Dr. MAHALINGAM
COLLEGE OF ENGINEERING AND TECHNOLOGY
An Autonomous Institution Since 2011
Udumalai Road, Pollachi, Coimbatore District - 642003
Established in 1998 ♦ Approved by AICTE ♦ Affiliated to Anna University
(A DIVISION OF NIA EDUCATIONAL INSTITUTIONS)
NAAC A++ GRADE
Cycle 3 (2023-2030)
The Highest Grade

Curriculum and Syllabi

M.E Communication systems

Semesters I to II

Regulations 2024

Programme: M.E Communication systems
Curriculum and Syllabi: Semester I to II
Recommended by Board of Studies on:28.6.24
Approved by Academic Council on:

Action	**Responsibility**	**Signature of Authorized Signatory**
Designed and Developed By	BoS Electronics and Communication Engineering	
Compiled By	Office of Controller of Examination	
Approved By	Principal	

Dr. Mahalingam College of Engineering and Technology, Pollachi 642003.

(An autonomous institution approved by AICTE and affiliated to Anna University)

Department of Electronics and Communication Engineering

Vision

To strive for excellence in Electronics and Communication Engineering education, research and technological services imparting quality training to students, to make them competent and motivated engineers.

Mission

- Impart high quality technical education in Electronics and Communication Engineering through effective teaching- learning process and updated curriculum.
- Equip the students with professionalism and technical expertise to provide appropriate solutions to societal and industrial needs.
- Provide stimulating environment for continuously updated facilities to pursue research through creative thinking and team work.

Programme Educational Objectives (PEOs) – Regulations 2024

Programme: M.E Communication systems

After 2 to 3 years of completion of the programme the graduates will be able to:

PEO1. Exhibit the sustained knowledge in the field of Communication Systems and possess leadership capability in their professional careers.

PEO2. Develop optimal solutions to the needs of industry and society in the area of RF Communication systems and networking.

PEO3. Carryout research in multidisciplinary areas allied with Communication Engineering through lifelong learning

Programme Outcomes (POs) - Regulations 2024

On successful completion of M.E. Communication systems programme, graduating students/graduates will be able to:

PO1. Achieve widespread knowledge in Communication Systems with an ability to analyze and synthesize Communication Engineering and Networking

PO2. Write and present a substantial technical report/document for communicating the research findings.

PO3. Apply appropriate techniques and modern tools to analyze and test Communication systems

PO4. Practice professional ethics in multidisciplinary environment with a desire for life-long learning

Programme Specific Outcomes (PSOs) - Regulations 2024

On successful completion of M.E. Communication systems programme, graduating students/graduates will be able to:

PSO1: Provide feasible solutions to the problem in the areas of Microwave, RF Communication, Networking and Signal processing

PSO2: Develop Communication subsystems using recent techniques

Dr. Mahalingam College of Technology, Pollachi
2024 Regulations - Course Code Generation Procedure for PG Courses

1	2	3	4	5	6	7	8
2	4	C	C	X	X	0	1

Positions 1–2: Regulation

Position 5: Mode of Assessment

Character Type – Number	
T	Theory
I	Theory with Practical
L	Practical
E	Elective
O	Open Elective
P	Project
A	Audit Course

Position 6: Semester Number

Character Type – Number	
1 to 4	Semester
0	Floating

Positions 7–8: Sequence Number

Character Type – Number
01, 02, 03, . . . , 99

Positions 3–4: Board/Department/Programme/Course Type

Character Type – Alphabet	
CC	CAD/CAM
CO	Communication Systems
CP	Computer Science and Engineering
ES	Embedded System Technologies
ST	Structural Engineering
CA	Computer Application
SH	Science and Humanities

Dr. Mahalingam College of Engineering and Technology, Pollachi
Department of Electronics and Communication Engineering
M.E Communication Systems
2024 Regulations – Curriculum for Semesters I to IV

Semester I

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
24MAT103	Linear Algebra and Stochastic Processes	3	1	0	4	100	-
24COT101	Advanced Digital Signal Processing	3	1	0	4	100	-
24COT102	Wireless Broad band Networks	3	0	0	3	100	-
24COEXXX	Professional Elective - I	3	0	0	3	100	-
24CCT101	Research Methodology and IPR	3	0	0	3	100	All
24COL101	VLSI and Wireless Communication Laboratory	0	0	4	2	100	-
24COL102	Advanced Communication Networks Laboratory	0	0	4	2	100	
24SHA101	English for Research Paper Writing	2	0	0	-	100	All
Total		**17**	**2**	**8**	**21**	**800**	

Semester II

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
24COT201	Advanced Antenna Design Technologies	3	0	0	3	100	-
24COT202	Signal Detection and Estimation Theory	3	0	0	3	100	-
24COT203	5G: Features, Standards and Evolution	3	0	0	3	100	-
24COEXXX	Professional Elective - II	3	0	0	3	100	-
24COEXXX	Professional Elective - III	3	0	0	3	100	-
24COL201	RF System Design Laboratory	0	0	4	2	100	-
24COL202	Research Paper seminar	0	0	2	1	100	-
24SHA201	Teaching and Learning in Engineering	0	0	4	-	100	All
Total		**15**	**0**	**10**	**18**	**800**	

Semester III

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
24COEXXX	Professional Elective – IV	3	0	0	3	100	-
24COEXXX	Professional Elective – V	3	0	0	3	100	-
24COOXXX	Open Elective/Online Course	3	0	0	3	100	
24COP301	Project – I	0	0	20	10	200	-
Total		**9**	**0**	**20**	**19**	**500**	

Semester IV

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
24COP401	Project – II	0	0	32	16	400	-
Total		**0**	**0**	**32**	**16**	**400**	

Total Credits: 74

Professional Electives

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
24COE001	Satellite Communication and Navigation System	3	0	0	3	100
24COE002	Modern Wireless Communication	3	0	0	3	100
24COE003	Massive MIMO and Beam forming Techniques	3	0	0	3	100
24COE004	Next Generation Mobile Communication Technologies	3	0	0	3	100
24COE005	IoT for Wireless Networks	3	0	0	3	100
24COE006	Wireless Network Security and Privacy	3	0	0	3	100
24COE007	RF Advanced Transceiver design	3	0	0	3	100
24COE008	VLSI Signal Processing	3	0	0	3	100
24COE009	Deep Learning in Computer Vision	3	0	0	3	100

SEMESTER 1

Course Code: 24MAT103	**Course Title: Linear Algebra and Stochastic Process**		
Course Category: FC		**Course Level: Introductory**	
L:T:P(Hours/Week) 3:1 :0	**Credits: 4**	**Total Contact Hours:60**	**Max Marks:100**

Course Objectives:

The course aims in illustrating the usage of mathematical tools like Linear algebra, Probability and stochastic process to facilitate deep understanding of the concepts related to telecommunication engineering.

Module I **22+8 Hours**

Vector Spaces

Four fundamental vector spaces of the matrix - Rank-Nullity theorem - Projection theorem - Linear transformation matrix with different basis - Gram-Schmidt orthogonalization procedure - QR factorization- Eigen values and Eigen vectors - Diagonalization of the matrix - Schur's lemma. Hermitian Matrices - Unitary Matrices - Normal Matrices - Singular Value Decomposition

Probability Spaces

Random variables and random vectors - Distributions and densities- Conditional distributions and densities - Independent random variables - Transformation of random variables

Multiple Random Variables

Expectations – Indicator - Moment generating function - Characteristic function - Multiple random variables - Gaussian random vector - Co-variance matrix - Complex random variables - Sequence of random variables - Central limit theorem.

Module II **23+7 Hours**

Random Walks and Other Applications

Random Walks - Poisson Points and Shot Noise - Modulation - Cyclostationary Processes –Band limited Processes and Sampling Theory - Deterministic Signals in Noise - Bispectra and System Identification -The Poisson Sum Formula - The Schwarz Inequality I Problems.

Spectral Representation

Factorization and Innovations - Finite-Order Systems and State Variables - Fourier Series and Karhunen-Loeve Expansions - Spectral Representation of Random Processes -Problems.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Enhance Problem solving skills by solving problems in linear algebra	Apply
CO2: Solve the problem associated with transformation of random variables-Application.	Apply
CO3: Apply the concepts associated with multiple random variable and solve the problems associated with Multivariate Gaussian random vector-Comprehension.	Apply
CO4: Apply the basic concepts in random process for application such as random signals, linear system in communication engineering.	Apply
CO5: Apply the knowledge of spectral representation of random process in telecommunication engineering.	Apply

Text Book(s):

T1. A.Papoulis, S.U.Pillai, "Probability, Random variables and Stochastic processes" 4th edition Tata-Mc Hill (4/e) ,2001.

T2. G.Strang, "Linear Algebra", Thomson Brooks/Cole Cengage Hill (4/e), 2006.

Reference Book(s):

R1. S. Boyd and L. Vandenberghe, Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares.

R2. Probability, Random Variables & Random Signal Principles -Peyton Z. Peebles, TMH, 4th Edition, 2001.

Web References:

1. https://web.ma.utexas.edu/users/gordanz/notes/introduction_to_stochastic_processes.pdf
2. https://www.math.ucdavis.edu/~linear/linear-guest.pdf

Course Code: 24COT101	**Course Title: Advanced Digital Signal Processing**		
Course Category: PCC		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 1: 0	**Credits:4**	**Total Contact Hours: 60**	**Max Marks: 100**

Course Objectives:
The course is intended to impart knowledge on stationary models, parametric and non-parametric methods of power spectrum estimation, designing of filters for linear prediction, principles of adaptive filters and concept of multirate signal processing.

Module I **30 Hours**

Stationary models: Random signal modeling, MA(q), AR(p), ARMA(p,q) models, Hidden markov model and its applications, Linear system with random input, Forward and Backward predictions, Levinson durbin Algorithm.

Spectral Estimation: Non Parametric methods, Periodogram, Modified Periodogram, Bartlett, Welch and Blackman Tukey methods, Parametric methods, Auto Regressive (AR) spectrum estimation, Moving Average and Auto Regressive Moving average spectrum Estimation.

Module II **30 Hours**

Linear Prediction: Linear Prediction and Optimum linear Filters, Forward-Backward linear prediction filters, Solution of normal equations, AR Lattice and ARMA lattice, Ladder filters, Wiener filters.

Adaptive Filtering: Gradient and Minimum Mean Square error, Method of steepest descent, LMS Algorithm, RLS algorithm, Kalman filter, Extended Kalman filter.

Multirate Signal Processing: Decimators and Interpolators, Sampling rate conversion, Multistage decimator & interpolator, polyphase filters, QMF filter banks, Subband Coding Application.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the concepts of stationary models in signal processing applications.	Apply
CO 2: Apply the parametric and Non parametric methods for estimating spectra in real life problems.	Apply
CO 3: Design Adaptive Stochastic Polyphase Filters and analyze the concept in real time applications.	Analyze

Text Book(s):

T1. Hayes MH, "Statistical Digital Signal Processing and Modelling", Wiley, Newyork 2008.

T2. Simon Haykin, "Adaptive Filter Theory", Fourth Edition, Pearson Education, 2010

T3. Vaidyanathan P P, "Multivariate systems and Filter banks", Prentice Hall, 2008

Reference Book(s):

R1. Widrow B and Stearns S D, "Adaptive Signal Processing", Pearson Education, 2009.

R2. Fliege N J, "Multirate Digital Signal Processing", John Wiley and Sons, 2010.

R3. Ristic, Arulampalam, Gordon, "Beyond the Kalman Filter:Tracking Applications of Particle Filters ", Artech House, 2003.

Web References:

1. https://nptel.ac.in/courses/117101001
2. https://archive.nptel.ac.in/courses/108/106/108106136/

Course Code: 24COT102	Course Title: Wireless Broad band Networks		
Course Category: PCC		**Course Level: Mastery**	
L:T:P(Hours/Week) 3:0:0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Course Objectives:

The course is intended to impart knowledge on wireless network infrastructure, Wireless protocols, layer level functions and emerging trends in wireless broadband networks.

Module I **22 Hours**

Wireless Protocols: Mobile network layer- Fundamentals of Mobile IP, data forwarding procedures in mobile IP, IPv4, IPv6, IP mobility management, IP addressing - DHCP, Mobile transport layer-Traditional TCP, congestion control, slow start, fast recovery/fast retransmission, classical TCP improvements-Indirect TCP, snooping TCP, Mobile TCP

3G Evolution: IMT-2000 - W-CDMA, CDMA 2000 - radio & network components, network structure, packet-data transport process flow, Channel Allocation, core network, interference-mitigation techniques,

UMTS-services, air interface, network architecture of 3GPP, UTRAN – architecture, High Speed Packet Data-HSDPA

Module II **23 Hours**

4G Evolution: Introduction to LTE-A – Requirements and Challenges, network architectures EPC, E- UTRAN architecture - mobility management, resource management, services, channel-logical and transport channel mapping, downlink/uplink data transfer, MAC control element, PDU packet formats, scheduling services, random access procedure.

Layer-Level Functions: Characteristics of wireless channels - downlink physical layer, uplink physical layer, MAC scheme -frame structure, resource structure, mapping, synchronization, reference signals and channel estimation, SC-FDMA, interference cancellation – CoMP, Carrier aggregation, Services - multimedia broadcast/multicast, location-based services.

5G Evolution: 5G Roadmap - Pillars of 5G - 5G Architecture

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Apply the knowledge to optimize wireless network infrastructure for different environments and applications.	Apply
CO 2: Analyze and implement layer level functions in broadband networks.	Analyze
CO 3 : Analyze emerging trends and technologies in the wireless broadband industry.	Analyze
CO 4: Evaluate various wireless communication standards and protocols.	Evaluate

Text Book(s):

T1. Kaveh Pahlavan, "Principles of wireless networks", Prentice-Hall of India, 2008

T2. Garg, Vijay Kumar. Wireless network evolution: 2G to 3G. United Kingdom, Prentice Hall PTR, 2001.

Reference Book(s):

R1. Smith, Clint, and Collins, Daniel. 3G Wireless Networks. United States, McGraw-Hill, 2002.

R2. Ahmadi, Sassan. LTE-Advanced: a Practical Systems Approach to Understanding the 3GPP LTE Releases 10 and 11 Radio Access Technologies. Oxford: Elsevier Science, 2014.

R3. Jonathan Rodriguez, "Fundamentals of 5G Mobile networks", John Wiley, 2015.

Web References:

1. http://nitttrc.edu.in/nptel/courses/video/117101050/L01.html
2. https://www.tutorialspoint.com/what-is-wireless-broadband-wibb

Course Code: 24CCT101	Course Title: Research Methodology and IPR		
Course Category: RMC		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on various research types and problem identification. It emphasizes selecting experiment designs, data types, tools, and data analysis processes. Additionally, it covers interpreting and presenting results effectively. The syllabus also delves into intellectual property rights, including types and procedures, and provides hands-on experience in executing patent filing and licensing.

Module I **22 Hours**

Overview of Research Methodology

Research methodology – definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modeling research, algorithmic research, Research process. Data collection methods- Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data- internal sources of data, external sources of data.

Attitude measurements, Scales and Sampling methods

Scales – measurement, Types of scale – Thurstone's Case V scale model, Osgood's Semantic Differential scale, Likert scale, Q- sort scale. Sampling methods- Probability sampling methods – simple random sampling with replacement, simple random sampling without replacement, stratified sampling, cluster sampling. Non- probability sampling method – convenience sampling, judgment sampling, quota sampling.

Module II **23 Hours**

Hypotheses testing

Hypotheses testing – Testing of hypotheses concerning means (one mean and difference between two means -one tailed and two tailed tests)

Report Writing and Presentation

Report writing- Types of report, guidelines to review report, typing instructions, oral presentation

Patenting

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1. Describe the overview of research methodology	Understand
CO 2. Explain the attitude measurements, scales and sampling methods	Understand
CO 3. Apply hypotheses testing in research problem	Apply
CO 4. Elucidate the research report writing and presentation effectively	Understand
CO 5: Apply patent and copyright for their innovative works	Apply

Reference Book(s):

R1. Panneerselvam, R., Research Methodology, Prentice-Hall of India, New Delhi, 2004.

R2. Kumar, Ranjit, , “Research Methodology: A Step by Step Guide for beginners”, London Sage: Publications, 2005.

R3. Halbert, “Resisting Intellectual Property”, Taylor & Francis Publications, 2007.

R4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, Clause 8 Publishing, 2016.

R5. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand Publications, 2008.

Course Code: 24COL101		Course Title: VLSI and Wireless Communication Laboratory	
Course Category: EEC		Course Level: Mastery	
L:T:P(Hours/Week) 0:0 :4	Credits:2	Total Contact Hours:60	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on simulation tool such as CADENCE, or other relevant software, for designing and analyzing various Electronic circuits and engage students in the design, implementation, and testing of various circuits such as LNA, Mixer, PLL, VCO and data converters.

List of Experiments:

1. Design a LNA for given specifications. Perform DC and transient analysis.
2. Design Gilbert mixer for given specifications. Perform DC and transient analysis using Cadence EDA tool**.**
3. Design PLL for given specifications perform analysis using Cadence EDA tool.
4. Design VCO for given specifications perform analysis using Cadence EDA tool.
5. Design Ring oscillator and show the effect of stage variation on the output frequency.
6. Design a transreceiver front end and perform impedance matching at layout level.
7. Design a CMOS A/D converter for data communication application.
8. Design a CMOS D/A converter for data communication application.

Simulation tools to be used: CADENCE EDA and other relevant open source tools

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Design and analyze the performance of various electronic circuits such as LNA, Mixer, PLL, VCO and Ring oscillator.	Analyze
CO 2: Design the front end of a transreceiver and analyze its performance for impedance matching at layout level.	Create
CO 3: Design and evaluate the performance of CMOS converters for data communication.	Analyze

Reference Book(s):

R1. Lab Manual prepared by the faculty members of ECE Department

Web References:

1. https://archive.nptel.ac.in/courses/106/103/106103016/f
2. https://archive.nptel.ac.in/courses/117/102/117102062/

Course Code: 24COL102		Course Title: Advanced Communication Networks Laboratory	
Course Category: EEC		Course Level: Mastery	
L:T:P(Hours/Week) 0:0 :4	Credits:2	Total Contact Hours:60	Max Marks:100

Course Objectives:
The course is intended to impart knowledge on configuring networks and Analyzing the various TCP congestion control mechanisms using necessary tools and to engage students in the configuration of various Networks.

List of Experiments:

1. Study of Networking Commands (Ping, Tracert, TELNET, nslookup, netstat, ARP, RARP) and Network Configuration Files.
2. Linux Network Configuration.
    1. Configuring NIC's IP Address
    2. Determining IP Address and MAC Address using if-config command
    3. Changing IP Address using if-config
    4. Static IP Address and Configuration by Editing
    5. Determining IP Address using DHCP
    6. Configuring Hostname in /etc/hosts file
3. Configuration of IP addressing for a given scenario for a given set of topologies
4. Performance Evaluation of TCP Congestion control Mechanisms
5. Simulation of Resource reservation Protocol (RSVP).
6. Network design and testing using simulation tools.
7. Simulation of Queuing and Scheduling algorithms.
8. Configure DHCP server and DHCP clients.
9. Configure DNS: Make a caching DNS client, and a DNS Proxy; implement reverse DNS and forward DNS.
10. Perform a case study about the different routing algorithms to select the network path with its optimum and economical during data transfer.

Simulation tools to be used: Networking tools (open source)

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Build and evaluate the performance of Linux network and IP addressing for a given scenario for a given set of topologies.	Create
CO 2: Simulate and evaluate the performance of various network protocols and algorithms for a given scenario.	Evaluate
CO 3 : Analyze the performance of different routing algorithm for optimum data transfer with case study.	Analyze

Reference Book(s):

R1. Lab Manual prepared by the faculty members of ECE Department

Web References:

1. https://archive.nptel.ac.in/courses/106/105/106105183/

<table>
<tr><td colspan="2">Course Code: 24SHA101</td><td colspan="3">Course Title: English for Research Paper Writing (Common to all PG Programme)</td></tr>
<tr><td colspan="2">Course Category :AC</td><td colspan="3">Course Level : Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)2:0:0</td><td colspan="2">Credits: -</td><td>Total Contact Hours: 30</td><td>Max Marks: 100</td></tr>
</table>

Course Objectives:

The course is intended to enhance the language skills concerning research paper writing and to explain the crucial role of technology in enhancing the quality and credibility of research.

Module I **15 hours**

Foundations of Academic English in Research: Academic English - Key Language Aspects - Clarity and Precision - Objectivity - Formal Tone - Integrating References.

Effective Writing Style for Research Papers: Word Order - Sentences and Paragraphs - Link Words for Cohesion - Avoiding Redundancy / Repetition - Breaking up long sentences - Paraphrasing Skills.

Advanced Reading and Research Vocabulary Development: Critical Reading Strategies - Analysing Research Articles - Identifying Arguments - Evaluating Findings - Formulaic Expressions - Academic Phrase Bank - Discipline-Specific Vocabulary - Commonly Misused Words.

Module II **15 hours**

Presentation Language Skills: Written vs. Spoken English - Dynamic Vocabulary for Presentations -Expressive Language for Audience Engagement- Language for Clear and Impactful Slides - Adapting Language Style to Different Audiences.

Grammar Refinement for Research Writing: Advanced Punctuation Usage- Proper Use of Modifiers - Avoiding Ambiguous Pronoun References - Verb Tense Consistency - Conditional Sentences.

Technology and Language for Research: Technology and Role of AI in Research Writing - Citations and References - Plagiarism and Ethical Considerations - Tools and Awareness - Fair Practices.

Course Outcomes: At the end of the course the student will be able to:	Cognitive Level
CO1: Enhance their English Language Skills concerning research paper writing	Understand
CO2: Develop a comprehensive set of linguistic skills essential for academic research.	Apply
CO3: Produce well-structured research papers using a variety of research and presentation technologies.	Apply

Reference Book(s):

R1: Craswell, G. 2004. Writing for Academic Success. Sage Publications, Springer, New York

R2: Wallwork, Adrian. 2015. English for Academic Research: Grammar, Usage and Style

R3: Swales, J. & C. Feak. 2012. Academic Writing for Graduate Students: Essential Skills and Tasks. Michigan University Press

Web References:

1. https://tiramisutes.github.io/images/PDF/English+for+Writing+Research+Papers.pdf
2. https://libguides.usc.edu/writingguide/grammar
3. https://onlinecourses.swayam2.ac.in/ntr24_ed15/preview

Assessment Pattern

	Assessment Component	Co. No.	Marks	Total
Continuous Comprehensive Evaluation(Internal)	Assignment 1	1	20	100
	Assignment 2	2	20	
	Assignment 3	3	20	
	MCQ	1,2,3	20	
	Descriptive Pattern Test	1,2,3	20	

Student will be finally awarded with three levels based on the score as follows:

Marks Scored	**Levels**
70% & above	Good
30-69 %	Average
< 30 %	Fair

SEMESTER 2

<table>
<tr><td colspan="2">Course Code: 24COT201</td><td colspan="3">Course Title: Advanced Antenna Design Technologies</td></tr>
<tr><td colspan="3">Course Category: PCC</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week) 3:0:0</td><td colspan="2">Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

Empower students with essential antenna engineering skills, encompassing radiation mechanisms, array analysis, special antennas, microstrip antennas, smart antennas, and radio wave propagation modes, fostering hands-on design expertise

Module I **22 Hours**

Aperture Antennas: Antenna Radiation Mechanism- Huygens' principle – radiation from rectangular and circular apertures – design considerations – Babinet's principle – Radiation from Sectoral and pyramidal horns – design concepts- prime-focus parabolic reflector and Cassegrain antennas.

Array Antenna Design Techniques: Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes – extension to planar Arrays-Phased array antenna

Microstrip Antenna Design Techniques: Basic characteristics of microstrip antennas– feeding Methods-Design of rectangular patch antennas – Planar Inverted-F Antenna (PIFA), Design of microstrip patch antenna using relevant software for given applications.

Module II **23 Hours**

Special Antennas and Design Techniques: Frequency Independent antennas-LPDA, Antenna miniaturization, Fractal antennas, Broadband Antennas-Helical Antenna- Bandwidth Improvement techniques.

Smart Antennas Design: Applications of Smart Antenna - Analog Beam Forming-Digital Beam forming- Direction of Arrival Estimation Methods-Diversity Combining Techniques-Digital radio receiver techniques and software radio for smart antenna

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Analyze the parameters and design concepts of Aperture Antennas.	Analyze
CO 2: Analyze the parameters and design concepts of Array Antenna	Analyze
CO 3: Investigate the techniques and methods to improve antenna performance.	Analyze
CO 4: Identify the suitable antenna for given application	Apply
CO 5: Involve in independent/team learning and use Modern tools to design antenna for practical applications	Create

Text Book(s):

T1. C.A. Balanis,"Antenna Theory and Design", 3 rd Ed., John Wiley & Sons. 2005.

T2. J.D.Kraus, R.J.Marhefka, “Antennas for all Applications”, Tata McGraw Hill, Third Edition, 2002

Reference Book(s):

R1. Frank Gross, Smart antennas for wireless communications, McGra-Hill, 2006.

R2. R.S.Elliot,"Antenna Theory and Design", Revised edition, Wiley-IEEE Press., 2003.

R3. Joseph C Liberti.Jr and Theodore S Rappaport, Smart Antennas for Wireless Communication: IS-95 and Third Generation CDMA Applications, Prentice Hall 1999

Web References:

1. https://www.antenna-theory.com/
2. https://www.mathworks.com/help/antenna/ref/antennadesigner-app.html
3. https://www.ansys.com/en-in/blog/common-antenna-designs

Course Code: 24COT202	Course Title: Signal Detection and Estimation Theory		
Course Category: Core		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on the application of statistical hypothesis testing for the detection of signals in noise, exploring the detection of multiple signals with unknown parameters. It aims to familiarize students with statistical parameter estimation methods to extract information from signals in noise and to summarize the application of filtering in the signal detection and estimation process.

Module I **22 Hours**

Signal Detection: Review of random variables and processes, review of vector space and vector-space interpretation of random variables, problem formulation and objectives of signal detection and signal parameter estimation in discrete-time domain. **Statistical Decision Theory:** Bayesian, minimax, and Neyman-Pearson decision rules, likelihood ratio test (LRT), receiver operating characteristics, composite hypothesis testing, locally optimum tests, generalized LRT, detector comparison techniques, asymptotic relative efficiency. **Detection of Deterministic Signals:** Matched filter detector and its performance, generalized matched filter, detection of sinusoid with unknown amplitude, phase, frequency and arrival time, linear model. **Detection of Random Signals:** Estimator-correlator, linear model, general Gaussian detection, detection of Gaussian random signal with unknown parameters, weak signal detection. **Nonparametric Detection:** Detection in the absence of complete statistical description of observations, sign detector, Wilcoxon detector, detectors based on quantized observations, robustness of detectors.

Module II **23 Hours**

Signal Estimation: Estimation of Signal Parameters **-** Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, sufficient statistics, minimum statistics, complete statistics, linear models; best linear unbiased estimation, maximum likelihood estimation, invariance principle; estimation efficiency, Bayesian estimation: philosophy, nuisance parameters, risk functions, minimum mean square error estimation, maximum a posteriori estimation. **Signal Estimation in Discrete-Time:** Linear Bayesian estimation, Weiner filtering, dynamical signal model, discrete Kalman filtering.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Use the statistical information in basic detection theory to solve the problems that involve detection of signals in the presence of real time noise.	Apply
CO 2: Detect multiple types of signals (deterministic signals, random signals, signal with unknown parameters).	Analyze
CO 3: Design optimal estimators for various signal parameters.	Create
CO 4: Develop optimal filters and Wiener/Kalman filters for the given specifications in communication applications.	Evaluate

Text Book(s):

T1. H. L. Van Trees, "Detection, Estimation and Modulation Theory", Part I, II, and III, Second Edition, John Wiley, 2012.

T2. H.V.Poor, "An Introduction to Signal Detection and Estimation", Second Edition, Spring Verlag,1994.

T3. S. M. Kay, "Fundamentals of Statistical Signal Processing: Estimation Theory", Prentice Hall PTR, 1993.

T4. S. M. Kay, "Fundamentals of Statistical Signal Processing: Detection Theory", First edition, Printice hall, Volume II, 1998.

Reference Book(s):

R1. D. L. Melsa and J. L. Cohn, "Detection and Estimation Theory", First edition, McGraw Hill, 1978.

R2. L. L. Scharf, "Statistical Signal Processing: Detection, Estimation, and Time Series Analysis", First edition, Addison-Wesley, 1991.

Web References:

1. https://nptel.ac.in/courses/117103018

Course Code: 24COT203	**Course Title: 5G : Features, Standards and Evolution**		
Course Category: PCC		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks: 100**

Course Objectives:

The course is intended to impart knowledge on essential principles of 5G communications, 5G architecture and 5G internet, 5G spectrum, cognitive networks of 5G.

Module I **22 Hours**

History of 5G: Historical background, 5G use cases and system concept: Use case requirements, 5G system concept.
The 5G Architecture: Introduction, High-level requirements for the 5G architecture, Functional architecture and 5G flexibility, Physical architecture and 5G deployment.
Machine-type communications: Introduction, Fundamental techniques for MTC, Massive MTC, Massive MTC, Summary of uMTC features.
Device to Device (D2D) communications: From 4G to 5G, Radio resource management for mobile broadband D2D, Multi-hop D2D communications for proximity and emergency services, Multi operator D2D communication.
The 5G radio-access technologies: Access design principles for multi-user communications, Multi-carrier with filtering: a new waveform, Non-orthogonal schemes for efficient multiple access.

Module II **23 Hours**

Radio access for dense deployments, Radio access for V2X communication, Radio access for massive machine-type communication.
Relaying and wireless network coding: The role of relaying and network coding in 5G wireless networks, Multi-flow wireless backhauling, Highly flexible multi-flow relaying, Buffer-aided relaying.
Interference management, mobility management and dynamic: Network deployment types, Interference management in 5G. Mobility management in 5G, Dynamic network reconfiguration in 5G
Spectrum: Introduction, 5G spectrum landscape and requirements, Spectrum access modes and sharing scenarios, 5G spectrum technologies, Value of spectrum for 5G: a techno-economic perspective.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Describe the concepts of 5G networks and its architecture.	Understand
CO 2: Analyze the spectrum optimization using cognitive radio in 5G network.	Apply
CO 3: Analyze the white space spectrum opportunities and challenges.	Analyze
CO 4: Analyze the security issues and challenges in 5G communication systems.	Create

Text Book(s):

T1. 5G Mobile and Wireless Communication Technology, Afif Osseran, Jose F Monserrat, Patrick Marsch, Cambridge University Press, 2016.

T2. Fundamentals of 5G Mobile Networks, Jonathan Rodriguez, John Wiley & Sons 2015.

Reference Book(s):

R1. 5G Core Networks Powering Digitization, Stephen Rommer, Academic Press, 2019.

R2. Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, Fundamentals of 5G Mobile Networks, Cambridge University Press

R3. Martin Sauter, From GSM to LTE—Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband, Wiley-Blackwell.

Web References:

1. https://www.researchgate.net/publication/305882445_5G_Mobile_and_Wireless_Communications
2. https://www.hindawi.com/journals/cje/2016/5974586/
3. https://www.sciencedirect.com/science/article/pii/S1110016820304737

Course Code: 24COL201		Course Title: RF System Design Laboratory	
Course Category: EEC		Course Level: Mastery	
L:T:P(Hours/Week) 0:0 :4	Credits:2	Total Contact Hours:60	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on designing and analyzing RF/microwave components and wireless systems using modern tools and engage students to gain hands-on experience with measurement and communication technologies tools.

List of Experiments :

1. Simulation of Planar Transmission Lines and matching network
2. Design and Simulation of Microwave Filters
3. Design and Simulation of Microstrip Couplers
4. Design and Simulation of Power dividers using ADS
5. Design and Simulation of Patch antenna for ISM Band
6. Simulation of RF Mixer Circuit
7. Design and Simulation Low noise amplifier
8. Simulation of RF Transceiver
9. Measurement of Microwave Devices and Antennas using VNA
10. Simulation and performance evaluation of Wireless MAC protocols
11. Study of ZIGBEE/Bluetooth
12. Study of Global Positioning System

Simulation tools to be used: ADS & Networking tools (open source)

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Design, simulate and Measure the performance of RF circuits, antenna and RF subsystems.	Create
CO 2: Analyze the performance of various communication systems.	Analyze

Reference Book(s):

R1. Lab Manual prepared by the faculty members of ECE Department

Web References:

1. https://nptel.ac.in/noc/courses/noc17/SEM1/noc17-ec03/

Course Code: 24SHA201	Course Title: Teaching and Learning in Engineering (common to all PG Programmes)		
Course Category: AC	Course Level: Introductory		
L:T:P(Hours/Week) 0:0:4	Credits: -	Total Contact Hours: 30	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on an outcome-based approach, employing active learning methods in lecture/practical/tutorial sessions. Assessments will be conducted using rubrics, focusing on higher-order thinking skills.

Module I **15 Hours**

Outcome Based Approach

Outcome based Education- Need & Approach- Washington accord- Graduate attributes- Learning outcomes –Blooms Taxonomy.

Active Learning Methods

Design and Delivery plan for lectures/practical/tutorial sessions-Need for Active learning methods-Active learning strategies- Benefits of Active learning Methods.

Module II **15 Hours**

Assessments

Assessments- types of assessments-need for rubrics, Types of rubrics- Assessment using rubrics.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Use outcome based approach in teaching courses in engineering Programmes.	Apply
CO2: Conduct lecture/practical/tutorial sessions using active learning methods.	Apply
CO3: Conduct higher order assessments by using rubrics.	Apply

Reference Book(s):

1. William G. Spady and Francis Aldrine A. Uy (2014). Outcome-Based Education: Critical Issues and Answers, ISBN: 978-971-0167-41-8, Maxcor Publishing House, Inc.
2. Dr. William G. Spady, WajidHussain, Joan Largo, Dr. Francis Uy (2018). Beyond Outcomes Accreditation: Exploring the Power of 'Real' OBE Practices.
3. Richard M. Felder, Rebecca Brent (2016), Teaching and Learning STEM: A Practical Guide, John Wiley & Sons Inc

PROFESSIONAL ELECTIVES

Course Code: 24COE001	Course Title: Satellite Communication and Navigation Systems		
Course Category: PEC		Course Level: Mastery	
L:T:P(Hours/Week) 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to impart knowledge on basic principles of satellite and navigation systems, classification of satellites, orbital parameters and launch vehicles.

Module1 **22 Hours**

Satellite Architecture and Orbital analysis: Architecture of Satellite Communication System: Principles and architecture of satellite Communication, Brief history of Satellite systems, advantages, disadvantages, applications, and frequency bands used for satellite communication and their advantages/drawbacks. Orbital equations, Kepler's laws of planetary motion, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity of a satellite, concepts of Solar day and Sidereal day.

Satellite Launch and In-orbit Operations: Acquiring the Desired Orbit, Launch Sequence, Orbital Perturbations, Satellite Stabilization, Orbital Effects on Satellite's Performance, Look Angles of a Satellite, Earth Coverage and Ground Tracks.

Satellite Hardware: Satellite Subsystems, Mechanical Structure, Propulsion Subsystem, Thermal Control Subsystem, Power Supply Subsystem, Attitude and Orbit Control, Tracking, Telemetry and Command Subsystem, Payload, Antenna Subsystem, Space Qualification and Equipment Reliability.

Module II **23 Hours**

Earth Station: Types of Earth Station, Earth Station Architecture, Earth Station Design Considerations, Earth Station Testing, Earth Station Hardware, Satellite Tracking.

Satellite Link Design Fundamentals : Transmission Equation, Satellite link parameters, Frequency Considerations, Propagation Considerations, Techniques to Counter Propagation Effects, Noise Considerations, Interference-related Problems, Antenna Gain-to-Noise Temperature (G/T) Ratio, Link Design.

Radar and GPS : Basic Radar, Radar Block Diagram, The simple form of the Radar Equation, Radar Frequencies, Application of radar, Types of Radars, Probability of Detection and False alarm. Global Navigation Satellite Systems, Basic concepts of GPS, Space segment, Control segment, user segment, GPS constellation, GPS measurement characteristic.

Navigation systems: Introduction and Classification of Wireless Positioning Systems, positioning and navigation systems.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Explain various Orbital Parameters, Satellite Link Parameters and Propagation considerations.	Understand
CO 2: Apply the concepts of radars, WLAN and satellites in determining the user position and navigation	Apply
CO 3: Analyze Orbital Mechanics, TT&C and other design issues	Analyze
CO 4: Design basic satellite link system for Uplink and Downlink and evaluate C/N overall for the link.	Create

Text Book(s):

T1. Satellite Technology - Principles and Applications, Anil K Maini, Varsha Agarwal, 2nd Edition, John Wiley and Sons, 2011

T2. Satellite Communication Concepts and applications, K N Raja Rao, , 2nd Edition, PHI, 2013.

Reference Book(s):

R1. Satellite Communication, Timothy Pratt, Charles W. Bostian, 2nd Edition, John Wiley & Sons, 2012.

R2. Satellite and Terrestrial Radio Positioning techniques- A signal processing perspective, Davidedardari, EmanuelaFalletti, Marco Luise, 1st Edition, Elsevier Academic Press, 2012.

R3. Introduction to RADAR Systems, M. L Skolnik, TaTa Mcgraw-Hill, 2001

Web References:

1. http://www.cse.wustl.edu/~jain/cis788-97/ftp/satellite_nets/index.html
2. https://www.cse.wustl.edu/~jain/cis788-97/satellite_data/index.htm

Course Code: 24COE002		Course Title: Modern Wireless Communication	
Course Category: PEC		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objective:

The course is intended to impart knowledge of modern wireless communication systems such as Mobile, Cellular systems, 5G etc.

Module I **23 Hours**

Wireless Systems: Wireless vision - Technical Issues- current wireless systems: Cellular Telephone Systems -Cordless Phones-Wireless LANs-Wide Area Wireless Data Services - Broadband Wireless Access-Paging Systems -Satellite Networks-Low-Cost Low-Power Radios: Bluetooth and Zigbee- Ultra wideband Radios-The Wireless Spectrum: Methods for Spectrum Allocation-Spectrum Allocations for Existing Systems.

Cellular System Design: Frequency Reuse, channel assignment strategies, handoff Strategies, Interference and system capacity, tracking and grade off service, improving coverage and capacity.

Wireless Channel Capacity: Capacity in AWGN-Capacity of Flat-Fading Channels - Capacity of Frequency-Selective Fading Channels: Time-Invariant Channels -Time-Varying Channels.

Module II **22 Hours**

Intelligent Cellular and Its Application: Intelligent cell concept, applications of intelligent micro- cell Systems, in-Building Communication and CDMA cellular Radio Networks.

Higher Generation Cellular Standards: Review of 2G Standards,3G Standards: evolved EDGE, enhancements in 4G standard, Architecture and representative protocols, call flow for LTE, VoLTE, UMTS, Introduction to 5G

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Describe the operation of various wireless communication systems	Understand
CO 2: Analyze the Capacity of Time varying and Time Invariant Channels for Flat Fading and Frequency Selective Fading.	Analyze
CO 3: Apply the intelligent cell concept for modern mobile communication techniques like VoLTE and 5G	Apply

Text Book:

T1: T.S.Rappaport, "Wireless Communications Principles and Practice", 2nd edition, PHI, 2002.

Reference Book(s):

R1. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2007.

R2. V.K.Garg, J.E.Wilkes, "Principle & Application of GSM", Pearson Education, 5th edition, 2008.

R3. V.K.Garg, "IS-95 CDMA & CDMA 2000", Pearson Education, 4th edition, 2009

R4. William C.Y.Lee, "Mobile Cellular Telecommunications Analog and Digital Systems", 2nd edition, TMH, 1995.

Web References:

1. https://www.youtube.com/watch?v=QE-GmtXIKGs

Course Code: 24COE003	Course Title: Massive MIMO and Beam forming Techniques		
Course Category: PEC		**Course Level: Mastery**	
L:T:P(Hours/Week) 3:0:0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Course Objectives: To understand the performance of MIMO system in 4G/5G wireless communications. This course covers the fundamentals of Multiple input multiple output (MIMO) antenna based wireless communication systems. MIMO is now an essential part of modern wireless communication systems, such as 3G, 4G, WLAN / Wifi, LTE, WiMax, etc.

Module I **22 Hours**

Diversity-multiplexing trade-off, transmit diversity schemes, advantages and applications of MIMO systems, Uncorrelated, fully correlated, separately correlated and keyhole MIMO fading models, parallel decomposition of MIMO channel. Uniform, adaptive and near optimal power allocation, Capacity for deterministic and random MIMO channels, Capacity of i.i.d., separately correlated and keyhole Rayleigh fading MIMO channels, Beam forming and its types.

Module II **23 Hours**

Advantages, code design criteria, Alamouti space-time codes, SER analysis of Alamouti space-time code over fading channels, Space-time block codes, Space-time trellis codes, Performance analysis of Space-time codes over separately correlated MIMO channel, Space-time turbo codes. ML, ZF, MMSE, ZF-SIC, MMSE-SIC, LR based detection, Spatial modulation, MIMO based cooperative communication and cognitive radio, multiuser MIMO, cognitive-femtocells and large MIMO systems for 5G wireless.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Understand the basic concept of antenna diversity schemes	Understand
CO 2: Analyze the signal processing of MIMO in 4G LTE Communication	Analyze
CO 3: Compare the channel capacity of MIMO system under different channel conditions	Analyze
CO 4: Analyze the problems related to Alamouti coding and BLAST structure of MIMO system.	Analyze
CO 5: Analyze the Massive MIMO environment in 5G systems.	Analyze

Text Book(s):

T1. B. Clerckx and C. Oestges, MIMO wireless networks, Elsevier Academic Press, 2nd ed., 2013.

T2. T. M. Duman and A. Ghrayeb, Coding for MIMO communication systems, John Wiley and Sons, 2007.

Reference Book(s):

R1. J. Choi, Optimal Combining & Detection, Cambridge University Press, 2010.

R2. A. Chokhalingam and B. S. Rajan, Large MIMO systems, Cambridge University Press, 2014.

R3. N. Costa and S. Haykin, Multiple-input multiple-output channel models, John Wiley & Sons, 2010.

Web References:

1. https://www.rcrwireless.com/20180912/5g/5g-nr-massive-mimo-and-beamforming-what-does-it-mean-and-how-can-i-measure-it-in-the-field
2. https://link.springer.com/article/10.1631/FITEE.1601817
3. https://www.youtube.com/watch?v=VhWpetDlehQ

Course Code: 24COE004	Course Title: Next Generation Mobile Communication Technologies		
Course Category: PEC		Course Level: Mastery	
L:T:P(Hours/Week) 3:0 :0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on the evolution of the mobile technology, future trends of 6G technology, Regulatory and Standardization Aspects. It also helps students to critically assess current mobile communication technologies, understand the potential and challenges of future developments, and apply their knowledge in practical and theoretical contexts.

Module I **22 Hours**

Past and Present Communication Technologies: Introduction to Wireless Personal Communication, Mobile radio systems, Modulation schemes for wireless Communication (MSK, GMSK), OFDM. Multiple access techniques: Spread spectrum techniques, Cellular CDMA, Wide-band CDMA, Multiple access Performance of CDMA, Capacities of multiple access schemes, Comparison, NOMA. Wireless Networks and Standards: GSM, CDMA Cellular standard, 3G, 4G, Introduction to 5G, The challenges of 5G; Key technologies of 5G; Design issues for 5G; Spectrum, regulation and standardization for 5G, 5G Networks Towards Smart and Sustainable Cities

Module II **23 Hours**

Leap to 6G: The 6G vision, Sub 6 GHz communication- The capacity problem, Technologies enabling 6G – Millimeter wave and Terahertz communications: Abundance of bandwidth, Free space path loss problem of Millimeter and Terahertz waves, Propagation ,Attenuation and losses, Visible light Communications, Multiplexing and channel access methods for 5G and 6G, Role of Artificial intelligence in 6G, edge computing, Licensing and Regulation challenges in 6G, privacy and security concerns, 6G-Green network,6G Research Areas

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Demonstrate a thorough understanding of the progression from early mobile communication systems (1G) to the latest technologies (5G) and potential future developments (6G).	Apply

CO2: Experiment the emerging trends and technologies, such as IoT, edge computing, and AI integration in mobile networks, and predict their potential impacts.	Analyze
CO3: Investigate independent research and contribute to advancements in the field of mobile communications, presenting findings through reports, presentations, or publications**.**	Create
CO4: Work effectively in teams to design and develop mobile communication solutions, and communicate technical information clearly to both technical and non-technical audiences.	Create

Text Book(s):

T1. Theodore Rappaport, "Wireless Communications: Principles and Practice", Pearson, 2nd Edition

T2. Božanić, Mladen, and Sinha, Saurabh. Mobile Communication Networks: 5G and a Vision of 6G. Germany, Springer International Publishing, 2021.

Reference Book(s):

R1. Andreas. F. Molisch, "Wireless Communication", John Wiley and Sons

R2. Mark and Zhuang, "Wireless Communication and Networking", PHI

R3. Paulo Sergio Rufino Henrique; Ramjee Prasad, "6G The Road to the Future Wireless Technologies 2030" River Publishers, 2021

Web References:

1. https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9665730
2. https://ieeexplore.ieee.org/document/6824752
3. https://ieeexplore.ieee.org/document/9864388

Course Code: 24COE005		Course Title: IoT for Wireless Networks	
Course Category: PEC		**Course Level: Mastery**	
L:T:P(Hours/Week) 3:0:0	**Credits: 3**	**Total Contact Hours:45**	**Max Marks: 100**

Course Objectives:

The course is intended to impart knowledge on concepts of Internet of Things (IoT) protocols and its applications, IoT security & system management framework.

Module I **22 Hours**

Introduction and Applications: Introduction to IoT – Definition, Characteristics, functional requirements, motivation, Physical design - things in IoT, IoT protocols, Logical Design - functional blocks, communication models, Communication APIs, Applications – Home Automation, Cities, Environment, Energy, Agriculture, Health, Industry

IoT Design and System Management: IoT &M2M – Machine to Machine, Difference between IoT & M2M, Software Defined Network, Network function virtualization, IoT system management – SNMP, NETCONF, YANG, IoT Design methodology.

IoT Protocols: Protocols – HTTP, UPnP, CoAP, MQTT, XMPP.

Module II **23 Hours**

IoT System: IoT systems logical design using python - python data types & data structures, control flow, functions or modules. Modules & package of python, python packages of interest for IoT-JSON, XML, HTTP & URL Lib, SMTP Lib. Exemplary Device: Raspberry Pi-Programming Raspberry Pi with Python.

IoT Cloud and Data Analytics: Introduction to Cloud storage Models – WAMP – Xively Cloud for IoT – Python Web Application Framework-Django – Designing a RESTful based Web API. Data Analytics for IoT – Apache Hadoop, Apache Oozie.

IoT Security: IoT attacks - Phase attacks, Attacks as per architecture, Attacks based on components. Security Protocols - Time-Based Secure Key Generation and Renewal - Security access algorithms for unidirectional data transmissions, Security access algorithms for bidirectional data transmissions.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Interpret the vision of IoT from a global context.	Analyze
CO 2: Compare and Contrast the use of Devices, Gateways and Data Management in IoT.	Analyze
CO 3: Design a portable IoT using any Single Board Computer and relevant protocols	Apply
CO 4: Analyze applications of IoT in real time scenario	Analyze
CO 5: Deploy an IoT application and connect to the cloud.	Apply

Text Book(s):

T1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things - A hand on approach”, Universities Press (India) Private Limited, 2014.

T2. Fei Hu, “Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations,” 1st Edition, CRC Press, 2016.

Reference Book(s):

R1. Pethuru Raj, Anupama C. Raman, “The Internet of Things – Enabling Technologies, Platforms and Use cases” , CRC Press, Taylor & Francis Group, 2017.

R2.William Stallings, Lawrie Brown, “Computer Security: Principles and Practice”, Pearson, 3rd Edition, 2014.

R3.Rajkumar Buyya, “Internet of Things – Principles and Paradigms” , Published by Morgan Kaufmann, Elsevier, 2016.

Web References:

1. https://archive.nptel.ac.in/courses/106/105/106105166/
2. https://archive.nptel.ac.in/courses/108/108/108108179/
3. https://archive.nptel.ac.in/courses/106/105/106105195/

Course Code: 24COE006	Course Title: Wireless Network Security and Privacy		
Course Category: PEC		Course Level: Mastery	
L:T:P(Hours/Week) 3:0 : 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge to identify and mitigate security threats, protect user privacy, and implement robust security policies and practices in wireless network.

Module I **22 Hours**

Network Security and Management: Principles of cryptography –Security in wireless local area network – Overview of security architecture for wireless sensor network- Security in RFID networks and communications- IOT security.

DoS-attacks and counter measures – security in many layers. Infrastructure for network management – The internet standard management framework – SMI, MIB, SNMP, Security and administration – ASN.1. Case Study - Kali Linux

Module II **23 Hours**

Wireless Security: Wi-Fi Security: Attacks on wireless networks, Security in the IEEE 802.11 standard, Security in 802.11i - security architecture, security policy negotiation. Authentication in wireless networks - RADIUS. Layer 3 security mechanisms - PKI, level 3 VPN. Security in Mobile Telecommunication networks - signaling, vulnerabilities of SS7, possible attacks on SS7, Security in GSM - security flaws.

Privacy and Storage Security: Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Implement the network management frame work for various attacks.	Apply
CO 2: Apply the knowledge of Privacy policies in appropriate security Issues	Apply
CO 3:Analyze security threats in Wireless networks and find a suitable countermeasure.	Analyze
CO 4: Develop security protocols for a real time scenario.	Create

Text Book(s):

T1. Chen, Lei, et al. Wireless Network Security: Theories and Applications. Germany, Higher Education Press, 2013.

T2. Hakima Chaouchi , maryline Laurent - Maknavicius, " Wireless and Mobile network security" Wiley, 2009.

Reference Book(s):

R1. Snmp, Snmpv2, Snmpv3, and Rmon 1&2, 3/E. India, Pearson Education, 1998.

R2. Fei Hu, “Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations,” 1st Edition, CRC Press, 2016.

R3.Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

R4.Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022

Web References:

1. https://www.tutorialspoint.com/kali_linux/index.htm
2. https://www.netacad.com/courses/cybersecurity/network-security

Course Code: 24COE007	**Course Title: RF Advanced Transceiver Design**		
Course Category: PEC		**Course Level: Mastery**	
L:T:P(Hours/Week) 3:0:0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Course Objectives:

The course is intended to impart knowledge on design topologies and techniques of RF Transceiver design for wireless applications

Module I **22 Hours**

Basic Concepts in RF Design: General Considerations-Effects of Nonlinearity-Harmonic Distortion-Gain Compression-Cross Modulation-Intermodulation-Cascaded Nonlinear Stages-Noise: Noise as a Random Process-Noise Spectrum-Effect of Transfer Function on Noise-Device Noise-Sensitivity and Dynamic Range-Passive Impedance Transformation-MOS models for RF, Characteristics of passive IC components at RF frequencies – interconnects, resistors, capacitors, inductors and transformers

Transceiver Architectures: Receiver Architectures-Basic Heterodyne Receivers-Modern Heterodyne Receivers-Direct-Conversion Receivers-Image-Reject Receivers-Low-IF Receivers. Transmitter Architectures-Direct-Conversion Transmitters-Modern Direct-Conversion Transmitters-Heterodyne Transmitters

Low Noise Amplifier: LNA Topologies-Gain Switching-Band Switching, Design of LNA using Keysight ADS

Module II **23 Hours**

Power Amplifier: Stability of feedback systems: Gain and phase margin, Root-locus techniques, Time and Frequency domain considerations, Compensation, Class A, AB, B, C, D, E and F amplifiers, Analysis of Power amplifier using Keysight ADS

Phase-Looked Loop and Mixers: Resonant LC-CMOS VCO design, Other VCO topologies: QVCOs Linearized PLL Model, Loop filters and Charge pumps, Integer-N frequency synthesizers, Direct Digital Frequency Synthesizers Active mixers, Passive and polyphaser filters

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Analyze the challenges in Circuit design based on noise figure, Conversion gain and implementation in CMOS technology	Analyze
CO 2: Analyze the different transceiver architectures for wireless applications	Analyze
CO 3: Design and Implementation of Low Noise Amplifier based on foundry models for Wireless Communication Systems	Apply
CO 4: Design and Implementation of Power amplifier for portable applications	Apply
CO 5: Design and analyze different types of Phase Locked Loops and mixers for wireless applications	Apply

Text Book(s):

T1. Behzad Razavi, RF Microelectronics, 2nd Ed., Prentice Hall, Reprint 2012. 2. Thomas.

T2. H. Lee, The Design of CMOS Radio Frequency Integrated Circuits, Cambridge, U.K., Cambridge University Press, 2004.

Reference Book(s):

R1. John W.M. Rogers and Calvin Plett, ―Radio Frequency Integrated Circuit Design‖, 2nd Edition, Artech House, Norwood, 2010.

R2. Devendra.K. Misra, ―Radio Frequency and Microwave Communication Circuits – Analysis and Design‖, John Wiley and Sons, Newyork, 2004.

R3. Wayne Wolf, Modern VLSI design, Pearson Education, 2003

Web References:

1. http://onlinecourses.nptel.ac.in/noc24_ee75
2. http://edadownload.software.keysight.com/eedl/ads/2011_01/pdf/dgrfsys.pdf
3. https://www.udemy.com/course/receiver-transmitter-transceiver-architecture-rf-wireless-systemdesign/

<table>
<tr><td colspan="2">Course Code: 24COE008</td><td colspan="2">Course Title: VLSI Signal Processing</td></tr>
<tr><td colspan="2">Course Category: PEC</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week) 3:0:0</td><td>Credits: 3</td><td>Total Contact Hours: 45</td><td>Max Marks: 100</td></tr>
</table>

Course Objectives:
The course is intended to impart knowledge on the concepts of pipelining and parallel processing, algorithmic level transformation techniques in VLSI design and algorithmic level strength reduction techniques in filters. This course is intended to explain scaling, round-off noise and design bit level arithmetic architectures, synchronous and wave pipelined architectures.

Module I **23 Hours**

Pipelining and Parallel Processing : Introduction to DSP Systems- Typical DSP Algorithms, Data flow and Dependence graphs-critical path, Loop bound, iteration bound, Longest path matrix algorithm, Pipelining and Parallel processing of FIR filters- Application in simple architectures, Pipelining and parallel processing for low power.
Algorithmic Level Transformation Techniques and Algorithmic Level Strength Reduction fast Convolution : Retiming-definitions and properties, Techniques : Unfolding – an algorithm for unfolding, properties of unfolding, sample period reduction and parallel processing application: Folding – folding transformation, Register minimization technique, Folding of multirate systems, Fast Convolution- Cook-Toom Algorithm, Algorithmic strength reduction in filters and transforms, 2-parallel FIR filter, DCT Architecture, Pipelined and parallel recursive filters, Look-Ahead pipelining in first-order IIR filters, Parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters.

Module II **22 Hours**

Scaling and Round off Noise and Bit-Level Arithmetic Architectures : Scaling and Round off noise, state variable description of digital filters, Bit-level arithmetic architectures – parallel multipliers with sign extension, parallel carry-ripple and carry-save multipliers, Design of Lyon's bit-serial multipliers using Horner's rule, bit-serial FIR filter, CSD representation, CSD multiplication using Horner's rule for precision improvement; Distributed arithmetic.
Numerical Strength Reduction, Wave and Asynchronous Pipelining : Numerical strength reduction- sub expression elimination, multiple constant multiplication, iterative matching, synchronous pipelining and clocking styles, clock skew in edge-triggered single phase clocking, two-phase clocking, wave-pipelining, Asynchronous pipelining bundled data versus dual rail protocol.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Utilize the concepts of pipelining and parallel processing to design VLSI architectures for DSP algorithms.	Apply
CO2: Analyze algorithmic level transformation techniques for DSP sub-systems and algorithmic level strength reduction techniques for filters.	Analyze
CO3: Construct scaling, round-off noise and design bit level arithmetic architectures.	Apply
CO4: Examine the concepts in numerical strength reduction, asynchronous and wave pipelined architectures.	Analyze

Text Book(s):

T1. Jose Franca, Yannis Tsividis, "Design of Analog-Digital VLSI Circuits for Telecommunications and Signal Processing", Prentice Hall 1994.

T2. Keshab K.Parhi, "VLSI Digital Signal Processing Systems: Design and Implementation", Wiley, First Edition, 2007.

Reference Book(s):

R1. U.Meyer-Baese,"Digital Signal Processing with Field Programmable Gate Arrays", Springer, Second Edition, 2004.

R2. Kung S.Y.,H.J.While house T.Kailath, "VLSI and Modern signal Processing", Prentice Hall 1985.

R3. Mohammed Ismail, Terri, Fiez, "Analog VLSI Signal and Information Processing", McGraw Hill, 1994.

Web References:

1. http://nptel.ac.in/courses/106104024
2. https://onlinecourses.nptel.ac.in/noc20_ee44

Course Code: 24COE009	**Course Title: Deep Learning in Computer Vision**		
Course Category: PEC		**Course Level: Mastery**	
L:T:P(Hours/Week) 3 : 0 : 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course is intended to impart knowledge on fundamental concepts of deep learning and its applications in the field of computer vision. This course also enables the students to implement deep learning architectures for real-world applications.

Module I **22 Hours**

Overview of Computer vision and Deep learning: Introduction to Image Formation, Capture and Representation; Linear Filtering, Correlation, Convolution, Visual Features and Representations: Edge, Blobs, Corner Detection; Scale Space and Scale Selection; Visual Matching: Bag-of-words, VLAD; RANSAC, Hough transform; Pyramid Matching; Optical Flow. Deep Learning Review: Review of Deep Learning, Multi-layer Perceptrons, Introduction to CNNs; Back propagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions, Various Optimizers, Evolution of CNN Architectures.

Module II **23 Hours**

Deep Learning Models: CNNs for Recognition and Verification (Siamese Networks, Triplet Loss, Contrastive Loss, Ranking Loss); CNNs for Detection: Background of Object Detection, R-CNN, Fast R-CNN, Faster R-CNN, YOLO, CNNs for Segmentation: FCN, SegNet, U-Net. Recurrent Neural Networks (RNNs): Review of RNNs; CNN + RNN Models for Video Understanding: Spatio-temporal Models, Spatial Transformers; Transformer Networks, GANs, VAEs, PixelRNNs, NADE, CycleGANs, Progressive GANs, StackGANs, Recent Trends: Zero-shot, One-shot, Few-shot Learning; Self-supervised Learning; Reinforcement Learning in Vision.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1. Identify basic concepts, terminology, models, and methods in the field of computer vision and deep learning.	Understand
CO2. Analyse the Deep Learning algorithms to solve various types of learning tasks and Computer Vision tasks.	Analyze
CO3. Apply the knowledge of transfer learning in the deep learning model for feature extraction, segmentation, detection and Classification applications.	Apply
CO4. Design deep learning architectures for real time applications using different hyper parameters.	Create
CO5. Implement Deep Learning Technique for computer vision applications and present a technical report.	Evaluate

Text Book(s):

T1. Ian Good fellow , Yoshua Bengio and Aaron Courville. "Deep learning", MIT Press , 2017.

T2. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010.

Reference Book(s):

R1. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly Media,2017

R2. Mohamed Elgendy, Deep Learning for vision systems, Manning publications Co, 2020.

R3. Forsyth and Ponce, “Computer Vision – A Modern Approach”, Second Edition, Prentice Hall, 2011.

Web References:

1. https://onlinecourses.nptel.ac.in/noc23_cs126/preview
2. https://www.deeplearningbook.org/
3. https://cs231n.stanford.edu/schedule.html