RV COLLEGE OF ENGINEERING ®

(Autonomous Institution Affiliated to VTU, Belagavi)
R.V. Vidyaniketan Post, Mysore Road
Bengaluru – 560 059

Scheme and Syllabus of I & II Semesters

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)

in

COMMUNICATION SYSTEMS

DEPARTMENT OF

ELECTRONICS & COMMUNICATION ENGINEERING

INNER FRONT COVER PAGE

College Vision & Mission
(To be included from our side)

RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)
R.V. Vidyaniketan Post, Mysore Road
Bengaluru – 560 059

Scheme and Syllabus of I & II Semesters

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)

in

COMMUNICATION SYSTEMS

DEPARTMENT OF

ELECTRONICS & COMMUNICATION ENGINEERING

Department Vision & Mission

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

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

ABBREVIATIONS

Sl. No.	Abbreviation	Meaning
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	Professional Core 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.	PHY	Physics
21.	CHY	Chemistry
22.	MAT	Mathematics

INDEX

R V COLLEGE OF ENGINEERNG, BENGALURU-560 059
(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 Credits				18	2	**2**	**22**
Total Number of Hours / Week				**18**	**4**	**6**	**28**

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	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 Credits				20	2	**3**	**25**
Total Number of Hours / Week				**20**	**4**	**9**	**33**

I Semester		
GROUP A: CORE 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: CORE ELECTIVES		
1.	18MVE1B1	MEMS and Smart Systems
2.	18MCS1B2	Digital Image Processing
3.	18MCS1B3	Cryptography and Network Security
II Semester		
GROUP C: CORE ELECTIVES		
1.	18MCS2C1	Antenna Theory
2.	18MCS2C2	Machine Learning
3.	18MCS2C3	Optical Communication Networks
GROUP D: CORE ELECTIVES		
1.	18MCS2D1	Wireless Sensor Networks and IOT
2.	18MCE2D2	Deep Learning
3.	18MVE2D3	VLSI Digital Signal Processing Systems

GROUP E: 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.	CHY	18CHY2G08	Composite Materials Science and Engineering	3
9.	PHY	18PHY2G09	Physics of Materials	3
10.	MAT	18MAT2G10	Advanced Statistical Methods	3

Semester I						
PROBABILITY THEORY & LINEAR ALGEBRA (Common to MCN, MCS, MDC, MCE, MRM, MIT, MSE)						
Course Code	**:**	**18MAT11B**		**CIE Marks**	**:**	**100**
Credits	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hrs	**:**	**48L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **9 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 **9 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 **10 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 **9 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.

Expected 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, 2008, Tata McGraw Hill Education Private Limited, 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, 2012, Elsevier Academic Press, ISBN 9780121726515.

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

Continuous Internal Evaluation (CIE): Total marks: 100

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project. **Total CIE is 20+50+30=100 Marks.**

Semester End Evaluation (SEE): Total marks: 100
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**
Hrs	**:**	**48L +36P**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 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 (Basics of CPFSK and CPM – Full Treatment of MSK), Transmit PSD for Modulation Schemes.

Unit – II	**10 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), Comparison of detection schemes.

Unit – III	**10 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.

Unit – IV	**9 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), Adaptive equalization of Trellis - coded signals.

Unit – V	**9 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.

Expected 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

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. Simulation of direct sequence Spread Spectrum and Frequency Hopped Spread Spectrum

Reference Books	
1.	John G. Proakis, MasoudSalehi,"Digital Communications ",5e,Pearson Education(2014),ISBN:978-9332535893
2.	Bernard Sklar,"Digital Communications: Fundamentals and Applications: Fundamentals &Applications",2e,Pearson Education(2009),ISBN:978-8131720929
3.	Simon Haykin ,"Digital Communications Systems",1e,Wiley(2014),ISBN:978-8126542314

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 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. The 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) mini project. **Total CIE is 20+50+30=100 Marks.**

Scheme of Continuous Internal Evaluation (CIE) for Practicals: (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.

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

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 I						
ADVANCED COMMUNICATION NETWORKS & PROTOCOL (Theory and Practice)						
Course Code	**:**	**18MCS13**		**CIE Marks**	**:**	**100+50**
Credits	**:**	**3:1:1**		**SEE Marks**	**:**	**100+50**
Hrs	**:**	**48L +36P**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 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	**10 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), Virtual Networks and Tunnels	
Unit – III	**10 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	**9 Hrs**
End-to-End Protocols: Simple Demultiplexer (UDP), Reliable Byte Stream(TCP), End-to-End Issues, Segment Format, Connecting Establishment and Termination, Sliding Window Revisited, Triggering Transmission, Adaptive Retransmission, Record Boundaries, TCP Extensions, Queuing Disciplines, FIFO, Fair Queuing, TCP Congestion Control, Additive Increase/ Multiplicative Decrease, Slow Start, Fast Retransmit and Fast Recovery	
Unit – V	**9 Hrs**
Congestion Control and Resource Allocation: Congestion-Avoidance Mechanisms, DEC bit, Random Early Detection (RED), Source-Based Congestion Avoidance. The Domain Name System(DNS),Electronic Mail(SMTP,POP,IMAP,MIME),World Wide Web(HTTP),Network Management(SNMP)	
Expected Course Outcomes: 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.	**Larry Peterson and Bruce S Davis** "Computer Networks :A System Approach" 5 th Edition , Elsevier -2014
2.	**Douglas E Comer, "** Internetworking with TCP/IP, Principles, Protocols and Architecture" 6th Edition, PHI - 2014
3.	**Uyless Black** "Computer Networks, Protocols , Standards and Interfaces" 2nd Edition – PHI
4.	**Behrouz A Forouzan** "TCP /IP Protocol Suite" 4 th Edition – Tata McGraw-Hill

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 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. The 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) mini project. **Total CIE is 20+50+30=100 Marks.**

Scheme of Continuous Internal Evaluation (CIE) for Practicals: (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.

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

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 I			
Professional Skill Development			
Course Code:	**18HSS14**		**CIE Marks:** 50
Credits: L: T:P	**3:0:0**		**SEE Marks: Audit Course**
Hours: 18L			**CIE Duration:** 02 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.	**03 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,	**08 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	**03 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;	**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.	**02 Hrs**
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, 2004 Edition, 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 2012 Edition, McGraw-Hill Publication ISBN: 9780071772204
4.	Ethnus, Aptimithra: Best Aptitude Book ,2014 Edition, Tata McGraw Hill ISBN: 9781259058738

Evaluation of CIE will be carried out in TWO Phases.

Phase	Activity
I	After 9 hours of training program, students are required to undergo a test set for a total of 50 marks. The structure of the test will have two parts. Part A will be quiz based evaluated for 15 marks and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).
II	Similarly students will have to take up another test after the completion 18 hours of training. The structure of the test will have two parts. Part A will be quiz based evaluated for 15 marks and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).
FINAL CIE COMPUTATION	
Continuous Internal Evaluation for this course will be based on the average of the score attained through the two tests. The CIE score in this course, which is a mandatory requirement for the award of degree, must be greater than 50%. Needless to say the attendance requirement will be the same as in any other course.	

Semester I						
ADVANCED EMBEDDED SYSTEM DESIGN (Group A : Core Elective)						
Course Code	**:**	**18MCS1A1**		**CIE Marks**	**:**	100
Credits	**:**	**4:0:0**		**SEE Marks**	**:**	100
Hrs	**:**	**48L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **10 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 **9 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 **9 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 **10 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

Expected 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.	James K Peckol, "Embedded Systems – A contemporary Design Tool", John Weily, 2008, ISBN: 0-444-51616-6
2.	Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2009, ISBN: 10: 0070678790
3.	David E.Simon, "Embedded Software Primer",Addison Wesley, ISBN-13: 978-0201615692
4.	Barry B.Brey, "The Intel Micro-processors, Architecture, Programming and Interfacing", 6th Edition, Pearson Education.
5.	Steve Heath, "Embedded System Design", Elsevier, 2nd Edition, 2004.
6.	Reference Manuals: RTX-ARM,MISRA C 2012,CERT,IS26262,DO-178B,IEC 62304

Continuous Internal Evaluation (CIE): Total marks: 100

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project. **Total CIE is 20+50+30=100 Marks.**

Semester End Evaluation (SEE): Total marks: 100
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 (Group A : Core Elective)						
Course Code	**:**	**18MCS1A2**		**CIE Marks**	**:**	**100**
Credits	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hrs	**:**	**48L**		**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	**10 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	**10 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	**9 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	**9 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	

Expected 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.	Proakis, and Manolakis, "Digital signal processing", 3rd edition, Prentice Hall, 1996. ISBN 0131873741, 9780131873742
2.	Robert. O. Cristi, "Modern Digital signal processing", Cengage Publishers, India, 2003. ISBN:978-0534400958, 10534400957
3.	Vaidyanathan, P.P.,"Multirate Systems and Filter Banks", Pearson Publication 2006, ISBN: 81-7758-942-3S.
4.	K. Mitra, "Digital signal processing: A computer based approach", 3rd edition, TMH, India, 2007.ISBN 9780070667563

Continuous Internal Evaluation (CIE): Total marks: 100

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

CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project. **Total CIE is 20+50+30=100 Marks.**

Semester End Evaluation (SEE): Total marks: 100
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 (Group A : Core Elective)						
Course Code	**:**	**18MCS1A3**		**CIE Marks**	**:**	**100**
Credits	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hrs	**:**	**48L**		**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	**10 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	**9 Hrs**
Basic consideration in active networks: Stability Consideration in Active Networks, Gain Considerations in Amplifiers, Noise Considerations in Active Networks	
Unit – V	**9 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	

Expected Course Outcomes:

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

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

Reference Books:

1.	Matthew M. Radmanesh, "RF and Microwave Electronics Illustrated", Pearson Education 1st edition, 2004.
2.	Reinhold Ludwig, and Pavel Bretchko,"RF circuit design theory and applications", Pearson Education edition, 2004.
3.	Inder Bahl and Prakash Bhartia, “Microwave Solid State Circuit Design”, Wiley India edition, Second edition.
4.	Ali A. Behagi, “RF and Microwave Circuit Design: A Design Approach Using (ADS)”, Techno Search Publishers, 2015.

Continuous Internal Evaluation (CIE): Total marks: 100

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

CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project. **Total CIE is 20+50+30=100 Marks.**

Semester End Evaluation (SEE): Total marks: 100
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
Group B : Core Elective
(Common to VLSI and CS)

Course Code	**:**	**18MVE1B1**		**CIE Marks**	**:**	100
Credits	**:**	**4:0:0**		**SEE Marks**	**:**	100
Hrs	**:**	**48L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **10 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 **10 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 **9 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 **9 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.

Expected 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.	Dr. A.K.Aatre, Ananth Suresh, K.J.Vinoy, S. Gopala krishna, K.N.Bhat., "Micro and Smart Systems", John Wiley Publications, 2002, ISBN: 1118213904, 9781118213902
2.	Tai-Ran Tsu, "MEMS & Microsystems: Design and Manufacture", Tata Mc-Graw-Hill.2002.8th reprint, ISBN-13:978-0-07-048709-3. ISBN-10:0-07-048709-X
3.	RF MEMS Theory, Design and Technology GABRIEL M. REBEIZ. 2003A JOHN WILEY & SONS PUBLICATION. ISBN: 978-0-471-20169-4
4.	S. D. Senturia, "Microsystems Design", Kluwer Academic Publishers, Boston, USA, 2001, ISBN 0-7923-7246-8

Continuous Internal Evaluation (CIE): Total marks: 100

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project. **Total CIE is 20+50+30=100 Marks.**

Semester End Evaluation (SEE): Total marks: 100
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 **Group B : Core Elective**						
Course Code	**:**	**18MCS1B2**		**CIE Marks**	**:**	**100**
Credits	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hrs	**:**	**48 L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I — **10 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 — **9 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 — **9 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..

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

Continuous Internal Evaluation (CIE): Total marks: 100

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project. **Total CIE is 20+50+30=100 Marks.**

Semester End Evaluation (SEE): Total marks: 100
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 **Group B : Core Elective**						
Course Code	**:**	**18MCS1B3**		**CIE Marks**	**:**	**100**
Credits	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hrs	**:**	**48L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 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	**10 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	**9 Hrs**
Cloud Security: Cloud Computing Concepts, Moving to the Cloud, Cloud security tools and Techniques, Cloud Identity management, Securing IaaS.	
Unit V	**9 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.	
Expected Course Outcomes: After going through this course the student will be able to: 1. Implement the security policies like authentication, integrity and confidentiality in the form of message exchange. 2. Implement cryptographic principles to various threats. 3. Learn about security issues when moving to cloud. 4. Analyze web and network security threats.	
Reference Books	
1. William Stallings, "Cryptography and Network Security: Principles and Practices", 6th Edition, Pearson education, 2014.	
2. Charles P.Pfleeger, Shari Lawrence P.Pfleeger, Jonathan Margulies, "Security in Computing", 5th Edition, Prentice Hall, 2015.	
3. Atul Kahate, "Cryptography and Network Security", 3rd Edition, Tata McGraw Hill, 2013.	

Continuous Internal Evaluation (CIE): Total marks: 100

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

CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project. **Total CIE is 20+50+30=100 Marks.**

Semester End Evaluation (SEE): Total marks: 100
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	**:**	**3:1:1**		**SEE Marks**	**:**	**100+50**
Hrs	**:**	**48L+36P**		**SEE Duration**	**:**	**3 Hrs**

Unit – I — **10 Hrs**

Synchronization – Signal Parameter estimation, Carrier Phase Estimation, Symbol Timing Recovery, Performance of ML estimators.

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 — **10 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.

Capacity of wireless channel: AWGN channel capacity, Resources of AWGN channel, Linear time invariant Gaussian channel, Capacity of Fading Channels.

Unit – III — **10 Hrs**

Multicarrier Signalling: A brief overview of Frequency Diversity.

Multicarrier Communications in AWGN channel- Single carrier vs Multicarrier, OFDM, FFT Implementation, Spectral Characteristics, Power and bit allocation, Capacity of Multicarrier Channel, Peak to Average Power Ratio, Channel Coding Considerations

Unit – IV — **9 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 — **9 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: an outage-optimal architecture, Sub optimality of V-BLAST, Coding across transmit antennas: D-BLAST

Lab Experiments

1. Radiation characteristics of Microstrip Patch and Printed Dipole Antenna
2. Measurement of S-parameters of a power divider, printed directional coupler and resonant antennas (Patch and Dipole antennas) using network analyser.
1. Design and Simulation of Waveguide Magic-Tee and Horn antenna.
2. Design and Simulation of a Printed Hybrid Ring and Power divider
6. Characterization of Microwave Waveguide Tee's, Directional Coupler, Circulator and Isolator
7. Analog and Digital communication link using optical fiber
   Study of Propagation loss, Bending loss and Measurement of Numerical Aperture in OFC
8. Matched filter & Linear equalizer simulation in Matlab
9. Students will be provided open ended problem to access their capabilities

Expected 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.	John G. Proakis, MasoudSalehi,"Digital Communications ",5e,Pearson Education(2014),ISBN:978-9332535893
2.	David Tse, PramodViswanath, "Fundamentals of Wireless Communication",1e,Cambridge University Press(2005), ISBN:0521845270
3.	Bernard Sklar,"Digital Communications: Fundamentals and Applications: Fundamentals &Applications",2e,Pearson Education(2009),ISBN:978-8131720929
4.	Simon Haykin ,"Digital Communications Systems",Wiley(2014),ISBN:978-0-471-64735-5

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 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. The 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) mini project. **Total CIE is 20+50+30=100 Marks.**

Scheme of Continuous Internal Evaluation (CIE) for Practicals: (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.

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

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 II						
ERROR CONTROL AND CODING						
Course Code	**:**	**18MCS22**		**CIE Marks**	**:**	**100**
Credits	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hrs	**:**	**48L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 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, Self dual codes.

Unit – II	**10 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, Shortened cyclic codes.

Unit – III	**10 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	**9 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, Multiple-step majority logic decoding (Algorithm only).
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	**9 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, Weighted Majority Logic + Bit Flipping.

Expected 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.
CO4: Construct and Decode Concatenated codes to perform close to Shannon Limit in a data Transmission system.

Reference Books:

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

	ISBN 978-81-317-3440-7
2.	Salvatore Gravano, "Introduction to Error control coding", Oxford university press, 2007. ISBN 0-19-856231-4
3.	Blahut. R. E, "Theory and practice of error control codes", Addison Wesley, 1984. ISBN 0201101025 , 9780201101027

Continuous Internal Evaluation (CIE): Total marks: 100

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project. **Total CIE is 20+50+30=100 Marks.**

Semester End Evaluation (SEE): Total marks: 100
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	**:**	**36L**		**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.	**07 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	**07 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.	**07 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	Kothari C.R., Research Methodology Methods and techniques by, New Age International Publishers, 4th edition, ISBN: 978-93-86649-22-5
2	Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Management Research Methodology, Pearson Education: New Delhi, 2006. ISBN: 978-81-77585-63-6
3	William M. K. Trochim, James P. Donnelly, The Research Methods Knowledge Base, 3rd Edition, Atomic Dog Publishing, 2006. ISBN: 978-1592602919
4	Levin, R.I. and Rubin, D.S., Statistics for Management, 7th Edition, Pearson Education: New Delhi.

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

CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project. **Total CIE 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**
Credits	**:**	**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 (Group C : Core Elective)						
Course Code	**:**	**18MCS2C1**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hrs	**:**	**48L**		**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 **9 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 **9 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.

Course Outcomes

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. Constantine A Balanis, "Advanced engineering electromagnetics", John Wiley & Sons, 1st edition, 1989, ISBN: 0-471-62194-3.

2. Roger F Harrington, "Time harmonic electromagnetic fields", John Wiley & Sons, IEEE press classic reissue, 2001, ISBN: 0-471-20806-X.
3. C. A. Balanis, "Antenna Theory Analysis and Design", John Wiley, 2nd Edition, 2007.

Continuous Internal Evaluation (CIE): Total marks: 100

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project. **Total CIE is 20+50+30=100 Marks.**

Semester End Evaluation (SEE): Total marks: 100
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 **(Group C: Core Elective)** **(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**
Hrs	**:**	**48L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**9 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	**10 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	**10 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	**10 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	**9Hrs**
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	
Expected 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, February 2006, Springer, ISBN-13: 978-0387-31073-2.
2.	The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani, and Jerome Friedman, 2nd Edition, 2008, Springer, ISBN 978-0-387-84858-7
3.	Data Mining – Concepts and Techniques, Jiawei Han and Micheline Kamber, Morgan Kaufmann, 3rd Edition, 2006,Elsevier, ISBN 1-55860-901-6
4.	Practical data science with R, Zumel, N., & Mount, J, 2014, Manning Publications ISBN 9781617291562

Continuous Internal Evaluation (CIE): Total marks: 100

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project. **Total CIE is 20+50+30=100 Marks.**

Semester End Evaluation (SEE): Total marks: 100
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 Communications Networks (Group C: Core Elective)						
Course Code	**:**	**18MCS2C3**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hrs	**:**	**48L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I — **10 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 — **10 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 — **9 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 — **9 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..

Expected Course Outcomes:

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

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

Reference Books:

1.	John M. Senior, “Optical Fiber Communications”, Pearson edition, 2000.
2.	Rajiv Ramswami, N Sivaranjan, “Optical Networks- A Practical Perspective”, M. Kauffman publishers, 2000
3.	Gerd Keiser, “Optical Fiber Communication”, MGH, 1991.
4.	G. P. Agarwal, “Fiber Optics communication” , John Wiley, New york, 1997
5.	P. E. Green, “Optical Networks”, Prentice Hall, 1994

Continuous Internal Evaluation (CIE): Total marks: 100

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project. **Total CIE is 20+50+30=100 Marks.**

Semester End Evaluation (SEE): Total marks: 100
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 (Group D: Core Elective)						
Course Code	**:**	**18MCS2D1**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**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 — **10 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 — **9 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 — **9 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. **WaltenegusDargie and Christian Poellabauer,** "Fundamentals ofWireless Sensor Networks Theory and Practice", John Wiley & Sons Ltd.ISBN 978-0-470-99765-9, 2010.
2. **Hwaaiyu Geng**, "Internet of Things and Data Analytics Handbook",John Wiley & Sons Ltd. ISBN 978-1-119-17364-9 (H/B), 2017.
3. **Ian F. Akyildiz** and **Mehmet Can Vuran** "Wireless Sensor Networks",John Wiley & Sons Ltd. ISBN 978-0-470-03601-3 (H/B), 2010.

Case Study References

4. M. T. Lazarescu, "Design of a WSN Platform for Long-Term Environmental Monitoring for IoT Applications," in *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
5. I. S. H. Martínez, I. P. O. J. Salcedo and I. B. S. R. Daza, "IoT application of WSN on 5G infrastructure," *2017 International Symposium on Networks, Computers and Communications (ISNCC)*, Marrakech, 2017, pp. 1-6. doi: 10.1109/ISNCC.2017.8071989.
6. J. Cabra, D. Castro, J. Colorado, D. Mendez and L. Trujillo, "An IoT Approach for Wireless Sensor Networks Applied to e-Health Environmental Monitoring," *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
7. 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

Continuous Internal Evaluation (CIE): Total marks: 100

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

CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project. **Total CIE is 20+50+30=100 Marks.**

Semester End Evaluation (SEE): Total marks: 100

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 (Group-D: Core Elective) (Common to CSE, CS)						
Course Code	**:**	**18MCE2D2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**46L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Deep Feedforward Networks: Multilayer Perceptron, Example: Learning XOR, Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation Algorithm	**08 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	**10 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	**10 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	**08 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	**10 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.	Ian Good Fellow, YoshuaBengio and Aaron Courville,Deep Learning (Adaptive Computation and Machine Learning Series), MIT Press (3 January 2017), ISBN-13: 978-0262035613.
2.	Simon Haykin, Neural Networks – A Comprehensive Foundation, Second Edition, PHI, 2005.
3.	Gunjan Goswami, Introduction to Artificial Neural Networks, S.K. Kataria & Sons; 2012 Edition, ISBN-13: 978-9350142967.
4.	Nikhil Buduma, Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms, by O'Reilly Publications, 2016 Edition, ISBN-13: 978-1491925614.

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

CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project.
Total CIE 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 **Group D: Core Elective** **(Common to VLSI & ES and CS)**						
Course Code	**:**	**18MVE2D3**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hrs	**:**	**48L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10Hrs**
Introduction to digital Signal Processing systems Introduction, Typical DSP algorithms, DSP Application demands and scaled CMOS technologies, Representations of DSP algorithms.	
Unit – II	**10Hrs**
Pipelining and parallel processing Introduction, Pipelining of FIR Digital filters, parallel processing, pipelining and parallel processing for low power.	
Unit – III	**10Hrs**
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	**9Hrs**
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	**9Hrs**
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.	
Expected 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	Keshab K. Parthi , "VLSI Digital Signal processing systems :Design and implementation" Wiley 1999,ISBN: 81-265-1098-6.
2	Rulph chasseing, "Digital Signal Processing and applications " with C6713 and C6416 DSK, Wiley 2005.
3.	Nasser Kehtarnavaz, " digital Signal Processing System Design: Lab view based hybrid programming,Academic press 2008.

Continuous Internal Evaluation (CIE): Total marks: 100

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

CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project. **Total CIE is 20+50+30=100 Marks.**

Semester End Evaluation (SEE): Total marks: 100
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 (Group G: Global Elective)						
Course Code	**:**	**18CS2G01**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Course Learning Objectives:

Graduates shall be able to

1. Formulate and solve business problems to support managerial decision making.
2. Explore the concepts, processes needed to develop, report, and analyze business data.
3. Use data mining techniques concepts to identify specific patterns in the data
4. Interpret data appropriately and solve problems from various sectors such as manufacturing, service, retail, software, banking and finance.

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.	**07 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.	**07 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.	**07 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	Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Business analytics Principles, Concepts, and Applications FT Press Analytics, 1st Edition, 2014, ISBN-13: 978-0133989403, ISBN-10: 0133989402
2	Evan Stubs , The Value of Business Analytics: Identifying the Path to Profitability, John Wiley & Sons, ISBN:9781118983881 |DOI:10.1002/9781118983881,1st edition 2014
3	James Evans, Business Analytics, Pearsons Education 2nd edition, ISBN-13: 978-0321997821 ISBN-10: 0321997824
4	Gary Cokins and Lawrence Maisel, Predictive Business Analytics Forward Looking Capabilities to Improve Business, Wiley; 1st edition, 2013.

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

CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project.

Total CIE 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 (Group G :Global Elective)		
Course Code: 18CV 2G 02		**CIE Marks:100**
Credits : L: T: P : 3:0:0		**SEE Marks :100**
Hours : 36L		**SEE Duration:3Hrs**

Course Learning Objectives :

1	To understand the Industrial and Occupational health and safety and its importance.
2	To understand the different materials, occupations to which the employee can exposed to.
3	To know the characteristics of materials and effect on health.
4	To evaluate the different processes and maintenance required in the industries to avoid accidents.

UNIT – I	**7Hrs**

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	**7Hrs**

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	**8Hrs**

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	**7Hrs**

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	**7Hrs**

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.	
Expected 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, SBN 10: 0070432015 / ISBN 13: 9780070432017, Published by McGraw-Hill Education. Da Information Services.
2.	H. P. Garg, Maintenance Engineering Principles, Practices & Management, 2009,S. Chand and Company, New Delhi, ISBN:9788121926447
3.	Fundamental Principles of Occupational Health and Safety, Benjamin O. ALLI, Second edition,2008 International Labour Office – Geneva: ILO, ISBN 978-92-2-120454-1
4.	Foundation Engineering Handbook, 2008, Winterkorn, Hans, Chapman & Hall London. ISBN:8788111925428.

Continuous Internal Evaluation (CIE): Total marks: 100
Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project.
Total CIE is 20+50+30=100 Marks.

Semester End Evaluation (SEE): Total marks: 100
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 (Group G: Global Elective)						
Course Code	**:**	**18IM2G03**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Linear Programming: Introduction to Linear Programming problem **Simplex methods:** Variants of Simplex Algorithm – Use of Artificial Variables	**07 Hrs**
Unit – II	
Advanced Linear Programming : Two Phase simplex techniques, Revised simplex method **Duality:** Primal-Dual relationships, Economic interpretation of duality	**07 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	**07 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	Taha H A, Operation Research An Introduction, PHI, 8th Edition, 2009, ISBN: 0130488089.
2	Philips, Ravindran and Solberg - Principles of Operations Research – Theory and Practice, John Wiley & Sons (Asia) Pvt Ltd, 2nd Edition, 2000, ISBN 13: 978-81-265-1256-0
3	Hiller, Liberman, Nag, Basu, Introduction to Operation Research, Tata McGraw Hill 9th Edition, 2012, ISBN 13: 978-0-07-133346-7
4	J K Sharma, Operations Research Theory and Application, 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 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. The 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) mini project. **Total CIE 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 (Group G: Global Elective)						
Course Code	**:**	**18IM2G04**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**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.	**07 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	**07 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	**07Hrs**
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	Prasanna Chandra, Project Planning Analysis Selection Financing Implementation & Review, Tata McGraw Hill Publication, 8th Edition, 2010, ISBN 0-07-007793-2.
2	Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK Guide), 5th Edition, 2013, ISBN: 978-1-935589-67-9
3	Harold Kerzner, Project Management A System approach to Planning Scheduling & Controlling, John Wiley & Sons Inc., 11th Edition, 2013, ISBN 978-1-118-02227-6.

4	Rory Burke, Project Management – Planning and Controlling Techniques, John Wiley & Sons, 4th Edition, 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 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. The 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) mini project. **Total CIE 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.

II Semester		
ENERGY MANAGEMENT (Group G: Global Elective)		
Course Code: 18CH2G05		**CIE Marks: 100**
Credits: L:T:P: 3:0:0		**SEE Marks: 100**
Hours: 36L		**SEE Hrs: 3**

Course Learning Objectives(CLO):

Students are able to:

1. Explain the importance of energy conservation and energy audit.
2. Understand basic principles of renewable sources of energy and technologies.
3. Outline utilization of renewable energy sources for both domestics and industrial application.
4. Analyse the environmental aspects of renewable energy resources.

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	07 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	07 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	07 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, 2011, New Age International (P) Limited, ISBN 13: 9788122402070.
2	Biogas Technology - A Practical Hand Book, Khandelwal K C and Mahdi S S, Vol. I & II, 1986, McGraw-Hill Education, ISBN-13: 978-0074517239.
3	Biomass Conversion and Technology, Charles Y Wereko-Brobby and Essel B Hagan, 1st Edition, 1996, John Wiley & Sons, ISBN-13: 978-0471962465.
4	Solar Photovoltaics: Fundamental Applications and Technologies, C. S. Solanki, 2nd Edition, 2009, Prentice Hall of India, ISBN:9788120343863.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks):
CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project.
Total CIE 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 (Group G: Global Elective)						
Course Code	**:**	**18ME2G06**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**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.	**07 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.	**07 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	**07 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	Alasdair Gilchrist, INDUSTRY 4.0 THE INDUSTRIAL INTERNET OF THINGS, Apress Publisher, ISBN-13 (pbk): 978-1-4842-2046-7
2	Alp Ustundag, Emre Cevikcan, Industry 4.0: Managing The Digital Transformation, Springer, 2018 ISBN 978-3-319-57869-9.
3	Ovidiu Vermesan and Peer Friess, Designing the industry - Internet of things connecting the physical, digital and virtual worlds, Rivers Publishers, 2016 ISBN 978-87-93379-81-7
4	Christoph Jan Bartodziej, The concept Industry 4.0- An Empirical Analysis of Technologies and Applications in Production Logistics, 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 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. The 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) mini project. **Total CIE 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 (Group G: Global Elective)						
Course Code	**:**	**18ME2G07**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**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.	**07 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.	**07 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.	**07 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	Donald R. Askeland, and Pradeep P. Fulay, The Science & Engineering of Materials, 5th Edition, Thomson, 2006, ISBN-13-978-0534553968
2	Gregory L. Timp, Nanotechnologym 1999th Editionmm Springer, 1999 ISBN-13: 978-0387983349
3	Dr. VD Kodgire and Dr. S V Kodgire, Material Science and Metallurgym 42nd Edition 2018, Everest Publishing House ISBN NO: 81 86314 00 8
4	N Bhatnagar, T S Srivatsan, Processing and Fabrication of Advanced Materials, 2008, IK International, ISBN: 978819077702

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

CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project. **Total CIE 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 (Common to AS, BT, CH, CV, IM, ME)		
Course Code: 18CHY2G08		**CIE Marks: 100**
Credits: L:T:P:S: 3:1:0:0		**SEE Marks: 100**
Hours: 36L +12T		**SEE Duration: 3Hrs**

Course Learning Objectives:	
1	Understand the properties of composite materials.
2	Apply the basic concepts of Chemistry to develop futuristic composite materials for high-tech applications in the area of Engineering.
3	Impart knowledge in the different fields of material chemistry so as to apply it to the problems in engineering field.
4	Develop analytical capabilities of students so that they can characterize, transform and use materials in engineering and apply knowledge gained in solving related engineering problems.

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.	**07 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.	**07 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.	**07 Hrs**
Unit –V	
Polymer nano composites Introduction and Significance of polymer Nano composites. Intercalated And Exfoliated Nanocomposites. Classification of Nano fillers- nanolayers, nanotubes, nanoparticles.	**07 Hrs**

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.	

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, , ISBN: 9780387743646, 0387743642
2	The Science and Engineering of Materials, K Balani, Donald R Askeland,6th Edition-Cengage, Publishers, ISBN: 9788131516416
3	Polymer Science and Technology, Joel R Fried , 2nd Edition, Prentice Hall, ISBN: 9780137039555
4	Nanomaterials and nanocomposites, Rajendra Kumar Goyal , 2nd Edition, CRC Press-Taylor & Francis, ISBN: 9781498761666, 1498761666

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

CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project.

Total CIE 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 (Group G: Global Elective)		
Course Code: 18PHY2G09		**CIE Marks: 100**
Credits: L:T:P:: 3:0:0		**SEE Marks: 100**
Hours: 36		**SEE Duration: 3Hrs**

Course Learning Objectives (CLO):
Student are able to 1.Classify the crystals based on lattice parameters. 2.Explain the behavior of Dielectrics with change in frequency. 3.Classify the magnetic materials based on Quantum theory as well understand superconductors. 4.Explain direct and indirect bandgap semiconductors, polymer semiconductors and Photoconductive polymers. 5.Describe the behavior of Smart materials and its phases and apply to Engineering applications.

Unit-I	**07 Hrs**
Crystal Structure : Symmetry elements-seven crystals systems-Reciprocal lattice-Packing fraction, Lattice Vibration-Brillouin zones, Analysis of Crystal structure using XRD, Thermal properties.	
Unit-II	**07 Hrs**
Dielectric Materials: Basic concepts-Langevin's Theory of Polarisation-Clausius-Mossotti Relation-Ferro electricity-Piezoelectricity-Properties of Dielectric in alternating fields-The complex Dielectric Constant and Dielectric Loss, Polarizability as a function of frequency-Complex dielectric constant of non-polar solids-Dipolar relaxation, Applications.	
Unit -III	**07Hrs**
Magnetic Materials : Dia and Paramagnetic materials-Quantum theory of paramagnetic materials-Paramagnetic susceptibility of conduction electrons-Ferro-anti ferromagnetic materials-Superconductors and Applications..	
Unit -IV	**07 Hrs**
Semiconducting Materials Semiconductor-Direct and Indirect bonding characteristics-Importance of Quantum confinement-quantum wires and dots-Ferro electric semiconductors-applications-Polymer semiconductors-Photo conductive polymers, Applications.	
Unit -V	**08 Hrs**
Novel Materials Smart materials-shape memory alloys-shape memory effects-Martensitia Transformation functional properties-processing-texture and its nature.	

Reference Books:	
1.	Solid State Physics, S O Pillai, 6th Edition, New Age International Publishers, ISBN 10-8122436978.
2.	Introduction to Solid State Physics, C.Kittel, 7th Edition, 2003, John Wiley & Sons, ISBN 9971-51-180.
3.	Material Science, Rajendran V and Marikani, 1st Edition, Tata McGraw Hill, ISBN 10-0071328971.
4.	The Science and Engineering of Materials, Askeland, Fulay, Wright, Balanai, 6th Edition, Cengage Learning, ISBN-13:978-0-495-66802-2.

Course Outcomes (CO's):
CO1: Analyse crystals using XRD technique.
CO2: Explain Dielectric and magnetic materials.
CO3:Integrate knowledge of various types of advanced engineering Materials.
CO4: Use materials for novel applications.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks):
CIE is executed by way of quizzes (Q), tests (T) and assignments. 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. The 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) mini project.
Total CIE 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.

II Semester		
ADVANCED STATISTICAL METHODS (Global Elective)		
Course Code: 18MAT2G10		**CIE Marks: 100**
Credits: L:T:P:: 3:0:0		**SEE Marks: 100**
Hours: 36		**SEE Duration: 3Hrs**

Course Learning Objectives (CLO):
Students are able to: 1. Adequate exposure to learn sampling techniques, random phenomena for analyzing data for solving real world problems. 2. To learn fundamentals of estimation and problems used in various fields of engineering and science. 3. Explore the fundamental principles of statistical inference and tests of hypothesis. 4. Apply the concepts of regression and statistical models to solve the problems of engineering applications.

Unit-I	**07 Hrs**
Sampling Techniques: Random numbers, Concepts of random sampling from finite and infinite populations, Simple random sampling (with replacement and without replacement). Expectation and standard error of sample mean and proportion.	
Unit-II	**07 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, Properties of maximum likelihood estimator (no proofs), Confidence intervals-population mean (large sample), population proportion.	
Unit -III	**07Hrs**
Tests of Hypothesis: Principles of Statistical Inference, Formulation of the problems with examples, Simple and composite hypothesis, Null and alternative hypothesis, Tests - type I and type II error, Testing of mean and variance of normal population (one sample and two samples), Chi squared test for goodness of fit.	
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.	
Unit -V	**08 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.	

Reference Books:	
1	Fundamentals of Statistics (Vol. I and Vol. II), A. M. Goon, M. K. Gupta and B. Dasgupta, 3rd Edition, 1968, World Press Private Limited, ISBN-13: 978-8187567806.
2	Applied Statistics and Probability for Engineers, John Wiley & Sons, Inc., 3rd Edition, 2003, ISBN 0-471-20454-4.
3	S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistic, D. C. Montgomery and G. C. Runger, 10th Edition, 2000, A Modern Approach, S Chand Publications, ISBN 81-7014-791-3.
4	Regression Analysis: Concepts and Applications , F. A. Graybill and H. K. Iyer, Belmont, Calif, 1994, Duxbury Press, ISBN-13: 978-0534198695.

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.

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

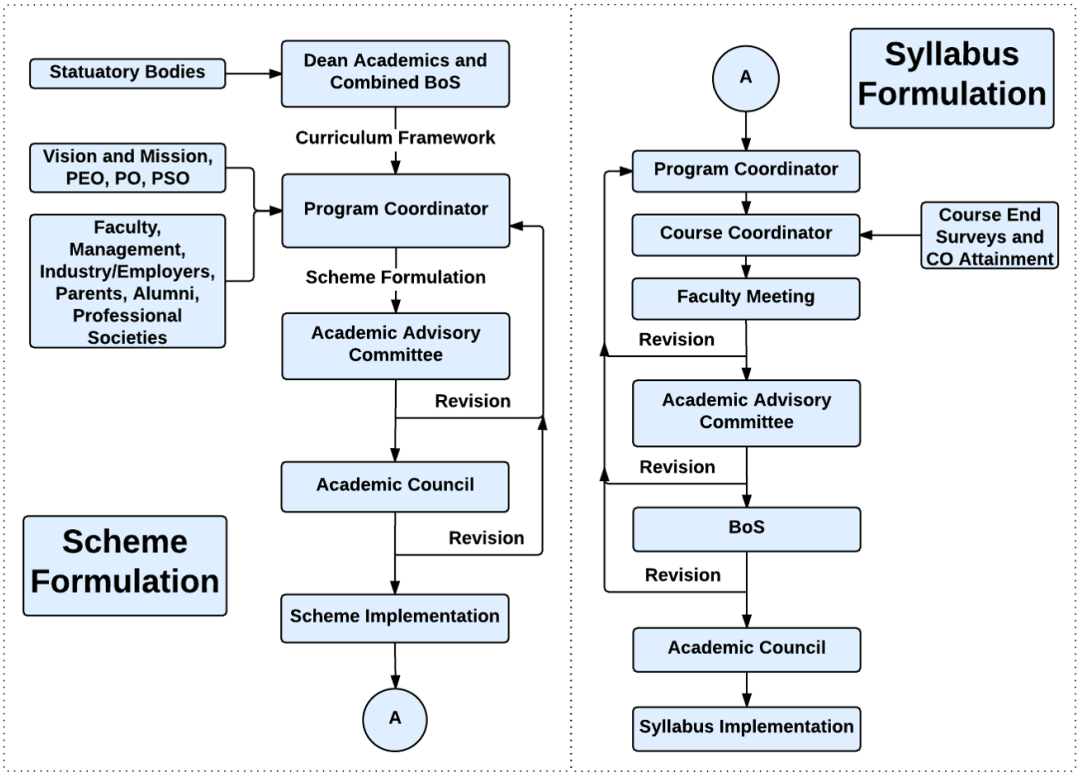
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum 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) mini project.

Total CIE is 20+50+30 = 100 marks.

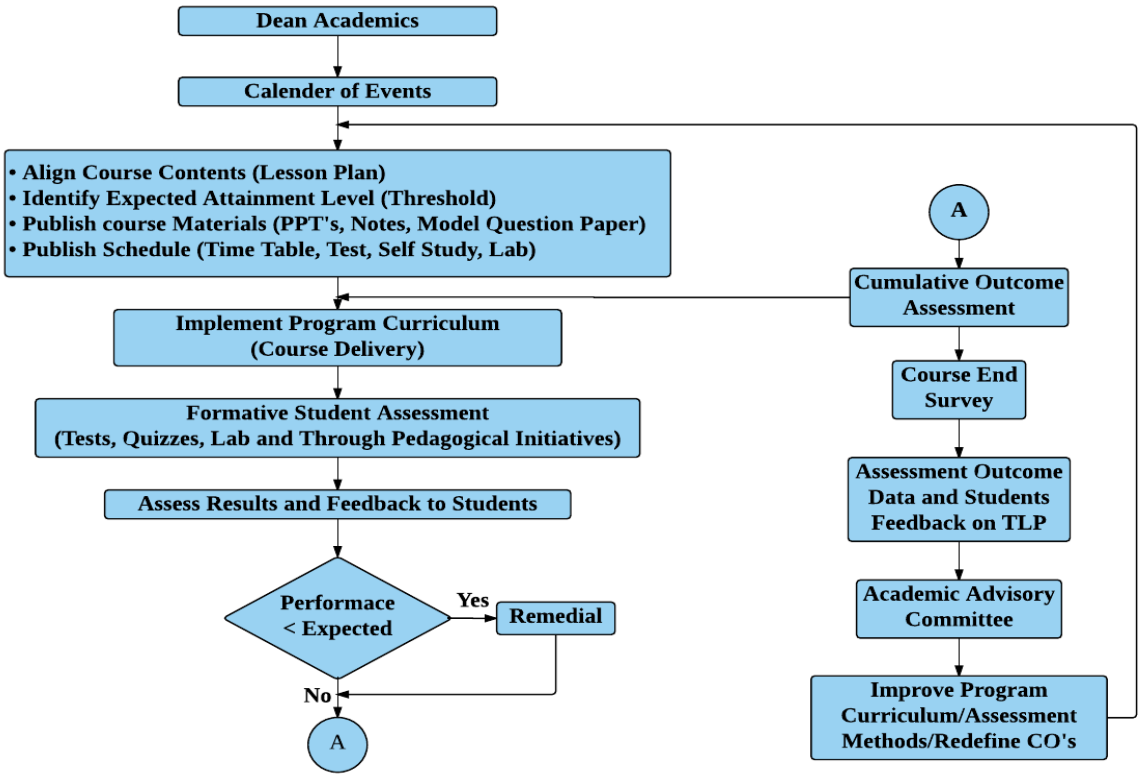
Scheme of Semester End Examination (SEE) for 100 marks:

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.

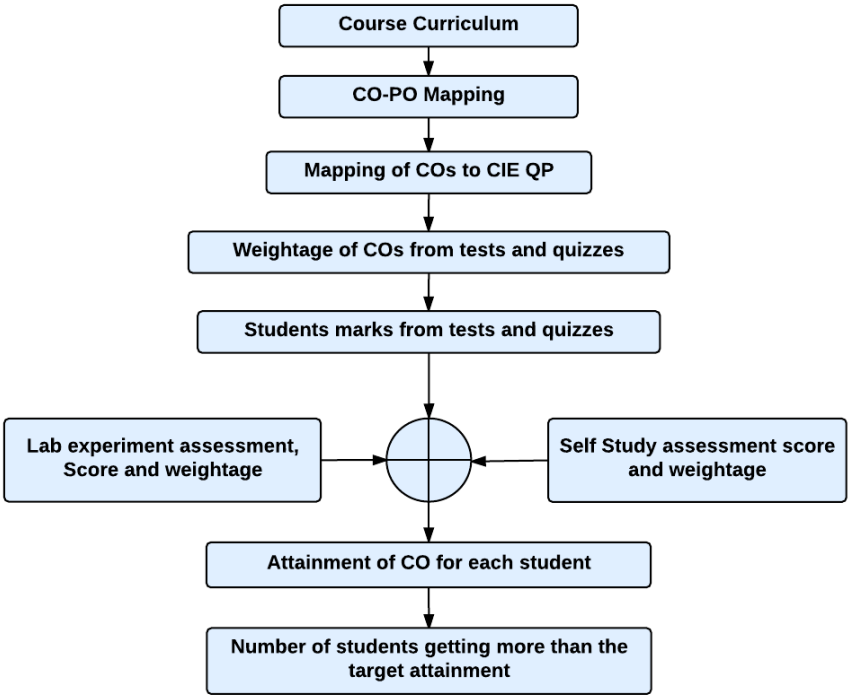
Curriculum Design Process



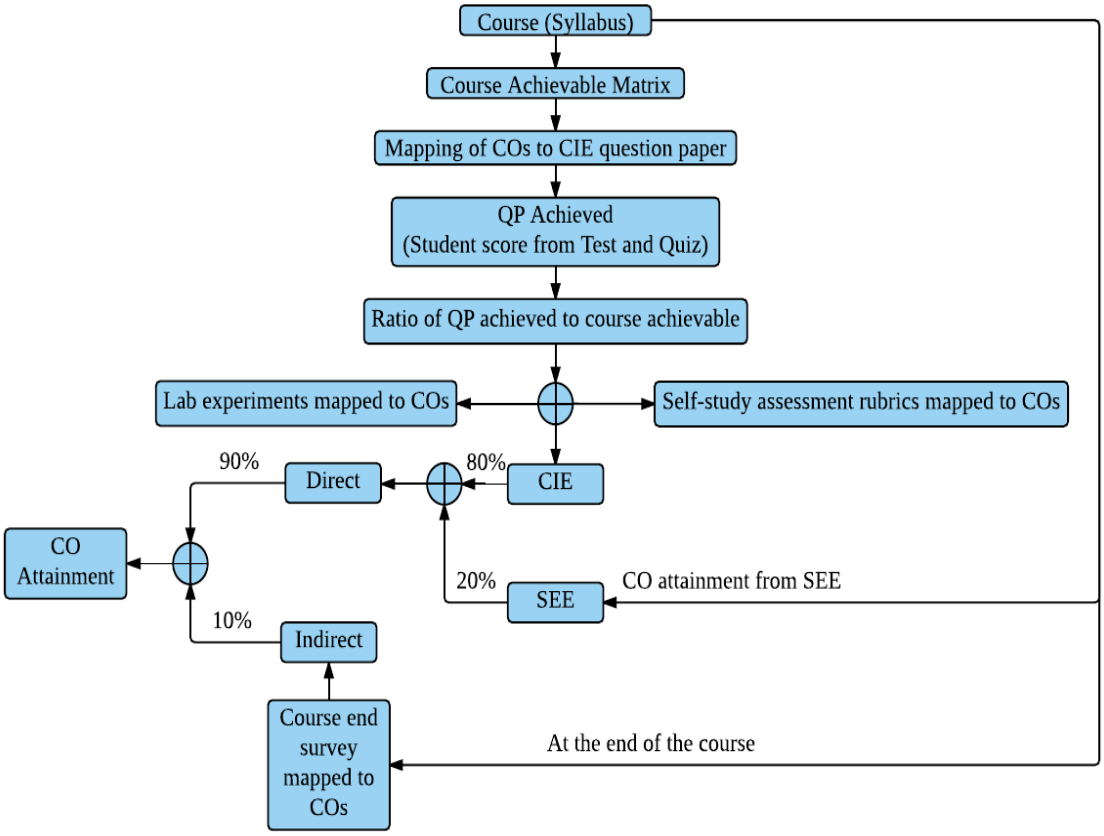
Academic Planning And Implementation



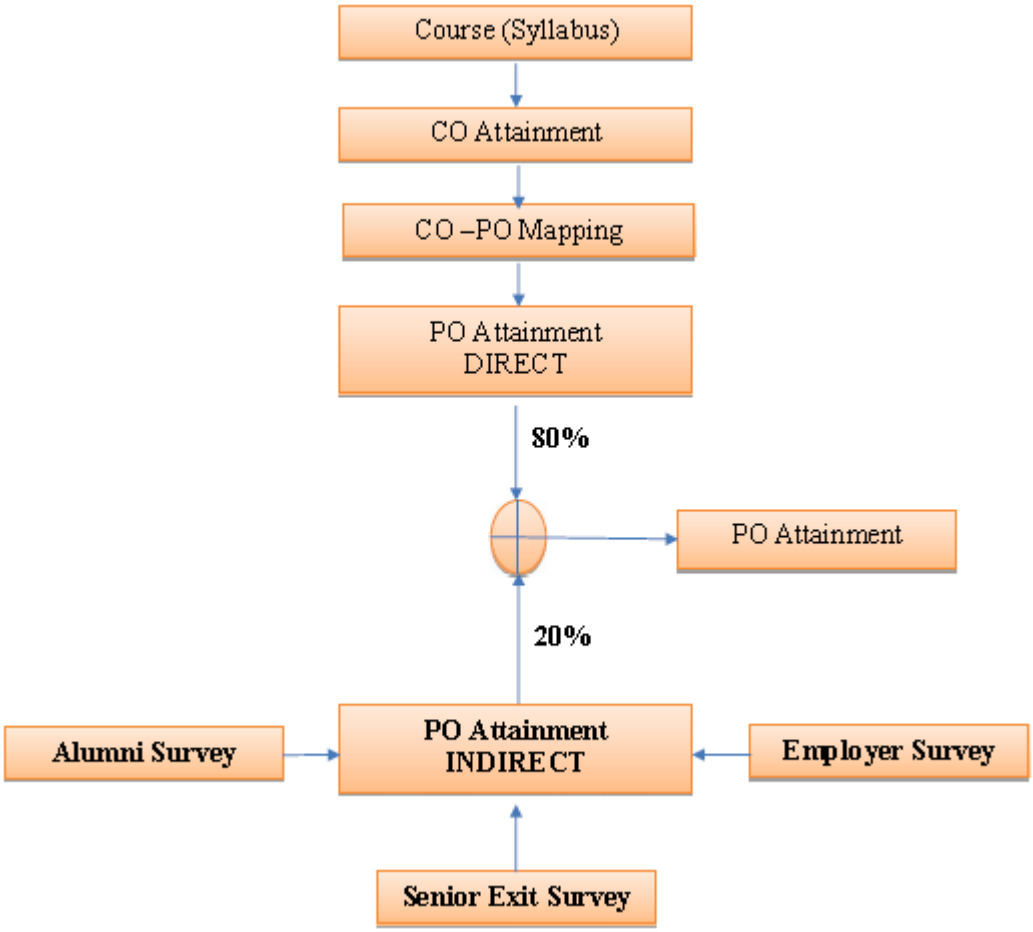
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



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.