Dr. Babasaheb Ambedkar Technological University (Established a University of Technology in the State of Maharashtra)
(under Maharashtra Act No. XXIX of 2014)
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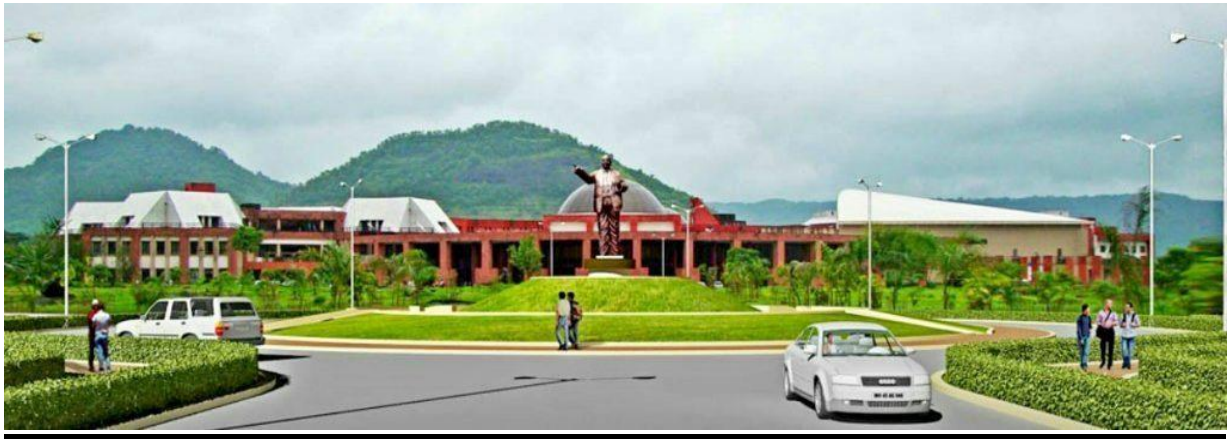
PROPOSED CURRICULUM POST GRADUATE PROGRAMME

M. TECH

Electronics and Communication (Advanced Communication Technology)

Two Year (Four Semester) Course

WITH EFFECT FROM THE ACADEMIC YEAR 2023-2024



M.Tech Electronics and Communication (Advanced Communication Technology)

The Master of Technology program in Advanced Communication Technology emphases on the equipment, systems, and technologies that convey mobile communication, wireless communication antenna design and multimedia information. Students learn how to design, run, install, and maintain communications systems and equipment for various applications using latest technologies for the benefit of societies. The programme sets the basis for career prospects in 5G communication based industries, research laboratories, and alleged national and international organizations.

Objectives:

I. To serve the society and nation, by providing high quality engineering educational programs to the students, engaging in research and innovations that will enhance the skill and knowledge and assisting the economic development of the region, state, and nation through technology transfer.

II. To equip the postgraduate students with the state of the art education through research and collaborative work experience/culture to enable successful, innovative, and life-long careers in Electronics and Communication field pertaining to 5G technology.

III. To encourage the post-graduates students, to acquire the academic excellence and skills necessary to work as Advanced Communication Technology professional in a modern, ever-evolving world.

IV. To provide the broad understanding of social, ethical and professional issues of contemporary engineering practice and related technologies, as well as professional, ethical, and societal responsibilities.

V. To inculcate the skills for perusing inventive concept to provide solutions to industrial, social or nation problem.

Outcomes

I. Students of this program will have ability to apply knowledge of mathematics, sciences and engineering to Electronics and Communication technology related problems.

II. Postgraduate students will gain an ability to design and conduct experiments, as well as to analyze and interpret data/results.

III. Learners of this program will built an ability to design and develop a system, components,

devices, or process to meet desired needs.

IV. Masters students of this program will have an ability to work on multi-disciplinaryteams and also as an individual for solving issues related to 5G technology domain.

V. Learners of this program will have an ability to identify, formulate, and solve Engineering problems by applying mathematical foundations, algorithmic principles, and advanced communication technology theory in the modeling and design of electronics and communication systems in a way that demonstrates comprehension of the tradeoffs involved in design choices.

VI. Postgraduate students will have an ability to communicate effectively orally andin writing and also understanding of professional and ethical responsibility.

VII. Postgraduate students will have an ability to use the techniques, skills, and modern engineering EDA tools necessary for advanced communication technology practices.

VIII. Learners of this program will have an ability to evaluate Electronics and communication Engineering problems with cost effectiveness, features, and user friendliness to cater needs for innovative product development.

IX. Postgraduate students will have an ability to solve contemporary social and industrial problems by engaging in life-long learning.

Dr. Babasaheb Ambedkar Technological University
Teaching and Examination Scheme for
M.Tech. Electronics and Communication (Advanced Communication Technology) w.e.f. Aug 2023

Sr. No.	Course Code	Name of the Course	Hours/Week			Credit	Examination scheme				
							Theory		IA	PR/ OR	TOTAL
			L	P	T		TH	Test			
First Semester											
01	MTACTC101	Digital Communication Techniques	03	--	1	04	60	20	20	--	**100**
02	MTACTC102	5G Technology-1	03	--	1	04	60	20	20	--	**100**
03	MTACTC103	Advanced Optical Communication	03	--	1	04	60	20	20	--	**100**
04	MTACTE114	Elective-I	03	--	--	03	60	20	20	--	**100**
05	MTACTE125	Elective-II	03	--	--	03	60	20	20	--	**100**
06	MTACTC106	Communication Skills	02	--	--	02	--	--	25	25	**50**
07	MTACTL107	PG Lab-I*	--	03	--	02	--	--	25	25	**50**
		Total for Semester I	**17**	**03**	**03**	**22**	**300**	**100**	**150**	**50**	**600**
Second Semester											
01	MTACTC201	5G Technology-2	03	--	1	04	60	20	20	--	**100**
02	MTACTC202	5G-Mobile Communication	03	--	1	04	60	20	20	--	**100**
03	MTACTE233	Elective-III	03	--	--	03	60	20	20	--	**100**
04	MTACTE244	Elective- IV	03	--	--	03	60	20	20	--	**100**
05	MTACTE255	Elective-V- (Open to all)	03	--	--	03	60	20	20	--	**100**
06	MTACTS206	Seminar-I	--	04	--	02	--	--	50	50	**100**
07	MTACTP207	Mini-Project	--	04	--	02	--	--	50	50	**100**
		Total for Semester II	**15**	**08**	**02**	**21**	**300**	**100**	**200**	**100**	**700**

*** PG Lab-I –Practical shall be based on courses of first semester.**

 # Student has to choose this course either from NPTEL/MOOC pool and submission of course completion certificate is mandatory.

Elective-I:

- Smart Antennas for 5G communications
- RF Engineering
- Advanced Wireless Communication
- Software Defined Radio
- Advanced Computer Networks

Elective-II:

- Advanced Antenna Technology

- Telecom Network Management
- VLSI System Design
- Fuzzy Systems and Neural Networks
- Mobile Handset Design

Elective-III:

- Satellite Communication
- Advanced Digital Signal processing
- Cryptography & Network Security
- Optical Networks
- Embedded System Design

Elective-IV:

- Cloud Computing
- Fault Tolerant Digital System Design
- Reconfigurable Computing
- Soft Computing & Applications
- Adaptive Signal Processing

Elective-V (Open):

- Artificial Intelligence & Machine learning
- Operation Research
- Business Analytics
- Composite Materials
- Industrial Safety

Sr. No.	Course Code	Name of the Course	Hours/Week			Credit	Examination scheme				
							Theory		IA	PR/ OR	TOTAL
			L	P	T		TH	Test			
Third Semester											
01	MTACTC301	Research Methodology & Intellectual Property Rights (Self Study)#	--	--	--	02	--	--	50	50	**100**
02	MTACTP302	Project-I	--	--	--	10	--	--	50	50	**100**
		Total for Semester III	**--**	**--**	**--**	**12**	**--**	**--**	**100**	**100**	**200**
Fourth Semester											
01	MTACTP401	Project-II	--	--	--	20	--	--	100	100	**200**
		Total for Semester IV	**--**	**--**	**--**	**20**	**--**	**--**	**100**	**100**	**200**
GRAND TOTAL											**1700**

SEMESTER-I

MTACTC101: DIGITAL COMMUNICATION TECHNIQUES

Weekly Teaching Hours: 4	TH: 03			Tut: 01
Scheme of Marking	TH: 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

1	To get introduced to the concept and basics of information theory and the basics of source and channel coding/decoding.
2	Explore the concept of various advanced modulation techniques used in communication.

Course Outcomes:

At the end of course, students should:

CO1	Understand and analyze the generation, detection signal space diagram, spectrum, bandwidth efficiency, and probability of error analysis of different advanced modulation techniques.
CO2	Understand the basics of information theory, source coding techniques and calculate Entropy of source.
CO3	Evaluate the performance of different error control coding schemes for the reliable transmission of digital representation of signals and information over the channel.
CO4	Understand the generation and detection of Digital base band system.
CO5	Evaluate and determine the methods to mitigate inter symbol interference
CO6	Able to use the concept of spread spectrum for communication system design.

UNIT-I:

Characterization of Communication Signal and Optimum Receiver for AWGN Channel:- Signal Space representation, Memory less Modulation methods, Linear Modulation with memory, Non-linear Modulation methods with memory, CPFSK & CPM, Power Spectra of Linear Modulated signal, Power Spectra of CPFSK & CPM Signals, Correlation Demodulator, Match Filter Demodulator, Optimum Detector, Probability of Error for Binary & Marray signals. **(8hrs)**

UNIT-II:

Source Coding:- Average mutual information & Entropy, Coding of discrete memory-less sources, Discrete Stationary Sources, Lempel-Ziv algorithm; Coding of analog sources, Rate distortion function, Scalar Quantization & Vector Quantization. **(7hrs)**

UNIT-III:

Channel Coding:- Temporal and Spectral Waveform Coding, BCH codes, Reed Soloman codes, Reed Muller Codes, Convolution Codes, Transfer function of convolution codes, Viterbi decoding algorithm, stack algorithm(No problems expected)., trellis coded modulation. **(7hrs)**

UNIT-IV:

Signal Design for Band Limited Channel:-Design of band limited signal for zero ISI, Nyquist Criterion, Design of band limited signal for controlled ISI, partial response signaling, Data detection for controlled ISI. **(6hrs)**

UNIT-V:

Linear Equalization Techniques : Peak Distortion Criterion, Mean Square Error (MSE) criterion, Decision Feedback Equalization, Coefficient Optimization, Adaptive Linear Equalizer, Zero Forcing Algorithm, LMS Algorithm. **(6hrs)**

Unit VI:

Spread Spectrum Techniques:-Generation of PN sequence, direct sequence spread spectrum system, processing gain, jamming margin, application of direct sequence spread spectrum signal,

frequency hopped spread spectrum signal, synchronization of spread spectrum signal – acquisition & tracking. **(6hrs)**

TEXT BOOKS:

1. "Digital Communication Fundamentals and Applications", Bernard Sklar, 2nd Ed, Pearson Education Asia
2. "Digital Communication", J.G. Proakis, Fourth Ed, Mc Graw Hill
3. " Error Control Coding – Fundamentals & Applications," Shu Lin & Costell , Addison Wessley Pub.

REFERENCES:

1. "Digital Communication Techniques", Simon Haykin, John Wiley & Sons.
2. "Advanced Digital Communication System and Signal Processing Techniques", Dr.Kemilo Feher Prentice Hall International.

MTACTC102: 5G Technology-1

Weekly Teaching Hours: 4	TH: 03			Tut: 01
Scheme of Marking	TH: 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

1	Understand the Fundamentals of 5G Technology and Comprehend 5G Architecture and Network Components
2	Explore 5G Radio Access Technologies and Learn about 5G Core Network and Virtualization

Course Outcomes:

At the end of course, students should:

CO1	Define the fundamental principles and concepts of 5G communication technology.
CO2	Describe the architecture and network elements of 5G networks, including their functionalities and interactions
CO3	Apply the knowledge of 5G radio access technologies to design and optimize 5G network configurations.
CO4	Evaluate the security challenges faced by 5G networks and propose solutions to enhance network security.
CO5	Develop a comprehensive plan for the deployment and management of a 5G network in a given scenario.
CO6	Review the effectiveness of 5G communication technologies in addressing specific use cases and applications.

UNIT-I:

Introduction: Basics of wireless communication systems, Frequency bands and spectrum allocation, Modulation techniques used in 5G,Overview of telecommunications and the evolution to 5G,Key features and benefits of 5G technology, Comparison with previous generations (2G, 3G, 4G) **(7hrs)**

UNIT-II:

OFDM and OFDMA – MIMO OFDM – Generalized Frequency Division Multiplexing (GFDM) – Non-Orthogonal Multiple Access (NOMA) - Universal Filtered OFDM –Filter bank multicarrier (FBMC). **(7hrs)**

UNIT-III:

Sparse Code Multiple Access (SCMA) –Comparison of multiple access methods, 5G NR requirements - 5G Core Network Architecture - Radio-Access Network (RAN)- Radio Protocol Architecture -User Plane Protocols. **(7hrs)**

UNIT-IV:

Radio Link Control - Medium-Access Control – Physical Layer functions -Control Plane Protocols - Network Slicing- RAN virtualization-Spectrum Management in 5G Channel Hierarchy in 5G NR – Logical Channels and Transport. **(6hrs)**

UNIT-V:

Channels in 5G NR -Physical Layer Data Channels in 5G NR - Downlink Physical Channel and Uplink Physical Channels - Propagation Channel models for 5G. **(6hrs)**

Unit VI:

Device-to-Device (D2D) Communication - 5G for Massive Machine Type Communication and Massive IoT- V2X Communication - Full Duplex and Green Communication -mmWave Communications -Massive MIMO and Beamforming Techniques. **(7hrs)**

REFERENCES:

1. R. Vannithamby and S. Talwar, "Towards 5G: Applications, Requirements and Candidate Technologi & Sons, 1st Edition, 2017.
2. Robert W. Heath Jr., Angel Lozano, "Foundations of MIMO Communication" Cambridge Universit Press, 1st Edition, 2019.
3. Long Zhao, Hui Zhao, Kan Zheng, Wei Xiang, "Massive MIMO in 5G Networks: Selecte Applications", Springer, 1st Edition, 2018.
4. Jonathan Rodriguez, "Fundamentals 5G Mobile Networks", John Wiley & Sons, 1st Edition, 2015.
5. Sassan Ahmadi : "Introduction to 5G: The New Radio".
6. Erik Dahlman, Stefan Parkvall, Johan Skold "5G NR: The Next Generation Wireless Acces Technology", Academic Press, 1st Edition, 2018.
7. Saad Z. Asif, "5G Mobile Communications Concepts and Technologies, CRC Press, 1st Edition, 2019.

MTACTC103: Advanced Optical Communication

Weekly Teaching Hours	TH: 03			Tut: 01
Scheme of Marking	TH: 60	Tests: 20	IA: 20	Total: 100

Course Objectives:

1	A basis in the essentials of optical fiber, amplifier, transmitters and receivers
2	Knowledge of different multiplexing technologies in the fiber optic communication.
3	To design optical communication systems to serve a defined purpose

Course Outcomes:

At the end of course, students should:

CO1	Understand and analyze various propagation modes in optical fiber, attenuation, Signal Degradation and Pulse Broadening in optical fiber.
CO2	Understand the operating principle of LED and Laser diodes.
CO3	Understand the working principle of optical receivers and noise performance in photo detector.
CO4	Understand the working of optical amplifiers.
CO5	To explore the multiplexing techniques like WDM, concept of solitons and SONET/SDH network.
CO6	Measure and evaluate the various parameters of optical fibre communication system.

UNIT-I: Introduction to Optical Fibers

Introduction to guided optical communication. Optical Fibers, types of fibers & optical Cables, Study of losses during transmission viz. Attenuation by Absorption &Scattering, Dispersion. Consideration of losses in designing of High Speed / High bandwidth optical communication systems, Selection of fiber for such systems. **(7hrs)**

UNIT-II: Optical Sources:

Direct and indirect Band gap Materials, Quantum efficiency and LED power, Types of LEDs used in optical communication, their construction & operating principle, Types of Lasers. Principle of working of Lasers, solid state & injection Lasers. **(7hrs)**

UNIT-III: Optical Detectors

Introduction & study of type of detectors characteristics. Spectral spread and availability of detectors for 980 nm, 1.3µm & 1.55µm systems. Calculation of detector sensitivity and design considerations of suitable receivers for LAN, WAN applications. **(7hrs)**

UNIT-IV: Optical Amplifiers

Gain spectrum, amplifier noise, amplifier specifications, semiconductor optical amplifiers, amplifier design characteristics, Raman amplifiers, EDFA, Soliton Systems & design of system required in LAN & WAN type of applications. Calculations of Power budgets and feasibility of system design for above optical sources. **(7hrs)**

UNIT-V: Multiplexing Components & Optical Networks:

Concepts of WDM, DWDM system design parameters, Optical multiplex / De-multiplex design considerations, Basic Networks, SONET / SDH, Broadcast and select WDM Networks, Wavelength Routed Networks, Non-linear effects on Network performance. **(6hrs)**

UNIT-VI: Optical Fiber Measurements

Optical fiber measurements: Fiber attenuation measurements, Fiber dispersion measurements, Fiber refractive index profile measurements, fiber cutoff wavelength measurements, numerical aperture measurements, Fiber diameter measurement. **(6hrs)**

TEXT BOOKS:

1. G.P.Agrawal, “Fiber Optic Communication Systems (4/e)”, Wiley, 2010
2. B.P.Pal , “Guided Wave Optical Components and Devices”, Elsevier , 2006

REFERENCES:

1. Gerd Keiser, “Optical Fiber Communication” McGraw-Hill International,4th Edition. 2010.
2. John M. Senior, “Optical Fiber Communication”, Second Edition, Pearson Education, 2007.
3. Ramaswami, Sivarajan and Sasaki “Optical Networks”, Morgan Kaufmann, 2009.
4. J.Senior, Optical Communication, Principles and Practice, Prentice Hall of India, 3rd Edition, 2008.
5. J.Gower, “Optical Communication System”, Prentice Hall of India, 2001

MTACTL106: Communication Skills

Weekly Teaching Hours	TH: 02	Credit: 02		Tut: -
Scheme of Marking	TH: 60	IA: 25	PR/OR: 25	Total: 50

Course Objectives:

A To become more effective confident speakers and deliver persuasive presentations
B To develop greater awareness and sensitivity to some important considerations in interpersonal communication and learn techniques to ensure smoother interpersonal relations

Course Outcomes:

CO1: Learner will be able to understand the fundamental principles of effective business communication
CO2: Learner will be able to apply the critical and creative thinking abilities necessary for effective communication in today's business world
CO3: Learner will be able to organize and express ideas in writing and speaking to produce messages suitably tailored for the topic, objective, audience, communication medium and context
CO4: Learner will be able to demonstrate clarity, precision, conciseness and coherence in your use of language
CO5: Learner will be able to become more effective confident speakers and deliver persuasive presentations

Course Contents:

UNIT I
Introduction to communication, Necessity of communication skills, Features of good communication, Speaking skills, Feedback & questioning technique, Objectivity in argument **(6hrs)**

UNIT II
Verbal and Non-verbal Communication, Use and importance of non-verbal communication while using a language, Study of different pictorial expressions of non-verbal communication and their analysis **(6hrs)**

UNIT III
Academic writing, Different types of academic writing, Writing Assignments and Research Papers, Writing dissertations and project reports **(7hrs)**

UNIT IV
Presentation Skills: Designing an effective Presentation, Contents, appearance, themes in a presentation, Tone and Language in a presentation, Role and Importance of different tools for effective presentation **(7hrs)**

UNIT V
Motivation/ Inspiration: Ability to shape and direct working methods according to self-defined criteria Ability to think for oneself, Apply oneself to a task independently with self-motivation, Motivation techniques: Motivation techniques based on needs and field situations **(7hrs)**

UNIT VI

Self Management, Self Evaluation, Self discipline, Self criticism, Recognition of one's own limits and deficiencies, dependency, etc. Self Awareness, Identifying one's strengths and weaknesses, Planning & Goal setting, Managing self-emotions, ego, pride, Leadership & Team Dynamics **(7hrs)**

Textbooks / References:

1. Mitra, Barun, "Personality Development and Soft Skills", Oxford University Press, 2016

2. Ramesh, Gopalswamy, "The Ace of Soft Skills: Attitude, Communication and Etiquette for Success," Pearson Education, 2013

3. Covey, Stephen R., "Seven Habits of Highly Effective People: Powerful Lessons in Personal Change".

4. Rosenberg Marshall B., "Nonviolent Communication: A Language of Life".

MTACTL107: PG LAB-1

Weekly Practical Hours:03	Credit: 02			Tut: -
Scheme of Marking	TH: -	PR/OR: 25	IA: 25	Total: 50

Practical's of the Lab - I shall be based on the courses of first semester. The lab work shall consists of hands on experiments on the different software and hardware platforms related to the syllabus.

SEMESTER-II

MTACTC201: 5G Technology-2

Weekly Teaching Hours: 4	TH: 03			Tut: 01
Scheme of Marking	TH: 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

1	Study 5G Network Security and Privacy and Investigate 5G Use Cases and Applications
2	Understand 5G Network Deployment and Management and Familiarize with 5G Standards and Organizations
3	Analyze 5G Performance and Future Developments and Hands-On Experience and Practical Applications

Course Outcomes:

At the end of course, students should:

CO1	Understand the architecture of SDR.
CO2	Understand & analyze the multi-antenna system used in 5G.
CO3	Understand the high level requirements and architectures used in 5G.
CO4	Analyze and apply the various wireless communication standards.

CO5	Understand the concept of Interleave division multiple access and OFDM, SCMA.
CO6	Understand the concept of interface management, mobility management in 5G.

UNIT-I:

Modeling requirements and scenarios, Channel model requirements, Propagation scenarios, Relaying multi-hop and cooperative communications: Principles of relaying, fundamentals of relaying, Cognitive radio: Architecture, spectrum sensing, Software Defined Radio (SDR). **(6hrs)**

UNIT-II:

Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems, MIMO vs. multi-antenna systems. Diversity, Exploiting multipath diversity, Transmit diversity, Space-time codes, The Alamouti scheme, Delay diversity, Cyclic delay diversity, Space-frequency codes, Receive diversity, The rake receiver, Combining techniques, Spatial Multiplexing. **(6hrs)**

UNIT-III:

Introduction, NFV and SDN, Basics about RAN architecture, High-level requirements for the 5G architecture, Functional architecture and 5G flexibility, Functional split criteria, Functional split alternatives, Functional optimization for specific applications, Integration of LTE and new air interface to fulfill 5G Requirements, Enhanced Multi-RAT coordination features, Physical architecture and 5G deployment. **(7hrs)**

UNIT-IV:

D2D: from 4G to 5G, D2D standardization: 4G LTE D2D, D2D in 5G: research challenges, Radio resource management for mobile broadband D2D, RRM techniques for mobile broadband D2D, RRM and system design for D2D, 5G D2D RRM concept: an example, Multi-hop D2D communications for proximity and emergency, services, National security and public safety requirements in 3GPP and METIS, Device discovery without and with network assistance. **(8hrs)**

UNIT-V:

Access design principles for multi-user communications, Orthogonal multiple-access systems, Spread spectrum multiple access systems, Capacity limits of multiple-access methods, Sparse code multiple access (SCMA), Interleave division multiple access (IDMA), Radio access for dense deployments, OFDM numerology for small-cell deployments **(6hrs)**

Unit VI:

Network deployment types, Ultra-dense network or densification, Moving networks, Heterogeneous networks, Interference management in 5G, Interference management in UDN, Interference management for moving relay nodes, Interference cancelation, mobility management in 5G, User equipment controlled versus network-controlled handover, Mobility management in heterogeneous 5G networks. **(7hrs)**

REFERENCES:

1. Afif Osseiran, Jose F. Monserrat, Patrick Marsch, 5G Mobile and Wireless Communications Technology, Second Edition,2011.

2. Erik Dahlman, Stefan Parkvall, Johan Sko¨ld, 5G NR: The Next Generation Wireless Access Technology, Elsevier, First Edition, 2016.

3. Jonathan Rodriguez,Fundamentals of 5G Mobile Networks, Wiley, First Edition, 2010.

MTACTC202: 5G-Mobile Communication

Weekly Teaching Hours: 4	TH: 03			Tut: 01
Scheme of Marking	TH: 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

1	Understand the Evolution of Mobile Communication & Comprehend 5G Technology and Architecture
2	Explore 5G Radio Access Technologies & Examine Spectrum Considerations for 5G
3	Understand 5G Core Network and Services & Address 5G Security and Privacy Concerns
4	Explore the Integration of IoT with 5G & Discuss Advanced Technologies and Future Trends
5	Learn about Deployment and Implementation & Explore Ethical and Social Implications

Course Outcomes:

At the end of course, students should:

CO1	Demonstrate a Comprehensive Understanding & Analyze 5G Radio Access Technologies
CO2	Evaluate Spectrum Considerations & Design and Optimize 5G Networks
CO3	Address Security and Privacy Concerns & Explore IoT Integration with 5G
CO4	Discuss Advanced Technologies & Plan 5G Deployment Strategies
CO5	Consider Ethical and Social Implications & Apply 5G Concepts in Real-World Scenarios
CO6	Understand the concept of interface management, dynamic network management in 5G.

UNIT-I:

5G RADIO SPECTRUM: 5G spectrum landscape and requirements, Spectrum access modes and sharing scenarios, 5G spectrum technologies. 5G Channel Model: The 5G wireless Propagation Channels: Channel modeling requirements, propagation scenarios and challenges in the 5G modeling. **(7hrs)**

UNIT-II:

Radio Interface Architecture: 5G architecture options, core network architecture, RAN architecture. 5G Physical Layer: Physical channels and signals, 5G frame structure. **(8hrs)**

UNIT-III:

5G Radio-Access Technologies: Access design principles for multi-user communications, multi-carrier with filtering: a new waveform. **(7hrs)**

UNIT-IV:

Introduction To 5G Network Slicing: Network Slicing, E2E Slicing, SDN and NFV Slicing Vehicular Communications: From V2V to AV2X, key standards, VC architectures. **(6hrs)**

UNIT-V:

Mobility And Handoff Management In 5G: Network deployment types. **(6hrs)**

Unit VI:

Interference management in 5G, Mobility management in 5G, Dynamic network reconfiguration in 5G. **(6hrs)**

REFERENCES:

1. Afif Osseiran, Jose F Monserrat, Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016
2. Saad Z. Asif, "5G Mobile Communications Concepts and Technologies", CRC Press, Taylor & Francis Group, First Edition, 2018

3. Harri Holma, Antti Toskala, Takehiro Nakamura, "5G Technology 3GPP NEW RADIO", John Wiley Sons First Edition,2020

MTACTS206: SEMINAR I

Weekly Practical Hours:04	Credit: 02			Tut: -
Scheme of Marking	TH: -	PR/OR: 50	IA: 50	Total: 100

The seminar shall be on the state of the art in the area of the Advanced Communication Technology and of student's choice approved by an authority. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work duly signed by the concerned guide and head of the Department/Institute.

MTACTP207: MINI PROJECT

Weekly Practical Hours:04	Credit: 02			Tut: -
Scheme of Marking	TH: -	PR/OR: 50	IA: 50	Total: 100

Content
The mini project shall be based on the recent trends in the industry, research and open problems from the industry and society. This may include mathematical analysis, modeling, simulation, and hardware implementation of the problem identified. The mini project shall be of the student's choice and approved by the guide. The student has to submit the report of the work carried out in the prescribed format signed by the guide and head of the department/institute.

Elective-I

MTACTE114 –A: Smart Antennas for 5G communication

Weekly Teaching Hours: 3 TH: 03 Tut: -

Scheme of Marking TH: 60 Tests : 20 IA: 20 Total : 100

Course Objectives:	
	This course enables the students to:
1	Understand the Principles of Smart Antennas & Explain 5G Communication Systems
2	Analyze Different Types of Smart Antennas & Apply Beamforming Techniques
3	Evaluate MIMO Technology & Analyze Massive MIMO Systems
4	Implement Hybrid Beamforming & Explore Smart Antenna Applications in 5G,
5	Engage in Research and Industry Trends & Develop Practical Skills, Critically Evaluate Smart Antenna Solutions, Communicate Effectively
Course Outcomes:	
	By the end of this course, students will be able to:
CO1	Demonstrate a comprehensive understanding of the principles, technologies, and applications of smart antennas in the context of 5G communication systems.
CO2	Differentiate between various types of smart antennas, and understand their advantages and limitations.
CO3	Evaluate the benefits and limitations of Multiple-Input, Multiple-Output (MIMO) technology, assess its impact on 5G communication systems.
CO4	Design and implement hybrid beamforming architectures to achieve efficient and cost-effective smart antenna systems for 5G communication.
CO5	Demonstrate an awareness of the latest research trends, industry implementations, and emerging technologies related to smart antennas in 5G.
CO6	Assess the impact of smart antennas on 5G network performance metrics, such as signal-to-interference-plus-noise ratio (SINR), throughput, and coverage.
Syllabus Contents	
Unit 1	Introduction to Smart Antennas, Architecture of a Smart Antenna System: Transmitter and Receiver, Types of Smart Antennas, Benefits and Drawbacks of Smart Antennas, Applications of Smart Antennas. **(7hrs)**
Unit 2	Fixed Sidelobe Canceling, Retrodirective Arrays, Beamforming, Adaptive Arrays, Butler Matrix, Spatial Filtering with Beamformers, Switched Beam Systems, Multiple Fixed Beam System. Uplink Processing. **(7hrs)**
Unit 3	Diversity Techniques, Angle Diversity, Maximum Ratio Combining, Adaptive Beamforming, Fixed Multiple Beams versus Adaptive Beamforming, Downlink Processing. **(7hrs)**
Unit 4	Fundamentals of Matrix Algebra, Array Correlation Matrix, AOA Estimation Methods: Bartlett AOA Estimate, Capon AOA Estimate, Linear Prediction AOA Estimate, Maximum Entropy AOA Estimate, Pisarenko Harmonic Decomposition AOA Estimate, Min-Norm AOA Estimate, MUSIC AOA Estimate, ESPRIT AOA Estimate. **(7hrs)**
Unit 5	Introduction, Multiple-Antenna MS Design, RAKE Receiver Size, Mutual Coupling Effects, Dual-Antenna Performance Improvements, Downlink Capacity Gains. **(6hrs)**
Unit 6	Principles of MIMO systems: SISO, SIMO, MISO,MIMO, Hybrid antenna array for mmWave massive MIMO: Massive Hybrid Array Architectures, Hardware Design for Analog Subarray. Current research and industry trends in smart antennas for 5G. **(6hrs)**

Text Books	
1	Smart Antennas for Wireless Communications: With MATLAB by Frank Gross, Publisher: McGraw-Hill Education ISBN-13: 978-0070242843, ISBN-10: 0070242849
2	Smart Antennas for Wireless Communications: IS-95 and Third Generation CDMA Applications by Thomas T. K. Tan, Publisher: Prentice Hall, ISBN-13: 978-0130862252, ISBN-10: 0130862252
3	Smart Antennas for Next Generation Wireless Systems, by Y. Jay Guo and Iain Colling Artech House, ISBN-13: 978-1630818124; ISBN-10: 1630818126

MTACTE114 –B: RF Engineering

Weekly Teaching Hours: 3 TH: 03 Tut: -

Scheme of Marking TH: 60 Tests : 20 IA: 20 Total : 100

Course Objectives:	
1	The objective of this course is to provide students with a comprehensive understanding of Radio Frequency (RF) engineering principles, techniques, and applications.
2	Students will learn about RF system design, transmission lines, antennas, microwave circuits, and the practical aspects of RF engineering to design, analyze, and optimize wireless communication systems.
Course Outcomes: By the end of this course, students will be able to:	
CO1	Understand the fundamental concepts of RF engineering and its importance in wireless communication systems.
CO2	Apply the concept of two-port network for analysis of RF networks.
CO3	Design and analyze RF systems, including RF amplifiers, oscillators, and frequency synthesizers.
CO4	Analyze and optimize the performance of transmission lines and RF networks.
CO5	Design and analyze RF antennas for various wireless applications.
CO6	Demonstrate proficiency in using RF simulation software tools.
Syllabus Contents	
Unit 1	Introduction to RF Engineering - Overview of RF engineering and its applications in wireless communication. - Frequency bands and spectrum allocation for various wireless systems. - RF system parameters and performance metrics. Transmission Lines and Waveguides - Characterization of transmission lines: impedance, reflection coefficient, and standing waves. - Smith Chart and its applications in impedance matching. - Types of waveguides and their properties. **(6hrs)**
Unit 2	RF System Design - Design considerations for RF amplifiers, oscillators, and frequency synthesizers. - Noise figure and noise temperature in RF systems. - Phase-locked loops (PLL) and frequency synthesis techniques. RF Network Analysis - S-parameters and their application in RF network analysis. - Matching networks and impedance transformation.

	- Scattering matrices and cascade analysis. **(7hrs)**
Unit 3	Microwave Circuits and Components - Microwave passive components: couplers, splitters, and filters. - Active microwave devices: PIN diodes, GaAsFETs, and HEMTs. - Microwave integrated circuits (MIC) and monolithic microwave integrated circuits (MMIC). RF Antennas - Fundamental principles of antenna theory. - Different types of RF antennas: wire antennas, patch antennas, and array antennas. - Antenna radiation patterns and impedance matching. **(7hrs)**
Unit 4	RF Simulation Tools - Introduction to RF simulation software (e.g., ADS, CST, HFSS). - Simulating and optimizing RF circuits and antennas using software tools. - Practical lab sessions using simulation tools. **(6hrs)**
Unit 5	RF Interference and Noise - Sources of RF interference and its impact on communication systems. - Noise in RF systems: thermal noise, shot noise, and flicker noise. - Noise figure and noise factor calculations. **(7hrs)**
Unit 6	RADAR: Introduction, Classifications, Radar range equation, Modulators, Displays, Scanning andtracking, Doppler effect, Blind speeds, FMCW radars, radar antennas. **(7hrs)**
Text Books	
	1. "Microwave Engineering" by David M. Pozar, Wiley (or latest edition).
	2."RF Microelectronics" by Behzad Razavi, Prentice Hall (or latest edition). 3. Microwave Devices and Circuits by Samuel Y. Liao, Pearson Education.
Reference Books	
	1. "RF Circuit Design" by Richard C. Li, Wiley (or latest edition).
	2. "Antenna Theory: Analysis and Design" by Constantine A. Balanis, Wiley (or latest edition). 3. D. M. Pozar, Microwave Engineering, 3nd Edition, John Wiley & Sons. 4. R. Sorrentino and G. Bianchi, Microwave and RF Engineering, John Wiley & Sons. Department of ECE Scheme and Syllabi w.e.f. 2021-22 5. Reinhold Ludwig and Gene Bogdanvov, ―RF Circuit Design – Theory and Application, 2nd Edition, Pearson, 2012. 6. E.da Silva, ―High Frequency and Microwave Engineering, Butterworth Heinmann publications, Oxford, 2001. 5. T. C. Edwards, Foundations of Interconnects and Microstrip lines, John Wiley & Sons.

MTACTE114 –C: Advanced Wireless Communication

Weekly Teaching Hours: 3 TH: 03 Tut: -

Scheme of Marking TH: 60 Tests : 20 IA: 20 Total : 100

Course Objectives:	
1	The objective of this course is to provide students with an in-depth understanding of advanced concepts and technologies in wireless communication systems.
2	Students will explore cutting-edge topics, including 5G and beyond, massive MIMO, millimeter-wave communication, Internet of Things (IoT), and advanced signal processing techniques for wireless applications.

Course Outcomes: By the end of this course, students will be able to:	
CO1	Analyze and compare various wireless communication technologies and standards.
CO2	Understand the principles and challenges of advanced wireless systems, such as 5G and beyond.
CO3	Design and optimize advanced wireless communication networks, including massive MIMO and millimeter-wave systems.
CO4	Analyze and mitigate interference and fading in wireless communication channels.
CO5	Apply advanced signal processing techniques for improved wireless communication performance.
CO6	Evaluate the performance of wireless communication systems using mathematical models and simulations.
Syllabus Contents	
Unit 1	Introduction to Advanced Wireless Communication - Overview of wireless communication evolution and the need for advanced technologies. - Challenges and design considerations for advanced wireless systems. 5G and Beyond - 5G wireless communication: features, requirements, and architecture. - Key technologies and components of 5G networks (e.g., Massive MIMO, mmWave, and beamforming). - Emerging technologies and research directions for beyond 5G communication. **(7hrs)**
Unit 2	Massive MIMO Systems - Principles of Massive MIMO and its advantages in capacity and energy efficiency. - Channel modeling for Massive MIMO systems. - Design and performance analysis of Massive MIMO networks. **(7hrs)**
Unit 3	Millimeter-Wave Communication - Millimeter-wave frequency bands for wireless communication. - Challenges and solutions in millimeter-wave propagation. - Millimeter-wave communication system design and applications. Internet of Things (IoT) Communication - Overview of IoT communication protocols and technologies (e.g., NB-IoT, LoRa, Sigfox). - IoT network architecture and design considerations. - Integration of IoT devices into existing wireless networks. **(7hrs)**
Unit 4	Advanced Signal Processing for Wireless Communication - Multi-carrier modulation techniques (e.g., OFDM, OFDMA). - Advanced error correction codes and coding schemes. - Interference management and advanced signal processing algorithms. **(7hrs)**
Unit 5	Wireless Channel Modeling and Performance Evaluation - Channel models for different wireless environments (e.g., indoor, outdoor, urban). - Link budget analysis and performance evaluation metrics. - Monte Carlo simulations for wireless system analysis. **(6hrs)**
Unit 6	Emerging Wireless Communication Technologies - Overview of emerging technologies, such as mmWave communication, terahertz communication, and visible light communication. - Research trends and challenges in emerging wireless communication. **(6hrs)**
Text Books	
	1. "Wireless Communications: Principles and Practice" by Theodore S. Rappaport, Prentice Hall (or latest edition).

	2. "MIMO Wireless Communications" by Ezio Biglieri, Robert Calderbank, Anthony Constantinides, Andrea Goldsmith, and Arogyaswami J. Paulraj, Cambridge University Press (or latest edition).
Reference Books	
	1. "Fundamentals of 5G Mobile Networks" by Jonathan Rodriguez, Wiley (or latest edition).
	2. "Millimeter Wave Wireless Communications" by Theodore S. Rappaport, Robert W. Heath Jr., Robert C. Daniels, and James N. Murdock, Prentice Hall (or latest edition).

MTACTE114 –D: Software Defined Radio

Weekly Teaching Hours: 3 TH: 03 Tut: -

Scheme of Marking TH: 60 Tests : 20 IA: 20 Total : 100

Course Objectives:	
1	The objective of this course is to provide students with a comprehensive understanding of Software Defined Radio (SDR) technology, including its principles, architectures, design, and practical applications.
2	Students will learn about the software-defined radio concept, its advantages over traditional radio systems, and how to design, implement, and analyze SDR systems for various wireless communication applications.
Course Outcomes: By the end of this course, students will be able to:	
CO1	Understand the concept and principles of Software Defined Radio (SDR) and its applications in modern wireless communication systems.
CO2	Analyze the advantages and challenges of SDR compared to traditional radio systems.
CO3	Design and implement various components of an SDR system, including radio frequency (RF) front-end, baseband processing, and digital signal processing (DSP) algorithms.
CO4	Develop SDR applications using popular SDR platforms and frameworks.
CO5	Analyze and evaluate the performance of SDR systems in different wireless communication scenarios.
CO6	Explore advanced topics and emerging trends in SDR, such as cognitive radio and dynamic spectrum access.
Syllabus Contents	
Unit 1	Introduction to Software Defined Radio - Evolution of radio systems: from analog to software-defined. - SDR architecture and components: RF front-end, baseband processing, and DSP. - SDR platforms and frameworks. SDR Hardware and Software - SDR hardware platforms: FPGAs, DSPs. - Software for SDR: GNU Radio, MATLAB tools. **(7hrs)**
Unit 2	SDR Transceiver Design - Design considerations for SDR transceivers. - SDR modulation and demodulation techniques. - Implementing SDR transceivers using hardware and software. **(7hrs)**
Unit 3	SDR Signal Processing - Digital signal processing (DSP) algorithms in SDR. - Filters, equalizers, and synchronization techniques in SDR.

	- Implementing DSP algorithms on SDR platforms. **(7hrs)**
Unit 4	SDR Applications - SDR applications in wireless communication, radar, and satellite communication. - SDR for cognitive radio and dynamic spectrum access. - SDR applications in IoT, robotics, and wireless sensor networks. **(7hrs)**
Unit 5	SDR Security and Spectrum Management - Security challenges in SDR and countermeasures. - Spectrum management and dynamic spectrum access in SDR. - Regulation and standardization of SDR systems. **(6hrs)**
Unit 6	Advanced Topics in SDR - Advanced SDR techniques: MIMO, beamforming, and interference cancellation. - SDR for 5G and beyond communication systems. - Emerging trends and research directions in SDR. **(6hrs)**
Text Books	
	1. "Software Defined Radio: Architectures, Systems and Functions" by Lucian L. J. Ciobanu and Josep M. Guerrero, Springer (or latest edition).
	2. "Software-Defined Radio for Engineers" by Travis F. Collins, Robin Getz, Di Pu, and Alexander M. Wyglinski, Artech House (or latest edition).
Reference Books	
	1. "Software Defined Radio using MATLAB & Simulink and the RTL-SDR" by Robert W. Stewart, Kartik Seshadri, and Dale S. Zimmerman, Morgan & Claypool Publishers (or latest edition).
	2. "Wireless Communications: Principles and Practice" by Theodore S. Rappaport, Prentice Hall (or latest edition).

MTACTE114 –E: Advanced Computer Networks

Weekly Teaching Hours: 3 TH: 03 Tut: -

Scheme of Marking TH: 60 Tests : 20 IA: 20 Total : 100

Course Objectives:	
1	The objective of this course is to provide students with an in-depth understanding of advanced concepts and technologies in computer networks.
2	Students will explore topics such as network protocol, network management, network architecture, network security, advanced routing and emerging networking paradigms.
3	The course aims to equip students with the knowledge and skills required to design, and analyze, complex computer networks for modern applications.
Course Outcomes: By the end of this course, students will be able to:	
CO1	Understand the concept of ISO-OSI model and ARQ in computer networking.
CO2	Explore the TCP/IP model.
CO3	Apply the knowledge of network management and algorithms to applications.
CO4	Analyze and the various multiple access techniques.
CO5	Compare different network architectures and protocols in a variety of scenarios.
CO6	Understand the principles and techniques of network security and apply them to protect networks from threats and attacks.
Syllabus Contents	
Unit 1	Review of computer networking: ISO-OSI reference model, Point to point Protocol, ARQ techniques, Data network switching techniques. **(7hrs)**

Unit 2	TCP/IP: TCP/IP architecture, TCP Segments, TCP flow control, IPv4 versus IPv6, UDP, Fragmentation, ARP & RARP , ICMP, IGMP, Mobile IP, Unicast and Multicast Routing protocols. **(7hrs)**
Unit 3	Network management: Delay models in data networks, Performance measures & architectural issues, Queuing Model (M/M/1 and M/G/1), Network management and congestion control algorithm. **(7hrs)**
Unit 4	Multiple access technique: Aloha and Slotted Aloha, CSMA/CD, CSMA/CA, CDMA, OFDM, Delay throughput characteristics. **(7hrs)**
Unit 5	Advance Network Architecture: Overlay model, MPLS, Integrated services, Differentiated services. ATM Networks: Need for ATM, ATM Layers, QoS in ATM. WAP architecture. **(6hrs)**
Unit 6	Network Security: Ciphers and its types, DES, public key cryptography, RSA algorithm, Digital Watermarking, Attacks and counter measure. Current research trends and challenges in computer networks. **(6hrs)**
Text Books	
	1. "Data Communication and Networking" by Behrouz A. Forouzan, 4th Ed., MGH. 2. "Computer Networking: A Top-Down Approach" by James F. Kurose and Keith W. Ross, Pearson (or latest edition).
	3."Computer Networks" by Andrew S. Tanenbaum and David J. Wetherall, Pearson (or latest edition) 4. Cryptography and Network Security: Principles and Practice", William Stallings, Pearson Education. .
Reference Books	
	1. "TCP/IP Illustrated, Volume 1: The Protocols" by W. Richard Stevens, Addison-Wesley Professional (or latest edition).
	2. "Software-Defined Networking (SDN) with OpenFlow" by Siamak Azodolmolky, Wiley (or latest edition). 4.Local Area Networks", Gerd E Kieser – Mc-Graw-Hill 5.Communication Networks", Leon Garcia & Wadeja, Tata McGraw Hill Publication.

Elective-II

MTACTE115 –A: Advanced Antenna Technology

Weekly Teaching Hours: 3 TH: 03 Tut: -

Scheme of Marking TH: 60 Tests : 20 IA: 20 Total : 100

Course Objectives:	
1	The objective of this course is to provide students with an advanced understanding of antenna technology beyond the basics.
2	The course aims to delve into advanced antenna design, analysis techniques, and emerging technologies.
3	Students will gain expertise in designing cutting-edge antennas for various applications and explore the latest advancements in the field.
Course Outcomes: By the end of this course, students will be able to:	
CO1	Understand advanced antenna design techniques and technologies.
CO2	Analyze and optimize the performance of complex antenna structures.
CO3	Design antennas for specific applications, including advanced wireless communication

	and radar systems.
CO4	Explore emerging trends in antenna technology, such as mmWave, meta-materials, and phased arrays.
CO5	Apply simulation and measurement tools to analyze and validate antenna designs.
CO6	Conduct independent research on advanced antenna topics and propose innovative solutions.
Syllabus Contents	
Unit 1	Advanced Antenna Fundamentals - Review of antenna fundamentals: radiation patterns, gain, impedance. - Antenna parameters: directivity, efficiency, bandwidth. - Numerical methods for antenna analysis: Method of Moments, Finite Element Method. Antenna Synthesis Techniques - Array synthesis methods: Taylor distributions. - Array pattern synthesis with constrained nulls and sidelobe levels. - Superdirective and adaptive arrays. **(7hrs)**
Unit 2	Wideband and Multiband Antennas - Techniques for achieving wideband and multiband characteristics. - Frequency-independent antennas: log-periodic, spiral antennas. - Techniques for reducing mutual coupling in multiband arrays. - Advanced Reflector and Lens Antennas: construction, working and applications. **(7hrs)**
Unit 3	Millimeter-Wave and THz Antennas - Challenges and opportunities in millimeter-wave and THz frequency ranges. - Design of millimeter-wave antennas for 5G and beyond. - Antennas for imaging and spectroscopy in THz applications. Phased Array Antennas - Phased array principles and beamforming techniques. **(7hrs)**
Unit 4	Metamaterial and Smart Antennas - Introduction to metamaterials and their role in antenna design. - Smart antennas and their applications in wireless communication. - Reconfigurable and tunable antennas using metamaterials. **(7hrs)**
Unit 5	Advanced Antenna Measurement Techniques - Near-field and far-field measurement techniques. - Anechoic chamber measurements and their challenges. - Compact range and holographic imaging techniques. **(6hrs)**
Unit 6	Research Trends in Advanced Antenna Technology - Emerging trends in antenna technology: mmWave, massive MIMO, IoT. - Antenna challenges and solutions for future wireless communication systems. **(6hrs)**
Text Books	
	1. "Antenna Theory and Design" by Warren L. Stutzman and Gary A. Thiele, John Wiley & Sons (or latest edition).
	2. "Array and Phased Array Antenna Basics" by Hubregt J. Visser, John Wiley & Sons (or latest edition).
Reference Books	
	1. "Advanced Antenna Systems for 5G Network Deployments" by Henrik Asplund, Xingqin Lin, and Katsuyuki Haneda, Wiley (or latest edition).
	2. "Millimeter Wave and Terahertz Antennas and Propagation" by George E. Ponchak and Yahya Rahmat-Samii, Morgan & Claypool Publishers (or latest edition).

MTACTE115 –B: Telecom Network Management

Weekly Teaching Hours: 3 TH: 03 Tut: -

Scheme of Marking TH: 60 Tests : 20 IA: 20 Total : 100

Course Objectives:	
1.	The objective of this course is to provide students with a comprehensive understanding of telecommunications network management concepts, methodologies, and technologies.
2.	The course aims to equip students with the knowledge and skills required to effectively design, operate, monitor, and troubleshoot modern telecommunications networks while ensuring optimal performance, security, and reliability.
Course Outcomes: By the end of this course, students will be able to:	
CO1	Understand the principles and importance of telecommunications network management.
CO2	Use network management strategies for different types of telecommunications networks.
CO3	Explore the concept of SNMP.
CO4	Understand the broadband network management.
CO5	Analyze network performance, diagnose faults, and identify corrective actions.
CO6	Implement security measures and policies to ensure the integrity and confidentiality of network data.
Syllabus Contents	
Unit 1	Overview of Network Management: Case histories on network, system and service management, challenges of IT managers, Network Management: Goals, organization and functions, Network management architecture and organization network management perspectives. **(7hrs)**
Unit 2	OSI Network Management: Network management standards, Network management models, Organization model, Information model, Communication model and functional model, Abstract syntax notation – encoding structure, macros functional model CMIP/CMISE. **(7hrs)**
Unit 3	Internet Management (SNMP): SNMP-organizational model, System overview, Information model, communication model, functional model. **(6hrs)**
Unit 4	Broadband Network Management: Broadband networks and services, ATM Technology – VP, VC, ATM Packet, Integrated service, ATM LAN emulation, Virtual LAN, ATM Network Management – ATM network reference model, integrated local management interface. ATM management information base. **(7hrs)**
Unit 5	Network Management Applications: Configuration management, Fault management, Performance management, Event correlation techniques, security management. **(7hrs)**
Unit 6	Telecommunication Management Networks(TMN): Need for TMN, Conceptual model, TMN standards, TMN management services architecture and TMN implementation. **(6hrs)**
Text Books	
	1. "Network Management: Principles and Practice" by Mani Subramanian, Addison-Wesley Professional (or latest edition).
	2. Lakshmi G. Raman, ―Fundamental of Telecommunications Network Management" Eastern Economy Edition, IEEE Press New Delhi. 3. "Telecommunications Network Management into the 21st Century" by Salah Aidarous and Mark Burgess, Wiley (or latest edition).
Reference Books	

	1. "Fault Management and Troubleshooting for Network Operators" by Ahmed M. Afifi and Salah Aidarous, Wiley (or latest edition).
	2. "SNMP, SNMPv2, SNMPv3, and RMON 1 and 2" by William Stallings, Addison-Wesley Professional (or latest edition).

MTACTE115 –C: VLSI System Design

Weekly Teaching Hours: 3 TH: 03 Tut: -

Scheme of Marking TH: 60 Tests : 20 IA: 20 Total : 100

Course Objectives:	
1.	The objective of this course is to provide students with a comprehensive understanding of Very Large Scale Integration (VLSI) system design techniques, methodologies, and tools.
2.	The course aims to equip students with the knowledge and skills required to design complex digital integrated circuits and systems, emphasizing efficient use of resources, performance optimization, and advanced design concepts.
Course Outcomes: By the end of this course, students will be able to:	
CO1	Understand the fundamentals of VLSI design.
CO2	Explore the MOS transistor theory.
CO3	Understand the CMOS processing technology.
CO4	Analyze and evaluate the performance of basic gates using simulation and synthesis tools.
CO5	Apply the knowledge for design of basic sequential circuits.
CO6	Understand the concept of analog IC design.
Syllabus Contents	
Unit 1	Introduction: Basic VLSI design cycle, design styles. Introduction to VHDL programming: Modelling styles, statements used in various modelling styles with examples of Gates, HA, FA MUX and Encoder/Decoder. **(7hrs)**
Unit 2	MOS Transistor Theory: Current voltage relationship, different regions of operation of MOSFET, channel length modulation, body bias effect, small signal model, device capacitances. **(7hrs)**
Unit 3	CMOS Processing Technology: Overview of integrated circuit processing, photolithography, self-aligned MOSFET, isolation and wells, CMOS process flow, mask design, layout, latch-up, defects and yield considerations, twin well and triple well processes, scaling aspects. **(7hrs)**
Unit 4	CMOS Circuit and Logic Design: Basic circuit and DC operation, CMOS inverter transfer characteristics, propagation delay, power dissipation, driving large capacitive loads, CMOS NAND, NOR gates, Exclusive-OR gate, efficient combinational logic circuits, transmission gates. **(6hrs)**
Unit 5	CMOS sequential logic circuits, dynamic logic circuit concepts, charge sharing, clock feed through, domino logics. **(6hrs)**
Unit 6	Analog IC design: Biasing techniques, single stage amplifier, CS amplifier with diode connected load, source degenerated CS amplifier, current mirror, sources and sinks, cascade amplifier, differential amplifier. Introduction to OP amp, band-gap reference circuits. Testing: Significance of DFT, Different types of errors, faults, BIST, reliability aspects. **(7hrs)**
Text Books	
	1. "CMOS VLSI Design: A Circuits and Systems Perspective" by Neil H. E. Weste and David Harris, Pearson (or latest edition).

	2. Pucknel and Eshraghian, Basic VLSI Design, PHI, 3rd Edition,1995 3. Wayne Wolf, Modern VLSI Design, Pearson Education Asia, 2002.
Reference Books	
	1. "ASIC Design in the Silicon Sandbox: A Complete Guide to Building Mixed-Signal Integrated Circuits" by Keith Barr, McGraw-Hill Education (or latest edition).
	2. "VHDL for Digital Design" by Frank Vahid, Wiley (or latest edition). 3. CMOS: circuit design, layout, and simulation by Jake Baker, Wiley, 4th Edition.

MTACTE115 –D: Fuzzy Systems and Neural Networks

Weekly Teaching Hours: 3 TH: 03 Tut: -

Scheme of Marking TH: 60 Tests : 20 IA: 20 Total : 100

Course Objectives:	
	This course enables the students to:
1	The objective of this course is to provide students with a comprehensive understanding of two important computational intelligence techniques: Fuzzy Systems and Neural Networks.
2	The course aims to equip students with the knowledge and skills required to design, implement, and apply fuzzy systems and neural networks to solve complex problems in various domains.
Course Outcomes:	By the end of this course, students will be able to:
CO1	Understand the principles and concepts of fuzzy logic and fuzzy systems.
CO2	Understand the fundamentals of neural networks and their various architectures.
CO3	Design and implement fuzzy logic systems for modeling uncertainty and imprecision.
CO4	Design and train artificial neural networks for various applications.
CO5	Apply fuzzy systems and neural networks to solve real-world problems.
CO6	Analyze and evaluate the performance of fuzzy systems and neural networks.
Syllabus Contents	
Unit 1	Introduction to Fuzzy Systems and Neural Networks - Fuzzy sets, fuzzy logic, and fuzzy inference systems. - Introduction to artificial neural networks and their biological inspiration. Fuzzy Logic and Fuzzy Systems - Fuzzy set theory: membership functions and linguistic variables. - Fuzzy operations and fuzzy relations. **(7hrs)**
Unit 2	Introduction to Neural Networks - Perceptron's and feed forward neural networks. - Activation functions and learning algorithms. - Back-propagation and error minimization in neural networks. - Radial basis function (RBF) networks. **(7hrs)**
Unit 3	Neural Network Architectures - Self-organizing maps (SOM) and competitive learning. - Recurrent neural networks (RNN). Neural Network Training and Optimization - Training algorithms: gradient descent, stochastic gradient descent. - Regularization and optimization techniques. **(7hrs)**
Unit 4	Fuzzy rule-based systems and fuzzy inference methods.

	-Fuzzy if-then rules, fuzzy inference system. Fuzzy Modeling and Control - Fuzzy modeling techniques: Mamdani and Sugeno models. **(6hrs)**
Unit 5	Genetic algorithm: -Introduction, encoding, fitness function, reproduction, crossover, mutation. Support vector machines (SVM) -Optimal hyperplane for linearly separable and non-separable patterns, - SVM as a Kernel machine. Principle Component Analysis (PCA). **(7hrs)**
Unit 6	Applications of Fuzzy Systems and Neural Networks - Fuzzy logic in control systems and decision-making. - Neural networks in pattern recognition and image processing. - Hybrid systems combining fuzzy logic and neural networks. **(7hrs)**
Text Books	
	1. "Fuzzy Logic with Engineering Applications" by Timothy J. Ross, Wiley (or latest edition).
	2. "Neural Networks and Deep Learning: A Textbook" by Charu C. Aggarwal, Springer (or latest edition). 3. "Neural Networks: A Comprehensive Foundation" by Simon Haykin, Pearson (or latest edition).
Reference Books	
	1. "Artificial Neural Networks" by Yegnanarayana, PHI publication.
	2. "Fuzzy Sets and Fuzzy Logic: Theory and Applications" by George J. Klir and Bo Yuan, Pearson (or latest edition).

MTACTE115 –E: Mobile Handset Design

Weekly Teaching Hours: 3 TH: 03 Tut: -

Scheme of Marking TH: 60 Tests : 20 IA: 20 Total : 100

Course Objectives:	
1	The objective of this course is to provide students with a comprehensive understanding of mobile handset design principles, technologies, and challenges.
2	The course aims to equip students with the knowledge and skills required to design, develop, and optimize mobile handsets, considering hardware, software, communication protocols, and user experience.
Course Outcomes:	By the end of this course, students will be able to:
CO1	Understand the architecture and components of mobile handsets.
CO2	Design and implement hardware and software components of mobile handsets.
CO3	Evaluate and optimize mobile handset performance, battery life, and user experience.
CO4	Gain knowledge of mobile communication protocols and technologies.
CO5	Apply their skills to design innovative and user-centric mobile handset solutions.
CO6	Analyze and solve real-world challenges in mobile handset design.
Syllabus Contents	
Unit 1	Introduction to Mobile Handset Design - Overview of mobile handset evolution and architecture. - Components and subsystems of a mobile handset.

	- Trends in mobile handset technology and user preferences. Mobile Handset Hardware Design - Mobile processor architectures and selection. - Memory subsystem design and optimization. - Display technologies, touchscreens, and user interfaces. **(7hrs)**
Unit 2	Mobile Handset Software Design - Operating systems for mobile devices: Android, iOS, etc. - Application development for mobile platforms. - Mobile app optimization and performance considerations. **(7hrs)**
Unit 3	Battery and Power Management - Battery technologies, capacity, and charging methods. - Power-efficient hardware and software design. - Battery life optimization techniques. Mobile Handset User Experience - Human-computer interaction (HCI) design principles. - User interface design, usability, and accessibility. - Mobile handset ergonomics and form factor considerations. **(7hrs)**
Unit 4	Mobile Handset Communication Protocols - Cellular communication standards: 4G, 5G, and beyond. - Wireless connectivity: Wi-Fi, Bluetooth, NFC. - Location-based services and global navigation satellite systems (GNSS). **(7hrs)**
Unit 5	Mobile Handset Security and Privacy - Security challenges in mobile devices and data protection. - Mobile device management and remote wipe solutions. - Biometric authentication and secure boot mechanisms. **(6hrs)**
Unit 6	Emerging Trends in Mobile Handset Design - Foldable and flexible display technologies. - Wearable and IoT integration with mobile handsets. - Augmented reality (AR) and virtual reality (VR) applications **(6hrs)**
Text Books	
	1. "Mobile Handset Design" by Sajal Kumar Das and Gerhard Fettweis, Springer (or latest edition).
	2. "Mobile Communications Engineering: Theory and Applications" by William C. Y. Lee, McGraw-Hill Education (or latest edition).
Reference Books	
	1. "Mobile Phone Programming: And its Application to Wireless Networking" by Frank H. P. Fitzek and Frank Reichert, Springer (or latest edition).
	2. "Mobile Computing Handbook" by Jason Flinn and Mahadev Satyanarayanan, CRC Press (or latest edition).

Elective-III

MTACTE233-A: Satellite Communication

Weekly Teaching Hours: 3	TH: 03			Tut: -
Scheme of Marking	TH: 60	Tests : 20	IA: 20	Total : 100

Course Objectives:	
1	The objective of this course is to provide students with a comprehensive understanding of satellite communication systems, technologies, and applications.
2	The course aims to equip students with the knowledge and skills required to design, analyze, and optimize satellite communication links, networks, and systems.
Course Outcomes: By the end of this course, students will be able to:	
CO1	Understand the fundamental concepts of satellite communication systems.
CO2	Design and analyze satellite communication links and networks.
CO3	Evaluate the performance of satellite communication systems and apply optimization techniques.
CO4	Gain knowledge of different satellite orbits, frequency bands, and modulation techniques.
CO5	Explore advanced topics in satellite communication, such as multiple access schemes and satellite constellations.
CO6	Apply their skills to solve real-world challenges in satellite communication.
Syllabus Contents	
Unit 1	Introduction to Satellite Communication 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, types of orbits and their characteristics. **(7hrs)**
Unit 2	Orbital Analysis: Orbital equations, Kepler's laws of planetary motion, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity, slant range etc. of a satellite, concepts of Solar day and Sidereal day, Doppler shift. **(6hrs)**
Unit 3	Satellite Link Design - Fundamentals of link budget analysis. - Calculation of uplink and downlink link budgets. - Effects of atmospheric and ionospheric factors on link performance. Satellite Frequency Bands and Modulation Techniques - Frequency allocation for satellite communication. **(7hrs)**
Unit 4	Satellite Networking and Protocols - Satellite network architecture and protocols. - VSAT (Very Small Aperture Terminal) systems and applications. - Internet over satellite: challenges and solutions. Satellite Antennas and Propagation - Types of satellite antennas: parabolic, phased array. - Antenna gain, beamwidth, and radiation patterns. - Satellite communication propagation models and impairments. **(7hrs)**
Unit 5	Earth Station Technology and Ground Segment

	- Earth station components: antennas, transceivers, and more. - Earth station architecture and operation. - Satellite control and monitoring systems. **(7hrs)**
Unit 6	Emerging Trends in Satellite Communication - High-throughput satellites (HTS) and broadband services. - CubeSats and small satellite constellations. - Satellite communication for IoT and 5G connectivity. **(6hrs)**
Text Books	
	1. "Satellite Communications" by Dennis Roddy, McGraw-Hill Education (or latest edition).
	2. "Understanding Satellite Communications" by Robert M. Gagliardi and Bruce R. Elbert, Artech House (or latest edition).
Reference Books	
	1. "Satellite Communications Systems Engineering: Atmospheric Effects, Satellite Link Design and System Performance" by Louis J. Ippolito Jr., Wiley (or latest edition).
	2. "Satellite Communications: Principles and Applications" by D.C. Agarwal and A. K. Maini, John Wiley & Sons (or latest edition).

MTACTE233-B: Advanced Digital Signal Processing

Weekly Teaching Hours:03	TH: 03			Tut: -
Scheme of Marking	TH: 60	Tests: 20	IA: 20	Total: 100

Course Objectives:

1	To provide graduates strong mathematical skills and in depth knowledge in signal theory to analyze and solve complex problems in the domain of signal processing
2	To instill research skills and bring in optimal solutions to signal processing and allied application areas using modern technology and tools that are technically sound, economically feasible and socially acceptable.

Course Outcomes:

At the end of course, students should:

CO1	Understand and analyze- DTFT, DFT, and FFT.
CO2	Create & Evaluate Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) Filters
CO3	Understand the fundamentals of multi rate signal processing and its application
CO4	Apply the knowledge of DSP processor for various real time applications.
CO5	Use the concept of wavelet transform for signal processing applications.
CO6	Understand the concept of adaptive filters.

UNIT- 1: Overview of Discrete time signal and systems:

Convolution, correlation, Z-transform, DTFT, DFT and their properties, DIT-FFT and DIF-FFT algorithm. **(6hrs)**

UNIT – II: Filter Design:

Analog filter design: Butterworth and Chebyshev filter to 2^{nd} order approximations, Discrete time IIR filter from analog filter, IIR filter design by Impulse Invariance, Bilinear transformation, Approximation of derivatives, HPF, BPF, BRF filter design using frequency translation, Structures of

FIR filters, Linear phase FIR filter, Filter design using windowing techniques and Frequency sampling techniques. Implementation of Filter using filter structure. **(7hrs)**

UNIT – III: Multi-rate Digital Signal Processing:
Decimation & Interpolation, Linear filtering with decimation and interpolation, Poly-phase filters, Filter banks, sub-band processing, Decimated filter banks, Uniform DFT filter banks, Quadrature mirror filters. **(7hrs)**

UNIT – IV: DSP Processors and its Application:
Issues involved in DSP processor design, Features of TMS 320C67XX, Architecture of TMS 320C67XX, Memory Organization, Addressing Modes, Pipeline operations, Assembly language instructions, Applications of DSP to Biomedical Signal Processing, Speech signal processing, Radar signal processing. **(7hrs)**

UNIT – V: Wavelets:
Time-Frequency Analysis and Continuous Wavelet Transform, an introduction to Hilbert Space Theory, Wavelet Properties, Discrete Wavelets, Scaling Function, Sub-band Coding, Discrete Wavelet Transform. **(6hrs)**

UNIT – VI: Adaptive Signal Processing:
Adaptive filter, Main components of the adaptive filter, Basic Wiener filter theory, the basic LMS adaptive algorithm, Practical limitations of the basic LMS algorithm, Recursive Least Square Algorithm, Limitations. Application- Adaptive filter as a Noise Canceller in fetal ECG. **(7hrs)**

TEXT BOOKS:
1. ‘Digital Signal Processing Principles, Algorithm and Applications", J. G. Proakis and D. G. Manolakis, Fourth Ed Prentice Hall 1997.
2. "A Course in Digital Signal Processing ", Boaz Porat John Wiley & Sons.
3. "Digital Signal Processing", Nagoor Kani, Tata-Mc-GrawHill.Publication.
4. "Digital Signal Processors", B. Venkatramani and M. Bhaskar, nd Ed., Mc-Graw Hill.
5. "Wavelet Transforms: Introduction to Theory and Applications", Bopardikar and Rao.

REFERENCES:
1. "Digital Signal Processing- A Computer based Approach", Sanjit K. Mitra, 4th Ed, Mc- Graw Hill.
2. "Discrete Time Signal Processing : A Practical Approach", E.C. Ifeacher & B.W. Jarvis Pearson Education 3rd Edition.
3. "Digital Signal Processing", Thomas J. Cavicchi, John Wiley
4. "DSP Handbook", Vijay Medisetti & D.B. Williams, CRC Press
5. "Discrete Wavelet Transform', Robi Polikar.
6. "Wavelets and Subband Coding", Valterli & Kovaceric, PHI.
7. "Analog Devices & Texas Instruments", Users Manuel of TMS320C4X and ADSP 2106X.

MTACTE233-C: Cryptography & Network Security

Weekly Teaching Hours:03	TH: 03			Tut: -
Scheme of Marking	TH: 60	Tests: 20	IA: 20	Total: 100

Course Objectives:	
This course enables the students:	
1	To imbibe good foundation of network security in students for implementation of new network security algorithms.
2	To understand different network models and the protocols used in each layer.
3. 4. 5. 6.	To acquire detailed approach of encryption decryption for the data to transmit To understand the role of network security as a tool for protection of different network entities To be able to accurately apply security algorithms to real world security issues. To ensure windows and web browser security through implementation of various encryption standards.
Course Outcomes: By the end of this course, students will be able to:	
CO1	Analyze attacks on computers and computer security.
CO2	Demonstrate knowledge of cryptography techniques
CO3	Illustrate various Symmetric and Asymmetric keys for Ciphers
CO4	Evaluate different Message Authentication Algorithms and Hash Functions.
CO5	Get acquainted with various aspects of E-Mail Security
CO6	Assimilate various aspects of Web Security
Syllabus Contents	
Unit 1	Introduction to Cryptography and Network Security - Overview of cryptography and its historical context. - Introduction, The need for security, Security approaches, Principles of security, Types of Security attacks, Security services, Security Mechanisms, A model for Network Security. **(6hrs)**
Unit 2	Introduction, plain text and cipher text, substitution techniques, transposition techniques, encryption and decryption, symmetric and asymmetric key cryptography, stenography, key range and key size, possible types of attacks. **(7hrs)**
Unit 3	Block Cipher principles & Algorithms (DES, AES, Blowfish), Differential and Linear Crypt analysis, Block cipher modes of operation, Stream ciphers, RC4, Location and placement of encryption function, Key distribution, Asymmetric key Ciphers, Principles of public key crypto systems, Algorithms (RSA, Diffie Hellman, ECC). **(7hrs)**
Unit 4	Authentication requirements, Functions, Message authentication codes, Hash Functions, Secure hash algorithm, HMAC, CMAC, Digital signatures, knapsack algorithm, Authentication Applications such as Kerberos, X.509 Authentication Service, Public – Key Infrastructure, Biometric Authentication. **(7hrs)**
Unit 5	Pretty Good Privacy, S/MIME, IP security overview, IP Security architecture, Authentication Header, Encapsulating , Security payload, Combining security associations, Key management. **(7hrs)**
Unit 6	Web security considerations, Secure Socket Layer and Transport Layer Security, Secure electronic transaction, Intruders, Intrusion detection, password management, virus and related threats, Countermeasures, Firewall design principles, types of firewalls, Secure Inter-branch Payment Transactions. **(6hrs)** Emerging Trends in Cryptography and Network Security

	- Blockchain technology and its security implications.
Text Books	
	1. William Stallings, "Cryptography and Network Security" ,Pearson Education, 4 th Edition 2. Atul Kahate, "Cryptography and Network Security", McGraw Hill, 3rd Edition. 3. C K Shymala, N Harini, Dr. T R Padmanabhan, "Cryptography and Network Security", Wiley India,1st Edition
Reference Books	
	1. Forouzan Mukhopadhyay, "Cryptography and Network Security", Mc Graw Hill, 2 ndEdition. 2. Mark Stamp, "Information Security, Principles and Practice", Wiley India, 2nd Edition. 3. W.M. Arthur Conklin, Greg White, "Principles of Computer Security", TMH, 4 th Edition. 4. Neal Krawetz, "Introduction to Network Security", CENGAGE Learning Distributor, 1st Edition. 1. 5. Bernard Menezes, "Network Security and Cryptography", CENGAGE Learning Distributor, 1st 2. Edition

MTACTE233-D: Optical Networks

Weekly Teaching Hours:03 TH: 03 Tut: -

Scheme of Marking TH: 60 Tests: 20 IA: 20 Total: 100

Course Objectives:	
	This course enables the students to:
1	The objective of this course is to provide students with a comprehensive understanding of optical networks, including their technologies, architectures, protocols, and applications.
2	The course aims to equip students with the knowledge and skills required to design, analyze, and optimize optical communication systems and networks.
Course Outcomes: By the end of this course, students will be able to:	
CO1	Understand the fundamental principles of optical communication and networks.
CO2	Analyze and evaluate different optical network architectures and topologies.
CO3	Design and implement optical transmission systems and networks.
CO4	Utilize optical network protocols for efficient data transport.
CO5	Apply their skills to solve real-world challenges in optical network design and management.
CO6	Explore emerging trends and advancements in optical networking technologies.
Syllabus Contents	
Unit 1	Introduction to Optical Networks - Basics of optical communication and fiber optics. - Historical development of optical networks. - Challenges and advantages of optical communication. Optical Fiber and Transmission Systems - Optical fiber characteristics and modes. - Optical signal propagation and attenuation. - Optical transmitters and receivers for high-speed transmission. **(7hrs)**
Unit 2	Wavelength Division Multiplexing (WDM) - Principles of WDM and dense WDM (DWDM).

	- Multiplexing techniques and components. - WDM network architectures: point-to-point, ring, and mesh. Optical Network Components and Devices - Optical amplifiers: EDFA, Raman amplifiers. - Optical switches and routers. - Optical cross-connects and reconfigurable optical add-drop multiplexers (ROADMs). **(7hrs)**
Unit 3	Optical Network Protocols and Management - Optical layer protocols: SONET/SDH, OTN. - Optical network management and control. - GMPLS (Generalized Multiprotocol Label Switching) for optical networks. Optical Access Networks - Passive optical networks (PON) architecture. - Ethernet-based PON (EPON) and Gigabit PON (GPON). - Next-generation optical access technologies. **(7hrs)**
Unit 4	Optical Network Security and Reliability - Security challenges in optical networks. - Physical layer security techniques. - Fault tolerance and restoration mechanisms. **(7hrs)**
Unit 5	Emerging Trends in Optical Networks - Software-defined optical networks. - Elastic optical networks and spectrum slicing. - Quantum communication and encryption in optical networks. **(7hrs)**
Unit 6	Recent trends & case studies - Recent trends in optical fiber technology and optical networks. - Case studies of successful optical network deployments and innovations. **(5hrs)**
Text Books	
	1. "Optical Networks: A Practical Perspective" by Rajiv Ramaswami, Kumar N. Sivarajan, and Galen H. Sasaki, Morgan Kaufmann (or latest edition).
	2. "High-Speed Optical Communications" by Le Nguyen Binh, Wiley (or latest edition).
Reference Books	
	1. "Optical Fiber Communications" by Gerd Keiser, McGraw-Hill Education (or latest edition).
	2. "Optical Networks: Design and Modeling" by Rajeev Ramaswami and Kumar N. Sivarajan, Springer (or latest edition).

MTACTE233-E: Embedded System Design

Weekly Teaching Hours:03	TH: 03			Tut: -
Scheme of Marking	TH: 60	Tests: 20	IA: 20	Total: 100

Course Objectives:	
	This course enables the students to:
1	The objective of this course is to provide students with a comprehensive understanding of embedded system design concepts, methodologies, and technologies.
2	The course aims to equip students with the knowledge and skills required to design, develop, and optimize embedded systems for various applications in communication, control, and beyond.

Course Outcomes: By the end of this course, students will be able to:	
CO1	Understand the fundamental principles of embedded systems and their components.
CO2	Design and develop embedded software using programming languages and tools.
CO3	Design and interface hardware components in embedded systems.
CO4	Evaluate and optimize embedded system performance and energy efficiency.
CO5	Apply their skills to solve real-world challenges in embedded system design.
CO6	Explore emerging trends and advancements in embedded system technology.
Syllabus Contents	
Unit 1	Introduction to Embedded Systems - Basics of embedded systems: characteristics and applications. - Microcontrollers and microprocessors: architecture and comparison. - Embedded system design flow and development cycle. Embedded Software Development - Programming languages for embedded systems: C, C++, assembly. - Embedded software development tools and integrated development environments (IDEs). - Real-time operating systems (RTOS) and their importance in embedded systems. **(7hrs)**
Unit 2	Embedded Hardware Design - Basics of digital logic and combinational circuits. - Interfacing techniques: GPIO, ADC, DAC, and more. - Design of embedded systems using field-programmable gate arrays (FPGAs). Sensors and Actuators - Types of sensors: temperature, pressure, proximity, etc. - Sensor interfacing and signal conditioning. - Control of actuators: motors, servos, and relays. **(7hrs)**
Unit 3	Communication Protocols for Embedded Systems - Serial communication protocols: UART, SPI, I2C. - Networking protocols: Ethernet, Wi-Fi, Bluetooth, Zigbee. - Interfacing sensors and devices with communication protocols. Embedded System Optimization - Memory management and optimization techniques. - Power management and energy-efficient design. - Performance analysis and optimization tools. **(7hrs)**
Unit 4	Real-Time Systems and Scheduling - Characteristics of real-time systems. - Task scheduling algorithms: preemptive, non-preemptive. - Deadline-based scheduling and rate-monotonic scheduling. **(7hrs)**
Unit 5	Embedded System Security - Security challenges in embedded systems. - Secure boot and authentication techniques. - Encryption and decryption in embedded systems. **(7hrs)**
Unit 6	Emerging Trends in Embedded System Design - Internet of Things (IoT) and embedded systems. - Edge computing and embedded AI. - Wearable and embedded systems for healthcare and smart technologies. **(5hrs)**
Text Books	
	1. "Embedded Systems: Architecture, Programming and Design" by Raj Kamal, McGraw-Hill Education (or latest edition).

	2. "The Art of Designing Embedded Systems" by Jack Ganssle, Newnes (or latest edition).
Reference Books	
	1. "Embedded Systems: Real-Time Interfacing to Arm Cortex-M Microcontrollers" by Jonathan W. Valvano, Cengage Learning (or latest edition).
	2. "Programming Embedded Systems in C and C++" by Michael Barr and Anthony Massa, O'Reilly Media (or latest edition).

Elective-IV:

MTACTE244-A: Cloud Computing

Weekly Teaching Hours:03	TH: 03			Tut: -
Scheme of Marking	TH: 60	Tests: 20	IA: 20	Total: 100

Course Objectives:	
This course enables the students to:	
1	The objective of this course is to provide students with a comprehensive understanding of cloud computing concepts, architectures, services, and deployment models.
2	The course aims to equip students with the knowledge and skills required to design, develop, and manage cloud-based solutions, considering the benefits, challenges, and emerging trends in cloud computing.
Course Outcomes: By the end of this course, students will be able to:	
CO1	Understand the fundamental principles and concepts of cloud computing.
CO2	Analyze and evaluate different cloud computing service models and deployment models.
CO3	Design and develop cloud-based applications and services.
CO4	Utilize cloud computing platforms for scalability and cost efficiency.
CO5	Apply their skills to solve real-world challenges in cloud computing.
CO6	Stay updated with emerging trends and advancements in cloud computing technologies.
Syllabus Contents	
Unit 1	Introduction to Cloud Computing - Basics of cloud computing: definition, characteristics, and benefits. - Historical development and evolution of cloud computing. - Cloud service models: IaaS, PaaS, SaaS, and XaaS. Cloud Infrastructure and Virtualization - Virtualization concepts and techniques. - Hypervisors and virtual machine management. - Containerization and microservices architecture.
Unit 2	Cloud Deployment Models - Public, private, hybrid, and multi-cloud deployment models. - Cloud service providers and their offerings. - Cloud orchestration and management platforms. Cloud Security and Privacy - Security challenges in cloud computing. - Identity and access management (IAM) in the cloud. - Data privacy, encryption, and compliance in the cloud.
Unit 3	Cloud Storage and Database Services - Cloud-based storage services: object storage, block storage.

	- Database services in the cloud: SQL, NoSQL, NewSQL. - Data migration and backup strategies in the cloud. Cloud Networking and Connectivity - Virtual networks and subnets in the cloud. - Load balancing and auto-scaling. - Content delivery networks (CDNs) and edge computing.
Unit 4	Cloud Application Development - Cloud-based application design and architecture. - Developing and deploying applications on cloud platforms. - Serverless computing and Function as a Service (FaaS).
Unit 5	Cloud Economics and Cost Management - Cloud cost models: pay-as-you-go, reserved instances. - Cost optimization strategies and cloud cost monitoring. - Total Cost of Ownership (TCO) analysis for cloud solutions.
Unit 6	Emerging Trends in Cloud Computing - Serverless computing and edge computing. - Cloud-native technologies and Kubernetes. - AI and machine learning in the cloud.
Text Books	
	1. "Cloud Computing: Concepts, Technology & Architecture" by Thomas Erl, Prentice Hall (or latest edition).
	2. "Cloud Computing Principles and Paradigms" by Rajkumar Buyya, James Broberg, and Andrzej Goscinski, Wiley (or latest edition).
Reference Books	
	1. "Cloud Native: Using Containers, Functions, and Data to Build Next-Generation Applications" by Boris Scholl, O'Reilly Media (or latest edition).
	2. "Cloud Computing: From Beginning to End" by Ray J. Rafaels, Apress (or latest edition).

MTACTE244-B: Fault Tolerant Digital System Design

Weekly Teaching Hours:03	TH: 03			Tut: -
Scheme of Marking	TH: 60	Tests: 20	IA: 20	Total: 100

Course Objectives:	
	This course enables the students to:
1	The objective of this course is to provide students with a comprehensive understanding of fault-tolerant digital system design principles, methodologies, and techniques.
2	The course aims to equip students with the knowledge and skills required to design and develop reliable and resilient digital systems that can tolerate faults and failures.
Course Outcomes: By the end of this course, students will be able to:	
CO1	Understand the fundamental concepts of fault tolerance and reliability in digital systems.
CO2	Analyze and evaluate different fault models and their impact on system behavior.
CO3	Design fault-tolerant digital systems using redundancy and error detection/correction techniques.
CO4	Implement and simulate fault injection for testing and validation.
CO5	Apply their skills to solve real-world challenges in fault-tolerant digital system design.
CO6	Stay updated with emerging trends and advancements in fault tolerance and reliability.

Syllabus Contents	
Unit 1	Introduction to Fault Tolerance - Basics of fault tolerance: definition, importance, and challenges. - Historical development and evolution of fault-tolerant systems. - Error, fault, and failure classifications. Fault Models and Reliability Analysis - Single and multiple fault models. - Reliability metrics: Mean Time Between Failures (MTBF), Mean Time To Repair (MTTR). - Reliability block diagrams and fault trees. **(7hrs)**
Unit 2	Redundancy Techniques - Hardware redundancy: duplex, triplex, N-modular redundancy. - Software redundancy: N-version programming, recovery blocks. - Comparison and trade-offs of redundancy techniques. Error Detection and Correction Codes - Basics of error detection and correction. - Linear Block code, Cyclic Code. - Syndrome decoding and error correction mechanisms. **(7hrs)**
Unit 3	Fault-Tolerant System Architectures - Fault-tolerant processors and memories. - Voting mechanisms: majority voting, triple modular redundancy. - Fault-tolerant interconnects and networks. Fault Injection and Testing - Fault injection techniques for testing fault tolerance. - Fault simulation and modeling tools. - Validation and verification of fault-tolerant systems. **(7hrs)**
Unit 4	Fault-Tolerant Software Design - Software fault tolerance mechanisms. - Recovery and error handling in software. - N-version programming and diversity in software. **(7hrs)**
Unit 5	Real-Time and Safety-Critical Systems - Fault tolerance in real-time and safety-critical systems. - Fault tolerance in automotive, aerospace, and medical applications. - Fault-tolerant design considerations for critical systems. **(6hrs)**
Unit 6	Emerging Trends in Fault-Tolerant Design - Hardware-software co-design for fault tolerance. - Self-healing and adaptive fault-tolerant systems. - Quantum computing and fault tolerance. **(6hrs)**
Text Books	
	1. "Fault-Tolerant Systems" by Israel Koren and C. Mani Krishna, Morgan Kaufmann (or latest edition).
	2. "Design of Fault-Tolerant Computing Systems" by Subhasish Mitra and T. M. Mak, Cambridge University Press (or latest edition).
Reference Books	
	1. "Introduction to Reliable and Secure Distributed Programming" by Christian Cachin, Rachid Guerraoui, and Luís Rodrigues, Springer (or latest edition).
	2. "Fundamentals of Dependable Computing for Software Engineers" by John Knight, CRC Press (or latest edition).

MTACTE244-C: Reconfigurable Computing

Weekly Teaching Hours:03	TH: 03			Tut: -
Scheme of Marking	TH: 60	Tests: 20	IA: 20	Total: 100

Course Objectives:	
	This course enables the students to:
1	The objective of this course is to provide students with a comprehensive understanding of reconfigurable computing concepts, architectures, and design methodologies.
2	The course aims to equip students with the knowledge and skills required to design, implement, and optimize reconfigurable hardware systems using Field-Programmable Gate Arrays (FPGAs) and related technologies.
Course Outcomes: By the end of this course, students will be able to:	
CO1	Understand the fundamental principles and concepts of reconfigurable computing.
CO2	Analyze and evaluate different types of reconfigurable hardware architectures.
CO3	Design and implement reconfigurable systems using FPGAs.
CO4	Optimize and customize hardware designs for specific applications.
CO5	Apply their skills to solve real-world challenges in reconfigurable computing.
CO6	Stay updated with emerging trends and advancements in reconfigurable computing technologies.
Syllabus Contents	
Unit 1	Introduction to Reconfigurable Computing - Basics of reconfigurable computing: definition and applications. - Evolution of reconfigurable hardware technologies. - Challenges and advantages of reconfigurable computing. Field-Programmable Gate Arrays (FPGAs) - FPGA architecture and components. - FPGA programming languages: VHDL. - FPGA design flow and development tools. **(7hrs)**
Unit 2	Reconfigurable Hardware Design Techniques - Sequential and combinational logic design on FPGAs. - Design optimization and resource management. - Timing constraints and performance analysis. Hardware Description Languages (HDLs) - Introduction to VHDL. - HDL-based design methodologies. - Synthesis and simulation tools for HDLs. **(7hrs)**
Unit 3	High-Level Synthesis (HLS) - Introduction to HLS and its advantages. - C-based design and optimization. - Mapping C using code to hardware HLS tools. Reconfigurable Computing Architectures - Configurable logic blocks and interconnects. - Partial and dynamic reconfiguration techniques. - Coarse-grained and fine-grained reconfigurable architectures. **(7hrs)**
Unit 4	Reconfigurable Computing Applications - Hardware acceleration for compute-intensive tasks. - Digital signal processing on FPGAs. - Reconfigurable computing in cryptography, networking, and image processing. **(7hrs)**

Unit 5	Reconfigurable Systems for Machine Learning - FPGA-based accelerators for neural networks. - Hardware-software co-design for AI applications. - FPGA-based inference engines. **(6hrs)**
Unit 6	Emerging Trends in Reconfigurable Computing - Reconfigurable computing for edge and IoT applications. - Quantum reconfigurable computing. - Reconfigurable computing in the context of advanced communication technologies. **(6hrs)**
Text Books	
	1. "Reconfigurable Computing: The Theory and Practice of FPGA-Based Computation" by Scott Hauck and André DeHon, Morgan Kaufmann (or latest edition).
	2. "Field-Programmable Gate Arrays" by Stephen Brown and Jonathan Rose, Springer (or latest edition).
Reference Books	
	1. "FPGA Prototyping by VHDL Examples: Xilinx Spartan-3 Version" by Pong P. Chu, Wiley (or latest edition).
	2. "Digital Design and Computer Architecture" by David Harris and Sarah Harris, Morgan Kaufmann (or latest edition).

MTACTE244-D: Soft Computing & Applications

Weekly Teaching Hours:03	TH: 03			Tut: -
Scheme of Marking	TH: 60	Tests: 20	IA: 20	Total: 100

Course Objectives:	
This course enables the students to:	
1	The objective of this course is to provide students with a comprehensive understanding of soft computing techniques and their applications in solving complex engineering problems.
2	The course aims to equip students with the knowledge and skills required to apply various soft computing methodologies to real-world problems in communication technologies and other domains.
Course Outcomes: By the end of this course, students will be able to:	
CO1	Understand the fundamental principles of soft computing techniques.
CO2	Analyze and evaluate different soft computing methodologies.
CO3	Apply soft computing techniques to solve complex engineering problems.
CO4	Design and implement soft computing-based solutions for communication technologies.
CO5	Apply their skills to solve real-world challenges using soft computing.
CO6	Stay updated with emerging trends and advancements in soft computing technologies.
Syllabus Contents	
Unit 1	Introduction to Soft Computing - Basics of soft computing: definition, characteristics, and applications. - Comparison with conventional computing techniques. - Challenges and advantages of soft computing. Fuzzy Logic Systems - Introduction to fuzzy logic and fuzzy sets. - Fuzzy logic operations and membership functions. - Fuzzy inference systems and applications. **(7hrs)**

Unit 2	Neural Networks and Deep Learning - Basics of artificial neural networks (ANN). - Perceptrons, multi-layer feedforward networks, and backpropagation. - Introduction to deep learning: convolutional neural networks (CNN) and recurrent neural networks (RNN). Evolutionary Algorithms - Genetic algorithms: representation, selection, crossover, mutation. - Particle swarm optimization (PSO) and differential evolution (DE). - Applications of evolutionary algorithms in optimization. **(7hrs)**
Unit 3	Swarm Intelligence - Ant colony optimization (ACO) and bee colony optimization. - Firefly algorithm and bat algorithm. - Applications of swarm intelligence in routing and optimization. Hybrid and Adaptive Systems - Hybridization of soft computing techniques. - Adaptive fuzzy systems and neuro-fuzzy systems. - Applications of hybrid and adaptive systems. **(7hrs)**
Unit 4	Soft Computing in Communication Technologies - Soft computing techniques for channel equalization. - Soft computing in modulation recognition and cognitive radio. - Applications of soft computing in wireless sensor networks. **(6hrs)**
Unit 5	Soft Computing in Image and Signal Processing - Fuzzy image processing and fuzzy clustering. - Neural network-based signal processing. - Soft computing applications in image denoising and compression. **(7hrs)**
Unit 6	Emerging Trends in Soft Computing - Soft computing applications in Internet of Things (IoT) and smart technologies. - Soft computing for edge computing and fog computing. - Quantum-inspired soft computing techniques. **(6hrs)**
Text Books	
	1. "Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence" by J.S.R. Jang, C.T. Sun, and E. Mizutani, Pearson (or latest edition).
	2. "Artificial Intelligence: A Guide to Intelligent Systems" by Michael Negnevitsky, Pearson (or latest edition).
Reference Books	
	1. "Fuzzy Logic with Engineering Applications" by Timothy J. Ross, Wiley (or latest edition).
	2. "Neural Networks and Deep Learning: A Textbook" by Charu C. Aggarwal, Springer (or latest edition).

MTACTE244-E: Adaptive Signal Processing

Weekly Teaching Hours:03	TH: 03			Tut: -
Scheme of Marking	TH: 60	Tests: 20	IA: 20	Total: 100

Course Objectives:	
	This course enables the students:
1	To provide a comprehensive understanding of adaptive signal processing techniques,

	algorithms, and applications.
2	To equip with the knowledge and skills required to analyze, design, and implement adaptive filters and algorithms for signal processing tasks in communication technologies and related domains.
Course Outcomes: By the end of this course, students will be able to:	
CO1	Understand the fundamental principles of adaptive signal processing.
CO2	Analyze and evaluate different adaptive filtering algorithms.
CO3	Design and implement adaptive filters for noise cancellation and system identification.
CO4	Apply adaptive signal processing techniques to solve real-world problems in communication technologies.
CO5	Utilize their skills to optimize and improve the performance of communication systems.
CO6	Stay updated with emerging trends and advancements in adaptive signal processing.
Syllabus Contents	
Unit 1	Introduction to Random Signals: Random variables, Sequences and Stochastic Process, Random Signals and Distributions, Averages, Stationary Processes, Probability Density Functions (PDF) and its properties, non-parametric spectral estimation, parametric methods of power spectral estimations.
Unit 2	Wiener Filters: Input signal and weight vectors, desired response and error, Mean Square Error (MSE), Principle of Orthogonality, FIR Wiener Filters, Wiener Hopf equation, Error performance surface, multiple linear regression model.
Unit 3	Adaptive Filtering Algorithms: Eigen values and Eigen Vectors of the correlation matrix, one dimensional gradient search algorithm, Steepest Descent algorithm, LMS algorithm, comparison of the LMS with Steepest Descent Algorithm, Modified LMS algorithm and Examples of LMS algorithm, Normalised LMS filter.
Unit 4	Kalman Filters and Square Root Adaptive Filters: Recursive minimum MSE for Scalar random variables, Kalman filtering problem, Innovation process and estimation of state, Kalman filtering, Square root Kalman filters, QRRLS algorithm.
Unit 5	Recursive Least Square Algorithms: Linear Least Square Estimation Problem, Introduction to Recursive Least-Squares Adaptive filters, Matrix Inversion Lemma, RLS Algorithm.
Unit 6	Applications of Adaptive filtering: Adaptive Equalization, noise cancellation, Echo Cancellation, System identification, Foetal monitoring, cancelling of maternal ECG during labour. Emerging Trends in Adaptive Signal Processing - Adaptive signal processing for 5G, Machine learning and deep learning in adaptive systems.
Text Books	
	1. "Adaptive Filter Theory" by Simon Haykin, Pearson (or latest edition).
	2. "Adaptive Signal Processing" by Bernard Widrow and Samuel D. Stearns, Prentice Hall (or latest edition).
Reference Books	
	1. "Adaptive Signal Processing: Applications to Real-World Problems" by Leszek Rutkowski, Marcin Korytkowski, and Rafal Scherer, Springer (or latest edition).
	2. "Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing" by Dimitris G. Manolakis and Vinay K. Ingle, Artech House (or latest edition).

ELECTTIVE-V (Open Elective)

MTACTE255-A: Artificial Intelligence & Machine Learning

Weekly Teaching Hours:03	TH: 03			Tut: -
Scheme of Marking	TH: 60	Tests: 20	IA: 20	Total: 100

Course Objectives:	
1	The objective of this course is to provide students with a comprehensive understanding of artificial intelligence (AI) and machine learning (ML) concepts, techniques, and applications.
2	The course aims to equip students with the knowledge and skills required to design, implement, and apply AI and ML algorithms in communication technologies and other domains.
Course Outcomes:	
CO1	Understand the fundamental principles of artificial intelligence and machine learning.
CO2	Analyze and evaluate different AI and ML algorithms and models.
CO3	Design and implement AI and ML solutions for real-world problems.
CO4	Apply AI and ML techniques to optimize and enhance communication systems.
CO5	Utilize their skills to develop AI-driven applications in various domains.
CO6	Stay updated with emerging trends and advancements in AI and machine learning technologies.
Syllabus Contents	
Unit 1	Introduction to Artificial Intelligence - Basics of artificial intelligence: definition, history, and applications. - Comparison between AI and traditional computing approaches. - Ethical considerations in AI. Machine Learning Fundamentals - Introduction to machine learning concepts. - Types of machine learning: supervised, unsupervised, reinforcement learning. - Machine learning process: data preprocessing, training, evaluation, and deployment. **(7hrs)**
Unit 2	Supervised Learning Algorithms - Linear regression. - Logistic regression. - k-Nearest Neighbors (k-NN). - Support Vector Machines (SVM). Unsupervised Learning Algorithms - K-Means clustering. - Hierarchical clustering. - Principal Component Analysis (PCA). **(7hrs)**
Unit 3	Neural Networks and Deep Learning - Basics of artificial neural networks (ANN). - Convolutional Neural Networks (CNN). - Recurrent Neural Networks (RNN).

	- Introduction to deep learning frameworks. Reinforcement Learning - Introduction to reinforcement learning. - Markov decision processes and Q-learning. - Applications of reinforcement learning in communication technologies. **(7hrs)**
Unit 4	Natural Language Processing (NLP) - Basics of NLP: tokenization, part-of-speech tagging, sentiment analysis. - Introduction to word embeddings. - Text generation and language models. **(7hrs)**
Unit 5	AI and ML in Communication Technologies - AI-driven network management and optimization. - ML-based channel estimation and equalization. - AI for spectrum sensing and allocation. **(7hrs)**
Unit 6	Emerging Trends in AI and Machine Learning - AI in edge computing and IoT. - Explainable AI and interpretability. - AI ethics and bias considerations. **(5hrs)**
Text Books	
	1. "Pattern Recognition and Machine Learning" by Christopher M. Bishop, Springer (or latest edition).
	2. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, MIT Press (or latest edition).
Reference Books	
	1. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig, Pearson (or latest edition).
	2. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron, O'Reilly Media (or latest edition).

MTACTE255-B: Operation Research

Weekly Teaching Hours:03	TH: 03			Tut: -
Scheme of Marking	TH: 60	Tests: 20	IA: 20	Total: 100

Course Objectives:	
1	The objective of this course is to provide students with a comprehensive understanding of operations research principles, methodologies, and techniques.
2	The course aims to equip students with the knowledge and skills required to analyze complex engineering problems, make informed decisions, and optimize processes in communication technologies and related domains.
Course Outcomes:	
CO1	Understand the fundamental principles of operations research.
CO2	Apply mathematical models and techniques to solve engineering optimization problems.
CO3	Analyze and evaluate different operations research methodologies.
CO4	Design and implement optimization solutions for real-world problems.
CO5	Utilize their skills to improve decision-making and resource allocation in communication systems.
CO6	Stay updated with emerging trends and advancements in operations research.

Syllabus Contents	
Unit 1	Introduction to Operations Research - Basics of operations research: definition, history, and applications. - Scope and limitations of operations research. - Phases of the operations research process. Linear Programming - Formulation of linear programming problems. - Graphical solution and simplex method. - Duality and sensitivity analysis. **(7hrs)**
Unit 2	Integer and Mixed-Integer Programming - Integer programming models and applications. - Branch-and-bound algorithm for solving integer programming problems. - Cutting-plane methods. Network Optimization - Shortest path and minimum spanning tree problems. - Max flow-min cut theorem and applications. - Transportation and assignment problems. **(7hrs)**
Unit 3	Nonlinear Optimization - Unconstrained optimization techniques: gradient descent, Newton's method. - Constrained optimization: Karush-Kuhn-Tucker conditions. - Applications of nonlinear optimization in engineering. Dynamic Programming - Principles of dynamic programming. - Forward and backward recursion methods. - Applications in resource allocation and project scheduling. **(7hrs)**
Unit 4	Queuing Theory - Basics of queuing systems and models. - M/M/1 and M/M/c queuing models. - Applications of queuing theory in communication networks. **(7hrs)**
Unit 5	Decision Analysis - Decision-making under uncertainty. - Decision trees and expected value of perfect information. - Sensitivity analysis and risk assessment. **(6hrs)**
Unit 6	Emerging Trends in Operations Research - Operations research in supply chain management and logistics. - Data-driven optimization and machine learning in operations research. - Operations research in smart cities and sustainable technologies. **(6hrs)**
Text Books	
	1. "Introduction to Operations Research" by Frederick S. Hillier and Gerald J. Lieberman, McGraw-Hill (or latest edition).
	2. "Operations Research: Applications and Algorithms" by Wayne L. Winston, Cengage Learning (or latest edition).
Reference Books	
	1. "Operations Research: An Introduction" by Hamdy A. Taha, Pearson (or latest edition).
	2. "Network Flows: Theory, Algorithms, and Applications" by Ravindra K. Ahuja, Thomas L. Magnanti, and James B. Orlin, Prentice Hall (or latest edition).

MTACTE255-C: Business Analytics

Weekly Teaching Hours:03 TH: 03 Tut: -

Scheme of Marking TH: 60 Tests: 20 IA: 20 Total: 100

Course Objectives:	
1	The objective of this course is to provide students with a comprehensive understanding of business analytics principles, methodologies, and techniques.
2	The course aims to equip students with the knowledge and skills required to analyze and interpret data, make data-driven decisions, and apply analytical techniques in communication technologies and related domains.
Course Outcomes:	
CO1	Understand the fundamental principles of business analytics.
CO2	Apply data visualization and statistical techniques to analyze and interpret data.
CO3	Evaluate and select appropriate analytical tools for various business scenarios.
CO4	Design and implement data-driven solutions to solve real-world problems.
CO5	Utilize their skills to optimize processes and enhance decision-making in communication systems.
CO6	Stay updated with emerging trends and advancements in business analytics.
Syllabus Contents	
Unit 1	Introduction to Business Analytics - Basics of business analytics: definition, importance, and applications. - Role of data in decision-making and business strategies. - Ethical considerations in business analytics. Data Exploration and Visualization - Data preprocessing and cleaning. - Exploratory data analysis. - Data visualization techniques using tools like Tableau, Power BI, etc. **(7hrs)**
Unit 2	Descriptive and Inferential Statistics - Measures of central tendency and dispersion. - Hypothesis testing and confidence intervals. - Analysis of variance (ANOVA) and regression analysis. Predictive Analytics - Regression analysis for prediction. - Time series analysis and forecasting. - Machine learning algorithms for predictive modeling. **(7hrs)**
Unit 3	Prescriptive Analytics - Introduction to optimization and linear programming. - Decision-making under uncertainty using decision trees and Monte Carlo simulation. - A/B testing and experimental design. Text Analytics and Natural Language Processing (NLP) - Basics of text analytics and sentiment analysis. - Introduction to NLP techniques. - Applications of NLP in business insights. **(7hrs)**
Unit 4	Data Mining and Machine Learning - Clustering and classification techniques. - Feature selection and dimensionality reduction. - Introduction to machine learning algorithms. **(7hrs)**
Unit 5	Business Analytics in Communication Technologies

	- Analytics-driven network performance optimization. - Customer churn prediction and management. - Data-driven resource allocation in communication systems. **(6hrs)**
Unit 6	Emerging Trends in Business Analytics - Big data analytics and real-time insights. - Ethical considerations in data-driven decision-making. - Business analytics in the context of emerging technologies. **(6hrs)**
Text Books	
	1. "Business Analytics" by Ramesh Sharda, Dursun Delen, Efraim Turban, Pearson (or latest edition).
	2. "Data Science for Business" by Foster Provost and Tom Fawcett, O'Reilly Media (or latest edition).
Reference Books	
	1. "Practical Business Analytics Using SAS: A Hands-On Guide" by Venkat Reddy Konasani, Apress (or latest edition).
	2. "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications" by Bart Baesens, McGraw-Hill (or latest edition).

MTACTE255-D: Composite Materials

Weekly Teaching Hours:03	TH: 03			Tut: -
Scheme of Marking	TH: 60	Tests: 20	IA: 20	Total: 100

Course Objectives:

1	Understand characteristics of Composite materials
2	To understand manufacturing technique of composites

Course Outcomes:

At the end of course, students should:

CO1	Demonstrate knowledge of composite materials
CO2	Ability to display preparation of molding compounds
CO3	Explore various metal diffusion techniques
CO4	Demonstrate methods of manufacturing molding compounds
CO5	Analyze stress and strain of material
CO6	Able to select proper material

Unit 1: Introduction: Definition, Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance. **(7hrs)**

Unit 2: Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. isostrain and isostress conditions. **(8hrs)**

Unit 3: Manufacturing of Metal Matrix Composites: Casting, Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications. **(8hrs)**

Unit 4: Manufacturing of Polymer Matrix Composites: Preparation of molding compounds and prepregs, hand layup method – Autoclave method – Filament winding method – Compression molding – Reaction injection molding. Properties and applications. **(7hrs)**

Unit 5: Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations. **(7hrs)**

Unit 6: Application and case studies of different composite materials **(3hrs)**

Text Books:

1. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

2. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.

Reference Books:

1. Composite Materials Science and Applications – Deborah D.L.Chung.

2. Composite Materials – K.K.Chawla

MTACTE255-E: Industrial Safety

Weekly Teaching Hours:03	TH: 03			Tut: -
Scheme of Marking	TH: 60	Tests: 20	IA: 20	Total: 100

Course Objectives:	
1	The objective of this course is to provide students with a comprehensive understanding of industrial safety principles, regulations, risk management, and best practices within the context of advanced communication technologies.
2	Students will learn how to identify, assess, and mitigate potential safety hazards in technology-driven industrial environments, ensuring the well-being of employees, assets, and the surrounding environment.
Course Outcomes:	
CO1	Understand the importance of industrial safety in the context of advanced communication technologies.
CO2	Identify potential safety hazards associated with communication technology equipment and systems.
CO3	Apply risk assessment techniques to evaluate and prioritize safety risks.
CO4	Design safety protocols and measures for technology-driven industrial processes.
CO5	Comply with relevant safety regulations and standards in communication

	technology environments.
CO6	Develop contingency plans for emergencies and incidents.
Syllabus Contents	
Unit 1	Introduction to Industrial Safety - Importance of industrial safety in technology-intensive industries - Historical accidents and their impacts - Regulatory frameworks and standards Hazard Identification and Risk Assessment - Common hazards in communication technology environments - Risk assessment methodologies - Quantitative and qualitative risk assessment techniques. **(7hrs)**
Unit 2	Safety in Communication Technology Infrastructure - Safety considerations in data centers and network facilities - Electrical safety for advanced communication equipment - Fire prevention and control measures. **(7hrs)**
Unit 3	Human Factors and Ergonomics - Understanding human error and its role in accidents - Designing user-friendly and safe workspaces - Managing fatigue and stress in technology-intensive roles. **(7hrs)**
Unit 4	Emergency Planning and Incident Response - Developing emergency response plans - Evacuation procedures and protocols - Crisis communication strategies. **(7hrs)**
Unit 5	Compliance and Regulations - Occupational Safety and Health Administration (OSHA) regulations - International safety standards for communication technologies - Ensuring compliance in a rapidly evolving technological landscape. **(6hrs)**
Unit 6	Compliance and Regulations - Occupational Safety and Health Administration (OSHA) regulations - International safety standards for communication technologies - Ensuring compliance in a rapidly evolving technological landscape Case Studies and Best Practices - Analyzing past industrial accidents related to communication technologies - Learning from success stories in industrial safety. **(6hrs)**
Text Books	
	1. "Industrial Safety and Health Management" by C. Ray Asfahl and David W. Rieske
	2. "Principles of Safety" by E. Scott Geller
Reference Books	
	1. "Introduction to Industrial and Systems Engineering" by Wayne C. Turner and Richard D. Ryan
	2. "Safety and Health for Engineers" by Roger L. Brauer
	3. "Introduction to Process Safety for Undergraduates and Engineers" by CCPS (Center for Chemical Process Safety)

M.Tech 2nd Year

SEMESTER-III

MTACTC301: Research Methodology & Intellectual Property Rights

Weekly Teaching Hours: - TH: - Tut: -

Scheme of Marking TH: - Tests : - IA: 50 PR/OR: 50 Total : 100

Course Objectives:

The objectives of the course are:

1	To develop an appropriate framework for research studies.
2	To develop an understanding of various research designs and techniques.
3	To develop an understanding of the ethical dimensions of conducting applied research.

Course Outcomes:

At the end of course, students should:

CO1	Understand research problem formulation
CO2	Analyze research related information
CO3	Follow research ethics
CO4	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
CO5	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
CO6	Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT-I:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations**. (7hrs)**

UNIT-II:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, Plagiarism, Research ethics. **(7hrs)**

UNIT-III:

Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective), outcome as new idea, hypothesis, concept, theory, model. **(7hrs)**

UNIT-IV:

Effective technical writing, how to write a manuscript/ responses to reviewers comments, preparation of research article/ research report, Writing a Research Proposal - presentation and assessment by a review committee. **(7hrs)**

UNIT-V:

Nature of Intellectual Property: Patents, Designs, Trade Mark and Copyright. Process of Patenting and Development: technological research, innovation, patenting & development. Procedure for grants of patents, Patenting under PCT. **(6hrs)**

Unit VI:

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Computer Software etc. **(6hrs)**

REFERENCES:

1.Kothari, C. R. Research Methodology - Methods and Techniques, New Age International publishers, New Delhi, 2004
2. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
3. Ann M. Korner, Guide to Publishing a Scientific paper, Bioscript Press 2004
4. Mayall, "Industrial Design", McGraw Hill, 1992.
5. Niebel, "Product Design", McGraw Hill, 1974.
6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

MTACTP302: PROJECT-I

Weekly Teaching Hours: -		TH: -	Credit: 10	Tut: -
Scheme of Marking	TH: -	IA: 50	PR/OR: 50	Total : 100

Project-I is an integral part of the final project work. In this, the student shall complete the partial work of the project which will consist of problem statement, literature review, project overview, scheme of implementation that may include mathematical model/SRS/UML/ERD/block diagram/ PERT chart, and layout and design of the proposed system/work. As a part of the progress report of project-I work; the candidate shall deliver a presentation on progress of the work on the selected dissertation topic. It is desired to publish the paper on the state of the art on the chosen topic in international conference/ journal.

The student shall submit the duly certified progress report of project -I in standard format for satisfactory completion of the work duly signed by the concerned guide and head of the department/institute.

SEMESTER-IV

MTACTP401: PROJECT-II

Weekly Teaching Hours: -		TH: -	Credit: 20	Tut: -
Scheme of Marking	TH: -	IA: 100	PR/OR: 100	Total : 200

In Project - II, the student shall complete the remaining part of the project which will consist of the simulation/ analysis/ synthesis/ implementation / fabrication of the proposed project work, work station, conducting experiments and taking results, analysis and validation of results and drawing conclusions.

It is mandatory to publish 02 paper on the state of the art on the chosen topic in reputed international conference/ journal.

The student shall prepare the duly certified final report of project work in standard format for satisfactory completion of the work duly signed by the concerned guide and head of the department/institute.