Balmain' Electromagnetic Waves and Radiating Systems' Prentice Hall of India, 2006
- 2. R.E.Collin,"Antennas and Radiowave Propagation", McGraw Hill 1985

Reference Books

- 1. Constantine.A.Balanis "Antenna Theory Analysis and Design", Wiley Student Edition, 2006.
- 2. Rajeswari Chatterjee, "Antenna Theory and Practice" Revised Second Edition New Age International Publishers, 2006.
- 3. H.Sizun "Radio Wave Propagation for Telecommunication Applications", First Indian Reprint, Springer Publications, 2007.

Web Resources

- https://www.ofcom.org.uk/research-and-data/technology/general/emerging-tech/smart-antennas
- https://searchmobilecomputing.techtarget.com/definition/smart-antenna

CO Vs PO Mapping and CO Vs PSO Mapping

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List of Professional Electives IV

S.No	Course	Course Name	Seme	L	Т	Р	С
	Code		ster				
1	24CS2709	VLSI Circuit Test and Verification Techniques	II	3	0	0	3
2	24CS2710	Modern Satellite Systems	II	3	0	0	3
3	24CS2711	Network Routing Algorithms	II	3	0	0	3
4	24CS2712	Remote Sensing	II	3	0	0	3

24CS2709	VLSI CIRCUIT TEST AND VERIFICATION TECHNIQUES	L	Т	Р	С
		3	0	0	3
Prerequisites	for the course				
The pre	-requisite knowledge required by the Students to study this Course	is bas	ic kn	owledg	ge in

Basic Electronics

Objectives 1. Understanding VLSI Testing Processes and Equipment. 2. Simulating Fault Logic and Testability Measures. 3. Analyzing Combinational Circuit Test Generation. 4. Analyzing Sequential Circuit Test Generation. 5. Applying Memory Testing Principles. FUNDAMENTALS OF VLSI TESTING AND FAULT 9 UNIT I MODELING Introduction- Principle of testing, Types of testing, Automatic test equipment, Electrical parametric testing. Fault modeling - Defects, errors and faults, Functional vs Structural testing, Levels of fault models, Glossary of fault models, Single stuck-at faults. UNIT II SIMULATION AND TESTABILITY MEASURES FOR 9 VLSI DESIGN VERIFICATION Simulation for design verification, test evaluation, modelling circuits for simulation, Algorithms for true value simulation and fault simulation, Statistical methods for fault simulation. Testability measures-SCOAP- Controllability and observability, Combinational and Sequential SCOAP measures. 9 UNIT III ADVANCED ALGORITHMS AND TECHNIQUES IN VLSI TESTING Algorithms and Representations, Redundancy Identification (RID), Testing as a Global Problem, Significant Combinational ATPG Algorithms, Test Generation Systems, Test Compaction. UNIT IV ADVANCED ATPG TECHNIQUES FOR SEQUENTIAL 9 **CIRCUITS** ATPG for Single-Clock Synchronous circuits, Time-Frame Expansion Method, Simulation- Based Sequential Circuit ATPG. UNIT V **ADVANCED CONCEPTS IN MEMORY TESTING AND** 9 **FAULT ANALYSIS** Memory Density and Defect Trends, Faults, Memory Test Levels, March Test Notation, Fault Modeling.

Case studies of Testing of Sensor chips, High voltage interface controllers, Case Studies on Transition Fault Test Generation for At-speed Scan Testing, Implementation combinational and sequential circuits testing for simple design.

	Τα	otal Periods	45
Suggestive Assessment Methods	5	I	
Continuous Assessment Test (30 Marks)	Formative Assessment Test (10 Marks)	End Semes (60 Mar	
1.Description Questions	1.Assignment2.Online Quizzes	1.Descripti	on Questions

2.Formative Multiple choice questions3.Problem solving Activities2.Formative Multiple choice questions										ple cho	vice	
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Objectives

- 1. To get familiarized with different protocols in internet routing and optical WDM networks.
- 2. To get acquainted with the concepts of supporting protocols in Mobile-IP networks.
- 3. To differentiate the routing processes involved in mobile ad-hoc networks and wireless sensor networks from conventional networks.
- 4. To understand the concept routing in mobile ad -hoc networks.
- 5. To understand the concept of routing in wireless sensor networks.

UNIT I	ROUTING IN TELEPHONE NETWORKS AND	9
	INTERNET	

General Classification of routing, Routing in telephone networks, Dynamic Non-hierarchical Routing (DNHR), Trunk status map routing (TSMR), Real-Time Network Routing (RTNR), Hierarchical routing. Exterior Routing Protocols: Exterior Gateway Protocol (EGP) and Border Gateway Protocol (BGP). Multicast Routing: Pros and cons of Multicast and Multiple Unicast Routing, Distance Vector Multicast Routing Protocol (DVMRP), Multicast Open Shortest Path First (MOSPF), MBONE, Core Based Tree Routing.

UNIT II	ROUTING IN OPTICAL WDM NETWORKS	9
Classification	of RWA algorithms, RWA algorithms, Fairness and Admission	Control, Distributed
Control Protoco	ols, Permanent Routing and Wavelength Requirements, Waveleng	th Rerouting- Benefits
and Issues, Lig	ht path Migration, Rerouting Schemes, Algorithms- AG, MWPG.	

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UNIT III	ROUTING IN MOBILE - IP NETWORKS	9
Macro-mobility	Protocols, Micro-mobility protocol: Tunnel based: Hierarchical N	Iobile IP, Intra domain
Mobility Mana	gement, Routing based: Cellular IP, Handoff Wireless Access	Internet Infrastructure

(HAWAII).

UNIT IV ROUTING IN MOBILE AD -HOC NETWORKS 9 Internet based mobile ad-hoc networking, communication strategies, routing algorithms - Table-driven routing - Destination Sequenced Distance Vector (DSDV), Source initiated on-demand routing- Dynamic Source Routing (DSR), Ad-hoc On-demand Distance Vector (AODV) routing, Hierarchical based routing- Cluster Head Gateway Switch Routing (CGSR) and Temporally-Ordered Routing Algorithm (TORA), Quality of Service.

ROUTING IN WIRELESS SENSOR NETWORKS 9 **UNIT V** Routing Protocols- Energy-Efficient Routing - Power-Aware Many-to-Many Routing (PAMR), Low-Energy Adaptive Clustering Hierarchy (LEACH), Geographic Routing.Data-centric protocols, Hierarchical protocols, Location-based protocols - directed Diffusion, Network flow and QoS-aware protocols.

Total Periods 45								
Suggestive Assessment Method	ls							
Continuous Assessment Test (30 Marks)	Formative Assessment Test (10 Marks)	End Semester Exams (60 Marks)						
1.Description Questions 2.Formative Multiple choice questions	1.Assignment 2.Online Quizzes 3.Problem solving Activities	2.Form	ription Questions native Multiple questions					
Outcomes								

Upon completion of the course, the students will be able to:

 CO711. 2 To understand various routing techniques in optical WDM networks CO711. 3 To Explore the various routing protocols of mobile ip networks. CO711. 4 To learn some routing protocols of mobile adhoc networks. CO711. 5 To understand various routing protocols of wireless sensor networks. Text Books I. M. Steen Strub, "Routing in Communication network", Prentice –Hall International, New York, 1995. S. Keshav, "An engineering approach to Computer Networking: ATM Networks, the Internet and the Telephone Network", Addison Wesley 1997. William Stallings, "High speed Networks TCP/IP and ATM Design Principles", Prentice-Hall, Second Edition, 2002. C. E. Perkins, "Ad hoc Networking", Addison-Wesley, 2001 C.Siva Ram Murthy and B.S.Manoj, "Ad hoc Wireless Networks Architectures and protocols", Pearson Education, Second Edition, 2007 Reference Books Kazem Sohraby, Daniel Minoli and TaiebZnati, "Wireless Sensor Networks", A John Wiley & Sons Inc. Publication, First Edition, 2007. Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2007. Ian F. Akyildiz, Jiang Xie and ShantidevMohanty, "A Survey of mobility Management in Next generation All IP- Based Wireless Systems", IEEE Wireless Communications Aug.2004, pp 16-28. A.T Campbell et al., "Comparison of IP Micromobility Protocols," IEEE Wireless Communications Vol No.9, Issue 1, Feb.2002, pp 72-82. C.Siva Ram Murthy and Mohan Gurusamy, "WDM Optical Networks – Concepts, Design and Algorithms", Prentice Hall of India Pvt. Ltd, 2002. Web Resources http://www.cs.iut.ac.in/uscrs/dheerai/cs425/lcc12.html/ http://www.cs.csu.cdu/-stan/classes/CS490/Slides/Networks4-Ch4-4.pdf http://www.cs.csu.cdu/-stan/classes/CS490/Slides/Networks4-Ch4-4.pdf http://www.cs.csu.	CO	711.1	Identi	ify var	rious r	outing	schen	nes and	d their	applica	tions to	the re	al world	d circuit	-
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24CS2712		REMOTE SENSING		L	T	Р	C				
-	for the course										
1	1 0	e required by the Students to study the	his Course	e is ba	sic k	nowle	edge i				
Total Qı	ality Management.										
Objectives											
2.To underst	and the characteristi	cepts and laws related to remote sense cs of different types of remote sense of different types of remote sensors	ors.								
4.To explain	the concepts of Geo	graphical Information System									
		note Sensing and GIS applications									
UNIT I Remote sen				9							
Particle theo of atmosphe interaction v	ory - Stefan Boltzman ere - Scattering - I with surface features	n law - Wien's-Displacement law - Ra Different types - Absorption - Atr - Spectral reflectance of vegetation, atterns - Multi concept in Remote se	adiometric mospheric , soil and v	c quar winc	ntities low	s - Eff - Ene	ects ergy				
UNIT II		emote Sensors and Systems	<i>. .</i>			9					
collection an	nd examples.	s, scanners. Thermal Remote sen		_		9					
Orbit pertur sensing plat	bations and maneuve forms - Sun synchro	s - Motions of planets and satellites ers - Escape velocity - Types and char nous and geosynchronous satellites.	racteristics			nt ren					
UNIT IV	-	caphical Information System		1 1 4	• • •	9	1				
raster data s	tructures, Vector dat	and coordinate system., Spatial and a analysis – buffering and overlaying and distance measure operations,									
UNIT V	Remote	Sensing and GIS applications				9					
Biophysical land cover n Surface and Mapping wa Remote ser	properties and proce napping programme ground water resound atersheds and ground nsing of urban en	egetation cover: EM spectrum of ve esses of vegetation. Classification sy s. urces: Remote sensing of inland wat dwater recharge and discharge site at vironments: Urbanization, land u lisaster emergency response.	ystems. Gl er quality t the region	obal and s nal sc	veget sedin cale.	ation	and oad.				
		Total	Periods			45					
Suggestive As	sessment Method	S									
	ssessment Test	Formative Assessment Test	End Se		er E	xams	5				
(30 Mar	ks)	(10 Marks)	(60 Ma	rks)							
	Questions	1.Assignment	1.Desc	rinti	nn ()	uncti	ons				

Outcomes	
Upon comple	etion of the course, the students will be able to:
CO712. 1	Understand the concepts and laws related to remote sensing
CO712. 2	Understand the characteristics of different types of remote sensors.
CO712. 3	Understand the characteristics of different types of remote sensors
CO712. 4	Understand the concepts of Geographical Information System
CO712. 5	Demonstrate the Remote Sensing and GIS applications
Text Books	
3. Lillesa & Sons Reference Bo 1. Sar Ch 2. The	nuel Purkis and Victor Klemas, — Remote Sensing and Global Environmenta angel (2011), Wiley-Blackwell, A John Wiley & Sons, Ltd. omas Lillesand, Ralph W. Kiefer, Jonathan Chipman, —Remote Sensing and Image erpretation, 6th Edition(2008) John Wiley & Sons, Publications
3. Ge	orge Joseph, "Fundamentals of Remote Sensing", Universities Press (India) Pvt Ltd derabad, 3rd edition, 2018.
3. Ge	derabad, 3rd edition, 2018.
3. Geo Hy Web Resource	derabad, 3rd edition, 2018.

СО	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	2	2							2	1	1	2	
2	2	3	1	2							1	3	2		3
3	2	2	1	2							1	2		2	
4	3	3	2	2							1	1	2		3
5	2	2	1	2							2	1	2	1	1

List of Professional Electives V

S.No	Course Code	Course Name	Seme ster	L	Т	Р	С
1	24CS3701	Embedded Wireless Sensor Networks	III	3	0	0	3
2	24CS3702	DSP Processor Architecture and Programming	III	3	0	0	3
3	24CS3703	RF and Radiation System Design	III	3	0	0	3
4	24CS3704	High Speed Communication Networks	III	3	0	0	3

24CS3701	EMBEDDED	WIRELESS SENSOR NETWORKS	5	L	Τ	Р	C
				3	0	0	3
Prerequisites	s for the course						
• The pre-	-requisite knowledge	e required by the Students to study this	s Course	e is ba	sic k	nowle	edge ii
		nication, Advanced Wireless Network	k and Co	mmu	nicat	ion S	ystem
Laborat	ory I						
Objectives							
		he basic of wireless sensor networks.					
		inderstand the sensor network compo	onents, a	rchite	cture	e and	desig
-	ciples of WSN					~ -	_
		now the need of Physical layer design c	challeng	es and	I MA	C Pro	otocol
		sign the Smart Sensors.	T 1				
	11	by the basic Embedded knowledge to	1	ent W	SN.		
		F WIRELESS SENSOR NETWOR			1	9	· ·
-		Networks - Characteristics requirement		-			
Difference bety	ween mobile ad-hoc	and sensor networks- Enabling Tech					
	1				0		
Networks. Sing		re - Hardware Components - Energy		-			
Networks. Sing Operating Syste	ems and Execution E	nvironments - Sensor Node Examples:		-		CAZ	
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3.	To address the issues of how to int	terface memory, peripherals onto DSP	processors.

- 4. To understand the concept of ADSP BF532 processor.
 - 5. To apply the coding in ADSP BF532 processor.

UNIT I OVERVIEW	OF DIGITAL SIGNAL PROCESS	ING	9
	tems, salient features and characterist		-
	s of DSP processors, numeric represe		
-	structures in DSP processors, VLIW		-
	ig concepts, on-chip peripherals found		
	MS320C5X PROCESSOR		9
	e syntax - Addressing modes – As	embly la	2
	ck Diagram of DSP starter kit – Appl	•	0 0
real time signals	ek Diagram of DSF statter kit – Appr		ograms for processing
	AS320C6748 PROCESSOR		9
	Mega module, memory map, adv	unnead a	
-			
	ystem Memory-DSP memories, sh		-
	peripherals- Memory protection		• •
	essing modes-Assembly language Inst	ructions -	
	DSP BF532 PROCESSOR	т.	9
	ckfin processor core-DMA controlle		-
	ic power management-Serial port cor	troller - U	JART port controller -
Real- time clock			
	NG USING ADSP BF533 PROCES		9
	ram flow control-load/store- move-		
	operations- shift / rotate operations-		-
•	-video pixel operations- vector opera	tions-para	allel issue instructions,
applications programs.			
		Periods	45
Suggestive Assessment Method	ls	T	
Continuous Assessment Test (30 Marks)	Formative Assessment Test (10 Marks)	End Sea (60 Ma	mester Exams rks)
1.Description Questions	1.Assignment	1.Desc	ription Questions
2.Formative Multiple choice	2.Online Quizzes		ative Multiple
questions	3.Problem solving Activities		questions
Outcomes	1		
Upon completion of the course	, the students will be able to:		
CO702. 1 Analyze the data add	ressing capabilities of programmable DS	SP process	ors.
CO702. 2 Narrate the architectu	ares of programmable TMS320C5X DSI	P processor	ſS.
CO702. 3 Narrate the architectu	ures of programmable TMS320C6748 D	SP process	ors.
CO702. 4 Narrate the architectu	ures of programmable BF532 DSP proce	ssors	
CO702. 5 Create application or	iented programming using BF533 DSP I	processors.	
Text Books			
1. Avatar Singh and S.Sriniv	asan, "Digital signal processing", T	Thomson	books, 2004.
Ũ	stems", John Wiley, 2008.		
· · · · ·			
Reference Books			

- $1. http://www.analog.com/static/imported-files/processor_manuals/bf 533_hwr_Rev 3.4.pdf$
- 2. http://read.pudn.com/downloads111/doc/462495/Analog%20Devices%20Blackfin.pdf
- 3. http://www.analog.com/static/imported-files/data_sheets/ADSP-BF531_BF532_BF533.pdf
- 4. http://www.ti.com/lit/ug/spru732j/spru732j.pdf
- 5. https://www.analog.com/en/products/adsp-bf532.html#product-documentation
- 6. https://www.analog.com/media/en/dsp-documentation/processor-manuals/ADSP-BF533_hwr_rev3.6.pdf

Web Resources

- https://nptel.ac.in/content/storage2/courses/108105057/Pdf/Lesson-7.pdf
- <u>https://onlinecourses.nptel.ac.in/noc19_ee70/preview</u>
- <u>https://www.kdkce.edu.in/pdf/DSP_Processor____Architecture_compressed.pdf</u>

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3											3	1	2	
2	3		3	2							2	3	2		3
3	3		3	2						1		3		2	
4	3		3	2							2	3	2		1
5	3		3	3							1	3	1	1	2

24CS3703	RF AND RADIATION SYSTEM DESIGN	L	Τ	Р	C
24003703		3	0	0	3
Prerequisites	s for the course				
• The pre	-requisite knowledge required by the Students to study this Course	e is ba	sic k	nowle	edge ir
Radiatio	on System.				
Objectives					
1. To unde	erstand the design of RF circuits and RFIC system				
2. To desig	gn passive and active microwave Circuits and MIC Systems				
3. To unde	erstand Special antennas and Smart antennas.				
UNIT I	RF CIRCUIT DESIGN			9	
Circles, Bro Mixers, Tran Compression	Operating and Available Power Gain Circles, Noise Figure Cir badband Amplifiers, High-Power Amplifiers, Multistage Ampli insceiver Architectures: Noise Figure, Effects of Nonlinearity, Harr n, Cross Modulation, Intermodulation, Cascaded Nonlinear Stages nd Dynamic Range.	fiers. nonic	Osc Dist	illato: tortio	rs An n, Gai
UNIT II	MICROWAVE PASSIVE CIRCUITS			9	
Realization	f Planar Transmission Lines- Design Parameters for Strip lir of L&C by Low Impedance, High Impedance method and STU anch Line Coupler, Rat- Race Coupler, Power Dividers.				
	SYSTEM DESIGN USING MMIC TECHNOLOGY	r			

Analysis of MMIC Technology -Micro Machined Antennas - Micro Electro Mechanical System Antennas, Design issues in Phased Array Radar- Satellite Transponder -Integrated electronic warfare T/R modules – Avionic Systems Integration.

UNIT IV

SPECIAL ANTENNAS

Antenna fundamental parameters - Need of metamaterial structures, Advantages of metamaterial structures. Design of the metamaterial antennas, Fractal antennas, sinuous antennas, EBG structure, PBG structures. CNT antennas.

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UNIT V SMART ANTENNAS AND ANTENNA SIMULATION

Introduction to Smart Antennas, Beam Forming, Estimation of DOA, AOA. Introduction to numerical techniques- FEM, FDTD, MoM. Introduction to simulators- Design of Microstrip antennas using Simulators. Simulation of Metamaterial Unit Cell, Fractal Structures.

Total Periods 45										
Suggestive Assessment Methods										
Continuous Assessment Test	Formative Assessment Test	End Ser	mester Exams							
(30 Marks)	(10 Marks)	(60 Ma	rks)							
1.Description Questions	1.Assignment	2.Form	ription Questions							
2.Formative Multiple choice	2.Online Quizzes		ative Multiple							
questions	3.Problem solving Activities		questions							

Outcomes

Upon completion of the course, the students will be able to:

CO703. 1 Design RF Amplifiers, Oscillators, and Mixers

CO703. 2 Design an MIC circuit for the required performance

CO703. 3 Design application specific MIC Systems

CO703.4 Design and analyze metamaterial antennas, and Fractal antennas.

CO703. 5 Create any type of antenna using simulation tools.

Text Books

- 1. Reinhold.Ludwig and PavelBretshko, "RF Circuit Design", Pearson Education, Inc., 2006
- 2. B.Razavi,"RF Micro electronics", Pearson Education, Second Edition, 2012
- 3. D.M.Pozar, "Microwave Engineering", 4th Edition, John Wiley & sons, Inc., 2011.
- 4. T.Lee,"Design of CMOS RF Integrated Circuits", Cambridge ,First Edition, 2004

Reference Books

- 1. Ravender Goyal, "Monolithic MIC; Technology & Design", Artech House, 1989.
- 2. Balanis.A, "Antenna Theory Analysis and Design", John Wiley and Sons, New York, Fourth Edition, 2012.

3. Kraus. J.D, "Antennas", John Wiley and sons, New York, Second edition, 1997.

Web Resources

- 1. <u>http://www.phd.etfbl.net/files/Works_PDF/Poprzen%20Nemanja%20.pdf</u>
- 2. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=1189650
- 3. <u>http://www.ece.iit.edu/~pfelber/fractalantennas.pdf</u>
- 4. https://nptel.ac.in/courses/106106046/
- 5. https://onlinecourses.nptel.ac.in/noc18_cs26/

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	1	1					2	2	3	1	2	
2	3	2	2	2	2					2	2	3			1
3	3	3	2	2	2					2	2	3		1	
4	2	3	3	2	1					2	2	3	2		1
5	2	2	2	2	2					1	2	3	1	1	2

24CS370	4

HIGH SPEED COMMUNICATION NETWORKS

L T P C 3 0 0 3

Prerequisites for the course

• The pre-requisite knowledge required by the Students to study this Course is basic knowledge in Communication Networks.

Objectives

- 1. To understand the high speed network architectures
- 2. To study high speed access and admission control
- 3. To understand shaping and scheduling algorithms
- 4. To discuss queuing and congestion control for high speed architectures
- 5. To understand flow and congestion control

UNIT I HIGH SPEED NETWORK ARCHITECTURE

Frame Relay Networks – Asynchronous transfer mode – ATM Protocol Architecture, ATM logical Connection, ATM Cell – ATM Service Categories – AAL, High Speed LANs: Emergence of High-Speed LANs, Gigabit Ethernet, WDM systems, Optical LANs, SONET.

UNIT II

ADMISSION AND ACCESS CONTROL

CAC for ATM VBR Services - Worst-Case Traffic Model and CAC, Effective Bandwidth, -Guaranteed Quality of Service, Controlled-Load Service, ATM Traffic Contract and Control Algorithms - Traffic Contract, PCR Conformance, SCR, and BT, Cell Delay Variation Tolerance, Generic Cell Rate Algorithm.

UNIT III SHAPING AND SCHEDULING

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An ATM Shaping Multiplexer -Dual Leaky Bucket, Algorithm, An Integrated Packet Shaper - Basics, Integrating Traffic Shaping and WFI Scheduling, Logical Structure and implementation of the WFI Packet Shaper, Packet Scheduling – FIFO, RR, Rate-Controlled Static Priority, GPS-WFQ, Virtual Clock, Self-Clocked Fair Queuing, Worst-case Fair Weighted Fair Queuing, Scheduling Algorithm -Shaped Virtual Clock Algorithm

UNIT IV	QUEUING & BUFFER MANAGEMENT	9
Conceptual Fra	mework and Design Issues, Sequencer - Store Cells in Logical (Queues, Sort Priorities
Using a Seque	ncer, RAM-Based Searching Engine - Hierarchical Searching, De	esign of the RSE, RSE
Operations, W	rite-in Operation, Reset Operation, Search Operation: A Look at A	ATM Networks - Self-

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List of Professional Electives VI

S.No	Course	Course Name	Seme	L	Т	Р	С
	Code		ster				
1	24CS3705	Cooperative Communication	III	3	0	0	3
2	24CS3706	VLSI Architecture for Image and Video Processing	III	3	0	0	3
3	24CS3707	Mobile Robotics	III	3	0	0	3
4	24CS3708	Advanced Radar and Navigational AIDS	III	3	0	0	3

24CS3705		L	Τ	Р	С
24055705	COOPERATIVE COMMUNICATION	3	0	0	3
Prerequisite	s for the course				
1	e-requisite knowledge required by the Students to study this Course ss Communication	e is ba	sic k	nowle	dge ii
Objectives					
1. Enable	e the student to understand the evolving paradigm of cooperat	ive co	mmu	inicat	ion,
networ	e the student to the usage of various Relay selection schemes a				
	is a platform to design novel cooperative protocols and routing	g algo	rithm	ıs.	
5. To des	ign routing algorithms for cooperative communication				
UNIT I	INTRODUCTION TO COOPERATIVE COMMUNICATIONS SYSTEMS AND COOPERATIVE DIVERSITY			9	
Communication the relay cha	n Wireless Network, Cooperation protocols - Hierarchical coo ons with single relay; Multi-node cooperative communications nnel, spatial diversity in wireless networks, Cooperative str relay networks, Capacity bounds for cooperative diversity	- Сарас	ity th	leorer	ns fo
UNIT II	COOPERATIVE DEMODULATION			9	
	nd demodulation for cooperative diversity in wireless syst emodulation with decode-and-forward relays, Symbol error pr nks				

UNIT III	COOPE	ERATIVE SPACE-TIME CODING		9
Space-Time	Codes for High Data	a Rate Wireless Communication,	Distributed	d space-time-code
		: performance limits and space-ti	me signal	design, Space-tim
diversity en	hancements using col	laborative communications		
UNIT IV	DISTRIB	SUTED COOPERATIVE ROUTING		9
Network M	odel, Cooperation ba	sed routing protocol, Source-chan	nel coding	g with cooperatior
		nications - System model - Coo		
issignment	scheme			
UNIT V		CHANNEL ACCESS ISSUE		9
Cooperative	e Multiple Access Com	munication ,Relay channel and pro	tocol ,Rela	y selection, Energy
I	-	ent-aware Cooperative multiple acc		
		Total I	Periods	45
Suggestive	Assessment Method		crious	10
00	Assessment Test	Formative Assessment Test	End Sem	ester Exams
	larks)	(10 Marks)	(60 Mar	
I.Descripti	on Questions	1.Assignment	1.Descri	ption Questions
2.Formativ	e Multiple choice	2.Online Quizzes	2.Forma	tive Multiple
questions		3.Problem solving Activities	choice q	uestions
Outcomes				
		, the students will be able to:		
CO302. 1		nt cooperative communication prot		
CO705. 2		ance of Cooperative demodulation		S
CO705. 3		y using collaborative communicati	on	
CO705. 4		band cooperative communication		
CO705. 5		ance of cooperative multiple acces	s protocol	
Fext Books				
		ı, A. Kwasinski, Cooperative Comm	unications	and Networking,
	oridge University Pre			
	na Donier, Yonghui Li Wiley & Sons, 2010	, "Cooperative Communications: Ha	ardware, C	nannel & PHY,
•		en, Mohsen Guizan, "Cooperative W	ireless Cou	nmunications
	erbach Publications 2		11 01035 001	innumeations
		ls., Handbook on Array Processing	and Sensor	Networks, IEEE
Wile	y, 2019.			
Reference	Books			
	0 0	gnitive Radio Networking and Secu	rity: A Gan	ne Theoretical
	, Cambridge Universi			
		J.R. Liu, Behavior Dynamics in Med	0	Social Networks,
		ss, 2011Cambridge University Pres		hn Wilow & Cona
5. Kwal 2009		amjee Prasad, "Cognitive Radio Net	works , ju	iiii wiiey & soiis,
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24CS3706 Prerequisites for • The pre-room Mathematic	PROCESSING	3		1	1
• The pre-re		~	0	0	3
-	or the course				
Mathemat	equisite knowledge required by the Students to study this Course	e is ba	sic k	nowle	dge i
Whathema	tics.				
Objectives					
1. To pro	ovide the basic understanding of the digital image formation and	l visua	lizat	ion.	
2. To pro	ovide the visualization of relationships between spatial and frequ	iency.			
3. To pr	ovide the understanding of mapping the signal processing tea	chniqu	ies to	the	digit
image).				
4. To pro	ovide an idea of multimedia data (image, video).				
5. To pro	ovide an exposure to various image and video compression stand	lards			
UNIT I	FUNDAMENTALS OF IMAGE PROCESSING AND IMAGE TRANSFORMS			9	
Basic steps of Ir	nage processing system sampling and quantization of an Ima	ge –B	Basic	relati	onshi
between pixels In	nage Transforms: 2 – D Discrete Fourier Transform, Discrete Co	sine T	ransf	form (DCT
Discrete Wavelet	transforms				
UNIT II	IMAGE PROCESSING TECHNIQUES			9	
Image Enhancem	ent: Spatial Domain methods: Histogram Processing, Fundament	tals of	Spat	ial Fil	terin
Smoothing Spatia	al filters, Sharpening Spatial filters Frequency Domain methods	s: Bas	ics o	f filter	ring
	in, image smoothing, image sharpening, selective filtering neepts, point, line and Edge detection, Thresholding, region base				tatio
UNIT III	IMAGE COMPRESSION			9	
Compression 1	ression fundamentals –coding Redundancy, spatial and models: Lossy and Lossless, Huffmann coding, Arithmetic cod Bit Plane coding, transform coding, predictive coding, wavelet	ling, I	LZW	codir	ng, ru
UNIT IV	BASIC STEPS OF VIDEO PROCESSING			9	
	igital Video, Time varying Image Formation models : 3D mot , Photometric Image formation, sampling of video signals, filter				metr
UNIT V	2-D MOTION ESTIMATION			9	
Optical flow, ger	neral methodologies, pixel based motion estimation, Block mat	ching	algo	rithm,	Mes
	timation, global Motion Estimation, Region based motion estim	-	-		

motion estimation. Waveform based coding, Block based transform coding, predictive coding, Application of motion estimation in video coding. Blocks of a VLSI circuit: Computer architecture, memory architectures, communication interfaces, mixed signal interfaces.

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Upon completion of the course, the students will be able to:

CO707.1 Understand the different types of mobile robots and functional design

- CO707.2 Analyzing Robot Kinematics and dynamics through different manipulators and end effectors
- CO707. 3 Understand various sensors and applications
- CO707.4 Analyzing the robotic localization & mapping
- CO707. 5 Analyzing path planning and navigation of robots

Text Books

- 1. R. Siegwart, I. R. Nourbakhsh, "Introduction to Autonomous Mobile Robots", The MIT Press, 2011.
- 2. Peter Corke , Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011.
- 3. S. M. LaValle, "Planning Algorithms", Cambridge University Press, 2006. (Available online http://planning.cs.uiuc.edu/)
- 4. Thrun, S., Burgard, W., and Fox, D., Probabilistic Robotics. MIT Press, Cambridge, MA, 2005.

Reference Books

- 1. Melgar, E. R., Diez, C. C., Arduino and Kinect Projects: Design, Build, Blow Their Minds, 2012.
- 2. H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, Principles of Robot Motion: Theory, Algorithms and Implementations, PHI Ltd., 2005L. Fausett, Fundamentals of Neural Networks, Prentice Hall

Web Resources

- https://nptel.ac.in/courses/106/105/106105173/
- https://onlinecourses.nptel.ac.in/noc24_cs11/preview
- <u>https://nptel.ac.in/courses/106/106/106106184/</u>

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	3						2	1	1	2	
2	3	3	3	3	3						2	1	3		1
3	3	3	3	3	3						2	1		3	
4	3	3	3	3	3						2	1	2		
5	3	3	3	3	3						2	1			2

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DVANCED RADAR AND NAVIGATIONAL AIDS

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Prerequisites for the course

• The pre-requisite knowledge required by the Students to study this Course is basic knowledge in Radar.

Objectives

- 1. To review the fundamentals of RADAR
- 2. To learn the MTI and Pulse Doppler RADAR
- 3. To understand the concept of RADAR signal processing.
- 4. To apply and learn the Navigation and Remote sensing RADARS.
- 5. To apply the concept through Navigation AIDS.

UNIT I INTRODUCTION TO RADAR

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Derivation of Radar Equation- Radar Block Diagram- Radar Frequencies –Applications of Radar – The Origins of Radar. The Radar Equation. Introduction- Detection of Signals in Noise- Receiver Noise and the Signal-to-Noise Ratio-Probability Density Functions- Probabilities of Detection and False Alarm-Integration of Radar Pulses- Radar Cross Section of Targets- Radar cross Section Fluctuations-Transmitter Power-Pulse Repetition Frequency- Antenna Parameters- System losses – Other Radar Equation Considerations.

UNIT II	MTI AND PULSE DOPPLER RADAR	9
Doppler and M	ITI Radar- Delay -Line Cancellers- Staggered Pulse Repetition	Frequencies –Doppler
Filter Banks - I	Digital MTI Processing - Moving Target Detector - Limitations to M	ITI Performance - MTI
from a Moving	Platform (AMIT) – Pulse Doppler Radar – Other Doppler Radar	Topics.

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UNIT III	RADAR SIGNAL PROCESSING	9

Phenomenology: Resolution, spatial frequency, Fourier transform, sampling, vector representation of signals, data integration and correlation. Signal models: Amplitude model, clutter model, noise model, jamming model, frequency model, spatial model Signal conditioning: Sampling, Digital I/Q Modulation.

UNIT IV NAVIGATIONAL AND REMOTE SENSING RADARS

Introduction – Airport Radars – MET Radar – Airbone Radar- Doppler Navigation – Navy Radar – Remote Sensing Radar- Pattern Synthesis – Phased Array – CW Radar – Imaging Radar – Monopulse Radar Imaging –Multifunction Array Radar

UNIT V NAVIGATIONAL AIDS

Elementary ideas of Navigation Aids: VOR, DVOR, TACAN, ILS and MLS, Hyperbolic Navigation (LORAN, DECA, OMEGA). GPS, DGPS, Automatic Direction finder.

	Total	Periods	45
Suggestive Assessment Metho	ds		
Continuous Assessment Test (30 Marks)	Formative Assessment Test (10 Marks)	End Ser (60 Ma	mester Exams rks)
1.Description Questions 2.Formative Multiple choice questions	1.Assignment 2.Online Quizzes 3.Problem solving Activities	2.Form	ription Questions ative Multiple questions
Outcomes			
Upon completion of the course	, the students will be able to:		

1 1	,
CO708. 1	Analyze the Fundamentals of RADAR Systems.

- CO708. 2 Analyse MTI and pulse DOPPLER radar.
- CO708. 3 Create the algorithm for RADAR signal processing
- CO708. 4 Analyse Navigational and Remote Sensing RADAR
- CO708. 5 Apply the learnt algorithms to analyze navigational aids

Text Books

- 1. Merrill. I. Skolnik, "Introduction to RADAR Systems", Tata McGraw Hill, Third Edition, 2001.
- 2. Mark. A.Richards, "Fundamentals of Radar Signal Processing", Tata McGraw Hill, First Edition, 2005.
- 3. Dr.A.K. Sen and Dr.A.B. Bhattacharya, "Radar Systems and Radio Aids to Navigation", Khanna Publishers, 2003.

Reference Books

- 1. Steven M.Kay, "Fundamentals of Statistical Signal Processing", Vol III Detection Theory, Prentice Hall Inc, First Edition, 2013.
- 2. Roger J Suullivan, "Radar Foundations for Imaging and Advanced Topics", SciTech Publishing, First Edition, 2004
- 3. N.S. Nagaraja, "Elements of Electronic Navigation", TMH, Second Edition, 2004.
- 4. Peyton Z Peebles Jr, "Radar Principles", Wiley Inter Science, First Edition, 2004.

Web Resources

- http://books.google.co.in/books/about/Radar_Engineering.html?id=B6jlxVqT130C
- https://archive.org/details/RadarAidsToNavigation
- https://www.jlab.org/ir/MITSeries/V2.pdf

CO Vs PO Mapping and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	2								1		2	
2	3	3	3	3	2							1	3		1
3	3	3	3	2	2							1		3	
4	3	3	3	3	2							1	2		
5	3	3	3	3	3							1			2