Rashtreeya Sikshana Samithi Trust

R.V. College of Engineering

(An Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi)

Department of Computer Science and Engineering

Master of Technology (M.Tech.)
in
Computer Network Engineering

Scheme and Syllabus of
Autonomous System w.e.f 2018

R. V. College of Engineering, Bengaluru – 59

(An Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi)

Department of Computer Science and Engineering

Vision

To achieve leadership in the field of Computer Science and Engineering by strengthening fundamentals and facilitating interdisciplinary sustainable research to meet the ever growing needs of the society.

Mission

- To evolve continually as a center of excellence in quality education in computers and allied fields.
- To develop state-of-the-art infrastructure and create environment capable for interdisciplinary research and skill enhancement.
- To collaborate with industries and institutions at national and international levels to enhance research in emerging areas.
- To develop professionals having social concern to become leaders in top-notch industries and/or become entrepreneurs with good ethics.

Program Outcomes (PO)

The graduates of M. Tech. in Computer Network Engineering (CNE) Program will be able to:

PO1 Independently carry out research and development work to solve practical problems related to Computer Network domain.

PO2 Write and present a substantial technical report/document.

PO3 Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4 Explore, enhance and solve complex problems with a research perspective by evaluating, analyzing, designing and applying computer networking principles to solve real world scenarios by engaging in lifelong learning.

PO5 Demonstrate leadership skills and apply computer networking principles for projects considering ethical factors to accomplish a common goal for sustainable society.

PO6 Explore, select, learn and model computer network applications through use of tools

Program Specific Criteria for M. Tech. in Computer Network Engineering (CNE)
Professional Bodies: IEEE-CS, ACM

The M.Tech program in Computer Network Engineering prepares the students for career in networking domain. The curriculum emphasizes (a) courses on Mathematics, Humanities, Ethics and Professional Practice, Information and Network Security, Computer Networks, Computer Network security, Wireless Communications along with elective courses. (b) problem solving, critical thinking and communication skills with focus on team work.

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Department of Computer Science and Engineering

M. Tech. in Computer Network Engineering

Sl. No.	Course Code	Course Title	BoS	CREDIT ALLOCATION			Total Credits
				Lecture L	Tutorial T	Practical P	
1.	18 MAT 11B	Probability Theory and Linear Algebra	MT	3	1	0	4
2.	18 MCN 12	Information and Network Security	CS	3	1	1	5
3.	18 MCN 13	Advances in Computer Networks	CS	3	1	1	5
4.	18 MCN 14x	Elective-1	CS	4	0	0	4
5.	18 MCN 15x	Elective-2	CS	4	0	0	4
6.	18 HSS 16	Professional Skills Development	HSS	0	0	0	0
			Total	**17**	**3**	**2**	**22**

LIST OF ELECTIVE COURSES

Elective 1	
18 MCN 141	Wireless Ad-Hoc and Sensor Networks
18 MCN 142	Data Management Essentials
18 MCN 143 / 18 MCE 143	Applied Cryptography
Elective 2	
18 MCN 151 / 18 MCE 151	Cloud Computing Technology
18 MCN 152	Information Coding
18 MCN 153 / 18 MCE 153	Wireless Network Security

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Department of Computer Science and Engineering

M. Tech. in Computer Network Engineering

Sl. No.	Course Code	Course Title	BoS	CREDIT ALLOCATION			Total Credits
				Lecture L	Tutorial T	Practical P	
1.	18 MCN 21	Wireless Communication Technologies	CS	3	1	1	5
2.	18 MCN 22	Advances in Network Management	CS	3	1	0	4
3.	18 IEM 23	Research Methodology	IEM	3	0	0	3
4.	18 MCN 24x	Elective-3	CS	4	0	0	4
5.	18 MCN 25x	Elective-4	CS	4	0	0	4
6.	18 GXX 26x	Global Elective	CS	3	0	0	3
7.	18 MCN 27	Minor Project	CS	0	0	2	2
		Total		**20**	**2**	**3**	**25**

LIST OF ELECTIVE COURSES

Elective 3	
18 MCN 241	Network Routing and Protocols
18 MCN 242/ 18 MSC 242/18 MCS 242/18 MBI 242/18 MDC 242	Machine Learning
18 MCN 243 / 18 MCE 243	Cloud Security
Elective 4	
18 MCN 251/ 18 MCE 251	Internet of Things and Applications
18 MCN 252	Advances in Algorithms
18 MCN 253/ 18 MCE 253	Security Engineering
Global Elective	
18 GCS 261	Business Analytics
18 GCV 262	Industrial & Occupational Health And Safety
18 GIM 263	Modeling Using Linear Programing
18 GIM 264	Project Management
18 GCH 265	Energy Management
18 GME 266	Industry 4.0
18 GME 267	Advanced Materials

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Department of Computer Science and Engineering

M. Tech. in Computer Network Engineering

THIRD SEMESTER

Sl. No.	Course Code	Course Title	BoS	CREDIT ALLOCATION			Total Credits
				Lecture L	Tutorial T	Practical P	
1	18 MCN 31	High Speed Networks	CS	4	1	0	5
2	18 MCN 32x	Elective -6	CS	4	0	0	4
3	18 MCN 33	Internship	CS	0	0	5	5
4	18 MCN 34	Dissertation Phase I	CS	0	0	5	5
			Total	**8**	**1**	**10**	**19**

LIST OF ELECTIVE COURSES

Elective 6	
18 MCN 321 / 18 MCE 321	Software Defined Systems
18 MCN 322	Secure Software Design
18 MCN 323 / 18 MCE 323	Cyber Security

FOURTH SEMSESTER

Sl. No	Course Code	Course Title	BoS	CREDIT ALLOCATION	Credits

				L	**T**	**P**	
1	18 MCN 41	Dissertation Phase II	CS	0	0	20	20
2	18 MCN 42	Technical Seminar	CS	0	0	2	2
		Total		**0**	**0**	**22**	**22**

FIRST SEMESTER

PROBABILITY THEORY AND LINEAR ALGEBRA						
Course Code	**:**	**18MAT11B**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**09 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	**09 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 a 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	**09 Hrs**

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

Course Outcomes:

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

CO1: Demonstrate the understanding of fundamentals of matrix theory, probability theory and random process.

CO2: Analyze and solve problems on matrix analysis, probability distributions and joint distributions.

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.	T. Veerarajan, Probability, Statistics and Random Processes, 3rd Edition, Tata McGraw Hill Education Private Limited, 2008, ISBN:978-0-07-066925-3.
	2.	Scott. L. Miller and Donald. G. Childers, "Probability and Random Processes With Applications to Signal Processing and Communications", Elsevier Academic Press, 2nd Edition, 2012, ISBN 9780121726515.
3.		Gilbert Strang, "Linear Algebra and its Applications", Cengage Learning, 4th Edition, 2006, ISBN 97809802327.
4.		Seymour Lipschutz and Marc Lipson, Schaum's Outline of Linear Algebra, 5th Edition, McGraw Hill Education, 2012, ISBN-9780071794565.

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:

CIE will consist of THREE Tests, TWO Quizzes and ONE assignment. Each test will be for 50 marks, each quiz will be for 20 marks and each assignment for 30 marks each. The total marks for CIE (Theory) will be 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 question from each unit.

INFORMATION AND NETWORK SECURITY (Theory and Practice)						
Course Code	**:**	**18MCN12**		**CIE Marks**	**:**	**100+50**
Hrs/Week	**:**	**L:T:P**	**3:2:2**	**SEE Marks**	**:**	**100+50**
Credits	**:**	**5**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**

Basics of Information Security:
NSTISSC security model; Components of an Information System, Securing components, Balancing Information Security and Access, Approaches to Information Security implementation; The Security System Development Life Cycle. Introduction; Information Security Policy, Standards, and Practices;

Unit – II	**07 Hrs**

Classical Encryption Techniques
Symmetric Cipher Model- Cryptography, Cryptanalysis and Brute-Force Attack, Block Ciphers and the Data Encryption Standard - Traditional Block Cipher Structure- Stream Ciphers and Block Ciphers, Feistel Cipher Structure, The Data Encryption Standard-Encryption and Decryption, Advanced Encryption Standard-AES Structure-General and Detailed.

Unit – III	**07 Hrs**

Public Key Cryptography and RSA
Principles of Public-Key Cryptosystems-Public-Key Cryptosystems, Applications for Public-Key Cryptosystems, Requirements for Public-Key Cryptosystems, Public-Key Cryptanalysis, The RSA algorithm-Algorithm, Computational Aspects, The security of RSA, Other Public key cryptography algorithms- Diffie-Hellman Key Exchange

Unit – IV	**07 Hrs**

Cryptographic Hash Functions
Applications of Cryptographic Hash Functions, Secure Hash Algorithms-SHA-512 Logic, Message Authentication Codes – Message Authentication Requirements, Message Authentication Functions-Message Encryption, Message Authentication Code, Digital Signatures-Properties, Attacks and Forgeries, Digital Signature Requirements, Direct Digital Signature, Remote Authentication: KERBEROS.

Unit – V	**07 Hrs**

Transport Layer Security and Network Security Applications: Web Security Considerations, Secure Socket Layer, Transport Layer security, HTTPS, Secure Shell-SSH. Pretty good privacy, notation, operational description. Block chain: Introduction to block chain, types of block chain.

Unit – VI (Lab Component)	**2 Hrs/Week**

PART A: ***Implement Programs from 1 to 4 in C / C++ or JAVA;***

1. Develop a program to demonstrate the secure data transmission using Encryption and Decryption.
2. Develop a program to demonstrate the usage of AES algorithm for Message Encryption and Decryption.
3. Develop a program to demonstrate the use of RSA cryptosystem for security.
4. Develop a program to demonstrate the usage of Diffie-Hellman key exchange for message authentication.

PART B: ***Simulate vulnerability tests, port scans and IDP using Penetration testing and Network security tools.***

1. Demonstrate the following using Nmap tool.
   - Determine open ports and services running in an host
   - Determine the operating system running on the host
   - Alter the source IP of the scan

2. Demonstrate the use of Digital signatures using Cryptool by performing following:
   - Creation of signature
   - Storing the signature
   - Verifying the signature

3. Demonstrate Intrusion Detection System using Snort tool by performing following:
   - Analyze packets, IP protocols
   - Capture alerts and send it to administrator
   - Detect Threats

4. Demonstrate Penetration testing using MetaSploit tool
   - Vulnerability scan
   - Target services detection

Course Outcomes:

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

CO1: Analyze security policies and standards at organizational level.

CO2: Analyze the requirement of various security issues, block chain and provide a secure solution for applications.

CO3: Develop applications to ensure Confidentiality, Integrity and Authenticity of the information.

CO4: Apply appropriate cryptographic algorithms to ensure security of information through network.

Reference Books:

1	Michael E. Whitman and Herbert J. Mattord, “Principles of Information Security”, Cengage Learning; 4th Edition, 2012, ISBN-10: 1111138214.
2	William Stallings, "Cryptography and Network Security", 6th Edition, ISBN-13: 978-0-13-335469-0.
3	Joseph Migga Kizza, Computer Network Security, Springer International Edition, 2009, ISBN 978-1-84800-916-5.
4	Imran Bashir, “Mastering Block chain” Packet Publishing Ltd. 1st Edition, 2017, ISBN 978-1-

	78712-544-5

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CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

Scheme of Semester End Examination (SEE) for Theory 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 question from each unit.

Scheme of Continuous Internal Evaluation (CIE) for Practical 50 Marks:
CIE for the practical courses will be based on the performance of the student in the laboratory, every week. The laboratory records will be evaluated for 30 marks. One test will be conducted for 20 marks. The total marks for CIE (Practical) will be for 50 marks

Scheme of Semester End Examination (SEE) for Practical 50 Marks:
SEE for the practical courses will be based on conducting the experiments and proper results for 40 marks and 10 marks for viva-voce. The total marks is 50.

ADVANCES IN COMPUTER NETWORKS (Theory and Practice)						
Course Code	**:**	**18MCN13**		**CIE Marks**	**:**	**100+50**
Hrs/Week	**:**	**L:T:P**	**3:2:2**	**SEE Marks**	**:**	**100+50**
Credits	**:**	**5**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**

Foundations and Internetworking

Network Architecture- layering & Protocols, Internet Architecture, Implementing Network Software-Application Programming Interface (sockets), High Speed Networks, Ethernet and multiple access networks (802.3), Wireless-802.11/Wi-Fi, Bluetooth (802.15.1), Cell Phone Technologies.

Switching and Bridging, Datagrams, Virtual Circuit Switching, Source Routing, Bridges and LAN Switches.

Unit – II	**07 Hrs**

Internetworking

Internetworking, Service Model, Global Addresses, Special IP addresses, Datagram Forwarding in IP, Subnetting and classless addressing-Classless Interdomain Routing (CIDR), Address Translation (ARP), Host Configuration (DHCP), Error Reporting (ICMP), Routing, Routing Information Protocol(RIP), Switch Basics-Ports, Fabrics, Routing Networks through Banyan Network

Unit – III	**07 Hrs**

Advanced Internetworking

Router Implementation, Network Address Translation(NAT), The Global Internet-Routing Areas, Interdomain Routing(BGP), IP Version 6(IPv6), Multiprotocol Label Switching(MPLS)-Destination Based forwarding, Explicit Routing, Virtual Private Networks and Tunnels, Routing among Mobile Devices- Challenges for Mobile Networking, Routing to Mobile Hosts (Mobile IP), Mobility in IPv6.

Unit – IV	**07 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-Silly Window Syndrome, Nagle's Algorithm, Adaptive Retransmission-Karn/Partridge Algorithm, Jacobson Karels Algorithm, Record Boundaries, TCP Extensions.

Unit – V	**07 Hrs**

Congestion Control/Avoidance and Applications

TCP Congestion Control-Additive Increase/ Multiplicative Decrease, Slow Start, Fast Retransmit and Fast Recovery, **Congestion-Avoidance Mechanisms**, DEC bit, Random Early Detection (RED), Source-Based Congestion Avoidance.

Domain Name System: Name space, Domain namespace, Distribution of Name space, DNS in the Internet, Resolution, DNS messages, Type of records, Registrars.

What Next: Internet of Things, Cloud Computing, The Future Internet, Deployment of IPv6

Unit – VI (Lab Component)	**2 Hrs/Week**

PART A: ***Implement Programs from 1 to 3 in any programming language. Using any Protocol Analyzer to analyze exercises given from 4-5***

1. A program to implement routing protocol for a simple topology of routers that simulates the routing tables for routers for observing the working of IP protocol.
2. Design and demonstrate the concepts of client-server communication using TCP/UDP protocol.
3. Design a solution to compute the Internet checksum and verify the same.
4. Capture the packets that are transmitted after clicking on the URL of the web site of your college. Analyze the packets captured and prepare a brief report of your analysis w.r.t different protocols.
5. Capture the traffic, analyze the data at lower levels and demonstrate the layering of the protocols. Filter the captured packets in a LAN for a unique subscriber.

PART B: ***Simulation Programs using Qualnet/ OPNET /NS3 or any other equivalent simulator***

6. Simulate a 3 node point to point network with duplex links between them. Set the Queue size and vary the bandwidth and find the number of packets dropped.
7. Simulate a four-node point-to-point network, and connect the links as follows: n0->n2, n1->n2 and n2->n3. Apply TCP agent changing the parameters and determine the number of packets sent/received by TCP/UDP.

Course Outcomes:

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

CO1: Gain knowledge on networking research by studying a combination of functionalities and services of networking.
CO2: Analyze different protocols used in each layer and emerging themes in networking research.
CO3: Design various protocols and implement algorithms in different layers to develop and implement effective communication mechanisms.
CO4: Apply emerging networking topics and solve the challenges in interfacing various protocols in real world.

Reference Books:

1.		Larry Peterson and Bruce S Davis “Computer Networks: A System Approach”, 5th edition, Elsevier, 2014, ISBN-13:978-0123850591, ISBN-10:0123850592.
2.		Behrouz A. Forouzan, “Data Communications and Networking”, 5th edition, Tata McGraw Hill, 2013,ISBN: 9781259064753
3.		S.Keshava, “An Engineering Approach to Computer Networking”, 1st edition, Pearson Education , ISBN-13: 978-0-201-63442-6

4.		Andrew S Tanenbaum, Computer Networks, 5th edition, Pearson, 2011, ISBN-9788-177-58-1652.

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Scheme of Semester End Examination (SEE) for Theory 100 marks:
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Scheme of Continuous Internal Evaluation (CIE) for Practical 50 Marks:
CIE for the practical courses will be based on the performance of the student in the laboratory, every week. The laboratory records will be evaluated for 30 marks. One test will be conducted for 20 marks. The total marks for CIE (Practical) will be for 50 marks

Scheme of Semester End Examination (SEE) for Practical 50 Marks:
SEE for the practical courses will be based on conducting the experiments and proper results for 40 marks and 10 marks for viva-voce. The total marks is 50.

WIRELESS ADHOC AND SENSOR NETWORKS (Elective-1)						
Course Code	**:**	**18MCN141**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**09 Hrs**

Ad-hoc Wireless Networks Introduction, Issues in Ad-hoc Wireless Networks, Adhoc Wireless Internet; MAC Protocols for Ad-hoc Wireless Networks: Introduction, Issues in Designing a MAC Protocol, Design Goals of MAC Protocols, Classification of MAC protocols, Contention-Based Protocols(MACAW,FAMA,BTMAMARCH), Contention-Based Protocols with Reservation Mechanisms(D-PRMA,CATA,HRMA) Contention-Based Protocols with Scheduling Mechanisms(DPS,DWOP).

Unit – II	**09 Hrs**

Routing Protocols for Ad-hoc Wireless Networks Introduction, Issues in Designing a Routing Protocol for Ad-hoc Wireless Networks; Classification of Routing Protocols; Table Driven Routing Protocols(DSDV,WRP,CGSR); On-Demand Routing Protocols(DSR,AODV,LAR,ABR), Hybrid Routing Protocols(CEDAR,ZHLS).

Unit – III	**10 Hrs**

Transport Layer and Security Protocols for Ad-hoc Networks: Introduction, Issues in Designing a Transport Layer Protocol; Design Goals of a Transport Layer Protocol; Classification of Transport Layer, Transport Layer Protocols for Ad-hoc Networks; Security in Ad-hoc Wireless Networks, Issues and Challenges in Security Provisioning, Network Security Attacks, Secure routing Ad-hoc Wireless Networks.

Unit – IV	**09 Hrs**

Basic Wireless Sensor Technology and Systems: Introduction, Sensor Node Technology, Sensor Taxonomy, WN Operating Environment, Wireless Transmission Technology and Systems, Available Wireless Technologies

Unit – V	**09 Hrs**

Fundamentals of MAC Protocols: Routing Challenges and Design Issues in WSNs, Routing Strategies in WSNs. Middleware for Wireless Sensor Networks: Introduction, WSN Middleware Principles, Middleware Architecture, Existing Middleware.
Case study: A Decade of Research in Opportunistic Networks: Challenges, Relevance, and Future Directions

Course Outcomes

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

CO1: Acquire appropriate knowledge to exploit the benefits of wireless adhoc and sensor networks

CO2: Analyze the protocol design issues of adhoc and sensor networks CO3: Solve issues related to security provisioning for Adhoc networks CO4: Critique protocol designs in terms of their energy-efficiency for various applications		
Reference Books:		
	1.	C. Siva Ram Murthy & B. S. Manoj, "Ad-hoc Wireless Networks", Pearson Education, 2nd Edition, 2011, ISBN-10: 0132465698, ISBN-13: 9780132465694.
2.		Kazem Sohraby, Daniel Minoli, Taieb Znati, "Wireless Sensor Networks:Technology, Protocols and Applications", WILEY , Second Edition (Indian), 2014, ISBN: 978-0-471-74300-2.
3.		Ozan K Tonguz, Gianluigi Ferrari-Adhoc Wireless Networks-2nd edition, WILEY student edition, ISBN-978-81-265-2304-7
4.		Feng Zhao & Leonidas J. Guibas, "Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007, ISBN-9781558609143.

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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 question from each unit.

DATA MANAGEMENT ESSENTIALS (Elective-1)						
Course Code	**:**	**18MCN142**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**09 Hrs**

Data and information modeling and representation: Relational Model Concepts, Relational Model Constraints and Relational Database Schemas, Update Operations and Dealing with Constraint Violations. Relational Database Design: Relational Database Design Using ER-to-Relational Mapping, Mapping EER Model Constructs to Relations.

Unit – II	**09 Hrs**

SQL: SQL Data Definition and Data Types, Specifying Basic Constraints in SQL, Schema Change Statements in SQL, Basic Queries in SQL, Insert, Delete, and Update Statements in SQL.

Unit – III	**10 Hrs**

Parallel database systems: Architecture of parallel databases, Parallel query evaluation, parallelizing joins and parallel − query optimization.
Distributed database systems: Distributed database architecture, Properties of distributed database, Types of distributed database, storing data in a distributed DBMS, distributed query processing, Database Concurrency control protocols. Transaction failure and Recovery, Database recovery protocol.

Unit – IV	**09 Hrs**

Data Pre-processing and Fundamentals of Data Mining
Data cleaning, Data Integration and Transformation, Data Reduction. Data Warehouse and OLAP Technology: A Multidimensional data model, Data warehouse Architecture, Data warehouse implementation, From Data Warehousing to Data Mining. Working with R and other tools.

Unit – V	**09 Hrs**

Data Models for Some Advanced Applications: Active database concepts and triggers; Temporal, Spatial, and Deductive Databases – Basic concepts. More Recent Applications: Mobile databases; Multimedia databases, Geographical Information Systems, Genome data management.

Course Outcomes:

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

CO1. Analyze appropriate database models to solve real world problem. **CO2.** Design and represent the real world data using parallel, distributed and other enhanced database models. **CO3.** Apply SQL queries and enhanced database techniques using modern tools. **CO4.** Examine the concept of relational, parallel and distributed database.	
Reference Books:	
1	Ramez Elmasri and B.Navathe, "Fundamentals of database systems", 6th edition, Addison Wesley, 2013, ISBN 9780130575913.
2	Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems", 3rd Edition, McGraw Hill,2007, ISBN 978-0072465631 .
3	Jiawei Han and Micheline Kamber, Data Mining Concepts and Techniques, Morgan Kaufmann Publishers, 3rd Edition, 2011, ISBN: 9780123814791.
4	Nina Zumel, John Mount, "Practical Data Science with R", Manning Publications, 2014, ISBN: 9781617291562.

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

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 question from each unit.

APPLIED CRYPTOGRAPHY (Elective-1)						
Course Code	**:**	**18MCE143/18MCN143**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**09 Hrs**

Overview of Cryptography: Introduction, Information security and cryptography: Background on functions: Functions (1-1, one-way, trapdoor one-way), Permutations, and Involutions. Basic terminology and concepts, Symmetric-key encryption: Overview of block ciphers and stream ciphers, Substitution ciphers and transposition ciphers, Composition of ciphers, Stream ciphers, The key space. Classes of attacks and security models: Attacks on encryption schemes, Attacks on protocols, Models for evaluating security, Perspective for computational security.

Unit – II	**09 Hrs**

Mathematical Background: Probability: Basic definitions, Conditional probability, Random variables, Binomial distribution, Birthday attacks and Random mappings. Information theory: Entropy, Mutual information. Number theory: The integers, Algorithms in Z, The integers modulo n, Algorithms in Zn, Legendre and Jacobi symbols, Blum integers. Abstract Algebra: Groups, Rings, Fields, Polynomial rings, Vector spaces.

Unit – III	**09 Hrs**

Stream Ciphers: Introduction: Classification, Feedback shift registers: Linear feedback shift registers, Linear complexity, Berlekamp-Massey algorithm, Nonlinear feedback shift registers. Stream ciphers based on LFSRs: Nonlinear combination generators, Nonlinear filter generators, Clock-controlled generators. Other stream ciphers: SEAL.

Unit – IV	**09 Hrs**

Block Ciphers: Introduction and overview, Background and general concepts: Introduction to block ciphers, Modes of operation, Exhaustive key search and multiple encryption. Classical ciphers and historical development: Transposition ciphers (background), Substitution ciphers (background), Polyalphabetic substitutions and Vigenere ciphers (historical). Polyalphabetic cipher machines and rotors (historical), Cryptanalysis of classical ciphers (historical).

Unit – V	**10 Hrs**

Identification and Entity Authentication: Introduction, Passwords (weak authentication), Challenge-response identification (strong authentication), Customized and zero-knowledge identification protocols: Overview of zero-knowledge concepts, Feige-Fiat-Shamir identification protocol, GQ identification protocol, Schnorr identification protocol, Comparison: Fiat-Shamir, GQ, and Schnorr, Attacks on identification protocols.

Course Outcomes:

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

CO1: Analyze background on functions, composition of ciphers and attacks on encryption schemes. CO2: Evaluate mathematical background on cryptographic functions. CO3: Identify stream cipher and block cipher algorithms and functionalities. CO4: Evaluate identification and Entity authentication schemes.

Reference Books:	
1	Alfred J. Menezes, Paul C. van Oorschot, Scott A. Vanstone, “HANDBOOK of APPLIED CRYPTOGRAPHY” CRC Press, Taylor and Francis Group, ISBN-13: 978-0-84-938523-0.
2	Bruce Schneier, Applied Cryptography: Protocols, Algorithms, and Source Code in C", 2nd Edition, **ISBN:**0-471-22357-3.
3	William Stallings, "Cryptography and Network Security", 6th Edition, **ISBN-13:** 978-0-13-335469-0.
4	Niels Ferguson, Bruce Schneier, Tadayoshi Kohno “Cryptography Engineering: Design Principles and Practical Applications” 2010, Wiley. ISBN: 978-0-470-47424-2.

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

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 question from each unit.

CLOUD COMPUTING TECHNOLOGY (Elective-2)						
Course Code	**:**	**18MCE151/18MCN151**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**09 Hrs**

Introduction, Cloud Infrastructure

Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Major challenges faced by cloud computing; Cloud Infrastructure: Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open-source software platforms for private clouds, Cloud storage diversity and vendor lock-in, Service- and compliance-level agreements, User experience and software licensing. Exercises and problems

Unit – II	**09 Hrs**

Cloud Computing: Application Paradigms

Challenges of cloud computing, Existing Cloud Applications and New Application Opportunities, Workflows: coordination of multiple activities, Coordination based on a state machine model: The ZooKeeper, The MapReduce Programming model, A case study: The Grep TheWeb application, HPC on cloud, Biology research

Unit – III	**09 Hrs**

Cloud Resource Virtualization.

Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and para virtualization, Hardware support for virtualization, Case Study: Xen a VMM based para virtualization, Optimization of network virtualization, The darker side of virtualization, Exercises and problems.

Unit – IV	**10 Hrs.**

Cloud Resource Management and Scheduling

Policies and mechanisms for resource management, Application of control theory to task scheduling on a cloud, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers; Scheduling algorithms for computing clouds, Fair queuing, Start-time fair queuing, Borrowed virtual time, Exercises and problems.

Unit – V	**09 Hrs**

Cloud Security, Cloud Application Development

Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor, Amazon web services: EC2 instances, Connecting clients to cloud instances

through firewalls, Security rules for application and transport layer protocols in EC2, How to launch an EC2 Linux instance and connect to it, How to use S3 in java, Cloud-based simulation of a distributed trust algorithm, A trust management service, A cloud service for adaptive data streaming, Cloud based optimal FPGA synthesis. Exercises and problems. Amazon Simple Notification services.

Latest topics:
Google messaging, Android Cloud to Device messaging, Isolation mechanisms for data privacy in cloud, Capability-oriented methodology to build private clouds.

Course Outcomes:

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

CO1: Explain industry relevance of cloud computing and its intricacies, in terms of various challenges, vulnerabilities, SLAs, virtualization, resource management and scheduling, etc.
CO2: Examine some of the application paradigms, and Illustrate security aspects for building cloud-based applications.
CO3: Conduct a research study pertaining to various issues of cloud computing.
CO4: Demonstrate the working of VM and VMM on any cloud platforms (public/private), and run a software service on that.

Reference Books

1.	Dan C Marinescu: Cloud Computing Theory and Practice. Elsevier (MK), 1st edition, 2013, ISBN: 9780124046276.
2.	Kai Hwang, Geoffery C.Fox, Jack J Dongarra: Distributed Computing and Cloud Computing, from parallel processing to internet of things. Elsevier(MK), 1st edition, 2012, ISBN: 978-0-12-385880-1
3.	Rajkumar Buyya, James Broberg, Andrzej Goscinski: Cloud Computing Principles and Paradigms, Willey, 1st Edition, 2014, ISBN: 978-0-470-88799-8.
4.	John W Rittinghouse, James F Ransome: Cloud Computing Implementation, Management and Security, CRC Press, 1st Edition, 2013, ISBN: 978-1-4398-0680-7.

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

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 question from each unit.

INFORMATION CODING (Elective-2)						
Course Code	**:**	**18MCN152**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**09 Hrs**

Information Theory: Information – Entropy, Information rate, classification of codes, Kraft McMillan inequality, Source coding theorem, Shannon-Fano coding, Huffman coding, Extended Huffman coding - Joint and conditional entropies, Mutual information - Discrete memory less channels – BSC, BEC – Channel capacity, Shannon limit.

Unit – II	**09 Hrs**

Data Coding Techniques:
Pulse Code Modulation-Delta modulation-Adaptive Delta Modulation-Differential Pulse code modulation-Comparison of Different Pulse code Modulation Techniques. Textual Data Encoding techniques: ASCII-Unicode- Adaptive Huffman Coding, Arithmetic Coding, LZW algorithm.

Unit – III	**10 Hrs**

Audio and Speech Coding : Audio: Perceptual coding, Masking techniques, Psychoacoustic model, MEG Audio layers I,II,III, Dolby AC3 - Speech: Coding Speech at lower pulse rate(ADPCM) Channel Vocoder, Linear Predictive Coding.
Source Coding: Image and Video, Image and Video Formats – GIF, TIFF, SIF, CIF, QCIF.

Unit – IV	**09 Hrs**

Image compression: READ, JPEG – Video Compression: Principles-I,B,P frames, Motion estimation, Motion compensation, H.261, MPEG standard.

Unit-V	**09 Hrs**

Error Control Coding: Block Codes : Definitions and Principles: Hamming weight, Hamming distance, Minimum distance decoding - Single parity codes, Hamming codes, Repetition codes - Linear block codes,
*Cyclic codes - Syndrome calculation, Encoder and decoder - CRC -Convolutional codes – code tree, trellis, state diagram - Encoding – Decoding

Course Outcome:

At the end of this course graduates will be able to:

CO1. Explore various concepts of Information Coding techniques

CO2. Apply appropriate coding techniques for different applications

CO3. Analyze the various coding, sampling and compression techniques

CO4. Implement data coding algorithms for real world applications

Reference Books

	R Bose, Information Theory, Coding and Cryptography, 2nd Edition, TMH, 2008 **ISBN:** 9780070669017
	Stefan M. Moser, Po-Ning Chen, A student's guide to Coding and Information Theory, Cambridge University Press, 2012. 1st Edition,ISBN-13: 978-1107684577 , ISBN-10: 1107684579.
	Amitabha Bhattacharya, Digital Communication, TMH 2006, Fred Halsall, Multimedia Communications: Applications, Networks, Protocols and Standards, Pearson Education Asia, 2011. ISBN-10: 0070591172
	Technical Journal papers, white papers, manuals

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:

CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

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 question from each unit.

WIRELESS NETWORKS SECURITY (Elective-2)						
Course Code	**:**	**18MCE153/18MCN153**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**09 Hrs**

Overview of wireless network security technology: Wireless network security fundamentals, Types of wireless network security Technology, Elements of wireless security, Available solutions and policies for wireless security, Perspectives- prevalence and issues for wireless security, Inverted security model

Unit – II	**09 Hrs**

Designing wireless network security: Wireless network security design issues , Cost justification and consideration –hitting where it hurts, assess your vulnerable point, security as Insurance, consequences of breach, Standard design issues- switches, flexible IP address assignment, router filtering, bandwidth management, firewalls and NAT, VLAN, VPN, Remote access security, third party solutions

Unit – III	**09 Hrs**

Installing and deploying wireless network security: Testing techniques- Phase I to IV, Internetworking Wireless Security - Operation modes of Performance Enhancing Proxy (PEP), Adaptive usage of PEPs over a Radio Access Network (RAN), Problems of PEP with IPSec, Problems of Interworking between PEP and IPSec, Solutions, Installation and Deployment

Unit – IV	**10 Hrs**

Security in Wireless Networks and Devices: Introduction, Cellular Wireless Communication Network Infrastructure , Development of Cellular Technology, Limited and Fixed Wireless Communication Networks , Wireless LAN (WLAN) or Wireless Fidelity (Wi-Fi) , WLAN (Wi-Fi) Technology, Mobile IP and Wireless Application Protocol, Standards for Wireless Networks , The IEEE 802.11, Bluetooth, Security in Wireless Networks, WLANs Security Concerns,
*Best Practices for Wi-Fi Security

Unit – V	**09 Hrs**

Security in Sensor Networks : Introduction , The Growth of Sensor Networks, Design Factors in Sensor Networks , Routing , Power Consumption, Fault Tolerance, Scalability , Product Costs, Nature of Hardware Deployed , Topology of Sensor Networks, Transmission Media, Security in Sensor Networks, Security Challenges, Sensor Network Vulnerabilities and Attacks, Securing Sensor Networks

*Security Mechanisms and Best Practices for Sensor Networks, Trends in Sensor Network Security Research
Course Outcomes: After going through this course the student will be able to: **CO1:** Explore the existing threats in wireless networks and security issues **CO2:** Design suitable security in wireless networks depending on context **CO3:** Analyze the wireless installation and deployment techniques in real-world networks **CO4:** Improve the security and energy management issues for the wireless devices
Reference Books:

1.	John R.Vacca, "Guide to Wireless Network security", 1st edition, 2006, Springer Publishers, ISBN 978-0-387-29845-0
2.	Joseph Migga Kizza, "A Guide to Computer Network Security", Springer, 2009, ISBN: 978-1-84800-916-5
3.	William Stallings, Cryptography and Network Security,4th edition, November 16, 2005, ISBN 13: 9780131873162
4*	Technical Journal papers and manuals.

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

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 question from each unit.

ADVANCES IN NETWORK MANAGEMENT						
Course Code	**:**	**18MCN22**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P**	**3:2:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**

Network Management Overview: Data and Telecommunication Network, Distributed Computing Environments, Case Studies of Networking and Management, Networks Systems and Services, Challenges of Information Technology Managers**,** Network Management Goals, Organization and Functions, Goal of Network Management, Network Provisioning, Network Operations and the NOC, Network Installation and Maintenance, Network Management Architecture and Organization, Network Management Perspectives.

Unit – II	**07 Hrs**

Basic Foundations: Standards, Models, and Language

Network Management Standards, Network Management Models, Organizational Model, Information model, Management Information Tree (MIT), Managed Object Perspective, Communication Model, Abstract Syntax Notation One: Terminology, Symbols and Conventions, Objects and Data Types, Object Names, An example of ASN.1 from ISO 8824, Encoding Structure, Macros, Functional Model **.**

Unit – III	**08 Hrs**

SNMPv1,v2,v3- Network Management:

The SNMP Model, The Organization Model, System Overview, Information model, Introduction, The structure of Management Information, Managed Objects, Management Information Base (MIB). SNMP Communication Model, The SNMP Architecture, The Administrative Model, SNMP Protocol Specifications, SNMP Operations, The SNMP MIB Group, Functional Model. SNMPv2 System architecture, SNMPv3 Key features, Architecture, SNMPv3 applications, SNMPv3 Management Information base, Security, SNMPv3 User based Security Model, Access Control,

Unit – IV	**07 Hrs**

Remote Network Monitoring: RMON1, RMON2

RMON1 Textual Conventions, RMON1Groups and Functions, RMON1 Common and Ethernet Groups, RMON Token-Ring Extension Groups, RMON2 Management Information Base, RMNO2 Conformance Specifications, ATM Remote Monitoring, WAN

Monitoring, Data Center Monitoring, Cloud Monitoring, Case Studies.

Unit-V	**07 Hrs**

Network Management Tools, Systems and Engineering:
System Utilities for management, SNMP Tools, Protocol Analyzer, Network Statistics Measurement Systems, Traffic Load Monitoring, Protocol Statistics, Data and Error Statistics, MIB Engineering, NMS Design, Network Management Systems, System and Application Management, Enterprise Management, Case Studies.
Web Based Network Management: NMS with Web Interface and Web-Based Management, Web Interface to SNMP Management, Embedded Web-Based Management, Desktop Management Interface, Web-Based Enterprise Management, XML Based NM Technology.

Course Outcomes:

At the end of this Course Graduates will be able to:

CO1. Apply various Network Management Protocols to Manage Practical Networks.

CO2. Identify and describe the different types of Network Management Protocols.

CO3. Analyze the issues and challenges pertaining to management of emerging Network Technologies.

CO4. Examine the various components of network and tools required to formulate the scheme for managing Enterprise and Complex networks.

Reference Books

	Mani Subramanian, "Network Management – Principles and Practice", 2nd Edition, Person Education Publication, 2012, ISBN-10: 8131727599, ISBN-13: 978-8131727591
2.	J. Richard Burke, "Network management Concepts and Practices: a Hands-On Approach", 1st Edition, PHI, 2008, ISBN-10: 8131718492, ISBN-13: 978-8131718490
3.	Stephen B. Morris, *"Network management"*, 1st Edition, Pearson Education, 2008, ISBN-10: 0131011138, ISBN-13: 978-0131011137
4.	Terplan, "Telecom Network Management, 2nd Edition, PHI, 1998, ISBN-9780131687288

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

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 question from each unit.

RESEARCH METHODOLOGY						
Course Code	**:**	**18 IEM 23**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P**	**3:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**3**		**SEE Duration**	**:**	**3 Hrs**
Unit – I						**07 Hrs**
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.						
Unit – II						**08 Hrs**
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						
Unit – III						**07 Hrs**
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						
Unit – IV						**07 Hrs**
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.						
Unit-V						**07 Hrs**
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						
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) Levin, R.I. and Rubin, D.S., Statistics for Management, 7th Edition, Pearson Education: New Delhi.

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

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 question from each unit.

NETWORK ROUTING AND PROTOCOLS (Elective-3)						
Course Code	**:**	**18MCN241**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P**	**3:1:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
IP Traffic Engineering: Traffic, Stochasticity, Delay and Utilization, Applications View, An Architectural Framework, Traffic Engineering, IGP Metric, Determining IGP Link Weights via Duality of MCNF Problems, Illustration of Link Weight Determination Through Duality, Link Weight Determination, Large Networks, IP Traffic Engineering of PoP-to- Datacenter Networks.	
Unit – II	**07 Hrs**
IP Packet Filtering and Classification- Importance of Packet Classification, Packet Classification Problem, Packet Classification Algorithms, Naive Solutions, Two-Dimensional Solutions, Approaches for 'd' Dimensions, Extending Two-Dimensional Solutions, Divide and Conquer Approaches, Tuple Space Approaches, Decision Tree Approaches, Hardware based Solutions,	
Unit – III	**07 Hrs**
Routing in Reservation-Oriented Networks: Hierarchical Call Routing, The Road to Dynamic Routing, Dynamic Non-Hierarchical Routing(DNHR) Dynamically Controlled led Routing, Dynamic Alternate Routing, Real-Time Network Routing, Classification of Dynamic Call Routing Schemes, Maximum Allowable Residual Capacity Routing, Dynamic Routing and its Relation to Other Routing, Network Control for Traffic Engineering, Analysis of Dynamic Routing, Performance for Heterogeneous Services.	
Unit – IV	**07 Hrs**
GSTN and VOIP Call Routing E.164 Addressing for GSTN, Provider identifier, Signaling System, SS7 Protocol Stack, SS7 ISUP and Call Processing, Call Routing, Call Routing with Multiple Service Providers, Number Portability, Non-Geographic or Toll-Free Number Portability, Multiple Provider Environment with Local number Portability, GSTN Call Routing using Internet, IP-GSTN Internetworking for VOIP, IP Multimedia Subsystems(IMS), All- IP Environment for VoIP	

services.

Unit-V	**08 Hrs**

Routing and Traffic Engineering in Software Defined Networks and Data Center Networks: An Overview, Open Flow, Routing Decisions, Traffic Engineering for Aggregated Flow Routing, Flow management Approaches, Cloud Services and Data Center Applications, Data Center Network, Routing, Forwarding Requirements, Fat-Tree Data Center Topology, Port Land Approach for the Fat-Tree Topology, Multipath Routing and Traffic Engineering for Fat-Tree Topology, Software Defined Networking for Data Center Networks.

Course Outcome:

At the end of this course graduates will be able to:

CO1. Explore different types of routing algorithms adopted in an Internet based applications.

CO2. Apply various routing protocols and standards used to optimize the routing in large networks.

CO3. Analyze the issues related to routing in an IP traffic engineering of complex networks.

CO4. Examine the various algorithms of routing used in VoIP call services and Traffic Engineering.

Reference Books

1. Deep Medhi, Karthik Ramasamy, Network Routing: Algorithms, Principles and Architectures, Second Edition, Morgan Kaufmann publications, 2018, ISBN: 978-0-12-800737-2.
2. Ravi Malhotra, IP Routing, First Edition, Oreilly Publication, 2002, ISBN: 81-7366-337-8
3. Kevin Dooley, Designing Large-Scale LANs, First Edition, Oreilly Publication, 2002, ISBN: 81-7366-337-2.
4. Technical and Research Papers on Traffic Engineering and Routing.

Sl.no	**Open ended experiments / Tutorial Questions**
1.	Consider policy-based routing for accessing Internet from a flying aircraft. Identify various challenges and address these issues to make routing work for this service.
2.	Examine various router products from different vendors and determine which of them fall into four router architecture classification. Also investigate the router architecture and its classifications for 100 routers to manage the network resources.
3.	Consider a three-node network numbered 1,2 and 3. Suppose that the voice circuit capacity of the links and the pair-wise offered load are given as follows: **Link-ID Capacity Pair-ID Offered Load** 1-2 50 1:2 40 1-3 40 1:3 20 2-3 60 2:3 60 Determine the link call blocking probability and pair-wise call blocking capability. Trace if this problem has the bi-stability problem and scale up this for more link-ids, capacity as-well. For this load and capacity, does the network need to invoke any of the control scheme? If so address these schemes implementations.
4.	A Router needs to be designed using a shared memory switch with 8 line cards. Each

	line card is capable of 10 Gbps. The minimum size of the packet is 64 bytes. Assuming an interleaved memory design is used. How many memory banks will be required if the memory access time is 50nanosec, if the electrical loading on the bus is 0.6?. What should be the width of the bus? Generate the sequence of packets and its corresponding memory access time require when packet size increases in terms of binary value position.

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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 question from each unit.

MACHINE LEARNING
(Elective-3)
(Common to ECE_VLSI, ECE_CS, CSE_CNE, TC_DCE, EI_BMI)

Course Code	**:**	**18MCS242**		**CIE Marks**	**:**	**100**
Hrs/Week L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**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	**9 Hrs**

Ensemble Learning:
Introduction, Boosting and Regularization Paths, Penalized Regression, The "Bet on Sparsity" Principle, Regularization Paths, Over-fitting and Margins, Learning Ensembles, Learning a Good Ensemble, Rule Ensembles

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.	Christopher M Bishop: Pattern Recognition and Machine Learning, Springer, February 2006 ISBN-10: 0-387-31073-8, ISBN-13: 978-0387-31073-2.
2.	Trevor Hastie, Robert Tibshirani, and Jerome Friedman: The Elements of Statistical Learning, Springer, 2008.
3.	Jiawei Han and Micheline Kamber: Data Mining – Concepts and Techniques, Third Edition, Morgan Kaufmann, 2006, ISBN 1-55860-901-6
4.	Zumel, N., & Mount, J. "Practical data science with R", Manning Publications, 2014, ISBN 9781617291562

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
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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 question from each unit.

CLOUD SECURITY **(Elective-3)**						
Course Code	**:**	**18MCE243/18MCN243**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**3:1:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**
Unit – I						**07 Hrs**
Introduction to cloud computing and security-A brief primer on security, architecture, defense in depth, cloud is driving broad changes. Securing the cloud: architecture-requirements, patterns and architectural elements, cloud security architecture, key strategies for secure operations						
Unit – II						**08 Hrs**
Securing the cloud: data security-overview of data security in cloud computing, data encryption: applications and limits, sensitive data categorization, cloud storage, cloud lock-in Securing cloud : key strategies and best practises- Overall strategy, security controls						
Unit – III						**07 Hrs**

Security criteria: Building an internal cloud, Security Criteria-private clouds: selecting an external cloud provide-Selecting CSP,-overview of assurance, over view of risks, security criteria, Evaluating clouds security: An information security framework- evaluation cloud security, checklist for evaluating cloud security	
Unit – IV	**07 Hrs**
Identity and access management Trust Boundaries, IAM Challenges, IAM Definitions ,IAM Architecture and Practice , Getting Ready for the Cloud 80 Relevant IAM Standards and Protocols for Cloud Services , IAM Practices in the Cloud, Cloud Authorization Management , Security Management in the Cloud, Security Management Standards , Security Management in the Cloud,	
Unit – V	**7 Hrs**
Privacy: Privacy, Data Life Cycle, Key Privacy Concerns in the Cloud, Protecting Privacy, Changes to Privacy Risk Management and Compliance in Relation to Cloud Computing , Legal and Regulatory Implications , U.S. Laws and Regulations , International Laws and Regulations, Audit and compliance, Internal Policy Compliance, Governance, Risk, and Compliance (GRC) Illustrative Control Objectives for Cloud Computing	
Course Outcomes: After going through this course the student will be able to: **CO1.** Explore compliance and security issues that arise from cloud computing architectures intended for delivering Cloud based enterprise IT services and business applications. **CO2.** Identify the known threats, risks, vulnerabilities and privacy issues associated with Cloud based IT services. **CO3.** Illustrate the concepts and guiding principles for designing and implementing appropriate safeguards and countermeasures for Cloud based IT services **CO4.** Design security architectures that assure secure isolation of physical and logical infrastructures of network and storage, comprehensive data protection at all layers, end-to-end identity and access management, monitoring and auditing processes and compliance with industry and regulatory mandates.	
Reference Books:	
1	Tim Mather, Subra Kumaraswamy, Shahed Latif, "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance" O'Reilly Media; 1st edition, 2009, ISBN: 0596802765
2	Vic (J.R.) Winkler, Securing the Cloud: Cloud Computer Security Techniques and Tactics", **Imprint:** Syngress, 1st edition, 2011, **ISBN:** 9781597495929
3	Ronald L. Krutz, Russell Dean Vine**, "**Cloud Security: A Comprehensive Guide to Secure Cloud Computing**"**, 1st edition, 2010, ISBN-13: 978-0470589878, 2010, ISBN-10: 0470589876
4	John Rittinghouse, James Ransome, "Cloud Computing: Implementation, Management, and Security", 1st edition, 2009, ISBN-13: 978-1439806807, ISBN-10: 1439806802

Open ended experiments / Tutorial Questions

1. Cloud authentication and authorization techniques
2. Cloud identity and access management
3. Cloud key management
4. Cloud auditing

5. Credential management
6. Cloud DoS protection
7. Cloud traffic hijacking protection
8. Identifying malicious insider, malilcious agent, malicious tenant
9. Virtualization attacks
10. Trust management and assurance
11. Resource Access Control schemes
12. Cloud data encryption and access
13. Cloud data integrity

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
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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 question from each unit.

INTERNET OF THINGS AND APPLICATIONS (Elective-4)						
Course Code	**:**	**18MCE251/18MCN251**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**
Unit – I						**09 Hrs**
FUNDAMENTAL IOT MECHANISM AND KEY TECHNOLOGIES-Identification of IoT Object and Services, Structural Aspects of the IoT, Key IoT Technologies. Evolving IoT Standards Overview and Approaches, IETF IPv6 Routing Protocol for RPL Roll, Constrained Application Protocol, Representational State Transfer, ETSI M2M,Third Generation Partnership Project Service Requirements for Machine-Type Communications, CENELEC, IETF IPv6 Over Lowpower WPAN, Zigbee IP(ZIP), IPSO						
Unit – II						**10 Hrs**
LAYER ½ CONNECTIVITY: Wireless Technologies for the IoT-WPAN Technologies for IoT/M2M, Cellular and Mobile Network Technologies for IoT/M2M,Layer 3 Connectivity :IPv6 Technologies for the IoT: Overview and Motivations. Address Capabilities,IPv6 Protocol Overview, IPv6 Tunneling, IPsec in IPv6,Header Compression Schemes, Quality of Service in						

IPv6, Migration Strategies to IPv6.

Unit – III	**09 Hrs**

Application Protocols- Common Protocols ,Web service protocols , MQ telemetry transport for sensor networks (MQTT-S) , ZigBee compact application protocol (CAP) , Service discovery ,Simple Network Management Protocol(SNMP) ,Real-time transport and sessions , Industry-specific protocols.

Unit – IV	**09 Hrs**

Wireless Embedded Internet -6LoWPAN, 6LoWPAN history and standardization ,Relation of 6LoWPAN to other trends , Applications of 6LoWPAN , Example: facility management , The 6LoWPAN Architecture , 6LoWPAN Introduction ,The protocol stack, Link layers for 6LoWPAN, Addressing , Header format , Bootstrapping , Mesh topologies , Internet integration

Unit – V	**09 Hrs**

***The evolution of computing models towards edge computing**-Shared and central resources versus exclusive and local computation , IoT disrupts the cloud, characteristics of the new computing model , Blueprint of edge computing intelligence Trend drivers and state of the art for edge intelligence Industry needs, Hardware evolution, Software evolution, Architecture

Course Outcomes:

After going through this course the student will be able to

CO1: Acquire knowledge of different use cases of IoT in real time scenarios
CO2: Explain key technologies for connectivity and communications in IoT
CO3: Examine different application protocols and their roles in IoT
CO4: Propose IoT-enabled applications for building smart spaces and services with security features, resource management and edge computing.

Reference Books:

1.	Daniel Minoli, ”Building the Internet of Things with IPv6 and MIPv6:The Evolving World of M2M Communications”, student edition ,Wiley, 2013. ISBN: 978-1-118-47347-4.
2.	Zach Shelby Sensinode , Carsten Bormann”, 6LoWPAN: The Wireless Embedded Internet”, 1st Edition, John Wiley & Sons Ltd, 2009 , ISBN 9780470747995
3.	ArshdeepBahga, Vijay Madisetti, ”Internet of Things: A Hands on Approach” , 1st Edition, Universities Press., 2015, ISBN, : 978-81-7371-954-7
4.	*www.iec.ch/whitepaper/pdf/IEC_WP_Edge_Intelligence.pdf

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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 question from each unit.

ADVANCES IN ALGORITHMS (Elective-4)				
Course Code:	**18MCN252**		**CIE Marks: 100**	
Hrs/week	**L:T:P**	**4:0:0**	**SEE Marks: 100**	
Credits:	**4**		**SEE Duration: 3 Hrs**	
Unit – I				**10 Hrs**
Analysis techniques: Growth of functions: Asymptotic notation, Standard notations and common functions, Substitution method for solving recurrences, Recursion tree method for solving recurrences, Master theorem. **Heapsort**				

Heaps, Maintaining the heap property, Building a Heap, The Heap sort algorithm, priority queues **Sorting in Linear Time** Lower bounds for sorting, Counting sort, Radix sort, Bucket sort	
Unit – II	**08 Hrs**
Advanced Design and Analysis Technique Matrix-chain multiplication, Longest common subsequence. An activity-selection problem, Elements of the greedy strategy **Amortized Analysis** Aggregate analysis, The accounting method , The potential method	
Unit – III	**08 Hrs**
Graph Algorithms Bellman-Ford Algorithm, Shortest paths in a DAG, Dijkstra algorithm, Johnson's Algorithm for sparse graphs. **Maximum Flow:** Flow networks, Ford Fulkerson method and Maximum Bipartite Matching	
Unit – IV	**10 Hrs**
Advanced Data structures Definition of B-trees, Basic operations on B-trees, Deleting a key from B-tree, Structure of Fibonacci heaps, Mergeable-heap operations, Decreasing a key and deleting a node, Disjoint-set operations, Linked-list representation of disjoint sets, Disjoint-set forests. **String Matching Algorithms:** Naïve algorithm, Rabin-Karp algorithm, String matching with finite automata, Knuth-Morris-Pratt algorithm	
Unit – V	**10 Hrs**
Multithreaded Algorithms The basics of dynamic multithreading, Multithreaded matrix multiplication, Multithreaded merge sort **Approximation Algorithms** The vertex-cover problem, The traveling-salesman problem, The set-covering problem	
Course Outcome: At the end of the course the student will be able to CO1: Explore the fundamentals in the area of algorithms by analysing various types of algorithms. CO2: Analyse algorithms for time and space complexity for various applications CO3: Apply appropriate mathematical techniques to construct robust algorithms. CO4: Demonstrate the ability to critically analyse and apply suitable algorithm for any given problem	
Reference Books:	

1.	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms; Columbia University", 3rd Edition, 2009, ISBN: 978-0262033848
2.	Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Addison-Wesley, 3rd Edition, 2007, ISBN: 978-0132847377
3.	Kozen DC, "The design and analysis of algorithms", Springer Science & Business Media, 2012, ISBN: 978-0387976877
4.	Kenneth A. Berman, Jerome L. Paul,"Algorithms", Cengage Learning, 2002. ISBN: 978-8131505212

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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 question from each unit.

SECURITY ENGINEERING (Elective-4)						
Course Code	**:**	**18MCE253/18MCN253**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**4:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**
Unit – I						**09 Hrs**
What Is Security Engineering: Introduction, A framework, Examples. Usability and Psychology: Introduction, Attacks Based on Psychology: Pretexting, Phishing, Insights from Psychology Research, What the Brain Does Better Than Computer.						
Unit – II						**09 Hrs**

Passwords: Difficulties with Reliable Password Entry, Difficulties with Remembering the Password, Naive Password Choice, User Abilities and Training, Social-Engineering Attacks, Trusted Path, Phishing Countermeasures, The Future of Phishing, System Issues, Attacks on Password Entry.

Unit – III	**09 Hrs**

Access Control: Introduction, Operating System Access Controls, Groups and Roles, Access Control Lists, Unix Operating System Security, Apple's OS/X, Windows — Basic Architecture, Capabilities, Windows — Added Features, Middleware, Database Access Controls, General Middleware Issues, ORBs and Policy Languages, Sandboxing and Proof-Carrying Code, Virtualization, Trusted Computing.

Unit – IV	**09 Hrs**

Network Attack and Defense: Introduction, Vulnerabilities in Network Protocols, Attacks on Local Networks, Attacks Using Internet Protocols and Mechanisms. Trojans, Viruses, Worms and Rootkits, Defense Against Network Attack, Filtering: Firewalls, Spam Filters, Censor ware and Wiretaps, Intrusion Detection.

Unit – V	**10 Hrs**

The Bleeding Edge: Introduction, Computer Games, Types of Cheating, Aimbots and Other Unauthorized Software, Virtual Worlds, Virtual Economies, Web Applications e Bay, Google. Social Networking Sites, Privacy Technology: Anonymous Email — The Dining Cryptographers and Mixes, Anonymous Web Browsing — Tor, Confidential and Anonymous Phone Calls, Email Encryption, Steganography and Forensics Countermeasures.

Course Outcomes:

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

CO1: Analyze attacks based on psychology, attacks on network and defense mechanisms
CO2: Identify password attacks and phishing counter measures.
CO3: Evaluate issues related to access control mechanisms.
CO4: Analyze exploiting the computing edge and countermeasures.

Reference Books:

1	Rose Anderson, "Security Engineering", 2nd Edition, Wiley 2012, ISBN-10: 1111138214.
2	William Stallings, "Cryptography and Network Security", 6th Edition, ISBN-13: 978-0-13-335469-0.
3	Joseph Migga Kizza, Computer Network Security, Springer International Edition, 2009, ISBN 978-1-84800-916-5.
4	Bruce Schneier, Applied Cryptography: Protocols, Algorithms, and Source Code in C", 2nd Edition, ISBN: 0-471-22357-3.

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marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

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 question from each unit.

BUSINESS ANALYTICS (Global Elective)						
Course Code	**:**	**18GCS261**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P**	**3:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**3**		**SEE Duration**	**:**	**3 Hrs**
Unit – I						**07 Hrs**
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.						

Unit – II	**07 Hrs**
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.	
Unit – III	**08 Hrs**
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.	
Unit – IV	**07 Hrs**
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.	
Unit-V	**07 Hrs**
Decision Analysis: Formulating Decision Problems, Decision Strategies with and without Outcome, Probabilities, Decision Trees, The Value of Information, Utility and Decision Making	

Course Outcome:

At the end of this course graduates 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 by,”, 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.

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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 question from each unit.

INDUSTRIAL & OCCUPATIONAL HEALTH AND SAFETY **(Global Elective)**						
Course Code	**:**	**18 GCV 262**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P**	**3:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**03**		**SEE Duration**	**:**	**3Hrs**
UNIT – I						**07 Hrs**

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

UNIT – II	**08 Hrs**

Occupational health and safety: Introduction, Occupational health: a definition, Interaction between work and health, Interaction between work and health, Health hazards, Unemployment, Health, 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, Accident factors. Evaluation of health hazards: Exposure measurement techniques, Interpretation of findings recommended exposure limits. Controlling hazards: Engineering controls, Work practice controls, Administrative controls. Occupational diseases: Definition, Characteristics of occupational diseases, Prevention of occupational diseases.

UNIT – III	**08 Hrs**

Hazardous Materials characteristics and effects on health: Introduction, Chemical Agents, Organic Liquids: Introduction, Glycol Ethers (Cellosolve, Methyl Cellosolve, and Butyl Cellosolve) Esters: (Ethyl, Butyl, Amyl, and Cellosolve Acetates), Ketones (Acetone, Methyl Ethyl ketone, and Methyl Isobutyl Ketone), Aromatics (Toluene, Benzene, Xylene, Phenol, Styrene and Isocyanates), Polyaromatics (Chlorinated Compounds), Halogenated Hydrocarbons (Trichloroethylene, Trichloroethylene, Trichloroethane, Perchloroethylene, Methylene Chloride, Chloroform and Fluorocarbons), Alkyl Nitrites (Dimethylformamide), Aldehydes (Formaldehyde).Gases: Introduction, Boron (Boron Trichloride, Diborane and Boron Tribromide), Metal Hydrides (Arsine and Germane), Asphyxiants (Simple Asphyxiants, Carbon Monoxide and Cyanides), Silicon (Silane, Dichlorosilane, Trichlorosilane and Chlorosilane), Phosphine, Phosgene, Nitrogen Oxides and Ozone. Metals and Metallic Compounds: Introduction, Lead, Gallium, Indium and Antimony, Cadmium, Yttrium, Silver, Beryllium, Platinum, Gold, Tantalum, Mercury, Nickel, Arsenic, Tellurium, Tin, Barium, Cobalt. Particulates and Fibers: Introduction, Resin Dust, Fibrous Glass, Silica, Portland Cement, Mica. Acids, Alkalies and Oxidizers: Introduction, Sulfuric Acid, Chromium Acids, Hydrogen Fluoride (Hydrofluoric Acid), Sodium Hydroxide, Hydrogen Peroxide.General Manufacturing Materials: Epoxy Resin Systems, Flux Fumes, Cutting Fluids, Nonacid etches, Fluoride Compounds, Phosphorus Compounds, Hexamethly Disilazane, Chemical Combined Effects, Chemical Substitutes, Allergens, Carcinogens, Mutagens, Reproductive Hazards, Sensitizers and Teratogens, Recommended Chemical Exposure Limits. Physical Agents: Electromagnetic and particulate Radiation, Microwave and Radio Frequency Radiation, Particulate Radiation, Infrared Radiation, Laser Radiation, Ultraviolet Radiation, X-Radiation, 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	**07 Hrs**

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v.

Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.		
UNIT – V		**07 Hrs**
Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, over hauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.		
Course Outcomes: After successful completion of this course the student will be able to:		
CO1	Explain the Industrial and Occupational health and safety and its importance.	
CO2	Demonstrate the exposure of different materials, occupational environment to which the employee can expose in the industries.	
CO3	Characterize the different type materials, with respect to safety and health hazards of it.	
CO4	Analyze the different processes with regards to safety and health and the maintenance required in the industries to avoid accidents.	
Reference Books:		
1.	Maintenance Engineering Handbook, Higgins & Morrow, SBN 10: 0070432015 / ISBN 13: 9780070432017, Published by McGraw-Hill Education. Da Information Services.	
2.	Maintenance Engineering, H. P. Garg, S. Chand and Company, New Delhi, 2009.	
3.	Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.	

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Scheme of Semester End Examination (SEE) for 100 marks:
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MODELING USING LINEAR PROGRAMMING (Global Elective)						
Course Code	**:**	**18 GIM 263**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P**	**3:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**3**		**SEE Duration**	**:**	**3 Hrs**
Unit – I						**7 Hrs**

Linear Programming: Introduction to Linear Programming problem
Simplex methods: Variants of Simplex Algorithm – Use of Artificial Variables

Unit – II	**7 Hrs**

Advanced Linear Programming : Two Phase simplex techniques, Revised simplex method
Duality: Primal-Dual relationships, Economic interpretation of duality

Unit – III	**7 Hrs**

Sensitivity Analysis: Graphical sensitivity analysis, Algebraic sensitivity analysis - changes in RHS, Changes in objectives, Post optimal analysis - changes affecting feasibility and optimality

Unit – IV	**8 Hrs**

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.

Unit-V	**7 Hrs**

Assignment Problem: Formulation of the Assignment problem, solution method of assignment problem-Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP).

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.

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Scheme of Semester End Examination (SEE) for 100 marks:
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PROJECT MANAGEMENT (Global Elective)						
Course Code	**:**	**18GIM264**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P**	**3:0:0**	**SEE Marks**	**:**	**100**

Credits	**:**	**3**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**7 Hrs**
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.	
Unit – II	**7 Hrs**
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	
Unit – III	**8 Hrs**
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	
Unit – IV	**7Hrs**
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	
Unit-V	**7 Hrs**
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.	

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

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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 question from each unit.

Course Code:	**18 GCH 265**	**CIE Marks: 100**
Hrs/Week: L:T:P:S	**3:0:0**	**SEE Marks: 100**
Credits:	**03**	**Exam Hrs: 3**

Unit – I	**08 Hrs**
Energy conservation: Principles of energy conservation and energy audit, types of energy audit, Energy conservation approaches, Cogeneration and types of cogeneration, Heat recuperators- classification, liquid/gas and gas/liquid heat exchangers	
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, Biogas from aquatic weed.	
Unit – III	**08 Hrs**
Dry Biomass Gasifiers : Biomass energy conversion routes, Thermal gasification of biomass, Classification of gasifiers, Fixed bed systems: Construction and operation of up draught and down draught gasifiers. Pyrolysis.	
Unit – IV	**08 Hrs**
Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Wind Energy: Atmospheric circulations, classification, factors influencing wind, wind shear,turbulence, wind speed monitoring, Betz limit, WECS: classification, characteristics, and applications	
Unit – V	**08 Hrs**
Alternative liquid fuels: Introduction. Ethanol production: Raw materials, Pre-treatment, Conversion processes, Fermentation systems. Methanol production: Raw materials, Gasification of wood, Gas purification and shift conversion, Synthesis, Gasification equipment.	
Course Outcomes: After completion of the course student will be able to: **1.** Understand the use alternate fuels for energy conversion **2.** Develop a scheme for energy audit **3.** Evaluate the factors affecting biomass energy conversion **4.** Design a biogas plant for wet and dry feed	

Reference Books:

1	Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2	Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3	Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
4	C. S. Solanki, Solar Photovoltaics: Fundamental Applications and Technologies, Prentice Hall of India, 2009, ISBN:9788120343863

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:
CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

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 question from each unit.

(Global Elective)						
Course Code	**:**	**18 GME 266**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**3:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**03**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**

Introduction: Industrial, Internet, Case studies, Cloud and Fog, M2M Learning and Artificial Intelligence, AR, Industrial Internet Architecture Framework (IIAF), Data Management.

Unit – II	**10 Hrs**

The Concept of the IIoT: Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture, Industry 4.0, Characteristics of Industry 4.0, The Value Chain, Industry 4.0 Design Principles.

Unit – III	**10 Hrs**

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, Predicting Drilling Efficiency, Estimation of Manufacturing Cost of Jet Engine, Components, Techniques Used for Predictive Analytics, Forecast Accuracy Calculation

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, Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications.

Unit – IV	**10 Hrs**

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, Application Areas of Additive Manufacturing, Impact of Additive Manufacturing Techniques on Society

Advances in Virtual Factory Research and Applications, The State of Art, The Virtual Factory Software , Limitations of the Commercial Software.

Unit – V	**10 Hrs**

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.

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

Scheme of Continuous Internal Evaluation (CIE) for 100 marks:

CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

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 question from each unit.

ADVANCED MATERIALS
(Global Elective)

Course Code	**:**	**18GME267**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**3:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**03**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **6 Hrs**

Classification and Selection of Materials: Classification of materials. Properties required in Engineering materials, Criteria of selection of materials.Requirements / needs of advance materials.

Unit – II **8 Hrs**

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.

Unit – III **8 Hrs**

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

Unit – IV **8 Hrs**

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.

Unit – V **6 Hrs**

Nanomaterials: Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Physical and mechanical properties, Applications of nanomaterials

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, Nanotechnology 1999th Edition 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) for 100 marks:
CIE will consist of THREE Tests, THREE Quizzes and TWO assignments. Each test will be for 50 marks, each quiz will be for 10 marks and each assignment for 10 marks each. The total marks of tests, quizzes, assignment will be divided by 2 for computing the CIE marks. All three tests, quizzes and assignments are compulsory.

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 question from each unit.

MINOR PROJECT						
Course Code	**:**	**18MCE27**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L:T:P**	**0:0:4**	**SEE Marks**	**:**	**50**
Credits	**:**	**2**		**SEE Duration**	**:**	**30 Min**

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 going through this course the students will be able to

CO1: Conceptualize, design and implement solutions for specific problems.

CO2: Communicate the solutions through presentations and technical reports.

CO3: Apply resource managements skills for projects

CO4: Synthesize self-learning, team work and ethics.

Scheme of Continuous Internal Examination (CIE)

Evaluation will be carried out in THREE Phases. The evaluation committee will comprise of FOUR members: guide, two senior faculty members and Head of the Department.

Phase	Activity	Weightage
I	Synopsis 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	40%

	documentation	
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 for Semester End Evaluation (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.