RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)
RV Vidyaniketan Post, Mysuru Road,
Bengaluru – 560059

Scheme and Syllabus of I to IV Semester

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)
in
COMMUNICATION SYSTEMS

DEPARTMENT OF

ELECTRONICS & COMMUNICATION ENGINEERING

VISION

Leadership in Quality Technical Education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology.

MISSION

1. To deliver outcome based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
2. To create a conducive environment for interdisciplinary research and innovation.
3. To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
4. To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
5. To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

QUALITY POLICY

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the global Best Practices.

CORE VALUES

Professionalism, Commitment, Integrity, Team Work and Innovation

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ELECTRONICS & COMMUNICATION ENGINEERING

DEPARTMENT OF
ELECTRONICS & COMMUNICATION ENGINEERING

VISION

Imparting quality technical education through interdisciplinary research, innovation and teamwork for developing inclusive & sustainable technology in the area of Electronics and Communication Engineering

MISSION

1. To impart quality technical education to produce industry-ready engineers with a research outlook.
2. To train the Electronics & Communication Engineering graduates to meet future global challenges by inculcating a quest for modern technologies in the emerging areas.
3. To create centers of excellence in the field of Electronics & Communication Engineering with industrial and university collaborations.
4. To develop entrepreneurial skills among the graduates to create new employment opportunities

PROGRAM OUTCOMES (PO)

M. Tech. Communication Systems graduates will be able to:

PO1: Independently carry out research /investigation and development work to solve practical problems related to Communication Systems.

PO2: Write and present a substantial technical report/document in the field of Communication Systems

PO3: Demonstrate a degree of mastery over the area of Communication Systems. The mastery should be at a level higher than the requirements in the bachelor's in Electronics & Communication Engineering program

PO4: Design and develop communication system modules with good economics and business practices in order to meet the global challenges.

PO5: Abstract the requirements of an application to interface with communication modules.

PO6: Acquire professional and intellectual integrity, ethics of research and execute projects efficiently.

ABBREVIATIONS

Sl. No.	Abbreviation	Acronym
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	Professional Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics
23.	MCA	Master of Computer Applications
24.	MST	Structural Engineering
25.	MHT	Highway Technology
26.	MPD	Product Design & Manufacturing
27.	MCM	Computer Integrated & Manufacturing
28.	MMD	Machine Design
29.	MPE	Power Electronics
30.	MVE	VLSI Design & Embedded Systems
31.	MCS	Communication Systems
32.	MBS	Bio Medical Signal Processing & Instrumentation
33.	MCH	Chemical Engineering
34.	MCE	Computer Science & Engineering
35.	MCN	Computer Network Engineering
36.	MDC	Digital Communication
37.	MRM	Radio Frequency and Microwave Engineering
38.	MSE	Software Engineering
39.	MIT	Information Technology
40.	MBT	Biotechnology
41.	MBI	Bioinformatics

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RV COLLEGE OF ENGINEERING®, BENGALURU-560059
(Autonomous Institution Affiliated to VTU, Belagavi)
DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING
M.Tech in COMMUNICATION SYSTEMS

FIRST SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Total Credits**
1	18 MAT11B	Probability Theory & Linear Algebra	MAT	4	0	0	**4**
2	18MCS12	Advanced Communications Systems -1	EC	3	1	1	**5**
3	18MCS13	Advanced Communication Networks & Protocols	EC	3	1	1	**5**
4	18HSS14	Professional Skill Development	HSS	0	0	0	**0**
5	18MCS1AX	Elective – A	EC	4	0	0	**4**
6	18MCS1BX	Elective – B	EC	4	0	0	**4**
Total number of Credit				18	2	2	**22**
Total Number of Hours / Week				**18**	**4**	**4**	**26**

SECOND SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Total Credits**
1	18MCS21	Advanced Communications Systems-2	EC	3	1	1	**5**
2	18MCS22	Error Control and Coding	EC	3	1	0	**4**
3	18IM23	Research Methodology (Common to all programs)	IM	3	0	0	**3**
4	18MCS24	Minor Project	EC	0	0	2	**2**
5	18MCS2CX	Elective – C	EC	4	0	0	**4**
6	18MCS2DX	Elective – D	EC	4	0	0	**4**
7	18XX2GX	Global Elective	Respective boards	3	0	0	**3**
Total number of Credit				20	2	3	**25**
Total Number of Hours / Week				**20**	**4**	**6**	**30**

SEMESTER: I		
GROUP A: PROFESSIONAL ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	18MCS1A1	Advanced Embedded Systems
2.	18MCS1A2	Advanced Digital Signal Processing
3.	18MCS1A3	RF and Microwave Circuits
GROUP B: PROFESSIONAL ELECTIVES		
1.	18MVE1B1	MEMS and Smart Systems (Common to VLSI and CS)
2.	18MCS1B2	Digital Image Processing
3.	18MCS1B3	Cryptography and Network Security
II Semester		
GROUP C: PROFESSIONAL ELECTIVES		
1.	18MCS2C1	Antenna Theory
2.	18MCS2C2	Machine Learning (Common to VLSI & ES, CS, CNE, DCE, BMI, SE)
3.	18MCS2C3	Optical Communication Networks
GROUP D: PROFESSIONAL ELECTIVES		
1.	18MCS2D1	Wireless Sensor Networks and IOT
2.	18MCE2D2	Deep Learning (Common to CSE and CS)
3.	18MVE2D3	VLSI Digital Signal Processing Systems (Common to VLSI & ES and CS)

GROUP G: GLOBAL ELECTIVES				
Sl. No.	**Host Dept**	**Course Code**	**Course Title**	**Credits**
1.	CS	18CS2G01	Business Analytics	3
2.	CV	18CV2G02	Industrial & Occupational Health and Safety	3
3.	IM	18IM2G03	Modelling using Linear Programming	3
4.	IM	18IM2G04	Project Management	3
5.	CH	18CH2G05	Energy Management	3
6.	ME	18ME2G06	Industry 4.0	3
7.	ME	18ME2G07	Advanced Materials	3
8.	CY	18CHY2G08	Composite Materials Science and Engineering (Common to AS, BT, CH, CV, IM, ME)	3
9.	PY	18PHY2G09	Physics of Materials	3
10.	MA	18MAT2G10	Advanced Statistical Methods	3

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M.Tech Program in COMMUNICATION SYSTEMS

THIRD SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credit**
1.	18MCS31	Smart Antenna Array Signal Processing	EC	4	1	0	**5**
2.	18MCS32	Internship	EC	0	0	5	**5**
3.	18MCS33	Major Project: Phase I	EC	0	0	5	**5**
4.	18MCS3EX	Professional Elective-E	EC	4	0	0	**4**
Total number of Credit				**8**	**1**	**10**	**19**
Total Number of Hours / Week				**8**	**2**	**20**	**30**

III Semester		
GROUP E: CORE ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
4.	18MCS3E1	Wireless Cellular and LTE 4G Broadband
5.	18MCS3E2	Wireline Broadband Communication
6.	18MCS3E3	Wireless Local area Networks

FOURTH SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credit**
1	18MCS41	Major Project: Phase II	EC	0	0	20	**20**
2	18MCS42	Technical Seminar	EC	0	0	2	**2**
Total number of Credit				**0**	**0**	**22**	**22**
Total Number of Hours / Week				**0**	**0**	**44**	**44**

SEMESTER: I						
PROBABILITY THEORY & LINEAR ALGEBRA (Common to MCN, MCS, MDC, MCE, MRM, MIT, MSE) (Theory)						
Course Code	**:**	**18MAT11B**		**CIE Marks**	**:**	**100**
Credits	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **10 Hrs**

Matrices and Vector spaces :
Geometry of system of linear equations, vector spaces and subspaces, linear independence, basis and dimension, four fundamental subspaces, Rank-Nullity theorem (without proof), linear transformations.

Unit – II **10 Hrs**

Orthogonality and Projections of vectors:
Orthogonal Vectors and subspaces, projections and least squares, orthogonal bases and Gram-Schmidt orthogonalization, Computation of Eigen values and Eigen vectors, diagonalization of the matrix, Singular Value Decomposition.

Unit – III **10 Hrs**

Random Variables:
Definition of random variables, continuous and discrete random variables, Cumulative distribution Function, probability density and mass functions, properties, Expectation, Moments, Central moments, Characteristic functions.

Unit – IV **11 Hrs**

Discrete and Continuous Distributions:
Binomial, Poisson, Exponential, Gaussian distributions.

Multiple Random variables:
Joint PMFs and PDFs, Marginal density function, Statistical Independence, Correlation and Covariance functions, Transformation of random variables, Central limit theorem (statement only).

Unit – V **11 Hrs**

Random Processes:
Introduction, Classification of Random Processes, Stationary and Independence, Auto correlation function and properties, Cross correlation, Cross covariance functions. Markov processes, Calculating transition and state probability in Markov chain.

Course Outcomes
After completion of the course, the students should have acquired the ability to:

CO1	Demonstrate the understanding of fundamentals of matrix theory, probability theory and random process.
CO2	Analyze and solve problems on matrix analysis, probability distributions and multiple Random variables.
CO3	Apply the properties of auto correlation function, rank, diagonalization of matrix, verify Rank Nullity theorem and moments.
CO4	Estimate Orthogonality of vector spaces, Cumulative distribution function and Characteristic function. Recognize problems which involve these concepts in Engineering applications.

Reference Books

1.	Probability, Statistics and Random Processes, T. Veerarajan, 3rd Edition, Tata McGraw Hill Education Private Limited, 2008, ISBN:978-0-07-066925-3.
2.	Probability and Random Processes With Applications to Signal Processing and Communications, Scott. L. Miller and Donald. G. Childers, 2nd Edition, Elsevier Academic

	Press, 2012, ISBN 9780121726515.
3.	Linear Algebra and its Applications, Gilbert Strang, 4th Edition, Cengage Learning, 2006, ISBN 97809802327.
4.	Schaum's Outline of Linear Algebra, Seymour Lipschutz and Marc Lipson, 5th Edition, McGraw Hill Education, 2012, ISBN-9780071794565.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: I

ADVANCED COMMUNICATIONS SYSTEMS -1
(Theory and Practice)

Course Code	**:**	**18MCS12**		**CIE Marks**	**:**	**100+50**
Credits	**:**	**3:1:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**39L+26T +26P**		**SEE Duration**	**:**	**3 +3 Hrs**

Unit – I **08 Hrs**

Signal Representation – Low pass representation of bandpass signals, Low pass representation of bandpass random process. Multiplexing and De-multiplexing of Signals.
Modulation: Modulation Schemes without memory (Band Limited Schemes - PAM, BPSK, QPSK, MPSK, MQAM, and Power Limited Schemes – FSK, MFSK, DPSK, DQPSK), modulation schemes with memory (MSK), Transmit PSD for Modulation Schemes.

Unit – II **08 Hrs**

Demodulation - Vector Channel, Vector Channel +AWGN, Performance parameters, Optimum Coherent Detection for power limited and Bandlimited schemes, Optimal Coherent detection for schemes with memory, Optimal Non – Coherent detection for schemes without and with memory (FSK, DPSK, DQPSK).

Unit – III **08 Hrs**

Bandlimited Channels: Bandlimited channel characterization, signalling through band limited linear filter channels, Sinc, RC, Duobinary and Modified Duobinary signaling schemes, Optimum receiver for channel with ISI and AWGN.
Linear Equalizers: Zero forcing Equalizer, MSE and MMSE, Baseband and Passband Linear Equalizers. Performance of ZFE and MSE discussion only.

Unit – IV **08 Hrs**

Non-Linear Equalizers: Decision - feedback equalization, Predictive DFE, Performance of DFE.
Adaptive equalization: Adaptive linear equalizer, adaptive decision feedback equalizer, Adaptive Fractionally spaced Equalizer (Tap Leakage Algorithm).

Unit – V **07 Hrs**

Spread spectrum signals for digital communication: Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, Frequency hopped spread spectrum signals, CDMA, Time hopping SS, Synchronization of SS systems.

Course Outcomes
After going through this course the student will be able to:

CO1	Explain the concept of low pass and Bandpass signals representations at the Transmitter, the process of Detection and Estimation at the receiver in the presence of AWGN only.
CO2	Evaluate Receiver performance for various types of single carrier symbol modulations through ideal and AWGN Non-band limited and band limited channels.
CO3	Design single carrier equalizers for various symbol modulation schemes and detection methods for defined channel models, and compute parameters to meet desired rate and performance requirements.
CO4	Design and Evaluate Non band limited and Non power limited spread spectrum systems for communications in a Jamming environment, multiuser situation and low power intercept environment.

LAB EXPERIMENTS **2 Hrs/Week**

1. Generation and study the properties of Line codes.
2. Pulse Amplitude Modulation and Demodulation.
3. ASK Modulation and Demodulation
4. Binary Phase Shift Keying Modulation and Demodulation
5. Frequency Shift Keying Generation and detection

6. QPSK Modulation and Demodulation 7. QAM Modulation and Demodulation 8. Minimum Shift Keying Modulation 9. Generation of PN Sequence and Gold sequence 10. Design of Linear Equalizers 11. Demo Experiment using Ham Radio	
Reference Books	
1.	Digital Communications, John G. Proakis, Masoud Salehi, 5th Edition, Pearson Education, 2014, ISBN:978-9332535893
2.	Digital Communications: Fundamentals and Applications: Fundamentals &Applications, Bernard Sklar,2nd Edition, Pearson Education, 2009, ISBN:978-8131720929
3.	Digital Communications Systems, Simon Haykin ,1st Edition ,Wiley, 2014, ISBN:978-8126542314
4.	Signal Detection and Estimation, Mourad Barkat, 2nd Edition, Artech house, 2005, ISBN: 1580530702

Scheme of Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Scheme of Continuous Internal Evaluation (CIE): Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Continuous Internal Evaluation (CIE): Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE): Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

SEMESTER: I

ADVANCED COMMUNICATION NETWORKS & PROTOCOLS
(Theory and Practice)

Course Code	**:**	**18MCS13**		**CIE Marks**	**:**	**100+50**
Credits	**:**	**3:1:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**39L+26T+26P**		**SEE Duration**	**:**	**3 +3 Hrs**

Unit – I **08 Hrs**

Foundation: Building a Network, Requirements, Perspectives, Scalable Connectivity, - Cost Effective Resource sharing, Support for Common Services, Manageability, Protocol layering, Performance, Bandwidth and Latency, Delay X Bandwidth Product, Perspectives on Connecting, Classes of Links, Reliable Transmission, Stop-and-Wait , Sliding Window, Concurrent Logical Channels.

Unit – II **08 Hrs**

Internetworking I: Switching and Bridging, Datagram's, Virtual Circuit Switching, Source Routing, Bridges and LAN Switches, Basic Internetworking (IP), What is an Internetwork?, Service Model, Global Addresses, Datagram Forwarding in IP, Subnetting and classless addressing, Address Translation (ARP) Host Configuration(DHCP), Error Reporting(ICMP).

Unit – III **08 Hrs**

Internetworking- II: Network as a Graph, Distance Vector(RIP), Link State(OSPF), Metrics, The Global Internet, Routing Areas, Routing among Autonomous systems(BGP), IP Version 6(IPv6), Mobility and Mobile IP

Unit – IV **08 Hrs**

End-to-End Protocols: Simple Demultiplexer (UDP), Reliable Byte Stream(TCP), End-to-End Issues, Segment Format, Connecting Establishment and Termination,TCP Congestion Control, Additive Increase/ Multiplicative Decrease, Slow Start, Fast Retransmit and Fast Recovery

Unit – V **07 Hrs**

Congestion Control and Resource Allocation: Congestion-Avoidance Mechanisms, DEC bit, Random Early Detection (RED), Source-Based Congestion Avoidance. The Domain Name System(DNS),),World Wide Web(HTTP).

Course Outcomes
After going through this course the student will be able to:

CO1	Explain the performance of various multiple access protocols.
CO2	Design the network protocol for given specifications of applications.
CO3	Design & develop the scheduling algorithms for various performance metrics.
CO4	Develop various network traffic management and control techniques for given specification

LAB EXPERIMENTS

Part –I: Experiments Using C/C++ programming.
1. Bit stuffing & character stuffing.
2. Cyclic Redundancy check.
3. Implement leaky bucket congestion control algorithm
4. Minimum spanning tree.

Part-II: The following experiments are to be conducted using CISCO Packet Tracer
5. Cable a network according to the given network topology and test and verify configurations using packet tracer by using ping commands.
6. Configuring Wireless LAN Access and test and verify configurations using packet tracer.
7.. Configuring Traditional Inter-VLAN Routing and test and verify configurations using packet tracer.

Part-III: Experiments that may be carried out using QUALNET

8. Study the performance of CSMA/CA protocols. 9.Study the performance of network with CSMA/CA protocol and compare CSMA/CD protocols.	
Reference Books	
1.	Computer Networks: A System Approach, Larry Peterson and Bruce S Davis, 5th Edition , Morgan Kaufmann, 2011, ISBN-10: 9780123850591.
2.	Internetworking with TCP/IP, Principles, Protocols and Architecture, Douglas E Comer, 6th Edition, PHI, 2014, ISBN-10: 9332550107.
3.	Computer Networks, Protocols , Standards and Interfaces, Uyless Black, 2nd Edition, PHI,1993, ISBN: 0-13-090861-4
4.	TCP /IP Protocol Suite, Behrouz A Forouzan , 4th Edition, Tata McGraw-Hill,2009, ISBN-10: 0073376043

Scheme of Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Scheme of Continuous Internal Evaluation (CIE): Theory (100 Marks)
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Scheme of Semester End Examination (SEE): Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

SEMESTER: I						
PROFESSIONAL SKILL DEVELOPMENT						
Course Code	**:**	**18HSS14**		**CIE Marks**	**:**	**50**
Credits: L: T:P	**:**	**0:0:3**		**SEE Marks**	**:**	**Audit Course**
Hours	**:**	**18L**		**CIE Duration**	**:**	**02 Hrs**

Unit-1	**03 Hrs**
Communication Skills: Basics of Communication, Personal Skills & Presentation Skills – Introduction, Application, Simulation, Attitudinal Development, Self Confidence, SWOC analysis. Resume Writing: Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts. Theory and Applications.	
Unit-2	**08 Hrs**
Quantitative Aptitude and Data Analysis: Number Systems, Math Vocabulary, fraction decimals, digit places etc. Simple equations – Linear equations, Elimination Method, Substitution Method, Inequalities. Reasoning – a. Verbal - Blood Relation, Sense of Direction, Arithmetic & Alphabet. b. Non- Verbal reasoning - Visual Sequence, Visual analogy and classification. Analytical Reasoning - Single & Multiple comparisons, Linear Sequencing. Logical Aptitude, - Syllogism, Venn-diagram method, Three statement syllogism, Deductive and inductive reasoning. Introduction to puzzle and games organizing information, parts of an argument, common flaws, arguments and assumptions. Verbal Analogies/Aptitude – introduction to different question types – analogies, Grammar review, sentence completions, sentence corrections, antonyms/synonyms, vocabulary building etc. Reading Comprehension, Problem Solving.	
Unit-3	**03 Hrs**
Interview Skills: Questions asked & how to handle them, Body language in interview, and Etiquette – Conversational and Professional, Dress code in interview, Professional attire and Grooming, Behavioral and technical interviews, Mock interviews - Mock interviews with different Panels. Practice on Stress Interviews, Technical Interviews, and General HR interviews.	
Unit-4	**02 Hrs**
Interpersonal and Managerial Skills: Optimal co-existence, cultural sensitivity, gender sensitivity; capability and maturity model, decision making ability and analysis for brain storming; Group discussion (Assertiveness) and presentation skills.	
Unit-4	**02 Hrs**
Motivation: Self-motivation, group motivation, Behavioral Management, Inspirational and motivational speech with conclusion. (Examples to be cited). **Leadership Skills:** Ethics and Integrity, Goal Setting, leadership ability.	
Note: The respective departments should discuss case studies and standards pertaining to their domain	

Course Outcomes: After completing the course, the students will be able to	
CO1	Develop professional skill to suit the industry requirement.
CO2	Analyze problems using quantitative and reasoning skills
CO3	Develop leadership and interpersonal working skills.
CO4	Demonstrate verbal communication skills with appropriate body language.

Reference Books	
1.	The 7 Habits of Highly Effective People, Stephen R Covey Free Press, 1st Edition, 2004, ISBN: 0743272455
2.	How to win friends and influence people, Dale Carnegie General Press, 1st Edition, 2016, ISBN: 9789380914787
3.	Crucial Conversation: Tools for Talking When Stakes are High, Kerry Patterson, Joseph Grenny, Ron Mcmillan 1st Edition, McGraw-Hill Publication, 2012, ISBN: 9780071772204
4.	Ethnus, Aptimithra: Best Aptitude Book ,1st Edition, Tata McGraw Hill, 2014, ISBN: 9781259058738

Scheme of Continuous Internal Examination (CIE)
Evaluation of CIE will be carried out in TWO Phases.

Phase	Activity	Weightage
I	Test 1 is conducted after completion 9 of hours training program (3 Class) for 50 marks Part A- Quiz for 15 Marks and Part B for 50 Marks (Descriptive answers). The marks are consolidated to 50 Marks.	50%
II	Test 2 is conducted after completion 18 hours of training program (6 Class) for 50 marks Part A- Quiz for 15 Marks and Part B for 50 Marks (Descriptive answers). The marks are consolidated to 50 Marks.	50%
III	Average of TWO tests and the score must be greater than 50% .Two tests are mandatory, 75% attendance mandatory to qualify, if not he / she will not be awarded with M.Tech degree.	

CIE Evaluation shall be done with weightage as follows:

Writing skills	10%
Logical Thinking	25%
Verbal Communication & Body Language	35%
Leadership, Interpersonal and Stress Bursting Skills	30%

SEE: Not Applicable

SEMESTER: I						
ADVANCED EMBEDDED SYSTEM DESIGN (Professional Elective-A1)						
Course Code	**:**	**18MCS1A1**		**CIE Marks**	**:**	**100**
Credits: L: T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **11 Hrs**

Introduction to Embedded System Design

Introduction, Characteristics of Embedding Computing Applications, Concept of Real time Systems, Challenges in Embedded System Design, Design Process: Requirements, Specifications, Hardware Software Partitioning, Architecture Design, Designing of Components, System Integration

Embedded System Architecture

Instruction Set Architectures with examples, Memory system Architecture: Von Neumann, Harvard, caches, Virtual Memory, Memory Management, I/O sub system: Busy wait I/O,DMA, Interrupt Driven I/O, Co-Processor & Hardware Accelerators, Processor performance Enhancement: Pipelining, Superscalar Execution, Multi Core CPUs, CPU Power Consumption, Benchmarking Standards: MIPS, MFLOPS, MMACS, Coremark

Unit – II **10 Hrs**

Designing Embedded System Hardware –I

CPU Bus: Bus Protocols, Bus Organisation, Memory Devices and their Characteristics: RAM, EEPROM, Flash Memory, DRAM; I/O Devices: Timers and Counters, Watchdog Timers, Interrupt, Controllers, DMA Controllers, A/D and D/A Converters, Displays, Keyboards, Infrared devices

Unit – III **10 Hrs**

Designing Embedded System Hardware –II

Component Interfacing: Memory interfacing with case study; I/O Device Interfacing with case Study: Programmed IO, Memory Mapped IO, Interfacing Protocols: SPI, I2C, CAN, USB, Reset Circuits, Designing with Processors: System Architecture, FPGA based Design, Processor Selection Criteria

Unit – IV **10 Hrs**

Designing Embedded System Software –I

Application Software, System Software, Use of High Level Languages: C,C++,Java, Programming & Integrated Development Environment tools: Editor, Compiler, Linker, Automatic Code Generators, Debugger, Board Support Library, Chip Support Library, Analysis and Optimization: Execution Time, Energy & Power, Program Size; Program Validation & Verification, Embedded System Coding Standards: MISRA C 2012/CERT, Standards in Automobiles, Aerospace &Biomedical Applications.

Unit – V **11 Hrs**

Designing Embedded System Software –II

OS based Design, Real Time Kernel, Process& Thread, Inter Process Communications, Synchronization, Case Study: RTX-ARM, Evaluating and Optimising Operating System Performance: Response time Calculation, Interrupt Latency, Time Loading, Memory Loading, Case Study: Embedded Control Applications-Software Coding of a PID Controller, PID Tuning, IoT based Resource Monitoring

Course Outcomes

After going through this course the student will be able to:

CO1	Describe hardware & software of an embedded systems for real time applications with suitable processor architecture, memory and communication interface.
CO2	Design embedded software & hardware to meet given constraints with the help of modern engineering tools.
CO3	Demonstrate compliance of prescribed safety norms through implementation of the identified engineering problems pertaining to automobiles, aerospace & biomedical applications.
CO4	Design, implement and demonstrate open ended problem to access their capabilities through assignments

Reference Books	
1.	Embedded Systems – A contemporary Design Tool, James K Peckol, 2nd edition, John Weily, 2008, ISBN: 0-444-51616-6
2.	Introduction to Embedded Systems, Shibu K V, 1st edition, Tata McGraw Hill Education Private Limited, 2009, ISBN: 10: 0070678790
3.	Embedded Software Primer, David E.Simon, Addison Wesley, 2nd edition, John Weily, 2002,ISBN-13: 978-0201615692
4.	The Intel Micro-processors, Architecture, Programming and Interfacing, Barry B.Brey, 6th Edition, Pearson Education, 2008, ISBN-10: 8131726223

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: I						
ADVANCED DIGITAL SIGNAL PROCESSING (Professional Elective-A2)						
Course Code	**:**	**18MCS1A2**		**CIE Marks**	**:**	**100**
Credits: L: T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
Review of Digital Filters Introduction, Filter Design specifications, FIR Filter Design, IIR Filter Design, Allpass Filters, IIR Filters Based on two Allpass Filters.	
Unit – II	**11 Hrs**
Fundamentals of Multirate Systems Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling Rate Conversion by a Rational Factor I/D. **Implementation of Sampling Rate Conversion:** Polyphase Filter Structures, Interchange of Filters and down samplers/Up samplers.	
Unit – III	**11 Hrs**
Implementation of Sampling Rate Conversion Sampling Rate Conversion with Cascaded Integrator Comb Filters, Polyphase Structures for Decimation and Interpolation filters and Structures for Rational Sampling Rate Conversion. **Multistage** Implementation of Sampling Rate Conversion, Sampling Rate Conversion, Sampling Rate Conversion by an Arbitrary Factor, Digital Filter Banks.	
Unit – IV	**10 Hrs**
Two Channel Quadrature Mirror Filter Bank Elimination of Aliasing, Condition for perfect Reconstruction, Polyphase form of the QMF Bank, IIR QMF Bank, Perfect Reconstruction Two-Channel FIR QMF Banks in Sub band Coding, M-channel QMF Bank	
Unit – V	**10 Hrs**
The Wavelet Transform and its relation to Multirate Filter Banks Introduction, The short-Time Fourier transform, The wavelet transform, Discrete-Time orthonormal wavelets, Continuous- Time orthonormal wavelet	

Course Outcomes
After going through this course the student will be able to:

CO1	Design & analyze the practical aspects of sampling and reconstruction and select a suitable sampling rate for a given signal processing problem.
CO2	Design & development of tree-structured maximally decimated filter bank through the concept of discrete-time wavelets.
CO3	Design and analyze multi-rate filters for a given specification.
CO4	Implement Multirate QMF, PR orthogonal filter banks and wavelet filters for various applications.

Reference Books

1.	Digital signal processing, Proakis and Manolakis, 3rd edition, Prentice Hall, 1996, ISBN 0131873741.
2.	Modern Digital signal processing, Robert. O. Cristi, 2nd edition, Cengage Publishers, India, 2003, ISBN:978-0534400958
3.	Multirate Systems and Filter Banks, Vaidyanathan P.P, 1st edition, Pearson Publication, 2006, ISBN: 81-7758-942-3S.
4.	Digital signal processing: A computer-based approach, K. Mitra, 3rd edition, TMH, India, 2007, ISBN 9780070667563

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: I						
RF AND MICROWAVE CIRCUITS (Professional Elective-A3)						
Course Code	**:**	**18MCS1A3**		**CIE Marks**	**:**	**100**
Credits: L: T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
Introduction – Reasons for using RF/ Microwaves, Applications, RF and Microwave (MW) Circuit Design **RF Electronics Concepts –** Introduction to Components basics, Analysis of a Simple Circuit Phasor Domain, RF Impedance Matching	
Unit – II	**11 Hrs**
Fundamentals of Wave Propagation: Properties of Waves, Transmission Media **Circuit Representations of Two-Port RF/MW Networks** - Low-Frequency Parameters, High-Frequency parameters, Formulation of S-parameters, Properties, Transmission Matrix, Generalized S-parameters, Signal Flow Graphs	
Unit – III	**10 Hrs**
Passive circuit design: Introduction, Smith chart and Applications **Design of matching networks:** Definition of Impedance Matching, Matching using lumped and distributed elements	
Unit – IV	**10 Hrs**
Basic consideration in active networks: Stability Consideration in Active Networks, Gain Considerations in Amplifiers, Noise Considerations in Active Networks	
Unit – V	**11 Hrs**
Active Networks: Linear and Non-Linear Design: Introduction, Types of Amplifiers, Small Signal Amplifiers, Design of different types of Amplifiers **Oscillators:** Introduction, Oscillator vs Amplifier Design, Oscillation Conditions, Design of Transistor Oscillators	

Course Outcomes
After going through this course the student will be able to:

CO1	Describe RF Circuits, impedance matching & working of small & large signal microwave amplifier
CO2	Calculate the RF circuits parameters like S-Parameter, SNR and VSWR and impedance transformation and also impedance matching
CO3	Analyze the performance of RF Circuits in terms of Gain, Stability and Noise
CO4	Design various active and passive networks with linear and non-linear design considerations

Reference Books

1.	RF and Microwave Electronics Illustrated, Matthew M. Radmanesh, 1st edition, Pearson Education, 2004, ISBN-10: 8177584014.
2.	RF circuit design theory and applications, Reinhold Ludwig, and Pavel Bretchko, 1st edition, Pearson Education edition, 2004, ISBN-10: 9788131762189
3.	Microwave Solid State Circuit Design, Inder Bahl and Prakash Bhartia, 2nd edition, Wiley India edition, 2011, ISBN-10: 9788126530472
4.	RF and Microwave Circuit Design: A Design Approach Using (ADS), Ali A. Behagi, 1st edition, Techno Search Publishers, 2015. ISBN-10: 0996446613

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: I

MEMS AND SMART SYSTEMS
(Professional Elective-B1)
(Common to VLSI and CS)

Course Code	**:**	**18MVE1B1**		**CIE Marks**	**:**	**100**
Credits: L: T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **11 Hrs**

Introduction to MEMS and principle of operation

Introduction, History of evolution, Definition of MEMS in a broader sense. Components of a smart system. Commercial products. Microsystems and Miniaturization. Evolution of micro-manufacturing. Design Aspects. Application and future scope of MEMS devices, Market trends.

Definitions and salient features of sensors, actuators and systems. Working principles of Microsystems. Sensors: silicon capacitive accelerometer, piezo-resistive pressure sensor, blood analyzer, conductometric gas sensor, Actuators: silicon micro-mirror arrays, piezo-electric based inkjet printhead, electrostatic comb-drive and micromotor, magnetic micro relay.

Unit – II **10 Hrs**

Micro and Smart Devices and Systems: Materials and Processing

Materials

Introduction, Substrates and Wafers, Active substrate materials, Si as a substrate material, Si compounds, Si Piezoresistors, Gallium Arsenide, Quartz, Piezoelectric Crystals and Polymers.

Processing

Silicon wafer processing, lithography, thin-film deposition, etching (wet and dry), wafer-bonding, and metallization, Silicon micromachining: surface and bulk, bonding based process flows. Thick-film processing: Smart material processing, Emerging trends.

Unit – III **11 Hrs**

Mechanical modelling and Scaling laws in Microsystems Modelling

Simplest deformable element: a bar, Transversely deformable element: a beam, Bimorph effect, Mechanical vibration: general formulation, Resonant Vibration, Design theory of accelerometers and damping coefficients. Basics of fluid mechanics in macro and mesoscales, Capillary effect, electro-phoresis and Dielectrophoresis.

Scaling laws in Miniaturization

Importance of scaling in MEMS- Scaling in geometry, Scaling in rigid body dynamics, scaling in electrostatic forces, scaling in electromagnetic forces, scaling in electricity, scaling in fluid dynamics. scaling effects in the optical domain, scaling in biochemical phenomena.

Unit – IV **10 Hrs**

RF MEMS

Introduction to RF MEMS, Static Analysis of RF MEMS devices: Spring Constant of Low-k Beams, Spring Constant of Cantilever Beams, Spring Constant of Circular Diaphragms, Beam Curvature due to Stress Gradients. Electrostatic Actuation, Shape of the Deformed Beam Under Electrostatic Actuation, DC Hold-Down Voltage of MEMS Beams and Cantilevers, Forces on MEMS Beams, Self-Actuation of MEMS Capacitive Switches, RF Hold-Down Voltage of MEMS Capacitive Switches.

Unit – V **10 Hrs**

Case study of devices: Pressure sensors, accelerometers, micro pump, micro heater. Introduction to CAD tool for simulation of devices.

Packaging : Integration of Microsystems and microelectronics, Packaging Introduction, Micro Systems Packaging, Objectives, Issues in packaging, Special issues in micro system packaging, Types of Microsystem Packages, Packaging Technologies.

Course Outcomes **After going through this course the student will be able to:**	
CO1	Explain the technology to fabricate advanced micro- and smart systems
CO2	Analyse different methods to fabricate MEMS devices.
CO3	Apply the basics of implementation of MEMS into products.
CO4	Evaluate the principles and processes involved in the implementation of MEMS devices
Reference Books	
1.	Micro and Smart Systems, Dr. A.K.Aatre, Ananth Suresh, K.J.Vinoy, S. Gopala krishna, K.N.Bhat, 1st edition, John Wiley Publications, 2002, ISBN: 1118213904, 9781118213902
2.	MEMS & Microsystems: Design and Manufacture,Tai-Ran Tsu, 1st edition, 8th reprint, Tata Mc-Graw-Hill, 2002. ISBN-13:978-0-07-048709-3
3.	RF MEMS Theory, Design and Technology, Gabriel M. Rebeiz, 1st edition, John Wiley Publications 2003, ISBN: 978-0-471-20169-4
4.	Microsystems Design, S. D. Senturia,1st edition, Kluwer Academic Publishers, Boston, USA, 2001, ISBN 0-7923-7246-8

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : I

DIGITAL IMAGE PROCESSING
(Professional Elective-B2)

Course Code	**:**	**18MCS1B2**		**CIE Marks**	**:**	**100**
Credits: L: T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52 L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **11 Hrs**

Digital Image Fundamentals:
Steps in Digital Image Processing, Components, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Relationships between pixels, Colour image fundamentals, RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms, DFT, DCT.

Unit – II **10 Hrs**

Image Enhancement:
Spatial Domain: Gray level transformations, Histogram processing, Basics of Spatial Filtering, Smoothing and Sharpening Spatial Filtering
Frequency Domain: Introduction to Fourier Transform, Smoothing and Sharpening frequency domain filters, Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.

Unit – III **10 Hrs**

Image Restoration:
Image Restoration, degradation model, Properties, Noise models, Mean Filters, Order Statistics, Adaptive filters, Band reject Filters, Band pass Filters, Notch Filters, Optimum Notch Filtering, Inverse Filtering, Wiener filtering

Unit – IV **10 Hrs**

Image Segmentation & Morphological Processing:
Edge detection, Edge linking via Hough transform, Tresholding, Region based segmentation, Region growing, Region splitting and merging, Morphological processing, erosion and dilation, Segmentation by morphological watersheds, Basic concepts, Dam construction, Watershed segmentation algorithm.

Unit – V **11 Hrs**

Image Compression:
Need for data compression, Redundancy in Images and Classification of Redundancy in Images, Classification of Image Compression Schemes, Run Length Coding, Shanon-Fano Coding, Huffman Coding, Arithmetic coding, Dictionary based Compression, JPEG &MPEG standards..

Course Outcomes

After going through this course the student will be able to:

CO1	Know and understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms.
CO2	Operate on images using the techniques of smoothing, sharpening and enhancement.
CO3	Understand the restoration concepts and filtering techniques.
CO4	Learn the basics of segmentation, features extraction, compression for images.

Reference Books

1.	Digital Image Processing, Rafael C. Gonzalez & Richard E. Woods, 3rd edition, Pearson Education , 2016, ISBN-10: 9332570329,978-9332570320
2.	Fundamental of Digital Image Processing, A.K. Jain,1st edition, PHI publications, 2015. ISBN: 978-933255191
3.	Digital Image Processing, Jähne, Bernd, 1st edition, Springer, 2005, ISBN: 9783540275633
4.	Fundamentals of Digital Image Processing: A Practical Approach with Examples in Matlab, Chris Solomon, Toby Breckon, 2nd edition, Wiley, 2011, ISBN: 978-0-470-84472-4

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: I						
CRYPTOGRAPHY & NETWORK SECURITY (Professional Elective-B3)						
Course Code	**:**	**18MCS1B3**		**CIE Marks**	**:**	**100**
Credits: L: T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**11 Hrs**
Introduction – Principles of Security, Basic Cryptographic techniques, Symmetric cipher model, substitution and transportation ciphers, DES, Triple DES, Block cipher design principles. **Symmetric Ciphers:** AES structure, transformation function and key expansion, RC2, RC4, RC5, RC6.	
Unit – II	**10 Hrs**
Finite Fields: Groups, Rings and Fields, Modulo Arithmetic, Euclidean Algorithm, Finite Fields of The Form GF(p), Polynomial Arithmetic, Finite Fields of The Form GF(2n).	
Unit – III	**11 Hrs**
Asymmetric Ciphers: Principles of public key cryptosystems, RSA algorithm, attacks over RSA algorithm, Elgamal crypto system, Elliptic curve cryptography, Message authentication and Hash Functions, pseudorandom number generation.	
Unit – IV	**10 Hrs**
Cloud Security: Cloud Computing Concepts, Moving to the Cloud, Cloud security tools and Techniques, Cloud Identity management, Securing IaaS.	
Unit V	**10 Hrs**
Strategic Defenses: Cryptogrphy in Network Security, Firewalls, Intrusion Detection and prevention systems, Network management. **Privacy:** Privacy on the Web, Email Security, Privacy impacts of emerging Technologies.	

Course Outcomes
After going through this course the student will be able to:

CO1	Implement the security policies like authentication, integrity and confidentiality in the form of message exchange
CO2	Implement cryptographic principles to various threats.
CO3	Learn about security issues when moving to cloud.
CO4	Analyze web and network security threats.

Reference Books

1. Cryptography and Network Security: Principles and Practices, William Stallings, 6th Edition, Pearson education, 2014, ISBN-10: 9789332585225

2. Security in Computing, Charles P.Pfleeger, Shari Lawrence P.Pfleeger, Jonathan Margulies, 5th Edition, Prentice Hall, 2015, ISBN-10: 9789352866533

3. Cryptography and Network Security, Atul Kahate, 3rd Edition, Tata McGraw Hill, 2013, ISBN-10: 9781259029882

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
ADVANCED COMMUNICATIONS SYSTEMS -2 (Theory and Practice)						
Course Code	**:**	**18MCS21**		**CIE Marks**	**:**	**100+50**
Credits L: T:P	**:**	**3:1:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**39L+26T+26P**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**

Synchronization – Signal Parameter estimation, Carrier Phase Estimation, Symbol Timing Recovery.

Fading – Large scale, small scale; Statistical characterization of multipath channels – Delay and Doppler spread, classification of multipath channels, scattering function; Binary signaling over frequency non selective Rayleigh fading channel.

Unit – II	**08 Hrs**

Fading Contd: - Diversity techniques for performance improvement with binary signaling over FNS, Slow fading channels – power combining and Maximal ratio combining; Frequency selective channels – Rake receivers, Performance, Tap weight Synchronization, Application to CDMA.

Unit – III	**08 Hrs**

Capacity of wireless channel: A Review of Differential Entropy. Shannon's Theorem, Capacity of a Linear time invariant Gaussian channel, Capacity of Colored Noise channels.

Multicarrier Signalling: Single carrier vs Multicarrier, Multicarrier Concepts, Types of Multicarrier in AWGN channel, OFDM Implementation, Spectral Characteristics, Power and bit allocation, Capacity of Multicarrier Channel, Peak to Average Power Ratio, Channel Equalization and Coding Considerations for OFDM.

Unit – IV	**08 Hrs**

MIMO spatial multiplexing and channel modeling: Multiplexing capability of deterministic MIMO channels, Physical modeling of MIMO channels, Modeling of MIMO fading channels**.**

Unit – V	**07 Hrs**

MIMO capacity and multiplexing architectures: The V-BLAST architecture, Fast fading MIMO channel, Capacity with CSI at receiver, Performance gains, Full CSI, Performance gains in a MIMO channel, Receiver architectures – (Linear decorrelator, Successive cancellation, Linear MMSE receiver), Information theoretic optimality, Connections with CDMA multiuser detection and ISI equalization, Slow fading MIMO channel, D-BLAST concepts and Considerations.

Lab Experiments

1. Modulation and Detection, Pulse Shaping and Matched Filtering
2. Synchronization: Symbol Timing Recovery in Narrowband channels
3. Channel Estimation & Equalization
4. Frame Detection & Frequency Offset Correction
5. OFDM Modulation & Frequency Domain Equalization
6. Synchronization in OFDM Systems using Schmidl and Cox Algorithm
7. Channel Coding in OFDM Systems
8. Generation of OFDM Signal using the 16-point QAM signal constellation.
9. Performance of AWGN and Rayleigh fading channels for different Binary modulation schemes- BPSK, BFSK, DPSK.
10. Performance improvement through Signal diversity on a Frequency non-selective channel. Performance improvement through RAKE demodulator on a Frequency selective channel.
11. Error rate Performance of 2x2 MIMO system in a Rayleigh fading AWGN channel using

a) Maximum-Likelihood Detector (MLD)
b) Minimum Mean-Square-Error Detector (MMSE) and
c) Minimum Inverse Channel Detector (ICD)

Course Outcomes **After going through this course the student will be able to:**	
CO1	Explain the concepts of multi-channel signaling scheme and synchronization for carrier and symbol timing recovery at receiver.
CO2	Evaluate the degradation in performance of various symbol signaling schemes in a multipath fading environment.
CO3	Develop & analyze schemes to improve performance in a multipath fading environment including diversity, maximal ratio combining and RAKE receivers.
CO4	Develop and evaluate the performance of a MIMO scheme to meet specified rate in a given multipath environment.

Reference Books	
1.	Digital Communications, John G. Proakis, Masoud Salehi, 5th Edition, Pearson Education, 2014, ISBN:978-9332535893
2.	Fundamentals of Wireless Communication, David Tse, Pramod Viswanath, 1st Edition, Cambridge University Press, 2005 , ISBN:0521845270
3.	Digital Communications: Fundamentals and Applications, Bernard Sklar,2nd Edition, Pearson Education, 2009, ISBN:978-8131720929
4.	Digital Communications Systems, Simon Haykin, Wiley, 2014 ,ISBN:978-0-471-64735-5

Scheme of Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Scheme of Continuous Internal Evaluation (CIE): Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Continuous Internal Evaluation (CIE): Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE): Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

SEMESTER: II						
ERROR CONTROL AND CODING (Theory)						
Course Code	**:**	**18MCS22**		**CIE Marks**	**:**	**100**
Credits: L: T:P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L+26T**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**

Information theory Review: Coding for a discrete memoryless channel, Coding for the binary symmetric channel.
Introduction to algebra: Groups, Fields, binary field arithmetic, Construction of Galois Field GF (2^m) and its properties, Computation using Galois filed GF (2^m) arithmetic, Vectors and Matrices.
Linear block codes: Generator and parity check matrices, Encoding circuits, Syndrome and error detection, Minimum distance considerations, Error detecting and error correcting capabilities, Standard array and syndrome decoding, Single Parity Check Codes(SPC),Repetition codes.

Unit – II	**08 Hrs**

Linear block codes Applications contd: Hamming codes, Single error and double error correcting Hamming code, Reed-Muller codes, and interleaved codes.
Cyclic codes: Introduction, Generator and parity check polynomials, Encoding of cyclic codes, Syndrome computing and error detection, Decoding of cyclic codes, Cyclic hamming codes, (23,12) Golay Code.

Unit – III	**08 Hrs**

BCH codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field arithmetic, Implementation of error correction.
Non-binary BCH codes: q-ary linear block codes, Primitive BCH codes over GF(q), Reed - Solomon codes, decoding of non-binary BCH and RS codes: The Berlekamp - Massey Algorithm.

Unit – IV	**08 Hrs**

Majority Logic decodable codes: One -step majority logic decoding, Class of One-step majority logic decodable codes, One-step majority logic decoding of Maximal length code.
Convolution codes: Encoding of convolutional codes, Transfer Function of convolution codes, Structural properties, Distance properties, Viterbi search decoding algorithm – soft decision and hard decision based, ZJ Stack Sequential decoding algorithm, Probability of error in convolution decoding for hard and soft decision cases. Punctured and Tail biting Convolution codes.

Unit – V	**07 Hrs**

Concatenated Codes: Single level Concatenated Codes, Multilevel Concatenated Codes (Formulation only), Soft decision Multistage Decoding (Formulation only).
Turbo Codes: Introduction, Distance Properties for an example PCBC and one PCCC, Performance Analysis Formulation and one example only.
Low Density parity-Check Codes: Introduction, Tanner Graphs, Geometric Construction of LDPC Codes, Decoding of LDPC Codes – Majority Logic, Bit Flipping.

Course Outcomes
After going through this course, the student will be able to:

CO1	Explain the principles and theory in the construction of Block Codes and Convolution Codes and their use in Storage and Communication systems.
CO2	Perform a decoding procedure for Block and Convolution codes.
CO3	Test and evaluate Block and Convolution Codes schemes for performance.
CO3	Construct and Decode Concatenated codes to perform close to Shannon Limit in a data Transmission system.

Reference Books

1.	Error control coding, Shu Lin and Daniel J. Costello. Jr, Pearson, 2nd edition, 2011, ISBN 978-

	81-317-3440-7
2.	Introduction to Error control coding, Salvatore Gravano, Oxford university press, 2007, ISBN 0-19-856231-4
3.	Theory and practice of error control codes, Blahut. R. E, Addison Wesley, 1984, ISBN 0201101025
4.	Coding theory A first course, Cambridge university press, SAN ling, chaoping xing, 2004, 052152923-9,9780521529235

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
RESEARCH METHODOLOGY (Common to all programs)						
Course Code	**:**	**18IM23**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 hours**

Unit – I	
Overview of Research: Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, completely randomized, randomized block, Latin Square, Factorial.	**08 Hrs**
Unit – II	
Data and data collection: Overview of probability and data types Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules. **Sampling Methods:** Probability sampling and Non-probability sampling	**08 Hrs**
Unit – III	
Processing and analysis of Data: Statistical measures of location, spread and shape, Correlation and regression, Hypothesis Testing and ANOVA. Interpretation of output from statistical software tools	**08 Hrs**
Unit – IV	
Advanced statistical analyses: Non parametric tests, Introduction to multiple regression, factor analysis, cluster analysis, principal component analysis. Usage and interpretation of output from statistical analysis software tools.	**08 Hrs**
Unit-V	
Essentials of Report writing and Ethical issues: Significance of Report Writing , Different Steps in Writing Report, Layout of the Research Report , Ethical issues related to Research, Publishing, Plagiarism **Case studies:** Discussion of case studies specific to the domain area of specialization	**07 Hrs**

Course Outcomes: After going through this course the student will be able to	
CO1	Explain the principles and concepts of research types, data types and analysis procedures.
CO2	Apply appropriate method for data collection and analyze the data using statistical principles.
CO3	Present research output in a structured report as per the technical and ethical standards.
CO4	Create research design for a given engineering and management problem situation.

Reference Books

1	Research Methodology Methods and techniques, Kothari C.R, 4th edition, New Age International Publishers, 2012, ISBN: 978-93-86649-22-5
2	Management Research Methodology, Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M, 1st edition, Pearson Education, 2006. ISBN: 978-81-77585-63-6
3	The Research Methods Knowledge Base, William M. K. Trochim, James P. Donnelly, 3rd Edition, Atomic Dog Publishing, 2006, ISBN: 978-1592602919
4	Statistics for Management, Levin, R.I. and Rubin, D.S, 7th Edition, Pearson Education, 2017, ISBN-10: 9332581185

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
MINOR PROJECT						
Course Code	**:**	**18MCS24**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**0:0:4**		**SEE Marks**	**:**	**100**
Hours	**:**	**02**		**SEE Duration**	**:**	**3 hrs**

GUIDELINES

1. Each project group will consist of maximum of two students.
2. Each student / group has to select a contemporary topic that will use the technical knowledge of their program of study after intensive literature survey.
3. Allocation of the guides preferably in accordance with the expertise of the faculty.
4. The number of projects that a faculty can guide would be limited to four.
5. The minor project would be performed in-house.
6. The implementation of the project must be preferably carried out using the resources available in the department/college.

Course Outcomes: After completing the course, the students will be able to	
CO1	Conceptualize, design and implement solutions for specific problems.
CO2	Communicate the solutions through presentations and technical reports.
CO3	Apply resource managements skills for projects.
CO4	Synthesize self-learning, team work and ethics.

Scheme of Continuous Internal Examination

Evaluation will be carried out in 3 phases. The evaluation committee will comprise of 4 members: Guide, Two Senior Faculty Members and Head of the Department.

Phase	Activity	Weightage
I	Synopsys submission, Preliminary seminar for the approval of selected topic and objectives formulation	20%
II	Mid term seminar to review the progress of the work and documentation	40%
III	Oral presentation, demonstration and submission of project report	40%

** Phase wise rubrics to be prepared by the respective departments

CIE Evaluation shall be done with weightage / distribution as follows:

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/ experimental setup 25%
- Conducting experiments/ implementation / testing 25%
- Demonstration & Presentation 15%
- Report writing 25%

Scheme of Semester End Examination (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

- Brief write up about the project 05%
- Presentation / Demonstration of the Project 20%
- Methodology and Experimental results & Discussion 25%
- Report 20%
- Viva Voce 30%

SEMESTER: II						
ANTENNA THEORY (Professional Elective-C1)						
Course Code	**:**	**18MCS2C1**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **10 Hrs**

Antenna Fundamentals and Arrays
Radiation Mechanisms, Overview, EM Fundamentals, Solution of Maxwell's Equations for Radiation Problems, Ideal Dipole, Radiation patterns, Directivity and Gain, Antenna impedance, Radiation efficiency, Antenna polarization.
Array factor for linear arrays, Uniformly excited equally spaced linear arrays, Pattern multiplication, Directivity of linear arrays, Non-uniformly excited equally spaced linear arrays, Mutual coupling.

Unit – II **10 Hrs**

Resonant Antennas: Wires and Patches, Dipole antenna, Yagi-Uda antennas, Micro-strip antenna.
Broadband antennas: Traveling wave antennas Helical antennas, Biconical antennas, Sleeve antennas, and Principles of frequency independent antennas, Spiral antennas, and Log - periodic antennas.

Unit – III **10 Hrs**

Antenna Synthesis
Formulation of the synthesis problem, Synthesis principles, Line sources shaped beam synthesis, Linear array shaped beam synthesis, Fourier series, Woodward - Lawson sampling method, Comparison of shaped beam synthesis methods, low side lobe narrow main beam synthesis methods, Dolph Chebyshev linear array, Taylor line source method.

Unit – IV **11 Hrs**

Radiation and Scattering
Solutions to the inhomogeneous vector potential wave equation, Far field radiation, Radiation and scattering equations in rectangular coordinates (Far field).
Infinite line source cylindrical wave radiation (Electrical line source and magnetic line source), plane wave scattering from a strip, plane wave scattering from a flat rectangular plate and scattering by a circular cylinder (TE or TM polarization).

Unit – V **11 Hrs**

Integral equation and Moment Method: Electrostatic charge distribution (finite wire and bent wire), Pocklington integral equation and Hallen's integral equation.
Geometrical optics: Amplitude relation, phase and polarization relation, reflection from a curved surface, reflection from a conducting sphere and reflection from a line source above a finite width strip.
Geometrical theory of diffraction: Amplitude, phase and polarization relation, diffraction by a curved edge, diffraction by a wedge with a straight edge, diffraction by a pyramidal horn antenna and diffraction by a paraboloidal reflector.

Expected Course Outcomes
After going through this course, the student will be able to:

CO1	Demonstrate analytical skills in applying electromagnetics concepts to design basic antenna structures.
CO2	Design antennas like Yagi-Uda, Helical antennas and other broad band antennas
CO3	Describe different antenna synthesis methods.
CO4	Evaluate and design scattering in guided and radiative structures like strip, plate, cylinder and sphere using numerical EM solver that employ the concepts studied

Reference Books

1	Advanced engineering electromagnetics, Constantine A Balanis, 1st edition, John Wiley & Sons, 1989, ISBN: 0-471-62194-3.
2	Time harmonic electromagnetic fields, Roger F Harrington,1st edition, John Wiley & Sons, IEEE press classic reissue, 2001, ISBN: 0-471-20806-X.
3	Antenna Theory Analysis and Design, C. A. Balanis, 3rd Edition, John Wiley, 2009, ISBN-10: 9788126524228
4	Antennas, John D.Krauss, 3rd Edition, McGraw-Hill International Edition, 2006.ISBN-13: 978-0071232012

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
MACHINE LEARNING **(Professional Elective-C2)** **(Common to VLSI & ES, CS, CNE, DCE, BMI, SE)**						
Course Code	**:**	**18MCS2C2**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
Introduction: Overview of Probability Theory, Model Selection, Introduction to Machine learning. Linear Regression – Basis Function models, Bias Variance Decomposition, Bayesian linear Regression; Stochastic gradient Descent, Discriminant Functions, Bayesian Logistic regression. Examples on linear regression, logistic regression	
Unit – II	**11 Hrs**
Supervised Learning Kernel Methods: Dual representations, Construction of a kernel, Radial Basis Function Networks, Gaussian Process, Tree Based methods . Sparse Kernel Machines: Maximum margin classifiers (SVM), RVM. Examples on spam, mixer and k nearest neighbour	
Unit – III	**11 Hrs**
Unsupervised Learning: **Mixture Models:** K-means Clustering, Mixtures of Gaussians, Maximum likelihood, EM for Gaussian mixtures, The EM Algorithm in General, Principal Component Analysis, Probabilistic PCA. Examples on Market booklet analysis	
Unit – IV	**11 Hrs**
Random Forests: Introduction, Definition of Random Forests, Details of Random ,Out of Bag Samples , Variable Importance, Proximity Plots, Random Forests and Over-fitting, Analysis of Random Forests, Variance and the De-Correlation Effect, Bias, Adaptive Nearest Neighbors.	
Unit – V	**09 Hrs**
Ensemble Learning: Introduction, Boosting and Regularization Paths, Penalized Regression, The "Bet on Sparsity" Principle, Regularization Paths, Over-fitting and Margins, Learning Ensembles, Learning a Good Ensemble, Rule Ensembles	

Course Outcomes

After going through this course the student will be able to:

CO1	Explore the basics of Probability, data distributions and neural networks Algorithms.
CO2	Apply the various dimensionality reduction techniques and learning models for the given Application.
CO3	Analyze the different types of supervised and unsupervised learning models.
CO4	Evaluate the classification and regression algorithms for given data set.

Reference Books

1.	Pattern Recognition and Machine Learning, Christopher M Bishop, 2nd Edition, , Springer, 2006, ISBN-13: 978-0387-31073-2.
2.	The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani, and Jerome Friedman, 2nd Edition, Springer, 2008, ISBN 978-0-387-84858-7
3.	Data Mining – Concepts and Techniques, Jiawei Han and Micheline Kamber, Morgan Kaufmann, 3rd Edition, Elsevier, 2006, ISBN 1-55860-901-6
4.	Practical data science, R Zumel, N., & Mount, J, 1st edition, Manning Publications, 2014, ISBN 9781617291562

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
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Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II

OPTICAL COMMUNICATION NETWORKS
(Professional Elective-C3)

Course Code	**:**	**18MCS2C3**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **11 Hrs**

Introduction
Overview of optical fiber communications, Basic principles of light propagation, Ray-Model, Wave-Model, Optical fiber modes, single and multi-mode fibers, single and multi-core fibers.

Signal degradation in optical fibers
Loss and Bandwidth windows, Intermodal Dispersion, Chromatic Dispersion, Practical issues in Implementation of fiber Link.

Unit – II **10 Hrs**

Optical Components
Couplers**,** Isolators and Circulators**,** amplifier Multiplexers and filters**,** Fiber Gratings**,** Mach-Zehnder Interferometers**.**

Non-linear effects in optical fiber
Non–Linear Schrodinger Equation, Group velocity dispersion, Stimulated Brillouin scattering, stimulated Raman scattering, Self -Phase Modulation, Cross-Phase Modulation, Four-wave Mixing, Solitons.

Unit – III **11 Hrs**

Modulation and Demodulation
Modulation, Signal formats, Subcarrier Modulation and Multiplexing, Spectral efficiency, Optical Duo-binary Modulation, Capacity Limits of Optical Fiber, An Ideal receiver, Practical detection Receivers, Noise considerations, Bit error rates, coherent detection.

Transmission System Engineering
System Model, Power penalty, Transmitter, Receiver, Different optical amplifiers - SOA, EDFA.

Unit – IV **10 Hrs**

Intensity Modulated Optic Fiber Sensors
Introduction, General features-Intensity modulation through through light interruption, shutter/schlineren multimode fiber optic sensors, Reflective fiber optic sensor, Evanescent-wave fiber sensor, Micro bend optical fiber sensors, Fiber optic refractometers, Intensity modulated optic fiber thermometers.

Unit – V **10 Hrs**

Optical Networks
WDM network elements: Optical line terminal, Optical line amplifiers, Optical cross connectors, Dense WDM, WDM network design,
Client layers of optical layer, SONET/SDH, Optical switches, Multiplexing layers, Frame Structure, ATM functions, Adaptation Layers, QoS and Flow control, ESCON, HIPPI..

Course Outcomes
After going through this course the student will be able to:

CO1	Select the proper Optical spectral band and incorporate the standards for optical fiber communication
CO2	Analyze the Optical Fiber Modes and Configurations and express the Single-mode Fibers, Graded-index Fiber Structure
CO3	Express various WDM Concepts and Components and Apply different Optical Network concepts and topologies and design WDM Network
CO4	Prepare an Optical Link Power Budget.

Reference Books	
1.	Optical Fiber Communications, John M. Senior, 2nd edition, Pearson, 2000, ISBN-10: 9332535787
2.	Optical Networks- A Practical Perspective, Rajiv Ramswami, N Sivaranjan,1st edition, M. Kauffman publishers, 2000, ISBN-10: 9380501374
3.	Optical Fiber Communication, Gerd Keiser, 1st edition, MGH, 1991, ISBN-10: 1259006875
4.	Fiber Optics communication, G. P. Agarwal , 2nd edition, John Wiley, 1997, ISBN-10: 8121923174

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
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Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II

WIRELESS SENSOR NETWORKS AND IOT
(Professional Elective-D1)

Course Code	**:**	**18MCS2D1**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **10 Hrs**

Motivation for a Network of Wireless Sensor Nodes
Sensing and Sensors, Wireless Sensor Networks, Challenges and Constraints
Applications: Structural Health Monitoring, Traffic Control, Health Care, Pipeline Monitoring, Precision Agriculture.

Unit – II **11 Hrs**

Sensing Node Architecture: The Sensing Subsystem ,The Processor subsystem Communication Interfaces, Prototypes.
Medium Access Control : Overview - Contention-Free Medium Access, Contention-Based Medium Access, Wireless MAC Protocols – CSMA, MACA and MACAW, MACA By Invitation, IEEE 802.11, IEEE 802.15.4 and ZigBee , Characteristics of MAC Protocols; Contention-Free, Contention-Based and Hybrid MAC Protocols.

Unit – III **10 Hrs**

Network Layer
Overview , Routing Metrics, Flooding and Gossiping, Data-Centric Routing, Proactive Routing, On-Demand Routing, Location-Based Routing , QoS-Based Routing Protocols. Power management in WSN.

Unit – IV **10 Hrs**

Networking protocols and standards for internet of things
Introduction, IoT Data Link Protocols, Network Layer Routing Protocols, Network Layer Encapsulation Protocols, 6LoWPAN and RPL, Session Layer Protocols, IoT Management Protocols, IoT Challenges.

Unit – V **11 Hrs**

Architectural Approaches for IoT, Business Markitecture, Functional Architecture, Application Architecture, Data and Analytics Architecture, Technology Architecture, Security and Governance, Suitable Case Studies / Assignment

Course Outcomes
After studying this course, students will be able to:

CO1	Explain the concepts of sensors and conversion to digitally formatted signal for transmission.
CO2	Evaluate the capacity and degradation in performance of various wireless MAC protocols in a transmission environment.
CO3	Analyze schemes to transport sensor data to a server in a power efficient and time efficient manner through IoT gateway.
CO4	Understand the IoT architecture through suitable case studies.

Reference Books

1	Fundamentals of Wireless Sensor Networks Theory and Practice, Waltenegus Dargie and Christian Poellabauer, 1st edition, John Wiley & Sons Ltd, 2010, ISBN 978-0-470-99765-9.
2	Internet of Things and Data Analytics Handbook, Hwaaiyu Geng,1st edition, John Wiley & Sons Ltd, 2017, ISBN 978-1-119-17364-9 (H/B).
3	Wireless Sensor Networks, Ian F. Akyildiz and Mehmet Can Vuran, 1st edition, John Wiley & Sons Ltd, 2010, ISBN 978-0-470-03601-3 (H/B).

Case Study References	
1	Design of a WSN Platform for Long-Term Environmental Monitoring for IoT Applications , M. T. Lazarescu, IEEE Journal on Emerging and Selected Topics in Circuits and Systems, vol. 3, no. 1, pp. 45-54, March 2013.doi: 10.1109/JETCAS.2013.2243032
2	IoT application of WSN on 5G infrastructure, I. S. H. Martínez, I. P. O. J. Salcedo and I. B. S. R. Daza, 2017 International Symposium on Networks, Computers and Communications (ISNCC), Marrakech, 2017, pp. 1-6. doi: 10.1109/ISNCC.2017.8071989.
3	An IoT Approach for Wireless Sensor Networks Applied to e-Health Environmental Monitoring, J. Cabra, D. Castro, J. Colorado, D. Mendez and L. Trujillo, 2017 IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData), Exeter, 2017, pp. 578-583.doi: 10.1109/iThings-GreenCom-CPSCom-SmartData.2017.91
4	N. Khalil, M. R. Abid, D. Benhaddou and M. Gerndt, Wireless sensors networks for Internet of Things, 2014 IEEE Ninth International Conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), Singapore, 2014, pp. 1-6. doi: 10.1109/ISSNIP.2014.6827681

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
DEEP LEARNING **(Professional Elective-D2)** **(Common to CSE and CS)**						
Course Code	**:**	**18MCE2D2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	
Deep Feedforward Networks: Multilayer Perceptron, Example: Learning XOR, Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation Algorithm	**10 Hrs**
Unit – II	
Convolutional Networks: Convolution Operation, Motivation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the basic convolution function, Structured Outputs, Data types, Efficient Convolution Algorithms, Random or Unsupervised features, The Neuroscientific basis for convolutional networks	**11 Hrs**
Unit – III	
Sequence Modeling: Recurrent and Recursive Nets: Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, Echo State Networks, The Long Short-Term Memory and Other Gated RNNs	**11 Hrs**
Unit – IV	
Autoencoders: Undercomplete Autoencoders, Regularized Autoencoders, Representational Power, Layer Size and Depth, Stochastic Encoders and Decoders, Denoising Autoencoders, Contractive Autoencoders, Applications of Autoencoders	**09 Hrs**
Unit –V	
Structured Probabilistic Models For Deep Learning: The challenge of unstructured modelling, Using graphs to describe model structure: Directed, Undirected, Partition function, Energy-based models, Factor graphs; Sampling from graphical models, Advantages of structured modelling, learning about dependencies, Inference and approximate inference, The deep learning approach to structured probabilistic models	**11 Hrs**

Course Outcomes:
After going through this course, the student will be able to:

CO1	Describe basic concepts of neural network, its applications and various learning models
CO2	Acquire the knowledge on Recurrent, Recursive Nets and Auto-encoder models
CO3	Analyze different Network Architectures, learning tasks, Convolutional networks
CO4	Evaluate and compare the solutions by various Neural Network approaches for a given problem

Reference Books

1.	Deep Learning (Adaptive Computation and Machine Learning Series), Ian Good Fellow, Yoshua Bengio and Aaron Courville,1st edition, MIT Press, 2017, ISBN-13: 978-0262035613.
2.	Neural Networks – A Comprehensive Foundation, Simon Haykin, 2nd edition, PHI, 2005, ISBN-10: 0139083855
3.	Introduction to Artificial Neural Networks, Gunjan Goswami, S.K. Kataria & Sons, 1st Edition, 2012, ISBN-13: 978-9350142967.
4.	Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms, Nikhil Buduma, 1st Edition, O'Reilly Publications, 2016, ISBN-13: 978-1491925614.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
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Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
VLSI DIGITAL SIGNAL PROCESSING SYSTEMS (Professional Elective-D3) (Common to VLSI & ES and CS)						
Course Code	**:**	**18MVE2D3**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
Introduction to digital Signal Processing systems Introduction, Typical DSP algorithms, DSP Application demands and scaled CMOS technologies, Representations of DSP algorithms.	
Unit – II	**10 Hrs**
Pipelining and parallel processing Introduction, Pipelining of FIR Digital filters, parallel processing, pipelining and parallel processing for low power.	
Unit – III	**10 Hrs**
Algorithmic strength reduction in filters and transforms Introduction, parallel FIR filters, Discrete Cosine transform and inverse DCT, Parallel architectures for Rank-Order Filters.	
Unit – IV	**11 Hrs**
Pipelined and parallel Recursive and Adaptive Filters Introduction, Pipeline interleaving in digital Filters, pipelining in 1st order IIR digital filters, Pipelining in higher order IIR Digital filters, parallel processing for IIR filters, combined pipelining and parallel processing for IIR filters, low power IIR digital Filter Design using Pipelining and parallel processing, Pipelined Adaptive Digital Filters.	
Unit – V	**11 Hrs**
Programmable digital Signal Processor Introduction, evolution of programmable Digital Signal processors, Important feature of DSP processors, DSP Processors for Mobile and wirelesses communication, Processor for multimedia signal Processing.	

Course Outcomes

After going through this course the student will be able to:

CO1	Develop a strong grounding in the fundamentals of VLSI digital signal processing ,
CO2	Understand DSP architectures and CMOS technologies to describe, analyze, and solve problems in VLSI digital signal processing.
CO3	Evaluate and test the modern VLSI digital signal processing systems using simulation tool.
CO4	Design suitable algorithm for specific applications & Develop applications using general purpose digital signal processors

Reference Books

1	VLSI Digital Signal processing systems: Design and implementation, Keshab K. Parthi , 1st edition, Wiley, 1999,ISBN: 81-265-1098-6.
2	Digital Signal Processing and applications, Rulph chasseing, with C6713 and C6416 DSK, 1st edition, Wiley, 2005, ISBN-10: 9788126528745.
3.	Digital Signal Processing System Design: LabView based hybrid programming, Nasser Kehtarnavaz,1st edition, Academic press, 2008, ISBN-10: 0123744903.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
BUSINESS ANALYTICS (Global Elective-G01)						
Course Code	**:**	**18CS2G01**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	
Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling.	**08 Hrs**
Unit – II	
Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	**08 Hrs**
Unit – III	
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, Predictive Analytics, Predicative Modelling, Predictive analytics analysis.	**08 Hrs**
Unit – IV	
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.	**08 Hrs**
Unit –V	
Decision Analysis: Formulating Decision Problems, Decision Strategies with and without Outcome, Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	**07 Hrs**

Course Outcomes

After going through this course the student will be able to:

CO1	Explore the concepts, data and models for Business Analytics.
CO2	Analyze various techniques for modelling and prediction.
CO3	Design the clear and actionable insights by translating data.
CO4	Formulate decision problems to solve business applications

Reference Books

1	Business analytics Principles, Concepts, and Applications FT Press Analytics, Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, 1st Edition, Pearson FT Press, 2014, ISBN-13: 978-0133989403.
2	The Value of Business Analytics: Identifying the Path to Profitability, Evan Stubs,1st edition, John Wiley & Sons, 2014, ISBN:9781118983881.
3	Business Analytics, James Evans, 2nd edition, Pearsons Education,2010, ISBN-10: 0321997824
4	Predictive Business Analytics Forward Looking Capabilities to Improve Business, Gary Cokins and Lawrence Maisel, 1st edition, Wiley, 2013, ISBN-10: 1118175565

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
INDUSTRIAL AND OCCUPATIONAL HEALTH AND SAFETY (Global Elective-G02)						
Course Code	**:**	**18CV2G02**		**CIE Marks**	**:**	**100**
Credits : L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3Hrs**

UNIT – I **08 Hrs**

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and fire fighting, equipment and methods.

UNIT – II **08 Hrs**

Occupational health and safety: Introduction, Health, Occupational health: definition, Interaction between work and health, Health hazards, workplace, economy and sustainable development, Work as a factor in health promotion. Health protection and promotion Activities in the workplace: National governments, Management, Workers, Workers' representatives and unions, Communities, Occupational health professionals. Potential health hazards: Air contaminants, Chemical hazards, Biological hazards, Physical hazards, Ergonomic hazards, Psychosocial factors, Evaluation of health hazards: Exposure measurement techniques, Interpretation of findings recommended exposure limits. Controlling hazards: Engineering controls, Work practice controls, Administrative controls. Occupational diseases: Definition, Characteristics of occupational diseases, Prevention of occupational diseases.

UNIT – III **08 Hrs**

Hazardous Materials characteristics and effects on health: Introduction, Chemical Agents, Organic Liquids, Gases, Metals and Metallic Compounds, Particulates and Fibers, Alkalies and Oxidizers, General Manufacturing Materials, Chemical Substitutes, Allergens, Carcinogens, Mutagens, Reproductive Hazards, Sensitizers and Teratogens, Recommended Chemical Exposure Limits. Physical Agents, Noise and Vibration, Temperature and Pressure, Carcinogenicity, Mutagenicity and Teratogenicity. Ergonomic Stresses: Stress-Related Health Incidents, Eyestrain, Repetitive Motion, Lower Back Pain, Video Display Terminals.

UNIT – IV **08 Hrs**

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT – V **07 Hrs**

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, over hauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Explain the Industrial and Occupational health and safety and its importance.
CO2	Demonstrate the exposure of different materials, occupational environment to which the employee can expose in the industries.
CO3	Characterize the different type materials, with respect to safety and health hazards of it.
CO4	Analyze the different processes with regards to safety and health and the maintenance required in the industries to avoid accidents.

Reference Books	
1.	Maintenance Engineering Handbook, Higgins & Morrow, 1st Edition, McGraw-Hill ducation,1994, ISBN 10: 0070432015
2.	Maintenance Engineering Principles, Practices & Management, H. P. Garg,1st Edition, S. Chand and Company, 2009, ISBN:9788121926447
3.	Fundamental Principles of Occupational Health and Safety, Benjamin O. Alli, 2nd edition, International Labour Office – Geneva: ILO, 2008, ISBN 978-92-2-120454-1
4.	Foundation Engineering Handbook, Winterkorn, Hans, 1st edition, Chapman & Hall London, 2008, ISBN:8788111925428.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
MODELING USING LINEAR PROGRAMMING (Global Elective-G03)						
Course Code	**:**	**18IM2G03**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39 L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Linear Programming: Introduction to Linear Programming problem **Simplex methods:** Variants of Simplex Algorithm – Use of Artificial Variables	**08 Hrs**
Unit – II	
Advanced Linear Programming : Two Phase simplex techniques, Revised simplex method **Duality:** Primal-Dual relationships, Economic interpretation of duality	**08 Hrs**
Unit – III	
Sensitivity Analysis: Graphical sensitivity analysis, Algebraic sensitivity analysis - changes in RHS, Changes in objectives, Post optimal analysis - changes affecting feasibility and optimality	**08 Hrs**
Unit – IV	
Transportation Problem: Formulation of Transportation Model, Basic Feasible Solution using North-West corner, Least Cost, Vogel's Approximation Method, Optimality Methods, Unbalanced Transportation Problem, Degeneracy in Transportation Problems, Variants in Transportation Problems.	**08 Hrs**
Unit –V	
Assignment Problem: Formulation of the Assignment problem, solution method of assignment problem-Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP).	**07 Hrs**

Course Outcomes:
After going through this course the student will be able to:

CO1	Explain the various Linear Programming models and their areas of application.
CO2	Formulate and solve problems using Linear Programming methods.
CO3	Develop models for real life problems using Linear Programming techniques.
CO4	Analyze solutions obtained through Linear Programming techniques.

Reference Books

1	Operation Research An Introduction, Taha H A, 8th Edition, PHI, 2009, ISBN: 0130488089.
2	Principles of Operations Research – Theory and Practice, Philips, Ravindran and Solberg, John Wiley & Sons (Asia) Pvt Ltd, 2nd Edition, 2000, ISBN 13: 978-81-265-1256-0.
3	Introduction to Operation Research, Hiller, Liberman, Nag, Basu, Tata McGraw Hill 9th Edition, 2012, ISBN 13: 978-0-07-133346-7.
4	Operations Research Theory and Application, J K Sharma, Pearson Education Pvt Ltd, 4th Edition, 2009, ISBN 13: 978-0-23-063885-3.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
PROJECT MANAGEMENT (Global Elective-G04)						
Course Code	**:**	**18IM2G04**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	
Introduction: Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS), Introduction to Agile Methodology.	**08 Hrs**
Unit – II	
Capital Budgeting: Capital Investments: Importance and Difficulties, phases of capital budgeting, levels of decision making, facets of project analysis, feasibility study – a schematic diagram, objectives of capital budgeting	**08 Hrs**
Unit – III	
Project Costing: Cost of Project, Means of Finance, Cost of Production, Working Capital Requirement and its Financing, Profitability Projections, Projected Cash Flow Statement, Projected Balance Sheet, Multi-year Projections, Financial Modeling, Social Cost Benefit Analysis	**08 Hrs**
Unit – IV	
Tools & Techniques of Project Management: Bar (GANTT) chart, bar chart for combined activities, logic diagrams and networks, Project evaluation and review Techniques (PERT) Critical Path Method (CPM), Computerized project management	**08Hrs**
Unit-V	
Project Management and Certification: An introduction to SEI, CMMI and project management institute USA – importance of the same for the industry and practitioners. PMBOK 6 - Introduction to Agile Methodology, Themes / Epics / Stories, Implementing Agile. **Domain Specific Case Studies on Project Management:** Case studies covering project planning, scheduling, use of tools & techniques, performance measurement.	**07 Hrs**

Course Outcomes:
After going through this course the student will be able to:

CO1	Explain project planning activities that accurately forecast project costs, timelines, and quality.
CO2	Evaluate the budget and cost analysis of project feasibility.
CO3	Analyze the concepts, tools and techniques for managing projects.
CO4	Illustrate project management practices to meet the needs of Domain specific stakeholders from multiple sectors of the economy (i.e. consulting, government, arts, media, and charity organizations).

Reference Books

1	Project Planning Analysis Selection Financing Implementation & Review, Prasanna Chandra, 8th Edition, Tata McGraw Hill Publication, 2010, ISBN 0-07-007793-2.
2	A Guide to the Project Management Body of Knowledge (PMBOK Guide) Project Management Institute, 5th Edition, 2013, ISBN: 978-1-935589-67-9
3	Project Management A System approach to Planning Scheduling & Controlling, Harold Kerzner, 11th Edition, John Wiley & Sons Inc, 2013, ISBN 978-1-118-02227-6.
4	Project Management – Planning and Controlling Techniques, Rory Burke, 4th Edition, John Wiley & Sons, 2004, ISBN: 9812-53-121-1

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
ENERGY MANAGEMENT (Global Elective-G05)						
Course Code	**:**	**18CH2G05**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I — **08 Hrs**

Energy conservation:
Principles of energy conservation, Energy audit and types of energy audit, Energy conservation approaches, Cogeneration and types of cogeneration, Heat Exchangers and classification.

Unit-II — **08 Hrs**

Wet Biomass Gasifiers:
Introduction, Classification of feedstock for biogas generation, Biomass conversion technologies: Wet and dry processes, Photosynthesis, Biogas generation, Factors affecting bio-digestion, Classification of biogas plants, Floating drum plant and fixed dome plant their advantages and disadvantages.

Unit -III — **08 Hrs**

Dry Biomass Gasifiers :
Biomass energy conversion routes, Thermal gasification of biomass, Classification of gasifiers, Fixed bed systems: Construction and operation of up draught and down draught gasifiers.

Unit -IV — **08 Hrs**

Solar Photovoltaic:
Principle of photovoltaic conversion of solar energy, Types of solar cells and fabrication.
Wind Energy:
Classification, Factors influencing wind, WECS & classification.

Unit -V — **07 Hrs**

Alternative liquid fuels:
Introduction, Ethanol production: Raw materials, Pre-treatment, Conversion processes with detailed flow sheet. Gasification of wood: Detailed process, Gas purification and shift conversion, Biofuel from water hyacinth.

Course outcomes (CO):
On completion of the course, the student should have acquired the ability to

CO1	Understand the use alternate fuels for energy conversion
CO2	Develop a scheme for energy audit
CO3	Evaluate the factors affecting biomass energy conversion
CO4	Design a biogas plant for wet and dry feed

Reference Books

1	Nonconventional energy, Ashok V Desai, 5th Edition, New Age International (P) Limited, 2011, ISBN 13: 9788122402070.
2	Biogas Technology - A Practical Hand Book, Khandelwal K C and Mahdi S S, Vol. I & II, 1st edition, McGraw-Hill Education, 1986,, ISBN-13: 978-0074517239.
3	Biomass Conversion and Technology, Charles Y Wereko-Brobby and Essel B Hagan, 1st Edition, John Wiley & Sons, 1996, ISBN-13: 978-0471962465.
4	Solar Photovoltaics: Fundamental Applications and Technologies, C. S. Solanki, 2nd Edition, Prentice Hall of India, 2009, ISBN:9788120343863.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
INDUSTRY 4.0 (Global Elective-G06)						
Course Code	**:**	**18ME2G06**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	
Introduction: Industrial, Internet, Case studies, Cloud and Fog, M2M Learning and Artificial Intelligence, AR, Industrial Internet Architecture Framework (IIAF), Data Management.	**08 Hrs**
Unit – II	
The Concept of the IIoT: Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture.	**08 Hrs**
Unit – III	
Data Analytics in Manufacturing: Introduction, Power Consumption in manufacturing, Anomaly Detection in Air Conditioning, Smart Remote Machinery Maintenance Systems with Komatsu, Quality Prediction in Steel Manufacturing. Internet of Things and New Value Proposition, Introduction, Internet of Things Examples, IoTs Value Creation Barriers: Standards, Security and Privacy Concerns. Advances in Robotics in the Era of Industry 4.0, Introduction, Recent Technological Components of Robots, Advanced Sensor Technologies, Artificial Intelligence, Internet of Robotic Things, Cloud Robotics.	**08 Hrs**
Unit – IV	
Additive Manufacturing Technologies and Applications: Introduction, Additive Manufacturing (AM) Technologies, Stereo lithography, 3DP, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, Laser Engineered Net Shaping, Advantages of Additive Manufacturing, Disadvantages of Additive Manufacturing. Advances in Virtual Factory Research and Applications, The State of Art, The Virtual Factory Software , Limitations of the Commercial Software	**08 Hrs**
Unit –V	
Augmented Reality: The Role of Augmented Reality in the Age of Industry 4.0, Introduction, AR Hardware and Software Technology, Industrial Applications of AR, Maintenance , Assembly, Collaborative Operations , Training. Smart Factories: Introduction, Smart factories in action, Importance, Real world smart factories, The way forward. A Roadmap: Digital Transformation, Transforming Operational Processes, Business Models, Increase Operational Efficiency, Develop New Business Models.	**07 Hrs**

Course Outcomes:
After going through this course the student will be able to:

CO1	Understand the opportunities, challenges brought about by Industry 4.0 for benefits of organizations and individuals
CO2	Analyze the effectiveness of Smart Factories, Smart cities, Smart products and Smart services
CO3	Apply the Industrial 4.0 concepts in a manufacturing plant to improve productivity and profits
CO4	Evaluate the effectiveness of Cloud Computing in a networked economy

Reference Books

1	Industry 4.0 the industrial Internet of Things , Alasdair Gilchrist, 1st edition, Apress Publisher,2017, ISBN-13: 978-1-4842-2046-7
2	Industry 4.0: Managing The Digital Transformation, Alp Ustundag, Emre Cevikcan, 1st edition, Springer, 2018, ISBN 978-3-319-57869-9.
3	Designing the Industry - Internet of things connecting the physical, digital and virtual worlds, Ovidiu Vermesan and Peer Friess,1st edition, Rivers Publishers, 2016, ISBN 978-87-93379-81-7

4	The concept Industry 4.0- An Empirical Analysis of Technologies and Applications in Production Logistics, Christoph Jan Bartodziej, 1st edition, Springer Gabler, 2017, ISBN 978-3-6581-6502-4.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
ADVANCED MATERIALS (Global Elective-G07)						
Course Code	**:**	**18ME2G07**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	
Classification and Selection of Materials: Classification of materials. Properties required in Engineering materials, Criteria of selection of materials. Requirements / needs of advance materials.	**08 Hrs**
Unit – II	
Non Metallic Materials: Classification of n on metallic materials, Rubber : Properties, processing and applications. Plastics : Thermosetting and Thermoplastics, Applications and properties. Ceramics : Properties and applications. Adhesives: Properties and applications. Optical fibers : Properties and applications. Composites : Properties and applications.	**08 Hrs**
Unit – III	
High Strength Materials: Methods of strengthening of alloys, Materials available for high strength applications, Properties required for high strength materials, Applications of high strength materials	**08 Hrs**
Unit – IV	
Low & High Temperature Materials Properties required for low temperature applications, Materials available for low temperature applications, Requirements of materials for high temperature applications, Materials available for high temperature applications, Applications of low and high temperature materials.	**08 Hrs**
Unit –V	
Nanomaterials: Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Physical and mechanical properties, Applications of nanomaterials	**07 Hrs**

Course Outcomes:
After going through this course the student will be able to:

CO1	Describe metallic and non metallic materials
CO2	Explain preparation of high strength Materials
CO3	Integrate knowledge of different types of advanced engineering Materials
CO4	Analyse problem and find appropriate solution for use of materials.

Reference Books

1	The Science & Engineering of Materials, Donald R. Askeland, and Pradeep P. Fulay, 5th Edition, Thomson, 2006, ISBN-13-978-0534553968
2	Nanotechnology , Gregory L. Timp, 1st edition, Springer, 1999 ISBN-13: 978-0387983349
3	Material Science and Metallurgy, Dr. VD Kodgire and Dr. S V Kodgire, 42nd Edition, Everest Publishing House, 2018, ISBN NO: 81 86314 00 8
4	Processing and Fabrication of Advanced Materials, N Bhatnagar, T S Srivatsan, 1st edition, IK International, 2008, ISBN: 978819077702

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
COMPOSITE MATERIALS SCIENCE AND ENGINEERING (Global Elective-G08)						
Course Code	**:**	**18CHY2G08**		**CIE Marks**	**:**	**100**
Credits: L: T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3Hrs**

Unit-I	
Introduction to composite materials Fundamentals of composites – need for composites – Enhancement of properties – Classification based on matrix- Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Constituents of composites, Interfaces and Interphases, Distribution of constituents, Types of Reinforcements, Particle reinforced composites, Fibre reinforced composites. Fiber production techniques for glass, carbon and ceramic fibers Applications of various types of composites.	**08 Hrs**
Unit – II	
Polymer matrix composites (PMC) Polymer resins – Thermosetting resins, Thermoplastic resins & Elastomers, Reinforcement fibres-Types, Rovings, Woven fabrics. PMC processes – Hand Layup Processes, Spray up processes – Compression Moulding – Injection Moulding – Resin Transfer Moulding – Pultrusion – Filament winding – Injection moulding. Glass fibre and carbon fibre reinforced composites (GFRP & CFRP). Laminates- Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Mechanical Testing of PMC- Tensile Strength, Flexural Strength, ILSS, Impact Strength- As per ASTM Standard. Applications of PMC in aerospace, automotive industries**.**	**08 Hrs**
Unit -III	
Ceramic matrix composites and special composites Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics – need for CMC – ceramic matrix – various types of ceramic matrix composites- oxide ceramics – non oxide ceramics – Aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering – Hot pressing – Cold Isostatic Pressing (CIPing) – Hot isostatic pressing (HIPing). Applications of CMC in aerospace, automotive industries- Carbon /carbon composites – advantages of carbon matrix – limitations of carbon matrix carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol-gel technique- Processing of Ceramic Matrix composites.	**08 Hrs**
Unit –IV	
Metal matrix composites Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement – volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process – diffusion bonding – stir casting – squeeze casting, a spray process, Liquid infiltration In-situ reactions-Interface-measurement of interface properties-applications of MMC in aerospace, automotive industries.	**08 Hrs**
Unit –V	
Polymer nano composites Introduction and Significance of polymer Nano composites. Intercalated And Exfoliated Nanocomposites. Classification of Nano fillers- nanolayers, nanotubes, nanoparticles. Preparation of Polymer Nano composites by Solution, In-situ Polymerization and melt mixing techniques. Characterization Of polymer nanocomposites- XRD, TEM, SEM and AFM. Mechanical and Rheological properties of Polymer Nano composites. Gas barrier, Chemical-Resistance, Thermal and Flame retardant properties of polymer nanocomposites. Optical properties and Biodegradability studies of Polymer nanocomposites, Applications of polymer nano-composites.	**07 Hrs**
Course Outcomes:	

After completing the course, the students will be able to	
CO1	Understand the purpose and the ways to develop new materials upon proper combination of known materials.
CO2	Identify the basic constituents of a composite materials and list the choice of materials available
CO3	Will be capable of comparing/evaluating the relative merits of using alternatives for important engineering and other applications.
CO4	Get insight to the possibility of replacing the existing macro materials with nano-materials.
Reference Books	
1	Composite Materials Science and Engineering, Krishan K Chawla, 3rd Edition Springer-verlag Gmbh,2012, ISBN: 9780387743646
2	The Science and Engineering of Materials, K Balani, Donald R Askeland,6th Edition-Cengage, Publishers,2017, ISBN: 9788131516416
3	Polymer Science and Technology, Joel R Fried, 2nd Edition, Prentice Hall, 2017, ISBN: 9780137039555
4	Nanomaterials and nanocomposites, Rajendra Kumar Goyal , 2nd Edition, CRC Press-Taylor & Francis,2013, ISBN: 9781498761666

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
PHYSICS OF MATERIALS (Global Elective-G09)						
Course Code:	**:**	**18PHY2G09**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3Hrs**

Unit-I — **08 Hrs**

Crystal Structure

Discussion of lattice and lattice parameters, seven crystals systems, crystal planes, Miller indices, Interplanar distance, Packing fraction, Structure of different crystals-NaCl and Diamond, Bragg's law, Powder method, Bragg's spectrometer, Qualitative Analysis of Crystal structure using XRD, Reciprocal lattice, Crystal defects-Point, Line, Planar and Volume defects.

Unit-II — **08 Hrs**

Dielectric Materials

Basic concepts, Langevin's Theory of Polarisation, Types of Polarisation, Dipolar relaxation, Frequency Dependence of total polarization (polarizability as a function of frequency), Qualitative discussion of Internal Field and Claussius Mossotti, Dielectric loss spectrum, Dielectric strength, Dielectric Breakdown, Breakdown mechanisms in solid dielectrics, Applications of Solid Insulating materials in capacitors and Liquid insulating materials in Transformers, Dielectric Heating, Piezoelectricity, Direct and Inverse Piezoelectric effect, Coupling factor, spontaneous polarization, Piezolelectricty in Quartz, Various piezoelectric materials- PZT, PVDF, Ferroelectricity, Barium titanate, Poling in Ceramics.

Unit -III — **08Hrs**

Magnetic Materials

Review of Dia, Para and Ferromagnetic materials, Weiss theory of Ferromagnetism, Hysteresis effect, Magnetostriction, Anti-ferromagnetism, Ferrimagnetsim, Soft and Hard magnetic materials, examples and applications in Transformer cores and Magnetic storage devices, Superconductors, properties, Types of Superconductors, BCS theory, High Temperature Superconductors, Applications in Cryotron and SQUID.

Unit -IV — **07 Hrs**

Semiconducting Materials

Semiconductors-Direct and Indirect band gap semiconductors, Importance of Quantum confinement- quantum wires and dots, size dependent properties, Top down approach, Fabrication process by Milling and Lithography, Bottom up approach, fabrication process by vapour phase expansion and vapor phase condensation, Polymer semi-conductors-Photo conductive polymers, Applications.

Unit -V — **08 Hrs**

Novel Materials

Smart materials-shape memory alloys, Austenite and Martensite phase, Effect of temperature and mechanical load on phase transformation, Pseudoeleasticity, Transformation hysteresis, Superelasticity, Characterization technique-Differntial Scanning calorimetry, Preparation technique-spin coating, Nitinol, CuAlNi alloy and applications. Biomaterials-Metallic, ceramic and polymer biomaterials, Titanium and Titanium alloys, Carbon nanotubes, Graphene- Properties and Applications.

Course Outcomes:

After completing the course, the students will be able to

CO1	Apply the principles of Physics in Engineering.
CO2	Apply the knowledge of Physics for material analysis.
CO3	Identify and Analyze Engineering Problems to achieve practical solutions.
CO4	Develop solutions for Problems associated with Technologies.

Reference Books

1.	Solid State Physics, S O Pillai, 6th Edition, New Age International Publishers, 2003, ISBN 10-8122436978.

2.	Introduction to Solid State Physics, C. Kittel, 7th Edition, John Wiley & Sons, 2003, ISBN 9971-51-180.
3.	Engineering Physics, Dr.M N Avadhanulu, Dr. P G Kshirsagar, 1st Edition, S Chand Publishing, Reprint 2015, ISBN 10-0071328971.
4.	The Science and Engineering of Materials, Askeland, Fulay, Wright, Balanai, 6th Edition, Cengage Learning,2012, ISBN-13:978-0-495-66802-2.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
ADVANCED STATISTICAL METHODS (Global Elective-G10)						
Course Code	**:**	**18MAT2G10**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3Hrs**

Unit-I — **07 Hrs**

Sampling Techniques:
Concepts of random sampling from finite and infinite populations, Simple random sampling (with replacement and without replacement), Sampling distribution of proportions, Expectation and standard error of sample mean and proportion, Sampling distributions of differences and sums.

Unit-II — **08 Hrs**

Estimation:
Point estimation, Estimator and estimate, Criteria for good estimates unbiasedness, consistency, efficiency and sufficiency, Method of moment's estimation and maximum likelihood estimation, Confidence intervals-population mean (large sample).

Unit -III — **08 Hrs**

Tests of Hypothesis:
Tests of Hypothesis: Principles of Statistical Inference, Formulation of the problems with examples. Simple and composite hypotheses. Null and alternative hypotheses. Tests - type I and type II error, Testing of mean and variance of normal population (one sample and two samples), Exact and asymptotic tests of proportions. Chi squared test for goodness of fit (Relevant case studies).

Unit -IV — **07 Hrs**

Linear Statistical Models:
Definition of linear model and types, One way ANOVA and two way ANOVA models-one observation per cell, multiple but equal number of observation per cell (Relevant case studies).

Unit -V — **09 Hrs**

Linear Regression:
Simple linear regression, Estimation of parameters, Properties of least square estimators, Estimation of error variance, Multivariate data, Multiple linear regressions, Multiple and partial correlation, Autocorrelation-introduction and plausibility of serial dependence, sources of autocorrelation, Durbin-Watson test for auto correlated variables.

Course outcomes (CO's):
On completion of the course, the student should have acquired the ability to

CO1	Identify and interpret the fundamental concepts of sampling techniques, estimates and types, hypothesis, linear statistical models and linear regression arising in various fields engineering.
CO2	Apply the knowledge and skills of simple random sampling, estimation, null and alternative hypotheses, errors, one-way ANOVA, linear and multiple linear regressions.
CO3	Analyze the physical problem to establish statistical/mathematical model and use appropriate statistical methods to solve and optimize the solution.
CO4	Distinguish the overall mathematical knowledge gained to demonstrate the problems of sampling techniques, estimation, tests of hypothesis, regression and statistical model arising in many practical situations.

Reference Books

1	Fundamentals of Statistics (Vol. I and Vol. II), A. M. Goon, M. K. Gupta and B. Dasgupta, 3rd Edition, World Press Private Limited, 1968, ISBN-13: 978-8187567806.

2	Applied Statistics and Probability for Engineers, Douglas C. Montgomery and George C. Runger, 3rd Edition, John Wiley & Sons, Inc, 2003, ISBN 0-471-20454-4.
3	Fundamentals of Mathematical Statistic A Modern Approach, S.C. Gupta, V.K. Kapoor, D. C. Montgomery and G. Runger, 10th Edition, S Chand Publications, 2000,ISBN 81-7014-791-3.
4	Regression Analysis: Concepts and Applications , F. A. Graybill and H. K. Iyer, Belmont, Calif, 1st edition, Duxbury Press, 1994, ISBN-13: 978-0534198695.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SYLLABUS

FOR

SEMESTER III & IV

SEMESTER : III						
SMART ANTENNA ARRAY SIGNAL PROCESSING (Theory)						
Course Code	**:**	**18MCS31**		**CIE Marks**	**:**	**100**
Credit L:T:P	**:**	**4:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L + 26T**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **11 Hrs**

Spectral Analysis of Deterministic Signals

Principles of Estimation Theory -Properties of Estimators, Estimation of Mean ,Estimation of Variance, Spectral Analysis of Deterministic Signals, Effect of Signal Sampling, Windowing, Periodic Extension, Effect of Spectrum Sampling, Estimation of the Autocorrelation of Stationary Random Signals, Estimation of the Power Spectrum of Stationary Random Signals, Power Spectrum Estimation Using the Periodogram, Power Spectrum Estimation by Smoothing a Single Periodogram, The Blackman-Tukey Method of Power Spectrum Estimation by Averaging Multiple Periodograms—The Welch Bartlett Method.

Unit – II **10 Hrs**

Joint Signal Analysis

Estimation of Cross-Power Spectrum, Estimation of Frequency Response Functions, Multi-taper Power Spectrum Estimation, Estimation of Auto Power Spectrum, Estimation of Cross Power Spectrum. Signal Modelling and Parametric Spectral Estimation - The Modelling Process: Theory and Practice Minimum-Variance Spectrum Estimation

Unit – III **11 Hrs**

Arrays

Introduction, Two-Element Array, N-Element Linear Array: Uniform Amplitude and Spacing, N-Element Linear Array: Directivity Design Procedure, N-Element Linear Array: Three-Dimensional Characteristics, Rectangular-to-Polar Graphical Solution, N-Element Linear Array: Uniform Spacing, Planar Array.

Narrowband Processing

Signal Model, Steering Vector Representation Eigenvalue Decomposition Conventional Beam former Source in Look Direction Directional Interference Random Noise Environment Signal-to-Noise Ratio

Unit – IV **10 Hrs**

Beam Forming

Conventional Spatial Beamforming - Spatial Matched Filter, Tapered Beamforming. Optimum Beamforming – Eigen analysis of the Optimum Beamformer, Interference Cancelation Performance, Tapered Optimum Beamforming, The Generalized Sidelobe Canceler, Performance
Considerations for Optimum Beamformer (In brief Effect of Signal Mismatch, Effect of Bandwidth)
Adaptive Beamforming - Sample Matrix Inversion, Diagonal Loading with the SMI Beamformer,
Implementation of the SMI Beamformer, Sample-by- Sample Adaptive Methods – RLS and Steepest Descent methods.
Other Adaptive Array Processing Methods - Linearly Constrained Minimum-Variance Beamformer.

Unit – V **10 Hrs**

Direction-of-Arrival Estimation Methods

Spectral Estimation Methods**,** Bartlett Method**,** Minimum Variance Distortion less Response Estimator**,** Linear Prediction Method**,** Maximum Entropy Method**,** Maximum Likelihood Method**,** Eigen structure Methods**,** MUSIC Algorithm, Minimum Norm Method, ESPRIT Method**,** Weighted Subspace

Course Outcomes

After going through this course the student will be able to:

CO1	Explain the concept of spatial spectrum of a planar array antenna understand the estimation process for a spatially distributed statistical signal being received by the antenna.
CO2	Analyze appropriate complex weighting technique for array elements that provide desirable spatial response

	and beam pattern.
CO3	Analyze the spatially sampled spectrum by an array and verify the performance of known spatial estimation algorithms like Bartlett, MUSIC and MVDR.
CO4	Evaluate and develop an array with spatial estimation algorithms that meet a specified spatial performance requirements including resolution and SNR.

Reference Books

1	Statistical and Adaptive Signal Processing, Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, 2005, Artech House, ISBN: 1-58053-610-7
2	Smart Antennas, Lal Chand Godara, 2004, CRC Press, ISBN: 978-0-84-931206-9
3	Array Signal Processing: Concepts and Techniques, Don H. Johnson, Dan E. Dugeon, 1993, Prentice Hall Signal Processing Series. ISBN: 0-130485136
4	Antenna Theory: Analysis and Design, Constantine A. Balanis, 3rd Edition. 2009, John Wiley & Sons, ISBN: 978-0-47-166782-7

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : III						
INTERNSHIP						
Course Code	**:**	**18MCS32**		**CIE Marks**	**:**	**100**
Credit L:T:P	**:**	**0:0:5**		**SEE Marks**	**:**	**100**
Hours/week	**:**	**10**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1) The duration of the internship shall be for a period of 8 weeks on full time basis after II semester final exams and before the commencement of III semester.
2) The student must submit letters from the industry clearly specifying his / her name and the duration of the internship on the company letter head with authorized signature.
3) Internship must be related to the field of specialization of the respective PG programme in which the student has enrolled.
4) Students undergoing internship training are advised to report their progress and submit periodic progress reports to their respective guides.
5) Students have to present the internship activities carried out to the departmental committee and only upon approval by the committee, the student can proceed to prepare and submit the hard copy of the final internship report. However, interim or periodic reports as required by the industry / organization can be submitted as per the format acceptable to the respective industry /organizations.
6) The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.
7) The broad format of the internship final report shall be as follows
    - Cover Page
    - Certificate from College
    - Certificate from Industry / Organization
    - Acknowledgement
    - Synopsis
    - Table of Contents
    - Chapter 1 - Profile of the Organization: Organizational structure, Products, Services, Business Partners, Financials, Manpower, Societal Concerns, Professional Practices,
    - Chapter 2 - Activities of the Department
    - Chapter 3 - Tasks Performed: summaries the tasks performed during 8-week period
    - Chapter 4 – Reflections: Highlight specific technical and soft skills that you acquired during internship
    - References & Annexure

Course Outcomes:

After going through the internship the student will be able to:

CO1: Apply engineering and management principles
CO2: Analyze real-time problems and suggest alternate solutions
CO3: Communicate effectively and work in teams
CO4: Imbibe the practice of professional ethics and need for lifelong learning.

Scheme of Continuous Internal Evaluation (CIE):

The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor. The committee shall assess the presentation and the progress reports in two reviews.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Explanation of the application of engineering knowledge in industries, ability to comprehend the functioning of the organization/ departments,	45%
Review-II	Importance of resource management, environment and sustainability presentation skills and report writing	55%

Scheme for Semester End Evaluation (SEE):
The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.

SEMESTER: III						
MAJOR PROJECT: PHASE-I						
Course Code	**:**	**18MCS33**		**CIE Marks**	**:**	**100**
Credit L:T:P	**:**	**0:0:5**		**SEE Marks**	**:**	**100**
Hours/week	**:**	**10**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. The Major Project work comprises of Phase-I and Phase-II. Phase-I is to be carried out in third semester and Phase-II in fourth semester.
2. The total duration of the Major project Phase-I shall be for 16 weeks.
3. Major project shall be carried out on individual student basis in his/her respective PG programme specialization. Interdisciplinary projects are also considered.
4. The allocation of the guides shall be preferably in accordance with the expertise of the faculty.
5. The project may be carried out on-campus/industry/organization with prior approval from Internal Guide, Associate Dean and Head of the Department.
6. Students have to complete Major Project Phase-I before starting Major Project Phase-II.
7. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes:

After going through this course the students will be able to:

CO1: Conceptualize, design and implement solutions for specific problems.
CO2: Communicate the solutions through presentations and technical reports.
CO3: Apply project and resource managements skills, professional ethics, societal concerns
CO4: Synthesize self-learning, sustainable solutions and demonstrate life-long learning

Scheme of Continuous Internal Examination (CIE)

Evaluation shall be carried out in two reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Selection of the topic, Literature Survey, Problem Formulation and Objectives	45%
Review-II	Methodology and Report writing	55%

Scheme for Semester End Evaluation (SEE):

Phase-I evaluation shall be done by an external examiner (domain expert) and respective guide as per the schedule. Maximum of four candidates per batch shall be allowed to take examination. The batches are to be formed based on specific domain of work.

SEMESTER : III

WIRELESS CELLULAR AND LTE 4G BROADBAND
(Professional Elective-E1)

Course Code	**:**	**18MCS3E1**		**CIE Marks**	**:**	**100**
Credit L:T:P	**:**	**0:0:5**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **10 Hrs**

LTE Standardization Phases, Evolution Beyond Release 8, LTE-Advanced for IMT-Advanced, LTE Specifications and 3GPP Structure.

System Architecture Based on 3GPP SAE

Basic System Architecture Configuration with only E-UTRAN Access Network ,System Architecture with E-UTRAN and Legacy 3GPP Access Networks, System Architecture with E-UTRAN and Non-3GPP Access Networks ,Architecture Configuration IMS Architecture PCC and QoS

Unit – II **11 Hrs**

OFDMA

SC-FDMA and MIMO in LTE, LTE Multiple Access Background, OFDMA Basics

SC-FDMA Basics MIMO Basics, Physical Layer- Transport Channels and their Mapping to the Physical Channels, Modulation Uplink User Data Transmission Downlink User Data Transmission, Uplink Physical Layer Signalling Transmission PRACH Structure, Downlink Physical Layer Signalling Transmission Physical Layer Procedures, UE Capability Classes and Supported Features Physical Layer Measurements, Physical Layer Parameter Configuration

Unit – III **10 Hrs**

LTE Radio Protocols

Protocol Architecture, The Medium Access Control The Radio Link Control Layer, Packet Data Convergence Protocol, Radio Resource Control (RRC) X2 Interface Protocols Understanding the RRC ASN.1 Protocol Definition Early UE Handling in LTE

Unit – IV **10 Hrs**

Mobility

Mobility Management in Idle State, Intra-LTE Handovers 190, Inter-system Handovers Differences in E-UTRAN and UTRAN Mobility

Unit – V **11 Hrs**

Radio Resource Management

Overview of RRM Algorithms, Admission Control and QoS Parameters, Downlink Dynamic Scheduling and Link Adaptation, Uplink Dynamic Scheduling and Link Adaptation, Interference Management and Power Settings, Discontinuous Transmission and Reception (DTX/DRX), RRC Connection Maintenance, Performance- Layer 1 Peak Bit Rates, Terminal Categories Link Level Performance, Link Budgets Spectral Efficiency Latency, LTE Reframing to GSM Spectrum, Dimensioning, Capacity Management Examples from HSPA Networks

Course Outcomes

After going through this course the student will be able to:

CO1: Understand the system architecture and the functional standard specified in LTE 4G.

CO2: Analyze the role of LTE radio interface protocols and EPS Data convergence protocols to set up, reconfigure and release data and voice from users.

CO3: Demonstrate the UTRAN and EPS handling processes from set up to release including mobility management for a variety of data call scenarios.

CO4: Test and Evaluate the Performance of resource management and packet data processing and transport algorithms.

Reference Books	
1.	Fundamentals of LTE, Arunabha Ghosh, Jan Zhang, Jefferey Andrews, Riaz Mohammed, 2010, Prentice Hall, Communications Engg and Emerging Technologies, ISBN: 978-9-35-306239-2.
2.	LTE for UMTS Evolution to LTE-Advanced, HarriHolma and Antti Toskala, 2nd Edition, 2011, John Wiley & Sons, Ltd, ISBN: 978-0-47-066000-3.
3.	Evolved Packet System (EPS); The LTE and SAE Evolution of 3G UMTS, Pierre L and Thierry Lucidarme, 2008, John Wiley & Sons, Ltd. ISBN:978-0-470-05976-0.
4.	LTE – The UMTS Long Term Evolution ; From Theory to Practice, Stefania Sesia, IssamToufik, and Matthew Baker, 2009, John Wiley & Sons Ltd, ISBN: 978-0-470-69716-0.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : III

WIRELINE BROADBAND COMMUNICATIONS
(Professional Elective-E2)

Course Code	**:**	**18MCS3E2**		**CIE Marks**	**:**	**100**
Credit L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**03 Hrs**

Unit – I **10 Hrs**

Plain Old Telephone System (POTS)
The Network Structure, Network Demarcation Points, Customer Premise Wiring, Hybrid circuits, High speed Voice Band Modems, ADSL and VDSL: Definition and Reference Model.
Copper Channel
Physical and Electrical Characteristics of Shielded Twisted pair, Models of DSL cables.

Unit – II **11 Hrs**

Noise and Noise Modelling on Twisted Pair Channel
Cross Talk Models, Impulsive noise, Noise from faults, Engineering measures, Mathematical Modelling of Crosstalk NEXT and FEXT.
Twisted pair channels capacity
Transmission Rate and Channel Capacity in Presence of Additive Gaussian Noise, Theoretical Rate Computations for PAM, QAM, and DMT Systems. Ideal DMT Data Rate Calculations
Overview of DSL
Performance Requirements for ADSL , VDSL, Representative DSL Multicarrier system, ADSL Frame and Multi-frame structure.

Unit – III **11 Hrs**

Fundamentals of Multicarrier Modulation
Basics of MCM, DMT, Initialization, Timing and Performance – Initialization Methods, Adaptation of Receiver and Transmitter – Activation, Channel discovery (Gain Initialization, Clock Synchronization, first channel Identification (equalization, filter training), Channel analysis (Gain Estimation), Bit allocation for Target Noise margin and Target Rate, Secondary channel Identification, Parameter exchange.
Steady State Adaptation of Tx and Rx – Receiver Equalizer Update, Noise monitoring, Channel gain and response Update, FEQ adaptation. Dynamic Measurement of Performance - Bit swapping, Seamless rate adaptation, Power management state machine.

Unit – IV **10 Hrs**

Error Control in DSL
Basic background of ECC, Reed Solomon Codes in DSL, Decoding of RS codes, Un-correctable codes, Interleaving Methods (Tong's Method, Forney Inter-leaver), Erasures, Concatenated Coding, Coding Gain. Principles of Trellis Coded Modulation, Trellis coding and decoding

Unit – V **10 Hrs**

DSL Channel Equalization
Basic background, Optimization Criteria, Equalizer Structures, Closed form equalizers, Adaptive equalizers, Training, Examples and Practical Design Issues.
DSL Synchronization: Overview, DMT synchronization, Timing Recovery Methods – Open loop Timing Recovery, Pilot based Timing Recovery, Decision directed Timing recovery, Frame Synchronization.

Course Outcomes
After completing the course the students will be able to:

CO1: Understand the technology issues and DSL Standards for broadband over wireline.
CO2: Apply a variety of signal processing algorithms to DSL modem in a wireline channel environment to improve specific performance parameters.
CO3: Test and validate performance parameters for DSL links for a variety of known channel topologies and channel noise profiles.
CO4: Demonstrate by simulation or emulation, different functional blocks of DSL Modem to meet performance parameters for specified channel environment.

Reference Books	
1	Fundamentals of DSL Technology, Philip Golden Hervé, Dedieu Krista Jacobsen, 2006, Auerbach Publications -Taylor & Francis Group. ISBN: 978-0-84-931913-6.
2	Understanding Digital Subscriber Line Technology, T. Starr, J.M. Cioffi, and P.J. Silverman, 1999, Prentice-Hall, Upper Saddle River, ISBN: 978-0-13-780545-7.
3	Implementation and Application of DSL, Philip Golden Hervé, Dedieu Krista Jacobsen, 2008, Auerbach Publications -Taylor & Francis Group, ISBN: 978-0-84-933423-8.
4	ADSL/VDSL Principles: A Practical and Precise Study of Asymmetric Digital Subscriber Lines and Very High Speed Digital Subscriber Lines, D. Rauschmayer, 1998, McMillan Technical Publishing, ISBN: 978-1-57-870015-8.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER-III

WIRELESS LOCAL AREA NETWORKS
(Professional Elective-E3)

Course Code	**:**	**18MCS3E3**		**CIE Marks**	**:**	**100**
Credit L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**03 Hrs**

Unit – I **11 Hrs**

Introduction – History of IEEE 802.11, IEEE802.11.
Physical Layer – OFDM, MIMO, SDM basics; 802.11n propagation model, Linear Receiver Design, Maximum Likelihood estimation.
Interoperability with 11a/g legacy OFDM devices- 11a packet structure review, Mixed format high throughput packet structure,

Unit – II **10 Hrs**

802.11n High Throughput - 40 MHz channel, 20 MHz enhancements: Additional data subcarriers, MCS enhancements: Spatial streams and code rate, Greenfield (GF) preamble, Short guard interval.
Robust performance - Receive diversity, Spatial expansion, Space-time block coding, Low density parity check codes,

Unit – III **10 Hrs**

Medium access control: Protocol layering, Management functions, distributed channel access, Data/ACK frame exchange, Hidden node problem, Enhanced distributed channel access, Block acknowledgement.
MAC throughput enhancements - Reasons for change, Aggregation, Block acknowledgement, HT-immediate block ack.

Unit – IV **11 Hrs**

Advanced channel access techniques – PCF, HCCA, Reverse Direction Protocol, PSMP
Interoperability and coexistence - Station and BSS capabilities, controlling station behavior, 20 MHz and 20/40 MHz operation, a summary of fields controlling 40 MHz operation, Phased coexistence operation (PCO), Protection.
Transmit Beam Forming - Eigenvalue analysis, Unequal MCS, Receiver design, Channel sounding, Channel state information feedback, Improved performance with transmit beamforming, Degradations, MAC considerations, Comparison between implicit and explicit, Fast link adaptation.

Unit – V **10 Hrs**

WiGiG – IEEE802.11ac and ad key features, 11ac and 11ad Physical Layer (Channels, Phy layer, Phy control, Single carrier Phy, Low Power SC Phy, OFDM Phy (Packet Structure, Modulation and coding) Beam forming and BeamfForm Training. D-Band measurement requirements for channel estimation and testing.

Course Outcomes
After completing the course, the students will be able to:

CO1:	Explain the use of OFDM, MIMO and SDM in WLAN 802.11n, ac & ad media access.
CO2:	Analyze Physical and MAC access layers for performance and throughput for typical Transmitters and Receivers using specified 802.11n channel models.
CO3:	Evaluate the performance and throughput using advanced channel access techniques as specified by 802.11ac and 802.11ad standards.
CO4:	Develop Evaluate schemes to ensure interoperability of 802.11 ac and ad with advanced access techniques with earlier 802.11a/b/g/n WLANs.

Reference Books

1	Next Generation Wireless LANs Throughput, robustness, and Reliability in 802.11n, Eldad Perahia and Robert Stacey, 2008, Cambridge University Press, ISBN:13 978-0-521-88584-3.
2	Controller-Based Wireless LAN Fundamentals, Jeff Smith, Jake Woodhams, Robert Marg, 2011, Cisco Press, ISBN: 978-1-58705-825-7.

3	802.11® Wireless Networks: The Definitive Guide, Matthew Gast, 2002, O'Reilly Publishers, ISBN: 0-596-00183-5.
4	Inside Bluetooth Low Energy (Mobile Communications), Naresh Gupta, Artech House; 2nd edition, 2016, ISBN: 978-1-63-081089-4

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : IV						
MAJOR PROJECT: PHASE II						
Course Code	**:**	**18MCS41**		**CIE Marks**	**:**	**100**
Credit L:T:P	**:**	**0:0:20**		**SEE Marks**	**:**	**100**
Hours/Week	**:**	**40**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. Major Project Phase-II is continuation of Phase-I.
2. The duration of the Phase-II shall be of 16 weeks.
3. The student needs to complete the project work in terms of methodology, algorithm development, experimentation, testing and analysis of results.
4. It is mandatory for the student to present/publish the work in National/International conferences or Journals
5. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes:

After going through this course the students will be able to:

CO1: Conceptualize, design and implement solutions for specific problems.
CO2: Communicate the solutions through presentations and technical reports.
CO3: Apply project and resource managements skills, professional ethics, societal concerns
CO4: Synthesize self-learning, sustainable solutions and demonstrate life-long learning

Scheme of Continuous Internal Examination (CIE)

Evaluation shall be carried out in three reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Review and refinement of Objectives, Methodology and Implementation	20%
Review-II	Design, Implementation and Testing	40%
Review-III	Experimental Result & Analysis, Conclusions and Future Scope of Work, Report Writing and Paper Publication	40%

Scheme for Semester End Evaluation (SEE):

Major Project Phase-II SEE shall be conducted in two stages. This is initiated after fulfilment of submission of project report and CIE marks.

Stage-1 Report Evaluation

Evaluation of Project Report shall be done by guide and an external examiner.

Stage-2 Project Viva-voce

Major Project Viva-voce examination is conducted after receipt of evaluation reports from guide and external examiner.

Both Stage-1 and Stage-2 evaluations shall be completed as per the evaluation formats.

SEE procedure is as follows:

	Internal Guide	External Examiner	TOTAL	
SEE Report Evaluation	100 marks	100 marks		200 marks
			(A)	(200/2) = 100 marks
Viva-Voce	Jointly evaluated by Internal Guide & External Evaluator		(B)	100 marks
			Total Marks	**[(A)+(B)]/2 = 100**

SEMESTER : IV						
TECHNICAL SEMINAR						
Course Code	**:**	**18MCS42**		**CIE Marks**	**:**	**50**
Credit L:T:P	**:**	**0:0:2**		**SEE Marks**	**:**	**50**
Hours/Week	**:**	**4**		**SEE Duration**	**:**	**30 Mins**

GUIDELINES

1) The presentation shall be done by individual students.
2) The seminar topic shall be in the thrust areas of respective PG programme.
3) The seminar topic could be complementary to the major project work
4) The student shall bring out the technological developments with sustainability and societal relevance.
5) Each student must submit both hard and soft copies of the presentation along with the report.
6) The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes

After going through this course the student will be able to:

CO1: Identify topics that are relevant to the present context of the world
CO2: Perform survey and review relevant information to the field of study.
CO3: Enhance presentation skills and report writing skills.
CO4: Develop alternative solutions which are sustainable

Scheme of Continuous Internal Evaluation (CIE): Evaluation shall be carried out in two reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Selection of Topic, Review of literature, Technical Relevance, Sustainability and Societal Concerns, Presentation Skills	45%
Review-II	Technological Developments, Key Competitors, Report writing	55%

Scheme for Semester End Evaluation (SEE):

The SEE examination shall be conducted by an external examiner and an internal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.