Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

(Accredited 'A++' Grade by NAAC with a score of 3.6)

Hingna Road, Wanadongri, Nagpur - 441 110

Master of Technology

SoE & Syllabus 20**23**

(Department of Electronics & Telecommunication)

M.Tech in Communication Engineering

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

SoE No. 23COM-101

M.TECH. SCHEME OF EXAMINATION 2023

M. Tech. in Communication Engineering

SN	Sem	Sub Code	Subject	T/P	Contact Hours				Credits	% Weightage		ESE Duration Hours
					L	T	P	Hrs		TA	ESE	
I SEMESTER												
1	1	23COM101	Probability & Stochastic Processes	T	3	0	0	3	3	20	80	3 Hours
2	1	23COM102	Passive RF Circuits & Systems	T	3	0	0	3	3	20	80	3 Hours
3	1	23COM103	**Lab:** Passive RF Circuits & Systems	P	0	0	2	2	1	60	40	
4	1	23COM104	Advanced Digital Communication	T	3	0	0	3	3	20	80	3 Hours
5	1	23COM105	**Lab:** Advanced Digital Communication	P	0	0	2	2	1	60	40	
6	1	23COM106	Adaptive Signal Processing	T	3	0	0	3	3	20	80	3 Hours
7	1	23COM107	**Lab:** Adaptive Signal Processing	P	0	0	2	2	1	60	40	
8	1		**Professional Elective- I**	**T**	3	0	0	3	3	20	80	3 Hours
9	1		**Professional Elective- II**	**T**	3	0	0	3	3	20	80	3 Hours
Total					**18**	**0**	**6**	**24**	**21**			

List of Professional Electives-I		
1	23COM111	PE I: Optical Communication & Networks
1	23COM112	PE I: RISC & CISC Processor

List of Professional Electives-II		
1	23COM121	PE II: Active RF Devices and Circuits
1	23COM123	PE II: Soft Computing

II SEMESTER												
1	2	23COM201	Antenna Design	T	3	0	0	3	3	20	80	3 Hours
2	2	23COM202	**Lab:** Antenna Design	P	0	0	2	2	1	60	40	
3	2	23COM203	VLSI Signal Processing	T	3	0	0	3	3	20	80	3 Hours
4	2	23COM204	Digital Image and Video processing	T	3	0	0	3	3	20	80	3 Hours
5	2	23COM205	**Lab:** Digital Image and Video processing	P	0	0	2	2	1	60	40	
6	2	23COM206	Wireless Communication Network	T	3	0	0	3	3	20	80	3 Hours
7	2		**Professional Elective -III**	T	3	0	0	3	3	20	80	3 Hours
8	2		**Professional Elective -IV**	T	3	0	0	3	3	20	80	3 Hours
9	2	23COM207	Seminar	P	0	0	2	2	1	60	40	
Total					**18**	**0**	**6**	**24**	**21**			

List of Professional Electives-III		
2	23COM211	PE III: Millimeter wave communication
2	23COM212	PE III: Real Time Operating System

List of Professional Electives-IV		
2	23COM231	PE IV: Selected Topics in Communication
2	23COM232	PE IV: Micro Electro Mechanical Systems

III SEMESTER												
3	3	23COM301	Project Phase-I	P	0	0	16	16	8	60	40	
Total					**0**	**0**	**16**	**16**	**8**			
IV SEMESTER												
1	4	23COM401	Project Phase-II	P	0	0	24	24	12	60	40	
Total					**0**	**0**	**24**	**24**	**12**			
Grand Total of Credits					**36**	**0**	**52**	**88**	62			

		June, 2023	**1.00**	**Applicable for AY 2023-24 Onwards**
Chairperson	**Dean (Acad. Matters)**	**Date of Release**	**Version**	

I Semester
23COM101- Probability & Stochastic Processes

Course Outcomes:
Upon successful completion of the course the students will be able to 1. Calculate probabilities by applying probability laws. 2. Derive probability distributions of functions of random variables. 3. Identify an appropriate probability distribution for a given discrete or continuous random variable.

Unit:1	**Probability**	**6 Hours**
Sets, fields, sample space and events; axiomatic definition of probability. Combinatory: Probability on finite sample spaces. Joint and conditional probabilities, independence, total probability; Bayes' rule and applications		
Unit:2	**Random variables**	**7 Hours**
Definition of random variables, continuous and discrete random variables, cumulative distribution function (cdf) for discrete and continuous random variables; probability mass function (pmf); probability density functions (pdf) and properties. Jointly distributed random variables, conditional and joint density and distribution functions, independence; Bayes' rule for continuous and mixed random variables.		
Unit:3	**Function of Random variables**	**7 Hours**
Uniform, Gaussian and Rayleigh distributions; Binomial, and Poisson distributions; Multivariate Gaussian distribution Functions of a random variable, Functions of two random variables; Sum of two independent random variables.		
Unit:4	**Expectations and Introduction to Estimation**	**6 Hours**
Expectation: mean, variance and moments of a random variable. Joint moments, conditional expectation, Moment generating and characteristic function		
Unit:5	**Introduction to Stochastic Processes**	**6 Hours**
Definition and examples of SPs, classification of random processes according to state space and parameter space, types of SPs, elementary problems.		
Unit :6	**Random Processes**	**6 Hours**
Discrete-time Markov Chains (MCs), Continuous-time Markov Chains (MCs), Brownian Motion, Stationary Processes **Contemporary Issues related to Topic**		
Total Lecture Hours		**38 Hours**

Textbooks	
1	Probability and Random Processes with Applications to Signal Processing, Henry Stark, J.W.Woods, Pearson Education, 3rd edition, 2001.
2	Probability, Random variables and Stochastic Processes, A.Papoulis , McGraw Hill, 3rd edition, 1991.
Reference Books	
1	P.Z. Peebles. Jr., PROBABILITY, RANDOM VARIABLES AND RANDOM SIGNAL PRINCIPLES, Tata McGraw Hill Education, 3rd edition, 2002.
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	
MOOCs Links and additional reading, learning, video material	
1	https://nptel.ac.in/courses/111102111
2	https://nptel.ac.in/courses/108106106

I Semester
23COM102- Passive RF Circuits & Systems

Course Outcomes:
Upon successful completion of the course the students will be able to 1) Analyze various transmission lines and its characteristics. 2) Analyze various microwave network models and passive components. 3) Apply the knowledge of various switches, phase shifters and MIC filters. 4) Explore various MMIC and MEMS technologies.

Unit:1	**Transmission Lines**	**6 Hours**
Review of Basic Transmission Line Theory, Planar Transmission Lines - Stripline, microstrip line, Suspended strip line and coplanar line; Parallel coupled lines in Stripline and microstrip – Analysis, Design and characteristics.		
Unit:2	**Networks**	**6 Hours**
Microwave Network Analysis - Microwave network representation, Impedance and admittance matrices, Scattering parameters, Typical two-port, three port, four port networks; Impedance Matching Techniques - Smith chart, Matching networks using lumped elements, Single- and double-stub matching, Quarter wave transformer, Baluns		
Unit:3	**Passive Components**	**6 Hours**
Basic Passive Components -Lumped elements in MIC, Discontinuities and resonators in microstrip, Analysis and design of Stripline/microstrip components- Directional couplers, Power divider, Hybrid ring.		
Unit:4	**Switches and Phase Shifters**	**6 Hours**
Switches and Phase Shifters Basic series and shunt switches in microstrip; SPST and SPDT switches, Switched line, branch line coupled and loaded line phase shifters in microstrip, Applications in phased arrays.		
Unit:5	**MIC Filters**	**6 Hours**
MIC Filters - Lumped element filter design at RF. Impedance and Low pass scaling, Frequency transformation, High impedance/Low impedance low pass filter, Parallel coupled band pass filter, High pass filter, band stop filter		
Unit :6	**MIC Technology**	**6 Hours**
MIC Technology Hybrid MIC's, Monolithic MIC technology, – Thick film and Thin film technology, Introduction: RF MEMS for microwave applications, MEMS technology and fabrication		
Total Lecture Hours		**36 Hours**

Textbooks	
1	M.M. Radmanesh, Radio Frequency and Microwave Electronics, Pearson Education Asia, 2001.
2	B. Bhat & S.K. Koul, Stripline-like Transmission Line for Microwave Integrated Circuits, New Age Intl. (P) Ltd., 1989.
Reference Books	
1	D. K. Misra, Radio Frequency and Microwave Communication Circuits – Analysis and Design, John Wiley & Sons, 2001.
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	http://103.152.199.179/YCCE/Suported%20file/Supprted%20file/e-copies%20of%20books/Electronics%20Engineering/73.john1.wiley.and.sons.rf.mems.and.their.applications.ebook-lib.pdf
2	http://103.152.199.179/YCCE/Suported%20file/Supprted%20file/e-copies%20of%20books/Electronics%20Engineering/81.microwave-devices-and-circuits-samuel-liao.pdf
MOOCs Links and additional reading, learning, video material	
1	https://youtu.be/KUDGGsyh1Hs
2	https://youtu.be/ZZEZUysFPDY
3	https://youtu.be/u59IUA6uvjk

I Semester
23COM103 – Lab: Passive RF Circuits & Systems

Course Outcomes:
Upon successful completion of the course the students will be able to
1) Analyze various transmission lines and its characteristics.
2) Analyze various microwave network models and passive components.
3) Apply the knowledge of various switches, phase shifters and MIC filters.
4) Explore various MMIC and MEMS technologies.

Sr. No.	Experiments based on
1	Low Pass, Band Pass, Band Stop Filters
2	Couplers
3	Phase Shifter
4	Power Divider
5	Hybrid ring Coupler
6	Switches

I Semester
23COM104 – Advanced Digital Communication

Course Outcomes:
Upon successful completion of the course the students will be able to 1. Construct time- and frequency-domain models for digital communications systems with linear channels and additive noise. 2. Design the optimal receiver when the noise is Gaussian. 3. compare the performance of the spread spectrum communication systems 4. Evaluate the performance of multicarrier & Multichannel communication systems

Unit:1	**Introduction to Digital Communication**	**6 Hours**
Review of fundamental concepts and parameters in Digital Communications, Performance of BPSK and QPSK in AWGN channel, Performance of binary FSK and M-ary PSK in AWGN channel.		
Unit:2	**Modulation**	**6 Hours**
Minimum Shift Keying (MSK) Modulation, GMSK, Continuous Phase Modulation (CPM) Schemes Channel Characterization and Modeling, Orthogonal Frequency Division Multiplexing (OFDM), Carrier Synchronization, Timing synchronization.		
Unit:3	**Baseband Signals**	**6Hours**
Introduction, Line code for Binary Signal, Baseband Reception and Probability of Error, ISI and Nyquist Criteria, Correlative coding, M-ary Baseband Signaling, Equalization, scrambling, The Eye Pattern		
Unit:4	**Baseband reception and probability of error**	**6 Hours**
the ML and MAP detection strategies, ML detection with zero mean AWGN, the optimum filter, Schwarz's inequality, transfer function of optimum filter, matched filter, properties of Matched filter, correlation receiver, equalization, the zero forcing equalizer, adaptive equalizer.		
Unit:5	**Spread Spectrum Communication**	**6 Hours**
Spread spectrum signals for digital communications: Introduction to Spread Spectrum Modulation, DSSS, FHSS, and CDMA signals, Code Acquisition and Tracking, Spread Spectrum as a Multiple Access Technique		
Unit :6	**Multichannel and Multicarrier Systems**	**6 Hours**
Digital Communications through Fading Multipath channels; Multi User Communications **Contemporary Issues related to Topic**		
Total Lecture Hours		**36 Hours**

Textbooks	
1	Digital Communications 1995 4 th Edition J.G.Proakis McGraw Hill,
2	Digital Communications 1998 Simon Haykin John Wiley & Sons
Reference Books	
1	Principles of Digital Communications and Coding 1979 J. Viterbi and J. K. Omura McGraw Hill,
2	Spread Spectrum Communications 1995. MarvinK.Simon,Jim K Omura, RobertA. Scholtz, Barry K.Levit John Wiley & Sons
3	CDMA Principles of Spread Spectrum Communications 1995. Andrew J Viterbi Addison Wesley
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	http://103.152.199.179/YCCE/Suported%20file/Supprted%20file/SERIES%20WISE%20BOOKS/COMMUNICATION%20ENGINEERING%20(PG)/COMM
MOOCs Links and additional reading, learning, video material	
1	https://nptel.ac.in/courses/117101051
2	https://nptel.ac.in/courses/117105144

I Semester
23COM105 – Lab: Advanced Digital Communication

Course Outcomes:
Upon successful completion of the course the students will be able to
1) Construct time- and frequency-domain models for digital communications systems with linear channels and additive noise.
2) Design the optimal receiver when the noise is Gaussian.
3) compare the performance of the spread spectrum communication systems
4) Evaluate the performance of multicarrier & Multichannel communication systems

Sr. No.	Name of Experiments
1	Implement generation of ASK signal
2	Implement generation of BPSK signal
3	Write Program for BER of BPSK signal
4	Write Program for BER of QPSK signal
5	Write Program for BER of BPSK using OFDM
6	Write Program for Matched filter receiver
7	Write Program for finding channel noise and ISI using eye diagram
8	Perform practical on the data scrambler and descrambler.
9	Perform a Monte Carlo simulation of an M=8 QAM communication system.
10	Implement generation of discrete time signal.

I Semester
23COM106 – Adaptive Signal Processing

Course Outcomes:
Upon successful completion of the course the students will be able to 1. Devise filtering solutions for optimising the cost function using wiener filters. 2. Analyze convergence and stability issues using LMS algorithm and its transform domain. 3. Evaluate the performance Recursive Least-Squares (RLS) techniques to improve convergence behaviour. 4. Devise filtering solutions for optimizing using Lattice and Kalman Filtering. 5. Devise filtering solutions for optimizing using FTRLS algorithm.

Unit:1	**Adaptive Filters**	**7 Hours**
Introduction to Adaptive Filters, Stochastic Processes, and Adaptive beam forming, Wiener filter: Mean-Squared Error Criterion, Wiener Filter – Transversal, Real-Valued Case, Principle of Orthogonality, Normalized Performance Function, Unconstrained Wiener Filters, Performance Function, Optimum Transfer Function, Modelling, Inverse Modelling and Noise Cancellation.		
Unit:2	**LMS algorithm**	**6 Hours**
LMS algorithm: Derivation of LMS Algorithm, Average Tap-Weight Behavior of the LMS Algorithm, MSE Behavior of the LMS Algorithm, Simplified LMS Algorithms, Normalized LMS Algorithm		
Unit:3	**Transform Domain Adaptive Filters**	**7 Hours**
Overview of Transform Domain Adaptive Filters, Band-Partitioning Property of Orthogonal Transforms, Orthogonalization Property of Orthogonal Transforms, Transform Domain LMS Algorithm, Ideal LMS-Newton Algorithm and Its Relationship with TDLMS, Selection of the Transform T.		
Unit:4	**Method of Least-Squares**	**6 Hours**
Formulation of Least-Squares Estimation for a Linear Combiner, Principle of Orthogonality, Projection Operator, Standard Recursive Least-Squares Algorithm, Convergence Behavior of the RLS Algorithm,		
Unit:5	**Lattice and Kalman Filters**	**7 Hours**
Forward Linear Prediction, Backward Linear Prediction, Relationship Between Forward and Backward Predictors, Prediction-Error Filters. Kalman filtering		
Unit :6	**Fast RLS Algorithms**	**6 Hours**
Least-Squares Forward Prediction, Least-Squares Backward Prediction, Least-Squares Lattice, RLSL Algorithm, FTRLS Algorithm. **Contemporary Issues related to Topic**		
Total Lecture Hours		**39 Hours**

Textbooks	
1	B. Farhang Boroujeny, Adaptive Filters: Theory & Applications, 2nd edition, Wiley Publication, 2013
2	Simon Haykin, Adaptive Filter Theory, 3rd edition Prentice Hall, 1996
Reference Books	
1	G. Manolakis, Statistical and Adaptive Signal Processing, McGraw Hill
2	Alexsander S.T, Adaptive Filters: Theory & Applications, springer verlag, 2012
3	M. H. Hays, Statistical Digital Signal Processing and Modeling, John Wiley
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	http://103.152.199.179/YCCE/yccelibrary.html
MOOCs Links and additional reading, learning, video material	
1	https://nptel.ac.in/courses/117/105/117105075/

I Semester
23COM107 – Lab: Adaptive Signal Processing

Course Outcomes:
Upon successful completion of the course the students will be able to 1. Devise filtering solutions for optimising the cost function using wiener filters. 2. Analyze convergence and stability issues using LMS algorithm and its transform domain. 3. Evaluate the performance Recursive Least-Squares (RLS) techniques to improve convergence behaviour. 4. Devise filtering solutions for optimizing using Lattice and Kalman Filtering. 5. Devise filtering solutions for optimizing using FTRLS algorithm.

Sr. No.	Experiments List
1	To implement the wiener filter and check mean square error
2	Write a program for noise cancellation
3	To implement LMS algorithm & plot the learning curve.
4	Write a program for Channel Equalizer using LMS
5	Implement Transform Domain LMS algorithm using DCT
6	Implement Recursive Least Square Algorithm.
7	To perform principle of orthogonality(RLS)
8	To Steady State Kalman Filter Design
9	To study Time Varying Kalman Filter Design
10	Implement Kalman Filter for Linear Gauss Markov System

I Semester
23COM111 – PE I: Optical Communication & Networks

Course Outcomes:
Upon successful completion of the course the students will be able to 1. Elaborate with basic concepts and theory of Optical Communication. 2. Illustrate various methods of fiber manufacturing 3. Compare different source of light as well as various detectors 4.Illustrate various transmissions links and optical networks

Unit :1	**Basic concepts of optical communication**	**6 Hours**
Basic concepts of optical communication. The nature of light. Light as an Electromagnetic Wave, Polarisation, Interference. Transmitting light on a Fibre Refractive index, Fibre refractive index profiles, Modes of propagation. Light Propagation in Multimode Fibre, Snell's Law Critical Angle, Numerical aperture.		
Unit:2	**Fiber materials**	**6 Hours**
Fiber materials, Fiber drawing apparatus, Outside Vapor, Phase Oxidation, Vapor Phase Axial Deposition, Double Crucible Method, Modified Chemical Vapor Deposition, Plasma Activated Chemical Vapor Deposition, Fiber Buffering, Optical Fiber Cable structure		
Unit:3	Optical Sources	**6 Hours**
Optical Sources: Light Emitting Diodes (LEDS), The Semiconductor Junction Diode, Construction and Operation of LED's , Heterojunctions (Practical LED's) , Characteristics of LED'S, Lasers, Principle of the LASER, Semiconductor Laser Diodes		
Unit:4	Optical Detectors	**6 Hours**
Optical Detectors: Photoconductors, Photodiodes, P-N Diodes, P-I-N Diodes, Schottky-Barrier Photodiodes, Avalanche Photodiodes (APDS), Hetero-interface Photodetectors, Phototransistors		
Unit:5	**Optical Communication Systems**	**6 Hours**
Optical Communication Systems: Point-to-point Transmission Systems, Modulation techniques, Onoff key, line coding, Forward Error correction, Receiving the signal, Timing recovery.		
Unit:6	**Optical Networks**	**6 Hours**
Optical Networks: System design consideration, Point – to –Point link design, WDM, Elements of optical networks, SONET/SDH. Optical Interfaces, SONET/SDH Rings and Networks, High speed light wave Links, Optical ETHERNET-Solution. **Contemporary Issues related to Topic**		
Total Lecture Hours		**36 Hours**

Textbooks	
1	Optical Fiber Communication Third Edition Gerd Keiser, McGraw-Hill International,
2.	Optical Communication, Principles and Practice. Third Edition J.Senior Prentice Hall of India
Reference Books	
1	Optical Communication System J. Gower Prentice Hall of India
2	Fiber-Optic Communication System Third Edition GovindAgrawal John Willy & Sons
3	Optical communication systems J. Gower, PHI
4	Optical Fiber System Kao Tata Mc Graw Hill
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	
MOOCs Links and additional reading, learning, video material	
1	https://onlinecourses.nptel.ac.in/noc22_ee88 Fiber Optic Communication Technology - Course (nptel.ac.in)

I Semester
23COM112 – PE I: RISC & CISC Processor

Course Outcomes:

Upon successful completion of the course the students will be able to

1. Explore different technologies related to embedded systems
2. Effectively utilise the knowledge gained about RISC processor architecture and its instruction set for programming.
3. Explore basics of CISC processor architecture
4. Effectively utilise the knowledge gained about CISC processor and its instruction set for programming

Unit:1	**Overview of embedded systems**	**5 Hours**
Embedded Systems, Introduction, Design Metrics, Processor Technology, IC Technology, Design Technology, Design Productivity Gap, Custom Single purpose Processor Design, RT level design, FSMD, Data-paths, Optimization, Instruction set simulators for simple processors.		
Unit:2	**Architectural Features Of RISC PROCESSORS**	**7Hours**
The ARM processor - Register organization, Processor modes Exceptions and their handling, Memory-mapped I/Os, ARM and THUMB instruction sets, Addressing modes, DSP extensions, programming examples		
Unit:3	**ARM7/9 Core**	**6Hours**
H/W architecture, Timing diagrams for Memory access, Co-processor interface, Debug support, Scan chains, Embedded Real Time ICE, Hardware and software breakpoints. Buses: AMBA, ASB, APB, Development tool like Compilers, Debuggers, IDE		
Unit:4	**ARM Cortex – M series**	**5 Hours**
Introduction to the ARM Cortex M4 and its targeted applications, ARM Cortex M4 architecture address space, on-chip peripherals (analog and digital) Register sets, addressing modes and instruction set basics.		
Unit:5	**Fundamentals of CISC processors**	**5 Hours**
The CISC processor :-DSP processor- MAC, Modified bus structures and Memory access schemes, Multiple access Memory , Multiported memory, VLIW architecture, Pipelining, Special addressing modes, On chip peripherals.		
Unit :6	**32- bit DSP processor**	**8 Hours**
Introduction to TI DSP processor family VLIW architecture and TMS320C6000 series, architecture study, data paths, cross paths, Introduction to Instruction level architecture of C6000 family, instruction set & programming examples, On chip peripherals **Contemporary Issues related to Topic**		
Total Lecture Hours		**36 Hours**

Textbooks	
1	Sloss Andrew N, Symes Dominic, Wright Chris ARM System Developer's Guide: Designing and Optimizing, Morgan Kaufman Publication
2	Steve Furber ,ARM System-on-Chip Architecture, 2nd Edition,2002, Pearson Education
3.	Frank Vahid and Tony Givargis, Embedded System Design, 2002, 1st Edition, Wiley Publication
4.	Venkataramani, M Bhaskar,Digital signal processors, 2002, 1st edition, Tata McGraw Hill
5	Jonathan W. Valvono "Introduction to ARM Cortex-M Microcontrollers", 2014, 5th Edition, Create Space Independent Publishing Platform, United States.
Reference Books	
1	Raj Kamal , Embedded System Design , 2003, Tata McGraw Hill
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	http://link.springer.com/openurl?genre=book&isbn=978-1-4614-4893-8
2.	http://link.springer.com/openurl?genre=book&isbn=978-1-4020-5868-4
3	http://link.springer.com/openurl?genre=book&isbn=978-0-387-25280-3
4	http://link.springer.com/openurl?genre=book&isbn=978-1-4614-3142-8
MOOCs Links and additional reading, learning, video material	
1	https://swayam.gov.in/explorer?searchText=embedded
2	Technical references and user manuals on www.arm.com, NXP Semiconductor www.nxp.com and Texas Instruments www.ti.com

I Semester
23COM121 – PE II: Active RF Devices and Circuits

Course Outcomes:
Upon successful completion of the course the students will be able to 1 Analyse modelling of semiconductor Device. 2. Design Two Port power gain Amplifier for Stability and Gain. 3. Estimate the efficiency for RF Power Amplifier. 4. Analyse Characteristics and equivalent circuit of detector and Mixer 5. Describe Oscillator circuits and Phase Lock Loop

Unit:1	**Active RF Component & their Modelling**	**06 Hours**
Active RF Component & their Modelling: RF Diodes, Linear & Non-linear Diode Models, small & large signal Model of BJT & FET.		
Unit:2	**Transistor Amplifiers**	**06 Hours**
Types of amplifiers. S parameter characterization of transistors; Two Port power gain Amplifier Stability , Stability Circle, Test for Unconditional Stability, MOSFETs , Equivalent circuit model.		
Unit:3	**Transistor Amplifier Design**	**06 Hours**
Single stage amplifier design for Unilateral and bilateral cases, Design for Maximum Gain, Constant gain, Design for Specified Gain, DC bias circuits for Transistor, Low Noise Amplifier Design.		
Unit:4	**RF Power amplifier**	**06 Hours**
Introduction, Class A, B, AB, C, Class D Amplifier, Class E Amplifier, Class F Amplifier. Modulation of Power amplifier.		
Unit :5	**Oscillators**	**06 Hours**
Feedback and Basic Concepts, Crystal Oscillators, Electronic Tuning of Oscillators; Phase-Locked Loop; Frequency Synthesizers; One-Port Negative Resistance Oscillators; Microwave Transistor Oscillators. **Contemporary Issues related to Topic**		
Unit:6	**Detectors & Mixers**	
Point contact and Schottky barrier diodes. Characteristics and equivalent circuit, Theory of microwave detection, Detector circuit design, FM detectors. Mixer theory and characteristics. SSB versus DSB mixers. Single-ended mixer and single-balanced mixer. Double balanced and image rejection mixers. **06 Hrs** **Contemporary Issues related to Topic**		
Total Lecture Hours		**36 Hours**

Textbooks	
1	D. K. Misra, John Wiley, Radio Frequency and Microwave Communication Circuits Analysis and Design, 2004.
2	D. M. Pozar, Microwave Engineering, John Wiley,1998.
3	Thomas H. Lee , The Design of CMOS Radio-Frequency Integrated Circuits, Second Edition, , CAMBRIDGE,1998
Reference Books	
1	G. Gonzalez, Microwave Transistor Amplifiers Analysis and Design, Prentice Hall, 1997
2	Renhold Ludwig and Pavel, Bretchko , RF Circuits Design, Prentice Hall
3	S.K. Koul and B. Bhat , Microwave and Millimeter Wave Phase Shifters, Vol.II- Semiconductor And Delay Line Phase Shifters, Artech House 1991.
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	http://103.152.199.179/YCCE/Suported%20file/Supprted%20file/e-copies%20of%20books/Electronics%20and%20Telecommunication/
MOOCs Links and additional reading, learning, video material	
1	https://www.digimat.in/nptel/courses/video/117102012/L01.html

I Semester
23COM122 – PE II: Soft Computing

Course Outcomes:
Upon successful completion of the course the students will be able to
CO1: Describe genetic techniques and their roles in soft computing.
CO2: Identify supervised/unsupervised neural networks algorithms to solve pattern classification problems.
CO3: Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.

Unit:1	**Genetic algorithms**	**6 Hours**
Population based search techniques, evolutionary strategies, mathematical foundations of genetic algorithms, search operators, genetic algorithms in function and combinational optimization, hybrid algorithms, application to pattern recognition.		
Unit:2	**Supervised Learning**	**6 Hours**
NN Architecture Neural learning and laws, Applications of ANN Evaluation of network, Single layer network: MP neuron, Perceptron, Perceptron training algorithm, LMS algorithm, ADALINE		
Unit:3	**Multiplayer Network**	**6 Hours**
Multilevel Discrimination, Backpropogation Algorithm, Setting the parameter values, Accelerating the learning Process, MADALINE, Adaptive Multilayer Networks, Recurrent Network, RBF networks.		
Unit:4	**Unsupervised Learning and Deep Learning**	**6 Hours**
Winner Take Network, Learning Vector Quantizer, ART Networks, self-organizing feature maps, PCA, Associate Models, Introduction to Deep Learning		
Unit:5	**Fuzzy Set Theory**	**6 Hours**
Overview of Crisp Sets, Concepts of Fuzzy sets, representation of fuzzy sets, extension principle, fuzzy compliments, t-norms and t- conorms Fuzzy numbers, arithmetic operation on intervals and on fuzzy sets, lattice of fuzzy numbers		
Unit :6	**Fuzzy Controller**	**6 Hours**
Fuzzy equations, fuzzy relations, Fuzzy controllers, Defuzzification Methods, Fuzzy Inference Techniques, applications of fuzzy logic, Learning and Statistical Approaches to Regression and Classification		
Total Lecture Hours		**36 Hours**

Textbooks	
1	Fuzzy sets and Fuzzy logic, George Klir,Bo Yuan,PHI
2	Elements of Artificial Neural Network, K. Mehrotra,MIT,Cognet
Reference Books	
1	Neural Networks, a comprehensive foundation, By Simon Haykins, PHI,
2	Fuzzy Logic & Applications, J. Ross, TMH/Mc
3	Neural Networks, Fuzzy Logic and Genetic Algorithms, Synthesis and Applications, S. Rajshekharan, Vijayalakshmi Pai
4	An Introduction to Genetic Algorithm Melanic Mitchell (MIT Press)
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	http://link.springer.com/openurl?genre=book&isbn=978-3-642-21331-1
MOOCs Links and additional reading, learning, video material	
1.	https://nptel.ac.in/courses/106105173
2.	https://onlinecourses.nptel.ac.in/noc22_cs54/preview
3.	https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-cs23/
4.	https://archive.nptel.ac.in/courses/106/105/106105173/

II Semester
23COM201 - Antenna Design

Course Outcomes:
Upon successful completion of the course the students will be able to 1. Understand the Antenna Fundamentals. 2. Design and Analysis of Microstrip Antenna and antenna arrays. 3. Analysed of Field equivalence Principle and its applications. 4. Understand the smart antenna system design.

Unit :1	**ANTENNA FUNDAMENTALS**	**6 Hours**
Introduction to antenna , need of Antenna, Types of antennas, Radiation Integrals & Auxiliary Potential Function, Half wave Dipole Antenna		
Unit:2	**PLANER ANTENNA**	**6 Hours**
Planar Antennas Microstrip rectangular and circular patch antennas. Analysis and design, Feeding Methods; Circularly polarized Microstrip antennas, Broadbanding techniques, Impedance matching techniques.		
Unit:3	**FREQUENCY DEPENDENT AND INDEPENDENT ANTENNA**	**6 Hours**
Yagi array of linear elements, folded dipole and printed version, Log-periodic dipole array. Frequency Independent Antennas , Planar – spiral antenna		
Unit:4	**ANTENNA ARRAYS**	**6 Hours**
Forms of Antenna Arrays, Array of point sources, Linear array; Broadside and end fire arrays, Planar array, beam width, directivity. Microstrip arrays , feed networks & its analysis.		
Unit:5	**APERTURE AND REFLECTOR ANTENNAS**	**6 Hours**
Aperture Antennas- Field equivalence principle, Babinet's principle. Rectangular waveguide horn antenna, Parabolic reflector antenna. Uniqueness theorem.		
Unit:6	**SMART ANTENNA**	**6 Hours**
Antennas for mobile communication. Handset antennas: FIFA, Smart antennas, Switch beam system, Antenna beam forming and beam steering, Adaptive array system, Spatial Division Multiple Access. **Contemporary Issues related to Topic**		
Total Lecture Hours		**36 Hours**

Textbooks	
1	Antenna Theory - C.A. Balanis, John Wiley and Sons
2.	Antennas and Wave Propagation – K.D. Prasad, Satya Prakashan,Tech India Publications, New Delhi, 2001.
Reference Books	
1	Antennas – John D. Kraus, McGraw-Hill,
2	Antennas and Radio Propagation- R.E. Collins, McGraw-Hill
3	Broadband Antenna Techniques by Girish Kumar, Artech House publication.
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	http://link.springer.com/openurl?genre=book&isbn=978-1-4419-5338-4
2	http://link.springer.com/openurl?genre=book&isbn=978-1-4757-2760-9
3	http://link.springer.com/openurl?genre=book&isbn=978-1-4614-7998-7
4	http://link.springer.com/openurl?genre=book&isbn=978-0-7923-7241-7
5	http://link.springer.com/openurl?genre=book&isbn=978-1-4020-8417-1
MOOCs Links and additional reading, learning, video material	
1	https://nptel.ac.in/courses/108101092

II Semester
23COM202 - Lab: Antenna Design

Course Outcomes:

Upon successful completion of the course the students will be able to

1. Understand the Antenna Fundamentals.
2. Design and Analysis of Microstrip Antenna and antenna arrays.
3. Analysed of Field equivalence Principle and its applications.
4. Understand the smart antenna system design.

Sr. No.	Experiments based on
1	To design and Simulate Patch Antenna with Probe Feed using Simulation software.
2	To performed parametric analysis of Patch Antenna using Simulation software.
3	To design and Simulate Patch Antenna with Microstrip Feed line using Simulation software.
4	To design and Simulate Lambda/2 Dipole Antenna using Simulation software and study it's Characteristic.
5	To design and Simulate Yagi-Uda Antenna using Simulation software and study it's Characteristic.
6	To design and Simulate Horn Antenna using Stimulation software and study it's Characteristic.
7	To design and Simulate parabolic Reflector using Stimulation software and study it's Characteristic.
8	To measure radiation Pattern of Yagi-Uda Antenna and its Characteristic using Antenna trainer Kit.
9	Measurement of Antenna Parameter Using Vector Network Analyser.
10	Mini Project on antenna.

II Semester
23COM203 - VLSI Signal Processing

Course Outcomes:
Upon successful completion of the course the students will be able to 1. Design parallel and pipelining processing systems for speed, power and area optimization. 2. Implement the pipelined and parallel architectures using folding and unfolding techniques. 3. Apply algorithmic strength reduction techniques such as Fast Convolution algorithms and FDCT algorithms for increasing the speed of computation. 4. Design DSP algorithms with reduced numerical strength by sub expression sharing techniques.

Unit:1	**Introduction to DSP systems and Iteration Bound**	**6 Hours**
Introduction to DSP systems – Typical DSP algorithms, Data flow and Dependence graphs - critical path, Loop bound, iteration bound, Algorithms for computing iteration bound		
Unit:2	**Pipelining , Parallel processing and Retiming**	**6 Hours**
Pipelining and Parallel processing of FIR filters, Pipelining and Parallel processing for low power, Retiming – definitions and properties, solving systems of inequalities, retiming techniques.		
Unit:3	**Unfolding and Folding**	**6 Hours**
Unfolding – an algorithm for unfolding, properties of unfolding, sample period reduction and parallel processing application, Folding transformation, Register minimization techniques		
Unit:4	**Fast convolution**	**6 Hours**
Cook-Toom algorithm, modified Cook-Toom algorithm, winograd algorithm, iterated convolution, cyclic convolution		
Unit:5	**Algorithmic strength reduction in filters and transforms**	**6 Hours**
2-parallel FIR filter, 2-parallel fast FIR filter, DCT architecture		
Unit :6	**Numerical strength reduction**	**6 Hours**
Sub expression elimination, CSD representation, multiple constant multiplication, iterative matching, sub-expression sharing in digital filters, additive and multiplicative number splitting **Contemporary Issues related to Topic**		
Total Lecture Hours		**36 Hours**

Textbooks	
1	VLSI Digital signal processing systems, Keshab K. Parhi, John Wiley and Sons, 2007 1st Edition.
Reference Books	
1	Digital Signal Processing with Field Programmable Gate Arrays, U. Meyer- Bease, 2nd edition 2004, Springer.
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	
MOOCs Links and additional reading, learning, video material	
1	https://nptel.ac.in/courses/108105157

II Semester
23COM204 - Digital Image and Video processing

Course Outcomes:
Upon successful completion of the course the students will be able to 1. Understand and apply knowledge of various transforms and probability theory in image processing 2. Understand digital image processing fundamentals like enhancement, segmentation and encoding. 3. Analyze, apply and critically evaluate various image and video processing algorithms appropriate for practical applications 4. Learn the concepts of motion in video processing

Unit:1	**Introduction to image processing**	**6 Hours**
Fundamental steps in Digital image processing, Elements of visual perception, Image sensing and acquisition, Basic Concepts in Sampling and Quantization, representing digital images, Basic Relationships between pixels.		
Unit:2	**Image Enhancement**	**7 Hours**
Some basic gray level transformations, Histogram Processing, Sharpening Spatial filters, Image Enhancement in the spatial and Frequency domain, Pseudo colouring		
Unit:3	**Segmentation**	**7 Hours**
Point, Edge based segmentation, Boundary detection, Threshold based segmentation, Region based segmentation, Morphological operations.		
Unit:4	**Image Compression**	**6 Hours**
Data redundancies Variable-length coding, Quantizers, Predictive coding, Transform coding, Image compression standards.		
Unit:5	**Video Processing**	**6 Hours**
Basics of video processing, Motion analysis, Introduction to video compression, video compression standards, Moving object detection.		
Unit :6	**Motion Estimation**	**7 Hours**
Optical flow, Use of motion in segmentation, Mesh based motion Estimation, Global Motion Estimation and Video coding.		
Total Lecture Hours		**39 Hours**

Textbooks	
1	Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson , 4rd Edition
2	A. Murat Tekalp, Digital Video Processing, first edition, Prentice Hall
3	Yao wang, Joem Ostarmann and Ya – quin Zhang, "Video processing and communication ",1st edition , PHI
Reference Books	
1	William K. Pratt, Digital Image Processing, 4th edition, A John Wiley & Sons, Inc., Publication, 2001.
2	Anit K. Jain, Fundamentals of Digital Image Processing, Prentice Hall.
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	http://103.152.199.179/YCCE/yccelibrary.html
MOOCs Links and additional reading, learning, video material	
1	http://nptel.iitm.ac.in/video.php?subjectId=117105079,
2	www.imageprocessingplace.com

II Semester

23COM205 - Lab: Digital Image and Video processing

Course Outcomes:
Upon successful completion of the course the students will be able to 1. Implement various image processing and image enhancement techniques in MATLAB and identify their application areas. 2. Execute various image segmentation techniques. 3. Implement image and video compression techniques.

Sr. No.	Experiments based on
1	Obtaining row profile of a given row of an image in MATLAB .
2	Plotting histogram of an image in MATLAB
3	Adjusting the brightness of an image using a constant value in MATLAB
4	Calculating mean and variance of an image in MATLAB
5	Histogram Equalization of an image in MATLAB
6	Spatial Filtering: Applying low pass, high pass and median filters on an image in MATLAB
7	Pseudo Coloring an image using sinusoidal transforms in MATLAB
8	Detection of edges of an image using Canny Edge Detection algorithm in MATLAB.
9	Image Thresholding using OTSU Thresholding algorithm in MATLAB.
10	Region-based Image Segmentation using region growing in MATLAB
11	Apply Discrete Cosine Transform (DCT) on an image in MATLAB.
12	Motion Estimation for video sequence using full search algorithm.

II Semester
23COM206 - Wireless Communication Networks

Course Outcomes:
Upon successful completion of the course the students will be able to 1. Quantify causes and effects of path loss and signal fading on received signal characteristic and used various technique to improve signal quality and link performance. 2. Analyze various Multicarrier Modulation and Multiple access techniques for wireless communication 3. Analyze GSM & CDMA systems and understand the fundamentals of wireless networking. 4. Elaborate and compare various generations of mobile communication systems

Unit :1	**Radio Propagation Characteristics**	**6 Hours**
Reflection, diffraction and Scattering, Models for path loss, shadowing and multipath fading (delay Spread, coherence band width, coherence time, Doppler spread), Multipath Fading Models.		
Unit:2	**Diversity**	**6 Hours**
Realization of Independent Fading Paths, Diversity System Model , Selection Combining , Threshold Combining , Maximal Ratio Combining, Equal-Gain Combining ,Moment Generating Functions in Diversity Analysis , Diversity Analysis for MRC , Diversity Analysis for EGC and SC , Diversity Analysis for Non-coherent and Differentially Coherent Modulation , Transmitter Diversity		
Unit:3	**Multicarrier Modulation**	**6 Hours**
Multicarrier Modulation ,Fading across Subcarriers , Frequency Equalization , Pre-coding , Adaptive Loading ,Coding across Sub channels RAKE receivers		
Unit:4	**Multiple access techniques for wireless communication**	**6 Hours**
SDMA ,Packet radio protocols: Pure & Slotted ALOHA,CSMA		
Unit:5	**Wireless Systems and Standards**	**6 Hours**
GSM-GSM services and features, Architecture, Radio Subsystem, GSM channel types, Frame structure and signal processing in GSM, CDMA-Forward CDMA channel, Reverse CDMA channel		
Unit:6	**Wireless Networks**	**6 Hours**
3G Overview, 3GPP Network Architecture, 4G features and challenges, Introduction to wireless LANs - IEEE 802.11 WLANs, Blue tooth , Wi-Max, Zigbee **Contemporary Issues related to Topic**		
Total Lecture Hours		**36 Hours**

Textbooks	
1	Wireless communications - Rappaport. T.S, Pearson Education
2.	Wireless Communications – Andrea Goldsmith, Cambridge University Press.
Reference Books	
1	Fixed Broadband Wireless System Design - HARRY R. ANDERSON- John Wiley –India
2	3G Wireless Networks- Smith . P.E.- Tata McGraw Hill
3	Principles of Wireless Networks- Kaufmann Kaveth Pahlavan,. K Prashanth- Prentice Hall of India
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	wireless Communication Andrea Goldsmith.pdf
2	wireless Communication by Rappaport (1).pdf
3	http://link.springer.com/openurl?genre=book&isbn=978-3-540-79040-2
4	http://link.springer.com/openurl?genre=book&isbn=978-0-7923-8126-6
5	http://link.springer.com/openurl?genre=book&isbn=978-3-540-76237-9
MOOCs Links and additional reading, learning, video material	
1	www.digimat.in/nptel/courses/video/106106167/L01.html
2	https://onlinecourses.nptel.ac.in/noc21_ee66/preview

II Semester
23COM207 - Seminar

II Semester
23COM211 - PE III: Millimeter wave communication

Course Outcomes:
Upon successful completion of the course the students will be able to 1. Understand Millimeter devices and circuits 2. Design antenna for Millimeter wave frequencies. 3. Gain Knowledge of Millimeter wave technology

Unit:1	**Overview of millimeter waves**	**6 Hours**
Millimeter wave characteristics and implementation challenges, radio wave propagation for mm wave, Millimeter wave generation and amplification, HEMT, transistor configurations		
Unit:2	**Analog mm wave components**	**7Hours**
Analog mm wave components, Consumption factor theory, Trends and architectures for mm wave wireless, ADC's and DAC's		
Unit:3	**Modulation for mm waves**	**6Hours**
Modulation for millimeter wave communications, Millimeter wave link budget, Transceiver architecture,		
Unit:4	**MIMO communications for mm waves**	**5 Hours**
Massive MIMO Communications, Potential benefits for mm wave systems, Spatial, Temporal and Frequency diversity, Dynamic spatial, frequency and modulation allocation		
Unit:5	**Antennas for mm wave communication**	**7 Hours**
Antenna beam width, polarization, advanced beam steering and beam forming, mm wave design consideration, On-chip and In package mm wave antennas, Techniques to improve gain of on-chip antennas, Implementation for mm wave in adaptive antenna arrays		
Unit :6	**Usage of mm waves for 5G**	**7 Hours**
Device to Device communications over 5G systems, Design techniques of 5G mobile.. **Contemporary Issues related to Topic**		
Total Lecture Hours		**36 Hours**

Textbooks	
1	K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, March 2011.
2	Robert W. Heath, Robert C. Daniel, James N. T.S. Rappaport, Murdock, "Millimeter Wave Wireless Communications", PH, 2014.
3.	Xiang, W.Zheng, K. Shen, X.S, "5G Mobile Communications", Springer, 2016.
Reference Books	
1	Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, "New Directions in Wireless Communication Systems from Mobile to 5G", CRC Press.
	Belov, L. A.-Smolskiy, Sergey M.-Kochemasov, V. N.,Handbook of RF, Microwave, and Millimeter-wave Components, Artech House Publishers
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	http://link.springer.com/openurl?genre=book&isbn=978-0-387-23665-0
2.	http://link.springer.com/openurl?genre=book&isbn=978-1-4020-6998-7
3	http://link.springer.com/openurl?genre=book&isbn=978-1-4020-7531-5
MOOCs Links and additional reading, learning, video material	
1	https://nptel.ac.in/courses/117105139

II Semester
23COM212 - PE III: Real Time Operating System

Course Outcomes:
Upon successful completion of the course the students will be able to 1) Analyzethe various real time systems with reference model 2) Discuss the various functional parameters , resources and scheduling. 3) Detect multiple Faults and reduce error containment. 4) Explore the various Memory management and Input/Output system process management

Unit :1	**Overview**	**6 Hours**
Digital Controller, Air traffic flight control, Real time command and Controls, Low and High level Control, Signal Processing and Radar System, Real Time Application.		
Unit:2	**Real Time Systems**	**6 Hours**
Typical Real Time Application, Hard Vs Soft Real Time Systems, a Reference Model of Real Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency		
Unit:3	**Functional Parameters**	**6 Hours**
Functional Parameters, Resource Parameters of Jobs and Parameters of Resources Clock Driven, Weighted Round Robin, Priority Driven, Dynamic Vs State Systems, Effective Release Times and Dead Lines, Offline Vs Online Scheduling.		
Unit:4	**Time Services and Scheduling Mechanisms**	**6 Hours**
Overview, Time Services and Scheduling Mechanisms, other Basic Operating System Function, Processor Reserves and Resource Kernel.Capabilities of Commercial Real Time Operating Systems.		
Unit:5	**Fault and Error Containment**	**6 Hours**
Introduction, Fault Causes, Types, Detection, Fault and Error Containment, Redundancy: Hardware, Software, Time. Integrated Failure Handling.		
Unit:6	**Memory Managements and Scheduling**	**6 Hours**
Memory Managements Task State Transition Diagram, Pre-Emptive Priority, Scheduling, Context Switches – Semaphore – Binary Mutex, Counting: Watch Dogs, I/O System Process Management, Interrupt Management, and Synchronization. **Contemporary Issues related to Topic**		
Total Lecture Hours		**36 Hours**

Textbooks	
1	Real Time Systems, 2013, Jane W.S. Liu , Pearson
2	Real Time Systems, C.M.Krishna, KANG G. Shin, McGraw.Hill
Reference Books	
1	Advanced Unix Programming Richard Stevens
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	
MOOCs Links and additional reading, learning, video material	
1	

II Semester
23COM231 - PE IV: Selected Topics in Communication Systems

Course Outcomes:
Upon successful completion of the course the students will be able to 1. Understand and design physical modelling of channels in free space along with time varying systems. 2. Compare and analyse Non-coherent and Coherent detection Time diversity. 3. Elaborate key features of various standards related to modelling of MIMO,SIMO,MISO 4. Understand and analyse V-BLAST and D-BLAST architecture. 5. Design and understand multiplexing trade off -Universal code design for scalar channels, parallel channels.

Unit :1	**PHYSICAL MODELING FOR WIRELESS CHANNELS**	**6 Hours**
Free space, fixed transmit and receive antennas, moving antenna, Reflection from wall, Reflection from a ground plane , Power decay with distance and shadowing ,Moving antenna with multiple reflectors Input /output model of the wireless channel: linear time-varying system, Baseband equivalent model, A discrete-time baseband model, Degrees of freedom, Additive white noise Time and frequency coherence :Doppler spread and coherence time, Delay spread and coherence bandwidth.		
Unit:2	**DETECTION IN A RAYLEIGH FADING CHANNEL**	**6 Hours**
Non-coherent and Coherent detection Time diversity Antenna diversity: Receive diversity, Transmit diversity, MIMO. Frequency diversity: Single-carrier with ISI equalization, Direct-sequence spread-spectrum.		
Unit:3	**AWGN CHANNEL CAPACITY**	**6 Hours**
Channel Distribution Information (CDI), Channel Side Information at Receiver, Channel Side Information at Transmitter and Receiver, Capacity with Receiver Diversity Capacity of Frequency: Selective Fading Channels-Linear time-invariant, Time-Varying Channels.		
Unit:4	**MULTIPLEXING CAPABILITY OF DETERMINISTIC MIMO CHANNELS**	**6 Hours**
Capacity via singular value decomposition, Rank and condition number. Physical modelling of MIMO channels: Line-of-sight SIMO channel ,Line-of-sight MISO channel , Antenna arrays with only a line-of-sight path ,Geographically separated antennas, Line-of-sight plus one reflected path Modelling of MIMO fading channels.		
Unit:5	**V-BLAST AND D-BLAST ARCHITECTURE**	**6 Hours**
The V-BLAST architecture Fast fading MIMO channel: Capacity with CSI at receiver and Full CSI. Receiver architectures: Linear decorrelator, Successive cancellation, Linear MMSE receiver D-BLAST: an outage-optimal architecture, Coding across transmit antennas: D- BLAST		

Unit:6	DIVERSITY–MULTIPLEXING TRADEOFF	6 Hours
Scalar Rayleigh channel, Parallel Rayleigh channel, MISO Rayleigh channel, 2×2 MIMO Rayleigh channel, nt×nr MIMO i.i.d. Rayleigh channel Universal code design for optimal diversity :multiplexing trade off - Universal code design for scalar channels, parallel channels, MISO channels, MIMO channels Uplink with multiple receive antennas: Space-division multiple access ,SDMA with multiple transmit antennas.		
Total Lecture Hours		**36 Hours**

Textbooks	
1	Fundamentals of Wireless Communications, David Tse, Pramod Viswanath CambridgeUniversity Press
Reference Books	
1	Coding for Wireless Channels 2007 E. Biglieri, Springer
2	MIMO Wireless Communications 2007 E. Biglieri, Andrea Cambridge University Press
3	WIRELESS COMMUNICATIONS 2005 Goldsmith Cambridge University Press
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	http://103.152.199.179/YCCE/Suported%20file/Supprted%20file/ecopies%20of%20books/Electronics%20and%20Telecommunication/Communication%20systems%20(analog%20and%20digital)%20(%20PDFDrive.com%20).pdf
2	http://103.152.199.179/YCCE/Suported%20file/Supprted%20file/ecopies%20of%20books/Electronics%20and%20Telecommunication/Rappaport%20-%20Wireless%20Communications,Principles%20and%20Practice-ISBN%200130422320.pdf
3	http://103.152.199.179/YCCE/Suported%20file/Supprted%20file/e-copies%20of%20books/Electronics%20and%20Telecommunication/WirelessCommunicationsbyTheodoreS.Rappaportz.pdf
MOOCs Links and additional reading, learning, video material	
1	https://www.youtube.com/watch?v=70wpxrp3tAQ&t=1206s
2	https://www.youtube.com/watch?v=Bg_4BSuXK_0

II Semester
23COM232 - PE IV: Micro Electro Mechanical Systems

Course Outcomes:

Upon successful completion of the course the students will be able to

1. Design parallel and pipelining processing systems for speed, power and area optimization.
2. Implement the pipelined and parallel architectures using folding and unfolding techniques.
3. Apply algorithmic strength reduction techniques such as Fast Convolution algorithms and FDCT algorithms for increasing the speed of computation.
4. Design DSP algorithms with reduced numerical strength by sub expression sharing techniques.

Unit:1	**Intrinsic Characteristic of MEMS**	**6 Hours**
Energy Domains & Transducers. Sensors & Actuators. Introduction to Micro fabrication- silicon based MEMS processes. New Materials- Review of Electrical and Mechanical concepts in MEMS. Semiconductor devices- Stress & Strain analysis- Flexural beam bending, Torsional deflection		
Unit:2	**Electrostatic sensors**	**6 Hours**
Parallel Plate capacitors, Applications, Interdigital Finger capacitor,Com drive devices, Thermal sensing and Actuation, Thermal Expansion, Thermal couples, Thermal resistors, Applications, Magnetic Actuators, Micro magnetic Components, Case studies of MEMS in magnetic actuators		
Unit:3	**Piezoelectric sensors and actuators**	**6 Hours**
Piezo resistive sensors, Piezo resistive sensor materials, Stress analysis of mechanical elements, Applications to Inertia, Pressure, Acoustic, Tactile and Flow sensors, Piezoelectric sensors and actuators, Piezoelectric effects, Piezoelectric materials		
Unit:4	**Silicon Anisotropic Etching**	**6 Hours**
Silicon Anisotropic Wet Etching, Dry Etching of Silicon, Plasma Etching, Deep reaction Ion Etching (DRIE), Isotropic Wet Etching, Gas phase Etchants-Case studies, Basic surface micromachining processes, Structural and sacrificial materials, Acceleration of sacrificial Etch, Striction and Anistriction methods, Assembly of 3D MEMS,Foundry process		
Unit:5	**Polymer MEMS**	**6 Hours**
Polymers in MEMS ,Polimide, SU-8, Liquid Crystal Polymer(LCP), PDMS, PMMA, Parylene, Flurocarbon, Application to acceleration, Pressure, Flow and Tactile sensors		
Unit :6	**Optical MEMS**	**6 Hours**
Optical MEMS, Lensens and Mirrors, Actuators for Active Optical MEMS. **Contemporary Issues related to Topic**		
Total Lecture Hours		**36 Hours**

Textbooks	
1	Foundations of MEMS, Chang Liu, Pearson Education Inc, 2006.
Reference Books	
1	An introduction to micro electro mechanical system design, NadimMaluf, Artech House,2000
2	The MEMS Handbook Mohames Gad-el-Hak, CRDC press , 2000
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	
MOOCs Links and additional reading, learning, video material	
1	https://nptel.ac.in/courses/117105082

III Semester
23COM301– Project Phase-I

IV Semester
23COM401– Project Phase-II