RV College of Engineering®

Master of Technology (M.Tech)
COMPUTER NETWORK ENGINEERING

Scheme And Syllabus Of I & IV Semester
(2024 Scheme)

B.E. Programs : AS, BT, CH, CS, CS - AI, CS - CD, CS - CY, CV, EC, EE, ET, IM, IS, ME.
M. Tech (13) MCA, M.Sc. (Engg.)
Ph.D. Programs : All Departments are recognized as Research Centres by VTU Except AI & AS

2024

Edition

99TH
NIRF RANKING IN ENGINEERING (2024)

1501+
Times Higher Education World University Rankings (2024)

601+
Asia University Ranking 2024

EduFuture Excellence Award
Best Private Engineering University (South)
by Zee Digital

1001+
Subject Ranking (Engineering)

801+
Subject Ranking (Computer Science)

IIRF 2024
Engineering Ranking India:

NATIONAL RANK - 07
STATE RANK - 02
ZONE RANK - 04

AAA
Rating in NPTEL Local Chapter (Jan - Apr 2024)
State Ranking -1
National Ranking -16

CURRICULUM STRUCTURE

07 CREDITS PROFESSIONAL CORE COURSE

04 CREDITS BASIC SCIENCE

16 CREDITS INTEGRATED PROFESSIONAL CORE COURSE

24 CREDITS PROJECT WORK

04 CREDITS AEC

19 CREDITS PROFESSIONAL ELECTIVES

06 CREDITS INTERNSHIP

80 CREDITS TOTAL

*ABILITY ENHANCEMENT COURSES (AEC), UNIVERSAL HUMAN VALUES (UHV), INDIAN KNOWLEDGE SYSTEM (IKS), YOGA.

17
Centers of Excellence

11
Centers of Competence

1569
Publications On SCI

440
Publications On Web Of Science

2842
Citations
Last 3 Years

70
Patents Filed

40
Patents Granted
Last 3 Years

61
Published Patents

29
Skill Based Laboratories Across Four Semesters

MOUS: 90+WITH INDUSTRIES / ACADEMIC INSTITUTIONS IN INDIA & ABROAD

₹5 crores
Sponsored Projects

₹14 crores
Consultancy Projects

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2024

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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

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

PROGRAMME OUTCOMES (PO)

M. Tech in **Computer Network Engineering** graduates will be able to:

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

PO2: Write and present a substantial technical report/document.

PO3: Demonstrate a degree of mastery over the area of Computer Network Engineering Program.

PO4: Explore, enhance and solve complex problems with a research perspective by evaluating, analysing, 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 a sustainable society.

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

GLOSSARY OF ABBREVIATIONS

1.	AS	Aerospace Engineering
2.	BS	Basic Sciences
3.	BT	Biotechnology
4.	CH	Chemical Engineering
5.	CHY	Chemistry
6.	CIE	Continuous Internal Evaluation
7.	CS	Computer Science & Engineering
8.	CV	Civil Engineering
9.	EC	Electronics & Communication Engineering
10.	EE	Electrical & Electronics Engineering
11.	EI	Electronics & Instrumentation Engineering
12.	ET	Electronics & Telecommunication Engineering
13.	GE	Global Elective
14.	HSS	Humanities and Social Sciences
15.	IM	Industrial Engineering & Management
16.	IS	Information Science & Engineering
17.	L	Laboratory
18.	MA	Mathematics
19.	MBT	M. Tech in Biotechnology
20.	MCE	M. Tech. in Computer Science & Engineering
21.	MCN	M. Tech. in Computer Network Engineering
22.	MCS	M. Tech. in Communication Systems
23.	MDC	M. Tech. in Digital Communication
24.	ME	Mechanical Engineering
25.	MHT	M. Tech. in Highway Technology
26.	MIT	M. Tech. in Information Technology
27.	MMD	M. Tech. in Machine Design
28.	MPD	M. Tech in Product Design & Manufacturing
29.	MPE	M. Tech. in Power Electronics
30.	MSE	M. Tech. in Software Engineering
31.	MST	M. Tech. in Structural Engineering
32.	MVE	M. Tech. in VLSI Design & Embedded Systems
33.	N	Internship
34.	P	Projects (Minor / Major)
35.	PHY	Physics
36.	SDA	Skill Development Activity
37.	SEE	Semester End Examination
38.	T	Theory
39.	TL	Theory Integrated with Laboratory
40.	VTU	Visvesvaraya Technological University

POSTGRADUATE PROGRAMS

Sl. No.	Core Department	Program	Code
1.	BT	M. Tech in Biotechnology	MBT
2.	CS	M. Tech in Computer Science & Engineering	MCE
3.	CS	M. Tech in Computer Network Engineering	MCN
4.	CV	M. Tech in Structural Engineering	MST
5.	CV	M. Tech in Highway Technology	MHT
6.	EC	M. Tech in VLSI Design & Embedded Systems	MVE
7.	EC	M. Tech in Communication Systems	MCS
8.	EE	M. Tech in Power Electronics	MPE
9.	ET	M. Tech in Digital Communication	MDC
10.	IS	M. Tech in Software Engineering	MSE
11.	IS	M. Tech in Information Technology	MIT
12.	ME	M. Tech in Product Design & Manufacturing	MPD
13.	ME	M. Tech in Machine Design	MMD
14.	MCA	Master of Computer Applications	MCA

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M. Tech in Computer Network Engineering: MCN												
I SEMESTER M. Tech												
Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Duration (H)	Max Marks CIE	SEE Duration (H)	Max Marks SEE
			L	T/ SDA	P	Total						
1	MMA211TB	Linear Algebra and Probability Theory	3	1	0	**4**	MA	Theory	1.5	100	3	100
2	MCN312IA	Advanced Network Principles and Protocols	3	0	1	**4**	CS	Theory+Lab	1.5	100+50	3+3	100+50
3	MCN313IA	Cryptography and Network security	3	0	1	**4**	CS	Theory+Lab	1.5	100+50	3+3	100+50
4	MXX314AX	Professional Core Courses (Cluster Electives) (Group-A)	3	1	0	**4**	CS/ IS	Theory	1.5	100	3	100
5	MCN415DL	Design Thinking Lab	0	0	2	**2**	CS	Lab	1.5	50	3	50
6	HSS116EL	Technical English	0	0	1	**1**	HSS	Lab (ONLINE)	1.5	50	--	--
Total Credits						**19**						

*Cluster-wise Courses Common to PG Programs

Clusters
CSE Cluster - PG Programs (CSE, CNE, SE, IT)
ECE Cluster - PG Programs (VLSI, CS, PE, DC)
ME Cluster - PG Programs (PDM, MD)
CV Cluster - PG Programs (ST, HT)
BT Cluster - PG Programs (BT)

Code	* Professional Core Courses (Cluster Electives) (Group-A)
MCN314A1	Advanced Cloud Computing and Distributed Systems
MCE314A2	Blockchain Technologies and Applications
MSE314A3	Microservices Development and Applications
MIT314A4	Robotic Process Automation

II SEMESTER M. Tech												
Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Duration (H)	Max Marks CIE	SEE Duration (H)	Max Marks SEE
			L	T/ SDA	P	Total						
1	MCN321IA	Advanced Algorithms and Complexity	3	0	1	**4**	CS	Theory+Lab	1.5	100+50	3+3	100+50
2	MCN322IA	Advanced Network Programming	3	0	1	**4**	CS	Theory+Lab	1.5	100+50	3+3	100+50
3	MCN323BX	Program Specific Courses (Elective) (Group-B)	3	1	0	**4**	CS	Theory	1.5	100	3	100
4	MXX324CX	Professional Core Courses (Cluster Electives) (Group-C)	3	1	0	**4**	CS	Theory	1.5	100	3	100
5	MXX325DX	Interdisciplinary Courses (Global Electives) (Group-D)	3	0	0	**3**	Resp. BoS	Theory	1.5	100	3	100
6	MIM426RT	Research Methodology (NPTEL)	2	0	0	**2**	IM	NPTEL	--	--	ONLINE	100
7	MCN427SL	Skill Lab	0	0	2	**2**	CS	Lab	1.5	50	3	50
Total Credits						**23**						

Code	Program Specific Courses (Elective) (Group-B)
MCN323B1	Network Analytics
MCN323B2	Foundations of Artificial Intelligence
MCN323B3	Advance Wireless communications and Networking
MCN323B4	Internet of Things

*** *Open to all PG programs**

*Cluster-wise Courses
CSE Cluster - PG Programs (CSE, CNE, SE, IT)
ECE Cluster - PG Programs (VLSI, CS, PE, DC)
ME Cluster - PG Programs (PDM, MD)
CV Cluster - PG Programs (ST, HT)
BT Cluster - PG Programs (BT)

Code	* Professional Core Courses (Cluster Electives) (Group-C)
MCN324C1	Advanced Routing Protocols
MCE324C2	Advances in Computer Vision
MSE324C3	Mobile Commerce and Applications
MIT324C4	Extended Reality

Interdisciplinary Courses (Global Electives) (Group-D)	
Course Code	Course Title
MCN325DC	Cyber Forensics and Cyber Laws

Common to PG Programs

III SEMESTER M. Tech												
Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Duration (H)	Max Marks CIE	SEE Duration (H)	Max Marks SEE
			L	T/ SDA	P	Total						
1	MCN331TA	Network Automation and Software defined Networks	3	1	0	**4**	CS	Theory	1.5	100	3	100
2	MXX332EX	Professional Elective Courses (NPTEL) (Group-E)	2	0	0	**2**	CS	NPTEL	--	--	ONLINE	100
3	MCN433P	Minor Project	0	0	6	**6**	CS	Project	1.5	50	3	50
4	MCN434N	Internship	0	0	6	**6**	CS	Internship	1.5	50	3	50
Total Credits						**18**						

***To be undertaken after completion of 2nd sem and before commencement of 3rd semester (6 weeks duration)**

Code	Professional Elective Courses (NPTEL) (Group-E)
MCN332E1	Database Management System
MCE332E2	Data Science for Engineers
MCE332E3	Introduction to Soft Computing
MCE332E4	Design and Engineering of Computer Systems

IV SEMESTER M. Tech												
Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Duration (H)	Max Marks CIE	SEE Duration (H)	Max Marks SEE
			L	T/ SDA	P	Total						
1	MXX341FX	Program Specific Courses (NPTEL-Elective) (Group-F)	2	0	0	**2**	CS	NPTEL	--	--	ONLINE	100
2	MCN442P	Major Project	0	0	18	**18**	CS	Project	--	100	3	100
Total Credits						**20**						

Code	Program Specific Courses (NPTEL-Elective) (Group-F)
MCN341F1	Edge Computing
MCE341F2	Embedded System Design with ARM
MCE341F3	Information Security -5 Secure Systems Engineering
MCE341F4	User Centric Computing for Human Computer Interaction

SEMESTER: I						
Course Code	**:**	**MMA211TB**	**Linear Algebra and Probability Theory**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-1-0**	**Theory: Common to MDC, MCE, MCN, MPE, MSE, MIT**	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL+30T**	***Professional Core Course***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**
Vector spaces and Linear Transformations: Vector spaces and subspaces, Linear independence, Basis and dimension, Four fundamental subspaces, Linear transformations, Matrix representation, Rank-nullity theorem.	
UNIT - II	**9 Hours**
Orthogonality and Least square approximations: Orthogonal vectors, orthogonal projections, orthogonal bases, Orthogonal complement subspaces, Gram-Schmidt orthogonalization process, QR factorisation, Least square problems, application to linear models.	
UNIT - III	**9 Hours**
Symmetric matrices and Quadratic forms: Real symmetric matrices, Eigenvalues and Eigenvectors, Diagonalization, Quadratic forms, constrained optimization, positive definiteness, Singular value decomposition, Principal component analysis	
UNIT - IV	**9 Hours**
Random variables and Probability Distributions: Random variables-discrete and continuous, probability mass function, probability density function, cumulative distribution function, mean and variance. Discrete distributions - Binomial and Poisson, Continuous distributions – Uniform and Normal.	
UNIT - V	**9 Hours**
Sampling and Inferential statistics: Population and sample, sample mean and sample proportion, central limit theorem, Sampling distributions - Sampling distributions of means, Sampling distributions of proportions. Principles of Statistical Inference, Null and alternative hypothesis, Type I and Type II errors, level of significance, one – tailed and two – tailed tests, z-test, t-test.	

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

CO1	:	Explore the fundamental concepts of linear algebra, random variables, probability distributions, sampling, inferential statistics. **(PO1)**
CO2	:	Apply theoretical concepts of linear algebra, discrete and continuous random variables, probability distributions, sampling, inferential statistics to evaluate the problems of engineering applications. **(PO1, PO4)**
CO3	:	Analyze the solution of the engineering problems solved using appropriate techniques of linear algebra, random variables, probability distributions, sampling theory, inferential statistics. **(PO1, PO4, PO5, PO6)**
CO4	:	Enhance the comprehensive understanding of linear algebra, random variables, probability distributions, sampling theory, inferential statistics gained to demonstrate the problems arising in many practical situations. **(PO1, PO4, PO5, PO6)**

Reference Books
1. Gilbert Strang, "Linear Algebra and its Applications", Cengage Learning, 4th Edition, 2006, ISBN: 97809802327.
2. Linear Algebra and its Applications, David C. Lay, 3rd Edition, 2002, Pearson Education India, ISBN:13: 978-81-7758-333-5.
3. Introduction to Probability and Statistics for Engineers and Scientists, Sheldon Ross, 5th Edition, 2014, Academic Press, ISBN: 13-978-0123948113.
4. Michael Baron, "Probability and Statistics for Computer Scientists", CRC Press, 2nd Edition, 2014, ISBN- 13: 978-1-4822-1410-9.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **THREE quizzes** will be conducted (Two regular quizzes and one optional improvement quiz) & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **THREE** tests will be conducted (Two regular tests and one optional improvement test). Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: I						
Course Code	**:**	**MCN312IA**	**Advanced Network Principles and Protocols**	**CIE Marks**	**:**	**100 + 50**
Credits L-T-P	**:**	**3-0-1**	***(Theory & Practice)***	**SEE Marks**	**:**	**100 + 50**
Hours	**:**	**45L+45EL+30P**	***(Professional Core Course with Integrated Lab) -1***	**SEE Duration**	**:**	**3+3Hours**

UNIT - I	**9 Hours**

Principles of Building Networks:
Applications, Classes of Applications, Requirements, Perspectives, Cost-Effective Resource Sharing, Support for Common Services, Implementing Network Software, Application Programming Interface (Sockets), Performance- Bandwidth and Latency, Delay × Bandwidth Product, High-Speed Networks, Application Performance Needs.

Internetworking:
Service Model, Global Addresses, Datagram Forwarding in IP, Network Address Translation, Subnetting and Classless Addressing

UNIT - II	**9 Hours**

Internetworking (Contd…):
Address Translation (ARP), Host Configuration (DHCP), Error Reporting (ICMP), Virtual Networks and Tunnels. IP Version 6 (IPv6)-Advantages, Historical Perspective, Addresses and Routing, Address Space Allocation, Address Notation, Global Unicast Addresses, IPv6 Packet Format,

Routing:
Distance Vector, Routing Information Protocol (RIP), Link State (OSPF), Interdomain Routing (BGP): Challenges in Interdomain Routing, Basics of BGP- BGP-4 update packet format, Common AS Relationships and Policies, Integrating Interdomain and Intradomain Routing, Routing Among Mobile Devices - Challenges for Mobile Networking, Routing to Mobile Hosts (Mobile IP), Route Optimization in Mobile IP,Mobility in IPv6.

UNIT - III	**9 Hours**

Implementation And Performance:
Switch Basics, Ports, Fabrics, Routing packets through a banyan network. Router Implementation**.**

End-to-End Protocols
Simple Demultiplexer (UDP), Reliable Byte Stream(TCP), End-to-End Issues, Segment Format, Connecting Establishment and Termination-Three-Way Handshake, State-Transition Diagram, Sliding Window Revisited-Reliable and Ordered Delivery, Flow Control, Protecting against Wraparound, Keeping the Pipe Full, Triggering Transmission- Silly Window Syndrome, Nagle's Algorithm, Adaptive RetransmissionOriginal Algorithm, Karn/Partridge Algorithm, Jacobson/Karels Algorithm.

UNIT - IV	**9 Hours**

Congestion-Avoidance Mechanisms,
DEC bit, Random Early Detection (RED), Source Based Congestion Avoidance.

TCP CongestionControl:
Additive Increase/ Multiplicative Decrease, Slow Start, Fast Retransmit and Fast Recovery. SCTP (Stream Control Transmission Protocol): SCTP services, SCTP Features, Packet format, An SCTP association, Flow Control and Error Control.

Applications –
Traditional Application: Electronic Mail (SMTP, MIME, IMAP) - Message Format, Message Transfer, Mail Reader.

UNIT - V	9 Hours

Applications -
Domain Name System(DNS) : Name space, Domain namespace, Distribution of Name Space, DNS in the Internet, Resolution, DNS messages, Type of records, Registrars.
Network Management : Network Management System; Simple Network Management Protocol (SNMP) - concept, management components, SMI, MIB, SNMP messages, features of SNMPv3.

LABORATORY	28 Hours

Implement the following using C/C++ or any programming languages equivalent with LINUX/Windows environment :
I

1. Implement communication using socket API between a client and server to illustrate the usage of TCP/UDP protocol.
2. Implement a program for a concurrent chat server that allows current logged in users to communicate one with another.
3. Implement a program to demonstrate the internet checksum algorithm for operation on 8-bit, 12-bit and 16-bit.
4. Implement distance vector routing protocol for a simple topology of routers.

Explore Network Simulation Tools for implementing open ended problem statements like,

- Case Study on Configuring Routers using CISCO-Packet tracer for firewall policies, DNS server etc.,
- Case study to simulate broadcast, multicast routing mechanism.
- Learn wireshark to generate different type of traffic, capture and prepare a brief report.

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

CO1	:	Explore and analyze the functionalities / services at different layers of network protocol stack.
CO2	:	Analyze the working principle of different protocols at different layers to build/design effective solutions.
CO3	:	Apply techniques and design Algorithms/approaches towards sustainable networking solutions by exploring modern tools.
CO4	:	Demonstrate network configuration, protocol usage and performance evaluation in networks by applying emerging networking topics to solve network challenges like congestion control 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. Andrew S Tanenbaum, Computer Networks, 5th edition, Pearson, 2011, ISBN-9788-177-58-1652.
4. S.Keshava, “An Engineering Approach to Computer Networking”, 1st Edition, Pearson Education, ISBN-13: 978-0-201-63442-6

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks]**		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	CIE THEORY TOTAL	**100**

RUBRIC FOR CONTINUOUS INTERNAL EVALUATION (CIE-Lab)		
Q.NO.	**CONTENTS**	**MARKS**
1	Conduction of the Experiments & Lab Record	30
2	Open-ended Lab Experiment	10
3	Lab Test	10
	CIE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE CIE	**150**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	SEE THEORY TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Lab)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva	10
	SEE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE SEE	**150**

SEMESTER: I						
Course Code	**:**	**MCN313IA**	**Cryptography and Network Security**	**CIE Marks**	**:**	**100 + 50**
Credits L-T-P	**:**	**3-0-1**	***(Theory & Practice)***	**SEE Marks**	**:**	**100 + 50**
Hours	**:**	**45L+45EL+30P**	***(Professional Core Course with Integrated Lab) -2***	**SEE Duration**	**:**	**3+3Hours**

UNIT - I	**9 Hours**
Computer Security Concepts: The OSI security Architecture, Security Attacks, Security Services, Security Mechanisms, A Model for Network Security, Classical Encryption Techniques : Symmetric Cipher Model: Substitution Techniques, Transposition Techniques.	
UNIT - II	**9 Hours**
Block Ciphers and Data Encryption standards: Traditional Block Cipher Structure- The Data Encryption Standard-Encryption and Decryption, The strength of DES, The Block cipher Design Principles, Advanced Encryption Standard: AES Structure, AES Transformation Functions, AES Key Expansion.	
UNIT - III	**9 Hours**
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	**9 Hours**
Cryptographic Hash Functions: Applications of Cryptographic Hash Functions, Secure Hash Algorithms-SHA-512 Logic, Digital Signatures-Properties, Attacks and Forgeries, Digital Signature Requirements, Direct Digital Signature, Remote Authentication: KERBEROS. Web Security Considerations, Secure Socket Layer, Transport Layer security, HTTPS, Secure Shell-SSH.	
UNIT - V	**9 Hours**
Wireless Network Security and IP Security: Wireless Security, Mobile Device Security, IEEE 802.11 Wireless LAN Overview, IEEE 802.11i, Wireless LAN Security, IP Security Overview, IP Security Policy, Encapsulating Security Payload, Combining Security Associations.	
LABORATORY	**28 Hours**

Part-A Experiments

(Implement Programs from 1 to 4 in C / C++ or JAVA)

1. Develop a program to demonstrate 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 Experiments

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	:	Analyzes security policies and standards at organizational level.
CO2	:	Analyze the requirement of various security issues 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. Cryptography and Network Security, William Stallings, 6th Edition, ISBN-13: 978-0-13-335469-0.
2. Computer Network Security, Joseph Migga Kizza, Springer International Edition, 2009, ISBN 978-1- 84800-916-5.
3. Mastering Block chain. Imran Bashir, 1st Edition, 2017, ISBN 978-1-78712-544-5, Packet Publishing Ltd.
4. Blockchain Systems and Communication Networks: From Concepts to Implementation by Mubashir Husain Rehmani 2021, ISBN 9783030717889, 3030717887, Springer International Publishing.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks]**		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	CIE THEORY TOTAL	**100**

RUBRIC FOR CONTINUOUS INTERNAL EVALUATION (CIE-Lab)		
Q.NO.	**CONTENTS**	**MARKS**
1	Conduction of the Experiments & Lab Record	30
2	Open-ended Lab Experiment	10
3	Lab Test	10
	CIE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE CIE	**150**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	SEE THEORY TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Lab)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva	10
	SEE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE SEE	**150**

SEMESTER: I						
Course Code	**:**	**MCN314A1**	**Advanced Cloud Computing and Distributed Systems**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-1-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL+30T**	***Professional Core Courses (Cluster Electives) (Group-A)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**
Distributed System Models & Cloud Computing: Technologies for network-based system, System models for distributed & cloud, Cloud Computing in a Nutshell, System Model for Distributed and Cloud Computing, Roots of Cloud Computing, Grid and Cloud, Layers and Types of Clouds, Desired Features of a Cloud	
UNIT - II	**9 Hours**
Service Oriented Architecture for Distributed Computing: Services & SOA, Message Oriented Middleware, Workflow in SOA. Cloud Programming & Software Environments: Features of Cloud & Grid, Parallel & Distributed programming paradigms, Programming support of Google Cloud, Amazon AWS & Azure	
UNIT - III	**9 Hours**
Virtual Machines and Virtualization: Levels of Virtualization, Virtualization structures/Tools and Mechanism, Virtualization of CPU, Memory and I/O Devices, Virtual Clusters and Resources Management, Virtualization Data-Centre Automation	
UNIT - IV	**9 Hours**
Virtualization of Cluster and Public Cloud Platforms: Virtual Machine Migration Services, VM Provisioning and Migration in Action. PUBLIC CLOUD PLATFORMS: GAE, AWS and AZURE: Cloud infrastructure, Architecture and Functional modules.	
UNIT - V	**9 Hours**
Designing Distributed Systems: **GOOGLE CASE STUDY**: Introducing the case study: Google Overall architecture and design philosophy Underlying communication paradigms, Data storage and coordination services Distributed computation services.	

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

CO1	:	Apply the distributed and cloud computing concepts to solve problems in computing domain.
CO2	:	Analyse various architectures, work flow models and algorithms used to implement cloud and distributed systems.
CO3	:	Design solutions using modern tools to solve applicable problems in cloud and distributed systems.
CO4	:	Demonstrate effective communication , report writing and usage of modern tools for implementing cloud and distributed systems applications

Reference Books
1. Kai Hwang. Geoffrey C. Fox, Jack J. Dongarra, "Distributed and Cloud Computing from parallel processing to the internet of things", Elsevier, 1st Edition, ISBN: 9780123858801-1, 2013
2. Rajkumar Buyya, James Broberg and Andrzej M. Goscinski, "Cloud Computing: principles and Paradigms (Wiley Series on Parallel and Distributed Computing), Wiley Publishing (c) 201, 1st edition, ISBN:978- 470887998, 2013
3. George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, DISTRIBUTED SYSTEMS Concepts and Design, Fifth Edition, Addison- Wesley, ISBN:978-0132143011, 2012
4. Cloud Computing Theory and Practice, Dan Marinescu,ISBN: 9780323852777 eBook ISBN: 9780323910477, 3rd Edition 2022

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: I						
Course Code	**:**	**MCE314A2**	**Blockchain Technologies And Applications**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-1-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL+30T**	***Professional Core Courses (Cluster Electives) (Group-A)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**

Introduction to Blockchain Technology:
Basic ideas behind block chain, how it is changing the landscape of digitalization, introduction to cryptographic concepts, Hashing, public key cryptosystems, private vs public block chain and use cases, Hash Puzzles
Blockchain Fundamentals: Basic architecture of Blockchain, different terminologies associated, Characteristics of Block chain, Types of networks, Introducing Smart contract concept in Blockchain. Components of Blockchain: Core components of Blockchain, Types of Block chains; Blockchain Protocol, Permission & Permission less Block chains

UNIT - II	**9 Hours**

Smart Contracts:
Introduction to Smart Contracts, Structure of Smart Contract, Smart Contract Interaction, Contracts, Patterns and Smart Contracts Examples
Ethereum Blockchain Components: Introduction to Ethereum Development Tools, Ethereum Clients, Ethereum Languages, Ethereum Wallets, Ethereum Accounts, Ethereum Key pairs, Ethereum Platform

UNIT - III	**9 Hours**

Bitcoins:
Introduction to Bitcoins, Bitcoin : Digital Signature, Digital Keys, Private Keys, Public Keys, Bitcoins Addresses, Bitcoins Transactions, Bitcoins Network, Bitcoins Wallets, Bitcoins Payments, Bitcoins Clients and APIs, Bitcoins Limitation

UNIT - IV	**9 Hours**

Hyperledgers:
Hyperledger Fabric, Saw tooth, Indy, Hyperledger tools Caliper and Hyperledger library Ursa, Blockchain as-a-service deployment model of Hyperledger Cello

UNIT - V	**9 Hours**

Emerging Trends in Blockchain: Cloud-based block chain, Multi chain, Geth , Stellar , Ripple, R3 Corda, Blockchain API, Blockchain Sandboxes

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

CO1	:	Comprehend the foundational concepts of blockchain technology and its impact on digital transformation
CO2	:	Analyze the fundamental architecture of blockchain, its core components, and the concept of smart contracts
CO3	:	Apply knowledge of Ethereum and Bitcoin ecosystems to develop blockchain-based solutions
CO4	:	Evaluate emerging blockchain platforms and technologies for practical deployment in industries

Reference Books
1. Artemis Caro, "Blockchain: The Beginners Guide to Understanding the Technology Behind Bitcoin & Crypto currency", Raven Media, 17 Feb. 2021
2. Scott Marks, "Blockchain for Beginners: Guide to Understanding the Foundation and Basics of the Revolutionary Blockchain Technology", Create Space Independent Publishing Platform, 14 August, 2017
3. Arvind Narayanan, Joseph Bonneau, EdwardFelten, Andrew Miller and Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University, July 19, 2016
4. Antonopoulos, Andreas M, "Mastering bitcoin : programming the open blockchain", Sebastopol, CA : O'Reilly Media, 2017

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: I						
Course Code	**:**	**MSE314A3**	**Microservices Development and Applications**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-1-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL+30T**	***Professional Core Courses (Cluster Electives) (Group-A)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**
Toward a Microservices Architecture: What Are Microservices?, Reducing Coordination Costs, Learning by Doing, Decisions, Decisions. Designing a Microservices Operating Model: Why Teams and People Matter, Introducing Team Topologies, Designing a Microservices Team Topology. Designing Microservices: The SEED(S) Process: Introducing the Seven Essential Evolutions of Design for Services, Identifying Actors, Identifying Jobs That Actors Have to Do, Discovering Interaction Patterns with Sequence Diagrams, Deriving Actions and Queries from JTBDs, Describing Each Query and Action as a Specification with an Open Standard, Getting Feedback on the API Specification, Implementing Microservices, Microservices Versus APIs.	
UNIT - II	**9 Hours**
Rightsizing Your Microservices: Finding Service Boundaries: Why Boundaries Matter, When They Matter, and How to Find Them, Domain-Driven Design and Microservice Boundaries, Introduction to Event Storming, Introducing the Universal Sizing Formula. Dealing with the Data: Independent Deployability and Data Sharing, Microservices Embed Their Data, Event Sourcing and CQRS, Event Sourcing and CQRS Beyond Microservices.	
UNIT - III	**9 Hours**
Building an Infrastructure Pipeline: DevOps Principles and Practices, Setting Up the IaC Environment, Configuring Amazon Web Services, Building an IaC Pipeline. Building a Microservices Infrastructure: Infrastructure Components, Implementing the Infrastructure.	
UNIT – IV	**9 Hours**
Developer Workspace: Coding Standards and the Developer's Setup, Setting Up a Containerized Environment Locally, Installing Docker, Advanced Local Docker Usage: Installing Cassandra, Installing Kubernetes. Developing Microservices: Designing Microservice Endpoints, Implementing the Data for a Microservice, Implementing Code for a Microservice, Introducing a Second Microservice to the Project, Hooking Services Up with an Umbrella Project.	
UNIT - V	**9 Hours**
Releasing Microservices: Setting Up the Staging Environment, Shipping the Flight Information Container, Deploying the Flights Service Container, Clean Up. Managing Change: Changes in a Microservices System, Considerations for Our Architecture. A Journey's End (and a New Beginning): On Complexity and Simplification Using Microservices, Measuring the Progress of a Microservices Transformation.	

Course Outcomes:		
After going through this course the student will be able to:		
CO1	:	Comprehend the key concepts of microservices architecture, including the SEED(S) process, microservice boundaries, and event sourcing techniques.
CO2	:	Apply design principles to create microservices, implement endpoints, and develop infrastructure pipelines using tools like Docker, Kubernetes, and AWS for deployment.
CO3	:	Analyze the impact of microservice team structures and topologies on architecture decisions, efficiency of microservices implementation.
CO4	:	Assess the scalability and maintainability of a microservices system, including the management of data and changes across services.

Reference Books

1. Irakli Nadareishvili, "Microservices: Up and Running A Step-by-Step Guide to Building a Microservices Architecture", Shroff Publication, 2020, ISBN: 9789385889608
2. Sam Newman, "Building Microservices: Designing Fine-Grained Systems", O'Reilly Media, 2nd Edition, 2021, ISBN: 978-1492034025
3. Harry Percival, Bob Gregory, "Architecture Patterns with Python", 1st Edition, Shroff Publication, 2020, ISBN: 9352139739
4. John Carnell, "Spring Microservices in Action", Manning, 1st Edition, 2017, ISBN: 978-1617293986

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: I						
Course Code	**:**	**MIT314A4**	**Robotic Process Automation**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-1-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL+30T**	***Professional Core Courses (Cluster Electives) (Group-A)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**
What is Robotic Process Automation? Scope and Techniques of automation: what should be automated? What can be automated? Techniques of automation Roboic Process Automation: What can RPA do? Benefits of RPA Components of RPA, RPA platforms. About UiPath. The future of automation. Record and Play: UiPath stack, Downloading and Installing UiPath Studio, Learning UiPath Studio, Task Recorder, Emptying trash in Gmail, Emptying Recycle Bin	
UNIT - II	**9 Hours**
Sequence, Flowchart, and Control Flow: Sequencing the workflow, Activities, Control flow, various types of loops, and decision making, how to use a sequence, how to use a flowchart, step by step example using sequence and control flow. Data Manipulation: Variables and scope, Collections, Arguments-purpose and use, Data table usage with examples, Clipboard management, File operation with step-by-step example. CSV/Excel to data table and vice versa examples.	
UNIT - III	**9 Hours**
Taking control of the controls : Finding and attaching windows, Finding the control, Techniques for waiting for a control, Act on controls-mouse and keyboard activities, working with UiExplorer, Handling events, Revisit recorder, Screen scraping, When to use OCR, Types of OCR available, How to use OCR, Avoiding typical failure points. Tame that Application with Plugins and Extensions Terminal plugin: SAP automation, Java Plugin, Citrix automation, Mail plugin, PDF plugin, web integration, Excel and Word plugins, Credential management.	
UNIT - IV	**9 Hours**
Handling User Events and Assistant Bots: What are assistant bots? Monitoring system event triggers, Monitoring image and element triggers, Launching an assistant bot on a keyboard event. Exception Handling, Debugging, and Logging Exception handling: Common exceptions and ways to handle them, Logging and taking screenshots, Debugging techniques, Collecting crash dumps, Error reporting.	
UNIT - V	**9 Hours**
Managing and Maintaining the Code: Project Organization, Nesting workflows, Reusability of workflows, commenting techniques, State Machine, When to use Flowcharts, State Machines or sequences, Using config files and examples of a config file. Deploying and Maintaining the Bot: Publishing using publish utility, Overview of Orchestration Server, Using Orchestration Server to control bots, Using Orchestration Server to deploy bots.	

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

CO1	:	Apply the concept of Robotic Process Automation to automate various applications.
CO2	:	Analyse the usage of appropriate Robotic Process Automation technique for a given application.
CO3	:	Design and implement techniques of Robotic Process Automation.
CO4	:	Evaluate the code for deployment and maintenance.

Reference Books
1. Alok Mani Tripathi, Learning Robotic Process Automation, 1st Edition, Packpub.com, 2018, ISBN: 978-1-78847-094-0
2. Ed Freitas, Robotic Process Automation Succinctly, Succinctly EBook Series, 2020, ISBN: 978-1-64200-199-0
3. Nividous, Robotic Process Automation, www.nividous.com, 2018
4. Vaibhav Srivastava, Getting started with RPA using Automation Anywhere, BPB Publications, 2021, ISBN: 978-9389898286

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: I						
Course Code	**:**	**MCN415DL**	**DESIGN THINKING LAB**	**CIE Marks**	**:**	**50**
Credits L-T-P	**:**	**0-0-2**	**(Design Thinking/Skill Lab)**	**SEE Marks**	**:**	**50**
Hours/Week	**:**	**4**	**(Practice)**	**SEE Duration**	**:**	**2 Hours**

Contents

Design thinking is a methodology which provides a solution-based approach to solving problems. It is extremely useful when used to tackle complex problems, as it serves to understand the societal needs involved, reframe the problem in human-centric ways, create numerous ideas in brainstorming sessions and adopt a hands-on approach to prototype and testing.

The 5 Stages in the Design Thinking Process

Stage 1: Empathize—Compile Users' Needs.
Stage 2: Define—State Users' Needs and Problems.
Stage 3: Ideate—Challenge Assumptions and Create Ideas.
Stage 4: Prototype—Start to Create Solutions.
Stage 5: Test—validate the solutions obtained.

The five stages of design thinking will help students to apply the methodology to solve complex problems that occur in product designs. The students are encouraged to apply the 5 stages in the Design Thinking Process to solve the problems in the area identified.

The broad area identified for the M.Tech in specialization is as under:

Health Care Sector- Monitoring and Tracking System for Health Care Analysis and Prediction: The concept focuses on utilizing Machine Learning (ML) and Deep Learning (DL) algorithms to develop a comprehensive system for monitoring and tracking patient health data. The goal is to analyze this data to predict potential health issues and enhance proactive healthcare solutions.

Business Monitoring System- Cloud-Based Network Model for Home/Office Business Operations: such type of project involves creating and implementing a cloud-based network infrastructure to support both home and office-based business activities. The model aims to improve flexibility, scalability, and efficiency in business operations.

Financial Services Customer Relationship Management (CRM) System: Project in this domain aims to develop a robust CRM system specifically designed for financial services. The system will help manage customer interactions, enhance customer satisfaction, and streamline service delivery.

Internet of Things (IoT)- IoT Data Processing with Cloud Services: Project in this domain focuses on integrating IoT solutions with cloud services to process and analyze large volumes of data collected from IoT devices. The objective is to extract valuable insights and improve decision-making processes.

Smart Traffic Management System: Create an IoT and cloud-based smart traffic management system for metro cities. The system will use real-time data to optimize traffic flow, reduce congestion, and enhance urban mobility.

Security and Compliance System: This project involves developing a system to address compliance issues and ensure the security of cloud pool resources for various internet-based web services. The objective is to protect data integrity and maintain regulatory compliance.

Agricultural Farming / Market Data Analytics Recommendation System for Farmers: A project in this domain focuses on developing a recommendation system that leverages data analytics to support farmers in making informed decisions. The system will analyze market trends, weather conditions, soil health, and crop yields to provide personalized recommendations, helping farmers optimize their practices and increase profitability.

Education Cloud-Based Platform for Sharing Educational Resources: The project involves creating a cloud-based platform designed for university and college campuses. The platform will enable the sharing of educational resources, including lecture notes, research papers, and study materials. It will foster collaboration and accessibility among students and faculty, enhancing the academic environment.

Course Outcomes: After going through this course, the student will be able to:		
CO1	:	Demonstrate a clear understanding of the principles and stages of the design thinking process, including empathy, ideation, prototyping, and testing.
CO2	:	Apply design thinking methodologies to address complex real-world challenges and drive innovation.
CO3	:	Analyse and evaluate the success of design solutions and identify areas for improvement.
CO4	:	Develop creativity, problem-solving skills and learn iterations, trial and error, and failure that are all part of the creative learning process.

Reference Books
1. CLOUD COMPUTING, Dr. Tarandeep Kaur https://www.lpude.in/SLMs/Master%20of%20 Computer%20Applications/Sem_2/DECAP470_CLOUD_COMPUTING.pdf
2. Practical Guide to Cloud Computing, Cloud standard customer Council https://www.omg.org/cloud/deliverables/CSCC-Practical-Guide-to-Cloud-Computing.pdf
3. Simon Holmes, Getting MEAN with Mongo, Express, Angular, and Node https://www.w3schools.com/nodejs/

RUBRIC FOR CONTINUOUS INTERNAL EVALUATION (CIE-Lab)

The evaluation of the work will be carried out by the committee appointed by the Head of the department. Student/team should submit a report on the Case Studies solved under the theme.
Evaluation will be carried out in THREE Phases.

Phase	Activity	MARKS
I	Phase I	10
II	Phase II	15
III	Phase III and Draft report	15
	Final report	10
	MAXIMUM MARKS FOR THE CIE	**50**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Lab)

The evaluation will be done by Internal and External examiners through Exhibition Mode.
The following weightage would be given for the exhibition:

Q.NO.	CONTENTS	MARKS
1	Presentation through posters	15
2	Demonstration of the Prototype	25
3	Viva-voce	10
	MAXIMUM MARKS FOR THE SEE	**50**

SEMESTER: I						
Course Code	**:**	**HSS116EL**	**Technical English** **Common to all Programs**	**CIE Marks**	**:**	**50**
Credits **L-T-P**	**:**	**0-0-1**	**Online English Laboratory Course**	**SEE Marks**	**:**	**50**
Hours	**:**	**30P**	***(Humanities and Social Sciences)***	**SEE Duration**	**:**	**2 Hours**

Unit-I	**10 Hrs**
The Basics. Business Documents, Questions, and the Technical Pursuit. Engineering Concepts and Complexity; The Future Tense for Technical Work. White Papers; Modifiers and Qualifiers.	
Unit – II	**10 Hrs**
Making Recommendations; Interpreting Data, Ethical Persuasion for Technical Projects; Cause and Effect; Calls for Proposals. Technical Complexity in Communication. Numbers, Plain English, Jargon, and Technical Terms, Active and Passive Structures.	
Unit –III	**10 Hrs**
Organization Needs; Seeing the Big Picture; Negotiating. Audience Needs and Assessment; Standards versus White Papers; Objectivity, Communicating within Expected Genres; Identifying Trustworthy Sources or Bias in. A Review of Major Course Takeaways	

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

CO1	:	Demonstrate clarity and precision in technical communication by structuring information effectively, balancing technical terms with plain English, and adapting to diverse audiences.
CO2	:	Analyze and produce professional documents, such as white papers, business proposals, and reports, while applying ethical persuasion, data interpretation, and evidence-based reasoning.
CO3	**:**	Evaluate and refine communication strategies by assessing audience needs, recognizing trustworthy sources, and navigating organizational and technical complexities.
CO4	:	Apply critical thinking and negotiation skills to align communication with organizational goals, anticipate future challenges, and support informed decision-making.

References

1. IEEE – EBSCO Technical English for Professionals – Online platform
2. Valerie Lambert, Elaine Murray, English for Work – Everyday Technical English, Pearson Education, 2003, ISBN- 0 582 53963 3
3. David Bonamy, Christpher Jacques, Technical English – First Course Book, Pearson Education, 2008
4. S Sumant. Technical English I, The McGraw Hill, 2011, ISBN -978 81 8209 308 9

Assessment and Evaluation Pattern (Online Mode)		
	CIE (Online Mode)	**SEE (Online Mode)**
Weightage	**50%**	**50%**
Test – I	Each test will be conducted for 50 marks adding to 100 marks. Final test marks will be reduced to 40 marks	**Final assessment will be conducted for 50 marks**
Test – II		
Experiential Learning	10 Marks	
Communication Skills- Activity based test – Script writing, Essay Writing, Role plays. Any other activity that enhances the Communication skills. The students will be assigned with a topic by the faculty handling the batch. The students can either prepare a presentation/write essay/role play etc. for the duration (4-5 minutes per student). **Parameters for evaluation of the Presentation** a. Clarity in the presentation/ Speaking/Presentation skills. b. Concept / Subject on which the drama is enacted/ scripted		
Maximum Marks	50 Marks	**50 Marks**
Total marks for the course	**50**	**50**

SEMESTER: II						
Course Code	**:**	**MCN321IA**	**Advanced Algorithms and Complexity**	**CIE Marks**	**:**	**100 + 50**
Credits L-T-P	**:**	**3-0-1**	***(Theory & Practice)***	**SEE Marks**	**:**	**100 + 50**
Hours	**:**	**45L+45EL+30P**	***(Professional Core Course with Integrated Lab) -1***	**SEE Duration**	**:**	**3+3Hours**

UNIT - I	**9 Hours**
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, Mathematical Analysis of Nonrecursive Algorithms, Mathematical Analysis of Recursive Algorithms, Empirical Analysis of Algorithms **Amortized Analysis** Aggregate analysis, The accounting method , The potential method.	
UNIT - II	**9 Hours**
Advanced Data structures Data structures on secondary storage, 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. **Sorting in linear time:** counting sort, radix sort, bucket sort	
UNIT - III	**9 Hours**
Advanced Design and Analysis Technique Dynamic Programming-Matrix-chain multiplication, Longest common subsequence. Greedy Technique - Prim's Algorithm, Kruskal's Algorithm, Disjoint Subsets and Union-Find Algorithms, An activity-selection problem, Elements of the greedy strategy.	
UNIT - IV	**9 Hours**
Graph Algorithms: Topological sort, Shortest paths in a DAG, Dijkstra algorithm, Bellman-Ford Algorithm, Difference constraints and shortest paths, Maximum Flow: Flow networks, Ford Fulkerson method and Maximum Bipartite Matching, Matchings in Bipartite Graphs-Maximum bipartite matching(Revisited)	
UNIT - V	**9 Hours**
Parallel Algorithms: Task-parallel programming, Fork-join parallelism, The basics of fork-join parallelism, Parallel keywords, Semantics of parallel keywords, A graph model for parallel execution, Performance measures, Scheduling, Analyzing parallel algorithms, Parallel loops, Race conditions. **Multithreaded Algorithms** The basics of dynamic multithreading, Multithreaded matrix multiplication, Multithreaded merge sort.	
LABORATORY	**30 Hours**
Laboratory Programs could be executed using C/C++/Java/Python or any equivalent programming language. Solve case studies by applying relevant algorithms and calculate complexity. For example: 1. Applications of Graph Algorithm 2. Applications of Maximum Flow algorithm 3. String Matching algorithms 4. Sorting Algorithms / Advanced Data Structures	

Course Outcomes: After going through this course the student will be able to:		
CO1	:	Explore the fundamentals in the area of algorithms and methods for choosing, designing and analyzing algorithms.
CO2	:	Analyse algorithms for time and space complexity to solve advanced algorithmic problems.
CO3	:	Apply appropriate mathematical techniques, paradigms and data structures to build robust algorithmic solutions.
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. Introduction to the Design and Analysis of Algorithms, Anany Levitin, University, 3rd Edition, 2012, Pearson, ISBN 13: 978-0-13-231681-1.
3. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++ , Addison-Wesley, 3rd Edition, 2007, ISBN: 978-0132847377
4. Kozen DC, The design and analysis of algorithms, Springer Science & Business Media, 2012, ISBN: 978-03879768737
5. Kenneth A. Berman, Jerome L. Paul, Algorithms, Cengage Learning, 2002. ISBN: 978-8131505212

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks]**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	CIE THEORY TOTAL	**100**

RUBRIC FOR CONTINUOUS INTERNAL EVALUATION (CIE-Lab)		
Q.NO.	**CONTENTS**	**MARKS**
1	Conduction of the Experiments & Lab Record	30
2	Open-ended Lab Experiment	10
3	Lab Test	10
	CIE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE CIE	**150**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	SEE THEORY TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Lab)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva	10
	SEE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE SEE	**150**

SEMESTER: II						
Course Code	**:**	**MCN322IA**	**Advanced Network Programming**	**CIE Marks**	**:**	**100 + 50**
Credits L-T-P	**:**	**3-0-1**	***(Theory & Practice)***	**SEE Marks**	**:**	**100 + 50**
Hours	**:**	**45L+45EL+30P**	***(Professional Core Course with Integrated Lab) -2***	**SEE Duration**	**:**	**3+3Hours**

UNIT - I — **9 Hours**

The Transport Layer: **TCP, UDP, and SCTP:** Introduction, The Big Picture, UserDatagram Protocol (UDP), Transmission Control Protocol (TCP), Stream Control Transmission Protocol (SCTP), TCP Connection Establishment and Termination, TIME_WAIT State, SCTP Association Establishment and Termination, Port Numbers, TCP Port Numbers and Concurrent Servers, Buffer Sizes and Limitations.

Elementary TCP Sockets sockets Introduction, Socket Address Structures, Value-Result Arguments, Byte Ordering Functions, Byte Manipulation Functions, inet_aton, inet_addr, and inet_ntoa Functions, inet_pton and inet_ntop Functions, sock_ntop and Related Functions, socket Function, connect Function, bind Function, listen Function, accept Function, fork and exec Functions, Concurrent Servers, close Function, getsockname and getpeername

UNIT - II — **9 Hours**

TCP Client/Server Example Introduction, TCP Echo Server:main Function, TCP Echo Server: str_echo Function, TCP Echo Client: main Function, TCP Echo Client: str_cli Function, Normal Startup, Normal Termination.

Elementary UDP Sockets: Introduction, recvfrom and sendto Functions, UDP Echo Server: main Function, UDP Echo Server: dg_echo Function, UDP Echo Client: main Function, UDP Echo Client: dg_cli Function, Lost Datagram

UNIT - III — **9 Hours**

Elementary SCTP Sockets: Introduction, Interface Models, sctp_bindx Function, sctp_connectx Function, Sctp_getpaddrs Function, Sctp_freepaddrs Function, Sctp_getladdrs Function, Sctp_freeladdrs Function, Ssctp_sendmsg Function, Sctp_recvmsg Function, Sctp_opt_info Function Sctp_peeloff Function, shutdown Function, Notifications.

SCTP Client/Server Example

SCTP One-to-Many-Style Streaming Echo Server: main Function,SCTP One-to-Many-Style Streaming Echo Client: main Function, SCTP Streaming Echo Client: str_cli Function, Exploring Head-of-Line Blocking, Controlling the Number of Streams, Controlling Termination

UNIT – IV — **9 Hours**

Socket Options Introduction, getsockopt and setsockopt Functions, Checking if an Option Is Supported and Obtaining the Default, Socket States, Generic Socket Options, IPv4 Socket Options, ICMPv6 Socket Option, IPv6 Socket Options, TCP Socket Options

Name and Address Conversions Introduction, Domain Name System (DNS), gethostbyname Function, gethostbyaddr Function, getservbyname and getservbyport Functions, getaddrinfo Function, gai_strerror Function, freeaddrinfo Function, getaddrinfo Function: IPv6

Daemon Processes and the inetd Superserver Introduction, syslogd Daemon, syslog Function, daemon_init Function, inetd Daemon, daemon_inetd Function.

UNIT - V — **9 Hours**

Advanced UDP Sockets Introduction, Receiving Flags, Destination IP Address, and Interface Index, Datagram Truncation, When to Use UDP Instead of TCP, Adding Reliability to a UDP Application, Binding Interface Addresses, Concurrent UDP Servers, IPv6 Packet Information, IPv6 Path MTU Control.

Advanced SCTP Sockets - Introduction, An Autoclosing One-to-Many-Style Server, Par tial Delivery , Notifications, Unordered Data, Binding a Subset of Addresses, Determining Peer and Local Address Information, Finding an Association ID Given an IP Address, Heartbeating and Address Failure, Peeling Off an Association, Controlling Timing, When to Use SCTP Instead of TCP.

LABORATORY	30 Hours

List of Experiments :

1. Working on Unix / Linux Commands, byte ordering and Byte Manipulation functions.
2. Implement client and server communication using sockets programming of IPv4 and observe the packets using Wireshark.
3. Write a program to implement distance vector routing protocol for a simple topology of routers.
4. Write a program to implement error detection and Correction concept using Checksum and Hamming code.
5. Implement a simple multicast routing mechanism.
6. Implementation of concurrent and iterative echo server using both connection and connectionless socket system calls.
7. Implementation of remote command execution using socket system calls.
8. Write a program to encrypt and decrypt the data using RSA and Exchange the key securely using Diffie-Hellman Key exchange protocol.
9. Implement client and server communication using sockets programming of IPv6 and observe the packets using Wireshark.
10. Implementation of SCTP Client server communication using sockets programming of IPV4 and observe the packets using Wireshark.
11. Write a program to convert DNS name and address conversions using different functions for different set of records.
12. Implementation of socket options and daemon processes functions.

Note: The above experiments shall be conducted using C / C++ on Unix/ Linux Operating System.

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

CO1	:	Exploring the concepts of neural network, its applications and various learning models
CO2	:	Apply the knowledge of neural networks in various deep learning architecture (Convnet, Recurrent and Nets and Auto-encoder models)
CO3	:	Analyze different deep Network Architectures, learning tasks for various applications
CO4	:	Evaluate and compare the solutions by various deep learning approaches for a given problem

Reference Books

1. Deep Learning (Adaptive Computation and Machine Learning Series), Ian Good Fellow, Yoshua Bengio and Aaron Courville, MIT Press (3 January 2017), ISBN-13: 978-0262035613.
2. Neural Networks and Learning Machines, Simon S. Haykin, 3rd Edition 2010, PHI Learning, ISBN-9789332586253, 933258625X.
3. Introduction to Artificial Neural Networks, Gunjan Goswami, S.K. Kataria & Sons; 2012 Edition, ISBN-13:978-9350142967.
4. Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms, Nikhil Buduma, by O'Reilly Publications, 2016 Edition, ISBN-13: 978-1491925614.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks]**		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	CIE THEORY TOTAL	**100**
RUBRIC FOR CONTINUOUS INTERNAL EVALUATION (CIE-Lab)		
Q.NO.	**CONTENTS**	**MARKS**
1	Conduction of the Experiments & Lab Record	30
2	Open-ended Lab Experiment	10
3	Lab Test	10
	CIE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE CIE	**150**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	SEE THEORY TOTAL	**100**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Lab)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva	10
	SEE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE SEE	**150**

SEMESTER: II						
Course Code	**:**	**MCN323B1**	**Network Analytics**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-1-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL+30T**	***Program Specific Courses (Elective) (Group-B)***	**SEE Duration**	**:**	**3 Hours**

UNIT – I — **9 Hours**

Market and Business Drivers for Big Data Analytics:
Separating the Big Data Reality from Hype, Understanding the Business Drivers, Lowering the Barrier to Entry, Considerations.**Business Problems Suited to Big Data Analytics:**Validating (Against) the Hype: Organizational Fitness, The Promotion of the Value of Big Data, Big Data Use Cases and Characteristics of Big Data Applications, Perception and Quantification of Value, Forward Thinking About Value. **Achieving Organizational Alignment for Big Data Analytics** Two Key Questions, The Historical Perspective to Reporting and Analytics, The Culture Clash Challenge, Considering Aspects of Adopting Big Data Technology, Involving the Right Decision Makers, Roles of Organizational Alignment.

UNIT – II — **9 Hours**

Switches and Routers:
Basic Switch Components, Network Processing Unit (NPU), Control Section, Datapath Section, Switch Fabric, Lookup Table Design, Switch Functions, Routing, Traffic Management, Scheduling, Congestion Control, Switch Performance Measures, Switch Classifications, Input Queuing Switch, Output Queuing Switch, Shared Buffer Switch, Multiple Input Queuing Switch, Multiple Output Queuing Switch, Multiple Input/Output Queuing Switch, Virtual Routing/Virtual Queuing (VRQ) Switch .

UNIT – III — **9 Hours**

Modelling Network Traffic:
Introduction, Flow Traffic Models, Modulated Poisson Processes, On–Off Model, Markov Modulated Poisson Process, Autoregressive Models, Continuous-Time Modeling: Poisson Traffic Description, Memoryless Property of Poisson Traffic, Realistic Models for Poisson Traffic, Flow Description, Interarrival Time Description, Extracting Poisson Traffic Parameters, Poisson Traffic and Queuing Analysis, Self-Similar Traffic, Self-Similarity and Random Processes, Case studies.

UNIT - IV — **9 Hours**

Interconnection Networks:
Crossbar Network, Crossbar Network Contention and Arbitration, Analysis of Crossbar Network, Multistage Interconnection Networks, Definitions, Generalized-Cube Network (GCN), Routing Algorithm for GCN Network, Analysis of GCN Network, The Banyan Network, Routing Algorithm for Banyan Network, Analysis of Banyan Network, Augmented Data Manipulator Network (ADMN), Routing Algorithms for ADMN Network, First ADMN Routing Algorithm, Second ADMN Routing Algorithm, Third ADMN Routing Algorithm, Analysis of ADMN Network, Improved Logical Neighborhood (ILN), Routing Algorithm for ILN Network, Path Selection Issues, Analysis of ILN Network, Case studies.

UNIT - V — **9 Hours**

Industry Applications of Network Analytics: Network Optimization in Industry-Performance tuning, congestion control, and throughput maximization-Traffic shaping and load balancing, Role of network analytics in IT operations (DevOps, NetOps), Analyzing IoT network traffic, **Smart Cities and Network Analytics-**Overview of smart city networks, Using analytics for urban planning and traffic management, Role of network analytics in smart grids, autonomous vehicles, and surveillance, **Emerging Trends in Network Analytics-**AI and machine learning in predictive network analytics-The role of Blockchain in network security and analytics-The future of autonomous network.

Course Outcomes:		After going through this course the student will be able to:
CO1	:	Apply the Big data trends on network models of different business models / domains
CO2	:	Develop an understanding of network, data and its analytics based on network components.
CO3	:	Performance evaluation and analysis of the network traffic models based on Internet based protocols and algorithms.
CO4	:	Explore the possibility of using network analytics tools for an emerging trends of industry applications.

Reference Books
1. Loshin, David. Big data analytics: from strategic planning to enterprise integration with tools, techniques, NoSQL, and graph. Elsevier, 2013.
2. Gebali, Fayez. Analysis of computer and communication networks. Springer Science & Business Media, 2008.
3. Networks, Crowds, and Markets: Reasoning About a Highly Connected World, Easle, David and Kleinberg, Jon. 2010, Cambridge University Press, USA.
4. Communication networking: an analytical approach , Anurag Kumar, D. Manjunath and Joy Kuri, 2004, Elsevier
5. Research publications on Network Analytics-IEEE / ACM Transactions

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
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1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MCN323B2**	**Foundations of Artificial Intelligence**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-1-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL+30T**	***Program Specific Courses (Elective) (Group-B)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**

Introduction, Intelligent agents, Searching:

Definition of AI, Intelligent Agents: Agents and environment; Rationality; the nature of environments; the structure of agents.

Problem-solving: Problem-solving agents; Searching for solution; Uninformed search strategies; Informed search strategies, Heuristic Functions

UNIT - II	**9 Hours**

Adversarial Search, Constraint Satisfaction Problems, Logical agents, First-order logic : Games,
Optimal decision in games, Alpha-Beta Pruning, Defining Constraint satisfaction problems; Backtracking search for CSPs; Knowledge-based agents; The Wumpus world as an example world;
Logic; propositional logic; Propositional theorem proving; Syntax and semantics of first-order logic;Using first-order logic;

UNIT - III	**9 Hours**

Introduction to machine learning: Types of Learning; Well-posed learning algorithms; Designing a learning algorithm; Perspectives and Issues in machine learning;
Decision tree learning: Introduction, Decision tree representation; Appropriate problems for decision tree learning, The basic decision tree learning algorithm, Hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning;

UNIT - IV	**9 Hours**

Instance based learning: Introduction; k-nearest neighbor learning; Locally weighted regression; Radial based regression case-based functions;
Reinforcement learning: Introduction; The learning task; Q learning; Nondeterministic rewards and actions

UNIT - V	**9 Hours**

Artificial Neural Networks
Introduction; Neural Network Representations; Appropriate Problems for Neural Network Learning, Perceptrons; Multilayer Neural Networks and the Backpropagation Algorithm; Remarks on the Backpropagation algorithm, An Illustrative Example: Face Recognition; Advanced topics in Artificial Neural Networks;

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

CO1	:	Apply fundamentals of Artificial Intelligence and Machine Learning to identify problems where AI techniques are used.
CO2	:	Analyse and formulate the problems using Artificial Intelligence and Machine Learning approaches that involves problem solving, knowledge representation, automated reasoning and learning.
CO3	:	Design and implement AI systems that act intelligently and learn from experience.
CO4	:	Recommend and develop the AI and ML-based solutions for the real-world problems.

Reference Books
1. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig, 4th edition, 2022, Pearson, ISBN-13: 978-9356063570
2. Machine Learning, Tom M. Mitchell, 2017 , McGraw Hill Education; First Edition, ISBN-13: 978-1259096952
3. Artificial Intelligence: Elaine Rich, Kevin Knight, 3rd Edition, 2017, McGraw Hill Education,ISBN: 9780070087705
4. Pattern Classification, Richard O. Duda, Peter E. Hart and David G. Stork, , Second edition, 2007, Wiley, ISBN-13: 978-8126511167

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MCN323B3**	**Advance Wireless Communications and Networking**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-1-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL+30T**	***Program Specific Courses (Elective) (Group-B)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**

Evolution of Wireless Communication Systems: 2G and 2.5G cellular networks standards, 3G Wireless Networks, Evolution of LTE Technology and 4G, Ten Pillars of 5G, Architecture of 5G

Modulation Techniques for Mobile Radio: Frequency modulation Vs amplitude modulation, Factors that influence the choice of digital modulation, Bandwidth and Power Spectral Density of digital signal, Linear Modulation techniques –Binary phases shift keying (BPSK), Differential PSK, Quadrature PSK, Constant envelope modulation – Binary Frequency Shift Keying, Minimum Shift Keying(MSK)

Multiple Access Techniques: Introduction, Narrowband channelized systems, Spectral Efficiency, Wideband systems

UNIT - II	**9 Hours**

The Cellular Concept-System Design Fundamentals: Introduction, Frequency reuse, Channel assignment strategies, Handoff strategies – prioritizing handoffs, Practical Handoff considerations, Interference and system capacity, Co-channel interference and system capacity, Channel planning for wireless systems, Adjacent channel interference, Power control for reducing interference, Capacity of cellular systems (FDMA and TDMA), Capacity of cellular CDMA systems

UNIT - III	**9 Hours**

Mobile Radio Propagation and fading: Introduction, Free space propagation model, Three basic propagation mechanisms, Reflection- reflection from dielectrics, Brewster angle, Diffraction-Fresnel Zone geometry, Scattering, Practical Link budget design- Log distance path loss model, Log normal shadowing, Small scale multipath propagation- Factors influencing small scale fading, Doppler shift, Types of small scale Fading- Fading effects due to multipath time delay spread and Doppler spread

UNIT - IV	**9 Hours**

Small Cells for 5G Mobile Networks: Introduction, Wi-Fi and Femtocells as Candidate Small-Cell Technologies, Small-Cell Challenges

Cognitive Radio for 5G Wireless Networks: Introduction, Overview of Cognitive Radio Technology in 5G Wireless, Spectrum Optimization using Cognitive Radio, Relevant Spectrum Optimization Literature in 5G, Dynamic Spectrum Access, Spectrum Regulatory Policy, Marketing Policy and Model, Cognitive Radio and Carrier Aggregation, Energy-Efficient Cognitive Radio Technology, Key Requirements and Challenges for 5G Cognitive Terminals, 5G Devices as Cognitive Radio Terminals, 5G Cognitive Terminal Challenges

UNIT - V	**9 Hours**

Introduction 6G Wireless Communications Networks: 6G Vision, KPI for 6G networks, Multiple Antenna Technology, Reconfigurable Intelligent Reflecting Surfaces, Holographic Radio Communications, New Spectrum Usage And Radio Design Paradigms, Light-Fidelity (Li-Fi), Non-Orthogonal Multiple Access (NOMA), Energy Harvesting, Backscatter Communication

Course Outcomes: After going through this course the student will be able to:		
CO1	:	Understand the existing wireless networks and advanced concepts in 5G/6G wireless communication systems
CO2	:	Analyze the cellular wireless system parameters, requirements, range of signals and path loss models in real world scenarios.
CO3	:	Evaluate and apply multiple access schemes, modulation techniques and energy management at different levels to optimize the performance and reliability of 5G networks
CO4	:	Design and implement wireless networks/frameworks/protocols for different applications with a focus on high-capacity, high-speed sustainable wireless communication.

Reference Books

1. Theodore S Rappaport, "Wireless Communications, Principles and Practice", Pearson Education Asia, 2nd edition, 2009, ISBN: 9780133755367
2. Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”, 1st Edition, May 2015, ISBN-13: 978-1-118-867525
3. Vijay Garg, “Wireless Communications and Networking”, Morgan Kaufmann Publishers, Indian Reprint, 2009, ISBN: 978-81-312-1889-1.
4. Harri Pennanen, Tuomo H¨anninen, Oskari Tervo, Antti Tolli, Matti Latva-aho, “6G: The Intelligent Network of Everything – A Comprehensive Vision, Survey, and Tutorial”, https://arxiv.org/abs/2407.09398

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
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2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom’s Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
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7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MCN323B4**	**Internet of Things**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-1-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL+30T**	***Program Specific Courses (Elective) (Group-B)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I — **9 Hours**

Internet Of Things – Introduction, Concepts and Use-Cases
Introduction and Concepts: Definition & Characteristics of IOT, Physical Design of IOT, Logical Design of IOT, IOT Enabling technologies, Levels of IOT deployment.
Use-Cases: Use cases of IOT pertaining to different domains. (Chapters 1,2 from the Reference book 1)

UNIT - II — **9 Hours**

Design Principles for Web Connectivity:
Introduction, Web Communication Protocols: Constrained Applications Protocol (CoAP), Lightweight Machine-to-Machine Communication; Message Communication Protocols: Message Queue Telemetry Transport (MQTT)

UNIT - III — **9 Hours**

Design and Deployment of Internet of Things (IOT)Applications using IOT physical devices and End points:
ESP32(RV-IOT-Board) and Raspberry. ESP32(RV-IOT-Board): Block diagram, Features and Interfaces. Interfacing I2C and SPI devices. Sample Embedded C programs for ESP 32 to read the sensors LDR, DHT11 using Arduino IDE. RaspberryPi : Block diagram, Features and Interfaces. OS installation and setup procedure. Sample Python Programs to read the data from IR sensor, Ultrasonic sensor and Camera.

UNIT - IV — **9 Hours**

IOT Physical Servers & Cloud Offerings:
Blynk, Thing Speak, Real Time Data Base – Firebase, AWS IOT: Features, Usage and Deployment. Example Programs to upload the sensor data to ThingSpeak cloud, to create the IOT Dashboard using the Blynk cloud, Integration of Web / Mobile Application with Firebase real time database.

UNIT - V — **9 Hours**

IOT Platforms Design Methodology:
Introduction, IOT Design Methodology, Designing for the case Studies on IOT systems for Weather Monitoring, Smart Lighting, Smart Parking, Smart Irrigation and Forest Fire Detection.

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

CO1	:	Analyze the fundamental concepts of IoT, including the physical and logical design, enabling technologies, and levels of deployment in various domains.
CO2	:	Implement web communication protocols such as Constrained Application Protocol (CoAP) and Lightweight M2M, as well as message communication protocols like MQTT in IoT systems.
CO3	:	Develop IoT applications using physical devices like ESP32 and Raspberry Pi, interfacing with sensors and writing embedded C and Python programs to collect and process sensor data.
CO4	:	Utilize cloud platforms like Blynk, ThingSpeak, and Firebase for uploading, managing, and visualizing sensor data, and integrate IoT applications with web or mobile interfaces.
CO5	:	Design and create IoT-based solutions for case studies such as weather monitoring, smart lighting, smart parking, smart irrigation, and forest fire detection, following systematic IoT design methodologies.

Reference Books
1. Internet of Things – A Hands on approach, Arshdeep Bahga, Vijay Madisetti, 2016, Universities Press, ISBN – 978-81-7371-954-7.
2. Internet of Things, V.K.Jain, Khanna Publications, 2021, ISBN No: 978-81-952075-2-7
3. Raj Kamal, "Internet of Things: Architecture and Design Principles". TMH Publications,1st Edition, 2017 ISBN: 9789352605224
4. Rajkumar Buyya , Satish Narayana Srirama," Fog and Edge Computing: Principles and Paradigms" ,Wiley series on parallel and distributed computing, 1st Edition, 2019 ISBN: 978-1-119-52498-4.
5. RV-IoT-Board – Lab Manual

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MCN324C1**	**Advanced Routing Protocols**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-1-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL+30T**	***Professional Core Courses (Cluster Electives) (Group-C)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I — **9 Hours**

Internet Protocol Traffic Engineering:

Routing Protocols, Routing Classification and Routing Table, Traffic, Stochasticity, Delay and Utilization, Traffic and Performance Measures, Characterizing Traffic, Average Delay in a single link system, Nonstationary of traffic, Applications View, An Architectural Framework, Traffic Engineering, a Four-Node Illustration, IGP Metric, Determining IGP Link Weights via Duality of MCNF Problems, Illustration of Link Weight Determination Through Duality, Link Weight Determination, Link weight determination Large Networks.

UNIT - II — **9 Hours**

Hierarchical and Dynamic Call Routing in the Telephone Network:

Hierarchical Call Routing, Overall Hierarchical Routing Architecture, The Road to Dynamic Routing, Limitations of Hierarchical Routing, Call Control and Crankback, Trunk Reservation, Mixing of OCC and PCC, Dynamic Non-hierarchical Routing, Dynamically Controlled Routing, Dynamic Alternate Routing, Real-Time Network Routing, Classification of Dynamic Call Routing Maximum Allowable Residual Capacity Routing, Dynamic Routing and Its Relation to Other Routing.

UNIT - III — **9 Hours**

Traffic Engineering in the Voice Telephone Network:

Traffic Engineering, Traffic Load and Blocking, Computing Erlang-B Loss Formula, Grade-of-Service and Trunk Occupancy, Centi-Call Seconds and Determining Based Load, Economic CCS Method Network Controls for Traffic Engineering, Guidelines on Detection of Congestion Examples of Controls, Communication of Congestion Control Information, Congestion Manifestation, State-Dependent Call Routing, Three-Node Network, N-Node Symmetric Network, N-Node Symmetric Network with Trunk Reservation, Illustration Without and with Trunk Reservation, Qualiy of Service(QoS), QoS Routing Classification, QoS Attributes.

UNIT - IV — **9 Hours**

IP Packet Filtering and Classification:

Importance of Packet Classification, Packet Classification Problem, Expressing Rules, Performance Metrics, Packet Classification Algorithms, Naïve Solutions, Two-Dimensional Solutions and its types, Approaches for d Dimensions, Extending Two-Dimensional Solutions Divide and Conquer Approaches-Lucent Bit Vector, Aggregated Bit Vector, Tuple Space Approaches, Decision Tree Approaches-Hierarchical Intelligent Cuttings, Hardware-Based Solutions Ternary Content Addressable Memory (TCAM).

UNIT - V — **9 Hours**

VoIP Routing: Interoperability Through IP and PSTN:

Traffic Engineering of IP/MPLS Networks, VPN Traffic Engineering, PSTN Call Routing Using the Internet, PSTN Call Routing: Managed IP Approach, IP-PSTN Interworking for VoIP, IP Multimedia Subsystem, Multiple Heterogeneous Providers Environment, All-IP Environment of VoIP Services

Course Outcomes:		
After going through this course the student will be able to:		
CO1	:	Explore different types of traffic engineering adopted in an Internet based services and Telephone networks
CO2	:	Apply call routing and voice routing approaches used to optimize the routing in different types of networks.
CO3	:	Analyze the performance issues related to routing in an IP traffic engineering networks
CO4	:	Examine the various algorithms of routing in VoIP call services, Traffic Engineering and Telephone networks.

Reference Books

1. Deepak Medhi, Karthik Ramasamy, and 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 VPN, Call Routing,Traffic Engineering, VoIP, PSTN and Hierarchical Routing

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)

CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**

Sl.No	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)

Q.NO.	CONTENTS	MARKS
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MCE324C2**	**Advances in Computer Vision**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-1-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL+30T**	***(Professional Core Courses (Cluster Electives) (Group-C)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**

Introduction to Digital Image Fundamentals :

Digital Image Processing concepts: The origin of Digital Image processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Image Sampling and Quantization, Some Basic Relationships between Pixels.

Histogram Processing: Histogram Equalization, Histogram Matching (Specification Local Histogram Processing. Fundamentals Of Spatial Filtering the Mechanics of Linear Spatial Filtering, Spatial Correlation and Convolution, Separable Filter Kernels.

UNIT - II	**9 Hours**

Image Segmentation: Fundamentals, Thresholding: The Basics of Intensity Thresholding, The Role of Noise in Image Thresholding, The Role of Illumination and Reflectance in Image Thresholding. Basic Global Thresholding Optimum Global Thresholding Using Otsu's Method Segmentation by Region Growing and By Region Splitting and Merging Region Growing Region Splitting and Merging.

UNIT - III	**9 Hours**

Region Segmentation Using Clustering and Super pixels: **R**egion Segmentation Using K-Means Clustering, Region Segmentation Using Super pixels, Slic Superpixel Algorithm.

Object Recognition: Image Pattern Classification: Priori by A Human Designer, Patterns and Pattern Classes, Pattern Vectors, Structural Patterns, Pattern Classification by Prototype Matching.

UNIT - IV	**9 Hours**

Object Recognition: Minimum-Distance Classifier Using Correlation for 2-D Prototype Matching Sift Feature Matching Structural Prototypes.

Tracking: Tracking as an Abstract Inference Problem, Independence Assumptions, Tracking as Inference. Data Association: Choosing the Nearest- Global Nearest Neighbours, Gating and Probabilistic Data Association, Applications and Examples, Vehicle Tracking, Finding and Tracking People.

UNIT - V	**9 Hours**

Applications:

Finding Faces Using Frame Invariance, Multilocal Visual Events, finding: Annotation and segmentation, Template matching, Shape and correspondence, Video Image-Based Rendering: Constructing 3D Models from Image Sequences, Scene Modelling from Registered Images, Scene Modelling from Unregistered Images Transfer-Based Approaches to Image-Based Rendering Affine View Synthesis.

Course Outcomes:		
After going through this course the student will be able to:		
CO1	:	Analyze the difficulties of the pattern recognition problems which include classification techniques, Feature detection and Histogram equalization process in feature extraction methods, which help identify meaningful patterns and structures in images.
CO2	:	Apply appropriate image processing methods for image filtering, image restoration, image reconstruction, segmentation, classification and representation
CO3	:	Designing and implement a Computer Vision system as part of an experiential learning initiative in teams to solve societal and environmental problems using pattern recognition in images and videos
CO4	:	Evaluation of the performances of different CV algorithms and its limitation, study of ethical issues related to CV applications including privacy concerns and bias in algorithms

Reference Books

1. David Forsyth and Jean Ponce, "Computer Vision: A Modern Approach", Prime student, 2nd edition, ISBN-13: 978-0136085928
2. Rafael C. Gonzalez, Richard E. Woods;" Digital Image Processing"; Pearson Education; 3rd Edition; 2012; ISBN 978-93-325-7032-0.
3. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis and Machine Vision". 3rd edition, CL Engineering, ISBN-13: 978-0495082521
4. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer Verlag : http://szeliski.org/Book/.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)

CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**

Sl. No.	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)

Q.NO.	CONTENTS	MARKS
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MSE324C3**	**Mobile Commerce and Applications**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-1-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL+30T**	***Professional Core Courses (Cluster Electives) (Group-C)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**

Introduction to Mobile commerce: Mobile commerce, Mobile commerce framework, Mobile commerce business models, M commerce applications, E commerce vs M commerce. Mobile commerce services: Types of M commerce services, Mobile portal, Applications of mobile commerce in industry, Mobile application development.

UNIT - II	**9 Hours**

Wireless and Mobile Communication: communication systems, wireless communication, satellite communication, mobile communication systems. Digital cellular Technology: Cellular communications, cellular networks, mobile phone cellular networks. Mobile access technology: Mobile communication standards, Evolution of mobile communication systems, 2G and 3G systems.

UNIT - III	**9 Hours**

4G and 5G systems: 4G features, 4G technologies, IPv6 support, LTE advanced, 4G objectives and Goals, 4G deployment plans, 5G systems, 5G features, 5G technologies, Cloud based systems, (IoT) Internet of Things systems, Artificial intelligence and Mobile Edge computing, Mobile Devices: Types of Mobile Devices, mobile computers, Mobile Internet Device (MID), Personal Digital Assistant (PDA), Handheld game console, portable media player, pager, Personal Navigation Device, Tablet, Mobile service providers: Mobile network operators, Mobile Virtual network operators, satellite based mobile operators.

Case Study: Mobile Shopping, Mobile Business Intelligence.

UNIT - IV	**9 Hours**

Mobile Banking: Bank in your mobile , Mobile banking business models, mobile banking technologies, mobile banking services, advantages and challenges of mobile banking , mobile banking applications, SMS banking, Tickets on mobile : Mobile ticketing, applications of mobile tickets, advantages of mobile tickets, privacy and security issues, mobile ticketing Apps, mobile ticket providers, Mobile Payment: characteristics of mobile payment systems, mobile payment models, types of mobile payments, security issues.

UNIT - V	**9 Hours**

Mobile computing : Ubiquitous computing, applications of mobile computing , challenges of mobile computing , mobile computing software platforms, Business applications of mobile computing, Mobile computing software platforms, Mobile business intelligence, Security and privacy issues: mobile security concepts, mobile security mechanism, Mobile network security, mobile information security, mobile device security, mobile device security arrangements, mobile application security, mobile security management, Legal aspects: mobile device related laws, cell phone freedom act 2010, information technology act 2000 of India, Privacy and Electronic Communication Regulations act 2003.

Case Study: Mobile Cloud Computing, Mobile Education.

Course Outcomes:		
After going through this course the student will be able to:		
CO1	:	Describe the value-added attributes, benefits, and fundamental drivers of m-commerce
CO2	:	Apply the mobile computing infrastructure that supports m-commerce (devices, software, and services)
CO3	:	Differentiate m-commerce applications in banking and financial services
CO4	:	Analyze consumer and personal applications of m-commerce, including entertainment, ubiquitous computing and sensory networks

Reference Books

1. Karabi Bandyopadhyay, Mobile commerce,1st edition , PHI Learning, 2013, ISBN-978-81-203-4805-9Stein, "Introduction to Algorithms", The MIT Press, 3rd Edition, 2009, ISBN: 978-0262033848
2. Nikhilesh Dholakia , Morten Rask, Ruby Roy Dholakia, M-commerce : global experiences and perspectives, 2nd edition Hershey PA : Idea Group Pub., 2006, ISBN-978-1591403159
3. Paul May, Mobile Commerce : Opportunities Applications And Technologies Of Wireless Business, South Asia Edition ,CAMBRIDGE UNIVERSITY PRESS, 2015, ISBN:9781316509968
4. Shiney Chib, M-Commerce, 1st edition, Himalaya Publishing House, 2017,ISBN: 978-93-5024-914-7

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MIT324C4**	**Extended Reality**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-1-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**42L+28T**	***Professional Core Courses (Cluster Electives) (Group-C)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**
Introduction Virtual Reality, Augmented Reality, Mixed Reality, Extended Reality applications. **Birds-eye view** : Hardware, Software, Human Physiology and perception, History of VR and AR **Programming with Unity**: Unity Basics, Manipulating the Scene, Code blocks and Methods, Debugging Conditional and looping statements.	
UNIT - II	**9 Hours**
Programming with Unity: Working with objects, Working with Scripts, Player movement, Camera Movement, Menu and UI, Advanced 3D movement Further Learning for Unity: The Asset Store **Mouse-Aimed camera:** First Person Controller, Third Person Controller **Further Learning for Unity**: The Asset Store	
UNIT - III	**9 Hours**
Augmented Reality: Types of tracking, Marker-based tracking, Marker-less tracking, Build and Run-Vuforia. **Modeling Tools:** An introduction to different modeling tools, Blender, Modeling of an object, Sculpting objects, Importing from Blender to Unity, Animation. Visual Scripting, Digital Twining	
UNIT - IV	**9 Hours**
XR Market, applications. **Introduction to WebXR:** Entering VR through WebXR, Life cycle of WebXR application, Creating an XR session through WebXR. Creating an AR website with WebXR: Object creation, spatial tracking, start AR session.	
UNIT - V	**9 Hours**
Extended Reality and Artificial Intelligence: XR and Artificial Intelligence, Future Research Agenda and Roadmap. **XR and Metaverse Software Platforms:** Enabling Platforms, Content Platforms, Human-Centered Platforms, Utility Platforms, Application Platforms.	

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

CO1	:	Understand the concepts of AR/VR/XR and its Applications
CO2	:	Identify, examine and develop software that reflects techniques for the design and deployment of VR/AR/XR experiences
CO3	:	Demonstrate a VR/AR/XR environment to captivate its experiences
CO4	:	Analyze the technology for unimodal/multimodal interaction

Reference Books
1."Virtual Reality", Steven M. LaValle, Copyright Steven M. LaValle 2017 Available for downloading at http://vr.cs .uiuc.edu/
2. "Roadmapping Extended Reality Fundamentals and Applications" , Mariano Alcañiz, Marco Sacco, Jolanda G. Tromp, 2022, Published by Wiley, ISBN 978-1-119-86514-8
3. "Blender 3D: Designing Objects" , Romain Caudron, Pierre-Armand Nicq, Enrico Valenza, 2016, Packt Publishing Ltd, ISBN 978-1-78712-719-7
4. Sanni Siltanen, Theory and applications of marker-based augmented reality, Julkaisija – Utgivare – publisher, ISBN 978-951-38-7449-0 (soft back ed.), ISSN 2242-119X (soft backed). AR and VR Using the WebXR API, Rakesh Baruah , 2021, ISBN-13 : 978-1-4842-6317- 4 ISBN-13 : 978-1-4842-6318-1 https://doi.org/10.1007/978-1-4842-6318-1

Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MBT325DA**	**NATURE IMPELLED ENGINEERING**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-0-0**		**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL**	***Interdisciplinary Courses (Global Electives) (Group-D)***	**SEE Durations**	**:**	**3 Hr**

UNIT - I	**9 Hrs**
Bio-Inspired designs-biomimetics: Termites; Sustainable buildings, Insect foot adaptations for adhesion. Bees and Honeycomb Structure. Namib Desert Beetle; Harvesting desert fog-Nature's water filter. Biopolymers, Bio-steel, Bio-composites, multi-functional biological materials. Antireflection and photo-thermal biomaterials, Invasive and non-invasive thermal detection inspired by skin.	
UNIT - II	**8 Hrs**
Plant inspired Technologies: Photosynthesis and Photovoltaic cells, Bionic/Artificial leaf. Lotus leaf effect for super hydrophobic surfaces. Flectofin®, a new façade-shading system inspired by flower of the Bird-of-Paradise (Strelitzia reginae). Robotic Solutions Inspired by Plant Root.	
UNIT - III	**9 Hrs**
Bio-Inspired technologies for medical applications: Organ system- Circulatory- artificial blood, artificial heart, pacemaker. Respiratory- artificial lungs. Excretory- Artificial kidney and skin. Artificial Support and replacement of human organs: artificial liver and pancreas. Total joint replacements- artificial limbs. Visual prosthesis -artificial / bionic eye.	
UNIT - IV	**8 Hrs**
Bio-Inspired driven technologies for industrial applications: Biosensors: Artificial tongue and nose. Biomimetic echolation. Insect foot adaptations for adhesion. Thermal insulation and storage materials. Bio-robotics.	
UNIT - V	**8 Hrs**
Bio-inspired computing: Cellular automata, neural networks, evolutionary computing, swarm intelligence, artificial life, and complex networks. Genetic Algorithms, Artificial Neural Networks. Artificial intelligence and MEMS.	

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

CO1	:	Contemplate a deep understanding of biological systems, mimetics structures, and functions that inspire engineering innovations for adaptability and sustainability.
CO2	:	Endeavor biological principles from nature driven techniques to design engineering systems for solving real-world challenges
CO3	:	Appraise the bioinspired materials for their advanced applications in the domain of health, energy and environmental sustainability.
CO4	:	Paraphrase biomimicry and ethics in bioinspired engineering designs, ensuring that their solutions are environmentally responsible and socially conscious

Reference Books:
1) Yoseph Bar-Cohen. Biomimetics: Biologically Inspired Technologies D. Floreano and C. Mattiussi, "Bio-Inspired Artificial Intelligence", CRC Press, 2018. ISBN: 1420037714, 9781420037715.
2) Guang Yang, Lin Xiao, and Lallepak Lamboni. Bioinspired Materials Science and Engineering. John Wiley, 2018. ISBN: 978-1-119-390336.
3) M.A. Meyers and P.Y. Chen. Biological Materials, Bioinspired Materials, and Biomaterials Cambridge University Press, 2014 ISBN 978-1-107-01045.
4) Tao Deng. Bioinspired Engineering of Thermal Materials. Wiley-VCH Press, 2018. ISBN: 978-3-527-33834-4.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	**MBT325DB**	**CLINICAL DATA MANAGEMENT**	**CIE Marks**	:	**100**
Credits L-T-P	:	**3-0-0**		**SEE Marks**	:	**100**
Hours	:	**45L+45EL**	***Interdisciplinary Courses (Global Electives) (Group-D)***	**SEE Durations**	:	**3 Hrs**

UNIT - I	**9 Hrs**
Fundamentals of Healthcare Data and Analytics: Overview, importance, and evolution of health informatics in the digital age, Healthcare Data Types: Structured vs. unstructured data, clinical vs. operational data, and sources of healthcare data, Data Conversion and Integration: Data standardization, integration into clinical data warehouses, and data cleaning. Data Analytics: Introduction to descriptive, predictive, and prescriptive analytics in healthcare. Use of AI and machine learning for improved outcomes, Challenges and Future Trends: Data privacy, interoperability issues, the role of informatics in personalized medicine, and the future of digital health.	
UNIT - II	**9 Hrs**
Electronic Health Records (EHRs) and Digital Health: Overview of EHRs: Key components, data capture mechanisms, and the shift towards integrated EHR systems. Scope and Adoption: Role of EHRs in enhancing patient care, interoperability, and data sharing between healthcare providers. Implementation Process: Steps for selecting, deploying, and optimizing EHR systems, including vendor selection and compliance with healthcare regulations. Challenges in EHRs: Usability issues, data quality, resistance to adoption, and strategies for overcoming these barriers. Digital Health Innovations: Impact of telemedicine, remote patient monitoring, and digital therapeutics on EHR integration.	
UNIT - III	**9 Hrs**
Data Standards, Interoperability, and Medical Coding: Introduction to Standards: Need for data standards in health informatics, and their role in ensuring interoperability. Terminology and Content Standards: Deep dive into ICD, SNOMED CT, LOINC, and HL7 FHIR. Data Exchange and Transport Standards: HL7, DICOM, CDA, and emerging standards for seamless data exchange. Medical Coding Systems: Role of medical coding in billing, clinical documentation, and outcome measurement. Overview of CPT, ICD-10, and DRG codes. Emerging Trends: Role of AI in medical coding and billing, and the shift towards real-time data standardization.	
UNIT - IV	**9 Hrs**
Health Informatics Ecosystem: Introduction to the ecosystem, including hospitals, clinics, insurance providers, and regulatory bodies. Key Players and Stakeholders: Role of informatics professionals, data scientists, clinicians, and IT staff in healthcare. Challenges and Barriers: Addressing technical, organizational, and regulatory challenges in health informatics. Career Opportunities: Overview of roles like clinical informatics specialist, health data analyst, and telehealth coordinator. Resources and Professional Development: Important certifications, online resources, and organizations (e.g., HIMSS, AMIA).	
UNIT - V	**9 Hrs**
Health Information Privacy, Security, and Ethics: Introduction to Privacy and Security: Core principles of data privacy, HIPAA, and GDPR in healthcare. Security Principles: Confidentiality, integrity, availability, encryption methods, and access control mechanisms. Authentication and Identity Management: Role of biometric authentication, two-factor authentication, and secure access protocols. Data Security in the Cloud: Cloud computing in healthcare, managing risks in cloud-based data storage, and hybrid cloud models. Ethics in the use of AI in healthcare, managing bias in algorithms, and ensuring equitable access to digital health technologies.	

Course Outcomes: **After going through this course the student will be able to:**		
CO1	:	Understand the key principles and challenges of health informatics, and apply them to real-world scenarios.
CO2	:	Effectively manage the process of data capture, conversion, and analysis to generate actionable insights.
CO3	:	Apply knowledge of medical coding, data standards, and interoperability to improve data sharing and clinical workflows.
CO4	:	Implement robust security measures to protect patient data, and navigate ethical issues in health informatics.

Reference Books:
1. Robert E. Hoyt Ann K. Yoshihashi, Health Informatics, Practical guide for Healthcare and Information Technology Professionals, 6th edition, Informatics Education, 2014, ISBN: 978-0-9887529-2-4
2. Kathryn J. Hannah Marion J. Ball, Health Informatics, Springer Series edition, Springer, 2005, ISBN: 1-85233-826-1
3. William R Hersh, Health Informatics, a Practical guide, 8th edition. 2022, ISBN 978-1-387-85475-2
4. Pentti Nieminen. Medical informatics and data analysis 1st edition, MDPI AG, 2021, ISBN-13 : 978-3036500980

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
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3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MCN325DC**	**Cyber Forensics and Cyber Laws**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-1-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL**	***Interdisciplinary Courses (Global Electives) (Group-D)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**

Computer Forensics in Today's World :

Introduction to Computer Forensics and Digital Evidence, the Role of the Forensic Investigator, Understanding Forensic Readiness. Legal Issues and Considerations, Types of Computer Forensic Investigations, Forensic Investigation Process.

UNIT - II	**9 Hours**

Investigation Process:

Computer Forensics Investigation Methodology, Handling Digital Evidence, Chain of Custody and Documentation, Evidence Preservation: Hashing and Imaging, Investigation Planning and Legal Approval, Searching and Seizing Computers: Search and Seizure Procedures, Obtaining a Search Warrant, Securing the Crime Scene

UNIT - III	**9 Hours**

Digital Evidence:

Types of Digital Evidence (Physical, Logical, Latent), Collecting and Preserving Digital Evidence, Writing Reports on Digital Evidence, Identifying Evidence Sources: Hard Drives, Network Logs, Databases, Evidence Recovery Techniques, First Responder Procedures: First Responder Role in Digital Investigations, Protecting and Securing Evidence, Best Practices for Incident Response

UNIT - IV	**9 Hours**

Jurisdiction of Cyberspace:

Information Technology Law Literature and Glossary, Information Technology Law Concepts, Jurisdictional Issues in Cyber Space, scope of I.T. laws,

Law and the Internet:

Domain issues in Internet, Regulatory body, ICANN regulations

UNIT - V	**9 Hours**

Security Governance Objectives –

Security Architecture, Risk Management Objective, Developing A Security Strategy, Sample Strategy Development

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

CO1	:	Gain a comprehensive understanding of Cyberfornsic and Investigation
CO2	:	Apply cyber forensics measures, tools, and techniques to protect systems, networks, and information.
CO3	:	Analyse the Legal Frameworks governing the internet,
CO4	:	Exploration of Security Frameworks in the Cyber space.

Reference Books
1. EC-Council CHFI Course Outline: https://www.eccouncil.org/programs/computer-hacking-forensic-investigator-chfi/
2. Guide to Computer Forensics and Investigations" by Bill Nelson, Amelia Phillips, and Christopher Steuart, 6th Edition (latest), Cengage Learning, February 15, 2018, 978-1337568944
3. The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics" by John Sammons, Edition: 2nd Edition (latest) Syngress (an imprint of Elsevier), June 30, 2014, ISBN-10: 0128016353

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3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MCV325DD**	**Industrial Safety and Health**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-0-0**	**(Theory)**	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL**	***Interdisciplinary Courses (Global Electives) (Group-D)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure. National Policy and Legislations on EHS in India - Regulations and Codes of Practice - Role of trade union safety representatives. Occupational health and safety:

Introduction: Health, Occupational health: definition, Interaction between work and health, Health hazards, workplace, economy and sustainable development. Development of accident prevention programs and development of safety organizations.

UNIT - II	**9 Hours**

Work as a factor in health promotion. Potential health hazards: Air contaminants, Chemical hazards, Biological hazards, Physical hazards, Ergonomic hazards, Psychosocial factors, Evaluation of health hazards: Exposure measurement techniques, Interpretation of findings, recommended exposure limits. Controlling hazards: Engineering controls, Work practice controls, Administrative controls. Occupational diseases: Definition, Characteristics of occupational diseases, Prevention of occupational diseases.

UNIT - III	**8 Hours**

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

UNIT - IV	**8 Hours**

Occupational safety and Health act. Occupational Safety and Health Administration, right to know Laws, Accident Causation, Correcting Missing Skills, Investigator Tendencies and Characteristics, Theories of accident causation: Domino theory, Human Factors theory, Accident/Incident theory, Epidemiological theory and systems theory of accident causation.GD

UNIT - V	**8 Hours**

ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and implementation and review – ISO 45001-Strucure and Clauses-Case Studies.

Occupational Health and Safety Considerations: Water and wastewater treatment plants, Construction material manufacturing industries like cement plants, RMC Plants, precast plants and construction sites, Municipal solid waste management.

Course Outcomes:

After going through 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	:	Exposure to the onset of regulatory acts and accident causation models.
CO4	:	Demonstrate the significance of safety policy, models and safety management practices.

Reference Books
1. Industrial Health and Safety Acts and Amendments, by Ministry of Labor and Employment, Government of India.
2. Fundamentals of Industrial Safety and Health by Dr.K.U.Mistry, Siddharth Prakashan, 2012.
3. Goetsch, D. L. (2011). Occupational Safety and Health for Technologists, Engineers and Managers 3rd edition. Prentice hall.
4. David. A. Calling - Industrial Safety Management and Technology, Prentice Hall, New Delhi.
5. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995.
6. ISO 45001:2018 Occupational health and safety management systems – Requirements with guidance for use, International Organisation for Standardisation, 2018.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
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3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MCV325DE**	**Advanced Technologies for Transportation Systems**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-0-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL**	***Interdisciplinary Courses (Global Electives) (Group-D)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**8 Hours**

Introduction to Intelligent Transportation Systems (ITS): Definition, objectives, Historical Background, Benefits of ITS –ITS. ITS User Services. ITS Applications. Strategic Needs Assessment and Deployment. Regional ITS Architecture Development Process. ITS Standards. ITS Evaluation. ITS Challenges and Opportunities.

UNIT - II	**8 Hours**

Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.
Telecommunications in ITS: Information Management, Traffic Management Centres (TMC). Application of sensors to Traffic management; Traffic flow sensor technologies; Transponders and Communication systems; Data fusion at traffic management centres; Sensor plan and specification requirements; Elements of Vehicle Location and Route Navigation and Guidance concepts.

UNIT - III	**9 Hours**

Traffic Engineering - Fundamental relations of traffic flow, Traffic Stream models - , Shock wave, Car following models, Lane changing models, Vehicle arrival models, PCU values, Interrupted and Uninterrupted flow. Signalized intersection design and Analysis based on IRC, HCM and Indo –HCM. Numerical Problems. Traffic Simulation. Numerical Problems. Application of IOT, Machine learning in traffic management.

UNIT - IV	**9 Hours**

Transportation Network Analysis – Basic Introduction to Travel demand modelling, Trip generation, Distribution, Modal Split and Trip Assignment. Transit Capacity, ITS functional areas: Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS)

UNIT - V	**8 Hours**

ITS applications: Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing. Parking Management; Transportation network operations; commercial vehicle operations; public transportation applications; Automated Highway Systems- Vehicles in Platoons –ITS in World – Overview of ITS implementations in developed countries, ITS in developing countries. Case Studies

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

CO1	:	Identify and apply ITS applications at different levels
CO2	:	Illustrate ITS architecture for planning process
CO3	:	Examine the significance of ITS for various levels
CO4	:	Compose the importance of ITS in implementations

Reference Books
1. Pradip Kumar Sarkar and Amit Kumar Jain, "Intelligent Transport Systems", PHI Learning Private Limited, Delhi,2018, ISBN-9789387472068
2. Choudury M A and Sadek A, "Fundamentals of Intelligent Transportation Systems Planning" Artech House publishers (31 March 2003); ISBN-10: 1580531601
3. Bob Williams, "Intelligent transportation systems standards", Artech House, London, 2008. ISBN-13: 978-1-59693-291-3
4. Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio García Zuazola "Intelligent Transport Systems: Technologies and Applications" Wiley Publishing ©2015, ISBN:1118894782 9781118894781

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
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3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

Semester: II						
Design and Implementation of Human-Machine Interface **Industry Assisted Elective-BOSCH**						
Course Code	**:**	**MEC325DF**	***Interdisciplinary Courses (Global Electives) (Group-D)***	**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L+45EL**		**SEE Duration**	**:**	**3Hours**

Unit-I	**08 Hrs**
FOUNDATIONS OF HMI: The Human: History of User Interface Designing, I/O channels, Hardware, Software and Operating environments, The Psychopathology of everyday Things, Psychology of everyday actions, Reasoning and problem solving. The computer: Devices, Memory, processing and networks. Interaction: Models, frameworks, Ergonomics, styles, elements, interactivity, Paradigms. **Introduction to HMI and domains**: Automotive, Industrial, CE, Medical, ECUs within car and their functionalities. Interaction between ECUs. Communication protocols for ECUs(CAN, LIN, Most, FlexRay, Ethernet etc.)	
Unit – II	**08 Hrs**
Automotive Human-Machine Interfaces: Automotive infotainment system - Evolution road map, Feature sets, System architecture, Trends, Human factors and ergonomics in automotive design, Automotive User Experience (UX) Design Principles, In-Vehicle Information Systems (IVIS), Driver-Assistance Systems (DAS) Interfaces, HMI design for adaptive cruise control, Voice and Gesture Recognition in Automotive HMIs, Touchscreen Interfaces and Controls, Usability Testing and Evaluation in Automotive HMIs, Safety Considerations and Regulations in Automotive HMIs, Emerging Technologies in Automotive HMIs, Human-Machine Interfaces for Autonomous Vehicles	
Unit –III	**08 Hrs**
UX and Guidelines: Introduction to UX design - stages, theory, Design thinking, UX Study, Interaction concepts, Graphic design tools - Adobe Photoshop, Adobe XD, Blender, GIMP, Asset Design - Overview , Guidelines and norms, 2D/3D rendering, OpenGL, OSG.	
Unit –IV	**08 Hrs**
HMI User Interface: User-centered HMI development process, Basics of Web-Server. Web-based HMI: Basics of TwinCAT and HTML, CSS, JavaScript. **HMI on Mobile**: Four Principles of Mobile UI Design, Benefits of Mobile HMIs, Mobile HMI Development Suites.	
Unit –V	**08 Hrs**
HMI Control Systems: Introduction to Voice-Based HMI, Gesture-Based HMI, Sensor-Based UI controls. **Haptics in Automotive HMI**: Kinesthetic Feedback Systems, Tactile Feedback Systems, Haptics in Multimodal HMI, Automotive Use-Cases **HMI Testing**: Limitations of Traditional Test Solutions, Case - Study: Bosch's HMI validation tool - Graphics Test Systems (GTS). **UI analytics**: Usage patterns, Debugging, Performance Profiling, Use Cases.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Explain the application of HMIs in various domain
CO2	Differentiate various communication protocols used in HMI development.
CO3	Describe car multimedia system and hardware and software evolution.
CO4	Use various graphic tools and advanced techniques to create UIs

Reference Books
1. Shuo gao, Shuo Yan, Hang Zhao, Arokia Nathan " Touch based HMI; Principles and Applications" Springer Nature Switzerland AG, 1st Edition. 2. Robert Wells, " Unity 2020 by Example: A Project based guide to building 2D, 3D augumented reality and Virtual reality games from sratch" Packt Publishing ltd , edition 2020 3. Ryan Cohen, Tao Wang, "GUI Design and Android Apps" Apress, Berkley, CA,2014

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
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	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MEE325DG**	**INTELLIGENT CONTROL TECHNIQUES IN ELECTRICAL DRIVES**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-0-0**	**(THEORY)**	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL**	***Interdisciplinary Courses (Global Electives) (Group-D)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**

Fuzzy Logic Systems: Introduction to fuzzy logic, fuzzy Vs crisp set, linguistic variables, membership functions, fuzzy sets and operations on crisp sets and fuzzy sets, Fuzzy relations, operations on fuzzy relation, Cartesian Product of Relation. linguistic variables, fuzzy if then rules, compositional rule of inference, Fuzzy Rule Base and Approximate Reasoning

UNIT - II	**9 Hours**

Fuzzy Logic Control: Basic concept of fuzzy logic control, relationship to PI, PD and PID control, design of FLC: determination of linguistic values, construction of knowledge base, inference engine, tuning, fuzzification, De-fuzzification methods. Fuzzy Inference Systems (FIS), Construction and Working Principle of FIS, Mamdani FIS models, Takagi-Sugeno-Kang (TSK) fuzzy models and concept of Adaptive Fuzzy control, Examples applicable to Drives.

UNIT - III	**8 Hours**

Neural network: Fundamental Concept, history and development of neural network principles, Biological Neural Network, Comparison Between Biological Neuron and Artificial Neuron, Important Terminologies of ANN. Basic Models and Advantages of Neural Networks.
Learning methods: types of learning, supervised, unsupervised, reinforced learning, knowledge representation and acquisition
Theory, architecture and learning algorithm of neural network models: McCulloc model, Hopfield model, Perceptron Network, Back propagation network.

UNIT - IV	**8 Hours**

Neural Networks for feedback Control: Identification of system models using neural networks, Model predictive control, feedback linearization and model reference control using neural networks, Neural Network Reinforcement Learning Controller, Radial basis function neural networks, Basic learning laws in REF nets, Recurrent back propagation, CMAC networks and ART networks, Kmeans clustering algorithm. Kohnen's feature maps, pattern recognition & mapping, Examples applicable to Drives.

UNIT - V	**8 Hours**

Hybrid algorithms: Neuro-fuzzy systems, ANFIS and extreme-ANFIS, derivative free optimization methods.
Genetic algorithms: introduction, principle of natural selection, Flow chart of simple genetic algorithm, GA operators and parameters. Particle swarm optimization, Solution of typical control problems. Case studies on Application to Electrical Drives.

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

CO1	:	Explain the concepts ANN and Fuzzy Logic.
CO2	:	Analyze the techniques involved in ANN and fuzzy logic applications.
CO3	:	Design and model hybrid system with ANN and FL or independent system.
CO4	:	Apply techniques in modern industrial drives and power electronics system.

Reference Books
1. Dr. S. N. Sivanandam and Dr. S. N. Deepa, "Principles of Soft Computing", WILEY publication, 2nd Edition, 2008, ISBN: 9788126527410.
2. John Yen and Reza Langari, "Fuzzy Logic – Intelligence, Control and Information", Pearson Education Inc, 3rd Edition, 2009, ISBN 978-81-317-0534-6.
3. Simon Haykin, "Neural Networks – A Comprehensive Foundation", PH Publisher, 2nd Edition, 1998, ISBN:978-81-203-2373-5.
4. Timothy J. Ross., "Fuzzy Logic with Engineering Applications", John Wiley and Sons, 3rd Edition, 2011, ISBN: 978-0-470-74376-8.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MET325DH**	**Electronic Navigation Systems**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-0-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL**	***Interdisciplinary Courses (Global Electives) (Group-D)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**
An Introduction to Radar: Basic Radar, The simple form of the Radar Equation, Radar Block Diagram, Radar Frequencies, Application of radar, Types of Radars. Detection of signals in Noise, Receiver Noise and the Signal-to Noise Ratio, Probability of Detection and False alarm, Introduction to Doppler, MTI, UWB Radars	
UNIT - II	**9 Hours**
Terrestrial Network based positioning and navigation: General Issues of wireless positions location, Fundamentals, positioning in cellular networks, positioning in WLANs, Positioning in Wireless sensor networks.	
UNIT - III	**8 Hours**
Satellite-based navigation systems: Global Navigation satellite systems (GNSS), GNSS receivers.	
UNIT - IV	**8 Hours**
LiDAR: Introduction to LiDAR, context and conceptual discussion of LiDAR, Types of LiDARS, LiDARS Detection modes, Flash LiDAR versus Scanning LiDAR, Monostatic versus Bistatic LiDAR, Major Devices in a LiDAR, LiDAR remote sensing, Basic components and physical principles of LiDAR, LiDAR accuracy and data formats.	
UNIT - V	**8 Hours**
SONAR: Underwater acoustics, applications, comparison with radar, submarine detection and warfare, overcoming the effects of the ocean, sonar and information processing.Transmission of the acoustic signal: Introduction, detection contrast and detection index, transmission equation, equation of passive and active sonar.	

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

CO1	:	Understand the concepts of Radar, LiDAR, Sonar, terrestrial and satellite based navigation system.
CO2	:	Apply the concepts of radars, LiDAR, Sonar, cellular networks, WLAN, sensor networks and satellites in determining the user position and navigation.
CO3	:	Analyze the different parameters of satellite and terrestrial networks for navigation systems.
CO4	:	Evaluate the Radar, LiDAR, Sonar systems and satellite and terrestrial network based navigation and tracking systems.

Reference Books
1. M. L Skolnik,Introduction to RADAR Systems,3rd edition, 2017,TATA Mcgraw-Hill, ISBN: 978-0070445338
2. Mark A Richards, James A Scheer, William A Holam,Principles of Modern Radar Basic Principles, 2010, 1st edition,SciTech Publishing Inc, ISBN:978-1891121524 .
3. Davide dardari, Emanuela Falletti, Marco Luise, Satellite and Terrestrial Radio Positioning techniques-A signal processing perspective, 1st Edition, 2012, Elsevier Academic Press, ISBN: 978-0-12-382084-6.
4. Paul McManamon,LiDAR Technologies and Systems, SPIE press, 2019.
5. Pinliang Dong and Qi Chen,LiDAR Remote Sensing and Applications, CRC Press, 2018, ISBN: 978-1- 4822-4301-7
6. Jean-Paul Marage, Yvon Mori, Sonar and Underwater Acoustics, Wiley, 2013, ISBN: 9781118600658

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
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Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MET325DJ**	**Vehicular Communication Ecosystem**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-0-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL**	***Interdisciplinary Courses (Global Electives) (Group-D)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**
Introduction: Basic Principles and Challenges, Past and Ongoing VANET Activities **Standards and Regulations of DSRC** Introduction, Layered Architecture for VANETs, DSRC Regulations, DSRC Physical Layer Standard, DSRC Data Link Layer Standard (MAC and LLC), DSRC Middle Layers.	
UNIT - II	**9 Hours**
Physical Layer Considerations for Vehicular Communications: Standards Overview, Wireless Propagation Theory, Channel Metrics, Measurement Theory, Empirical Channel Characterization at 5.9 GHz. **MAC Layer and Scalability Aspects of Vehicular Communication Networks:** Challenges and Requirements. MAC Approaches for VANETs, Communication Based on IEEE 802.11p.	
UNIT - III	**9 Hours**
MAC Layer and Scalability Aspects of Vehicular Communication Networks Performance Evaluation and Modeling, Aspects of congestion control. **Data Security in Vehicular Communication Networks**: Challenges of Data Security in Vehicular Networks, Network, Applications, and Adversarial Model, Security Infrastructure, Cryptographic Protocols.	
UNIT - IV	**9 Hours**
Intra-vehicle communication:-In-vehicle networks, Automotive bus systems, In-vehicle Ethernet, Wireless in-vehicle networks **Inter-vehicle communication**: Applications, Requirements and components, Concepts for inter-vehicle communication, Fundamental limit.	
UNIT - V	**9 Hours**
Cooperative Vehicular Safety Applications: Introduction, Enabling technologies, Cooperative system architecture, Mapping for safety applications. **VANET-enabled Active Safety Applications:** Infrastructure-to-vehicle applications, Vehicle-to-vehicle applications, Pedestrian-to-vehicle applications.	

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

CO1	:	Illustrate fundamentals of wireless vehicular networks.
CO2	:	Design of Physical & MAC layer and routing protocols for vehicular networks.
CO3	:	Analyse the security issues and energy management in vehicular networks.
CO4	:	Evaluate the performance of vehicular networks in different use cases.

Reference Books
1. Hannes Hartenstein and Kenneth Laberteaux (eds.), VANET Vehicular Applications and Inter-networking Technologies, John Wiley & Sons, 2009.
2. Christophe Sommer and Falko Dressler, Vehicular Networking, Cambridge University Press, 2014.
3. Claudia Campolo, AntonellaMolinaro and Riccardo Scopigno, Vehicular ad hoc Networks: Standards, Solutions, and Research, Springer, 2015.
4. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005.
5. Hannes Hartenstein and Kenneth Laberteaux (eds.), VANET Vehicular Applications and Inter-networking Technologies, John Wiley & Sons, 2009.

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Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MIM325DK**	**ESSENTIALS OF PROJECT MANAGEMENT**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-0-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL**	***Interdisciplinary Courses (Global Electives) (Group-D)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**
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	**9 Hours**
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	**9 Hours**
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	**9 Hours**
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	**9 Hours**
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, hemes / 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, 9th Edition, 2017, ISBN: 978-9332902572.
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: 978-0470851241

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Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MIS325DM**	**USER INTERFACE AND USER EXPERIENCE**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-0-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL**	***Interdisciplinary Courses (Global Electives) (Group-D)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**
What's a UI Pattern?: How Users Interact With Design Patterns, Following Universal Design Conventions, Applying Empathy to UI Design Patterns. Why Use UI Patterns?: Why Patterns Work, Expectations Reinforce Themselves, Deadline-Busting Communication, Why not use patterns?. The Importance of Prototyping First: Got a Pattern? Plan it Out, Thinking Through the Process, Patterns Take Guesswork Off of Developers' Plates.	
UNIT - II	**9 Hours**
User Testing: Insights You Can't Ignore. Prototyping UI Patterns: Explaining the Gray Box, Pattern Libraries Are Prototyping Shortcuts, Reusable elements, Patterns and Prototypes Work Together, Applying UI Design Patterns: Building a Pattern Library, Riffing on Design Patterns, Tweaking Pattern Styles, Going forward, Useful UI Pattern Examples, Formatting Data, Getting input, Navigation, Teasers.	
UNIT - III	**9 Hours**
Design for Usefulness: Painkillers & Vitamins, Embracing Goal-Centered Design, Test for Relevancy With an MVP, A Quick MVP Case Study: Buffer. Designing for Usability: Forgiving, Satisfying, The 6-Step Process to Improve Usability. Designing for Desirability: Desirable Products Are More Usable, Desire Is Relative to Users, Elements of Desirable Design.	
UNIT - IV	**9 Hours**
Designing for Findability: Building the Right Information Architecture, 5 IA Layouts for the Web, 5 Navigational Menu Patterns, Testing Findability. Designing for Accessibility: Universal Design, What Accessibility Means for UX Design, Benefits of Accessibility, Accessibility Best Practices,	
UNIT - V	**9 Hours**
The Core of Desirable Design: The Habit Loop, A Quick Case Study, Quick Case Study: Apple.com. Designing for Credibility: First Impressions Matter, Quick Case Study: Chase, Building a Credible Product Interface, Selling the Product Through Social Proof, Persuading Through Transparency.	

Course Outcomes:

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

CO1	:	Apply the concept of User Interface and User Experience to increase look and feel various applications.
CO2	:	Analyse the usability, accesssibility, availability and other factors of User Interface design patterns.
CO3	:	Design and implement techniques of implementing design patterns.
CO4	:	Evaluate the design patetrns and elements of user experience.

Reference Books
1. Ben Gremillion, Jerry Cao, Kamil, Tactical UI Design Patterns, The Handbook to faster Design, UXPin Inc., 2015.
2. Jerry Cao, Kamil, Matt Ellis, The Elements of Successful UX Design, Best Practices of Meaningful products, UXPin Inc., 2015.
3. User Friendly- How the Hidden Rules of Design Are Changing the Way We Live, Work, and Play, Cliff Kuang, Picador Paper; Reprint edition, 2020, ISBN: 1250758203
4. Jenifer Tidwel, Designing Interfaces: Patterns for Effective Interaction Design, 3rd Edition, O'Reilly, 2020, ISBN: 1492051969

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2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MMA325DN**	**MATHEMATICAL METHODS FOR DATA SCIENCE**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-0-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL**	***Interdisciplinary Courses (Global Electives) (Group-D)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**
Parameter Estimation: Introduction to probability models of univariate random variables, Discrete distribution (Bernoulli, Binomial, Poisson), Continuous distributions (Uniform, Exponential, Normal), Estimation - Criteria for good estimates - unbiasedness, consistency, efficiency and sufficiency, Variance of a point estimator, Parameter estimation via maximum likelihood, Method of moments, Bayesian estimation of parameters.	
UNIT - II	**9 Hours**
Optimization I: Introduction and formulation, Optimality conditions, Review of local maxima, and local minima along with first and second order conditions. Taylor series and local function approximation, automatic differentiation, One dimensional Search Methods - Sequential search method, Fibonacci search method, Golden section search method.	
UNIT - III	**9 Hours**
Optimization II: Constrained and Unconstrained optimization, Gradient vector, Hessian matrix, optimization using Hessian matrix, Gradient descent method, Step size selection and convergence, Newton method, Stochastic gradient descent (SGD), Convex optimization, Duality - weak and strong duality, Optimization using duality.	
UNIT - IV	**9 Hours**
Fuzzy Optimization: Basic concepts of fuzzy sets - Operations on fuzzy sets, Fuzzy relation equations, Fuzzy logic control, Fuzzification, Defuzzification, Decision making logic, Membership functions. **Artificial Neural Networks:** Introduction - Neuron model, Multilayer perceptions - Back propagation algorithm and its variants, Loss functions in artificial neural networks.	
UNIT - V	**9 Hours**
Machine Learning Algorithms: Unsupervised learning, Supervised learning, Linear regression, Multiple Linear Regression, Overfitting, Naïve Bayes classifier. Clustering methods, k-means clustering, Linear support vector machine, Kernel functions and Nonlinear support vector machine.	

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

CO1	:	Explore fundamental concepts of estimation, optimization, and machine learning applied in various branches of engineering. **(PO1, PO4, PO6)**
CO2	:	Apply theoretical concepts of estimation and optimization to model problems using a machine learning approach on model requirements and to evaluate solutions within given constraints effectively. **(PO1, PO2, PO4, PO6)**
CO3	:	Analyze and solve the modern engineering problems using appropriate techniques of statistical and mathematical learning to the real-world problems arising in many practical situations. **(PO1, PO3, PO4, PO6)**
CO4	:	Develop and implement algorithms for constrained and unconstrained optimization, utilizing estimation techniques to classify, predict, and optimize solutions for practical applications, emphasizing model accuracy and performance and also engage in lifelong learning. **(PO1, PO2, PO3, PO4, PO6)**

Reference Books
1. Jorge Nocedal Stephen J. Wright, Numerical Optimization, Springer, 2nd Edition, 2006, ISBN-10: 0-387-30303-0 ISBN-13: 978-0387-30303-1.
2. Mykel J. Kochenderfer, Tim A. Wheeler, Algorithms for Optimization, MIT Press, Illustrated Edition, 2019, ISBN-13 978-0262039420.
3. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 1st Edition, 2006, ISBN-10: 0-387-31073-8 ISBN-13: 978-0387-31073-2.
4. Shai Shalev-Shwartz and Shai Ben-David "Understanding Machine Learning: From Theory to Algorithms", 1st Edition, Cambridge University Press, 2014, ISBN: 978-1-107-05713-5.
5. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications**,** 1st Edition, Prentice Hall PTR, 1995, ISBN 0-13-101171-5.

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2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MME325DO**	**Industry 4.0: The Smart Manufacturing**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-0-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL**	***Interdisciplinary Courses (Global Electives) (Group-D)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**
Fundamentals of Industry 4.0-Introduction, Key Components of Industry 4.0, RAMI 4.0, Cyber-Physical Systems. **Servitization and Product-Service Systems** - Integrated Overview, Examples Across Sectors. Industry 4.0 Across Sectors- Introduction, Smart Manufacturing, Transportation 4.0, Multimodal Transportation Systems, Rail 4.0, Logistics 4.0 and Implications. **Future Trends and Challenges**- Emerging Applications, Risks and Barriers to Implementation	
UNIT - II	**9 Hours**
The Concept of IIoT- Introduction to IIoT, Key Features and Applications **Modern Communication Protocols**- Overview, TCP/IP, Wireless Communication, Technologies. **API**- A Technical Perspective, Importance in IIoT, Examples and Applications, **Middleware Architecture**- Role in IIoT, Integration and Data Flow Management. **Emerging Trends in IIoT**- Industrial IoT Standards and Frameworks, Edge Computing in IIoT.	
UNIT - III	**8 Hours**
Data Analytics in Manufacturing: Energy Efficiency in Manufacturing, Anomaly Detection in Air Conditioning Systems, Smart Remote Machinery Maintenance Systems with Komatsu, Quality Prediction in Steel Manufacturing, Predictive Maintenance with Data Analytics **Internet of Things and New Value Proposition**: IoT in Manufacturing, Value Creation Barriers: Standards, security, and privacy concerns. **Advances in Robotics in the Era of Industry 4.0**: Recent Technological Components of Robots, Advanced Sensor Technologies, Artificial Intelligence in Robotics, Collaborative Robots, Internet of Robotic Things, Cloud Robotics, Digital Twin Technology	
UNIT - IV	**8 Hours**
Additive Manufacturing Technologies and Applications: Additive Manufacturing Technologies Overview, Stereo lithography, 3D Printing, Fused Deposition Modeling, Selective Laser Sintering, Laser Engineered Net Shaping, Manufacturing in Industry 4.0, Hybrid Manufacturing Processes. **Advances in Virtual Factory Research and Applications**: The State of Art, The Virtual Factory Software	
UNIT - V	**8 Hours**
Cybersecurity and Resilience in Industry 4.0: Introduction to Cybersecurity in Industry 4.0, Industrial IoT security, Edge and Cloud Security, Digital Twin Security, AI and Machine Learning for Cybersecurity, Standards and Frameworks for Industry 4.0 Cybersecurity, Resilience Strategies for Industry 4.0, Future Trends in Cybersecurity for Industry 4.0	

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

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CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MME325DQ**	**Industrial Internet of Things (IIoT)**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-0-0**	**(Theory)**	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL**	***Interdisciplinary Courses (Global Electives) (Group-D)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I — **9 Hours**

Introduction:
IoT vs IIoT, challenges in deployment, building blocks of business model and architecture, layers, sensing for manufacturing process, processing, communication and networking. Applications – Factories and assembly lines, inventory management and quality control, facility management.

Industrial Control Systems
Process Industries versus Discrete Manufacturing Industries – Levels, variables and parameters, Continuous Control Systems, Discrete Control Systems, Computer Process Control - Control Requirements, Capabilities of Computer Control, Forms of Computer Process Control.

UNIT - II — **9 Hours**

Sensors in IIoT applications
Temperature sensor interfacing, accelerometer sensor interfacing, MoS Gas sensor, magneto strictive sensors, speed sensor, ultrasonic sensor, smart sensors.

Automatic identification and data Capture
Overview Of Automatic Identification Methods, Linear (One-Dimensional) Bar Code, Two-Dimensional Bar Codes, Radio Frequency Identification, Magnetic Stripes, Optical Character Recognition, Machine Vision

UNIT - III — **8 Hours**

Group Technology and Cellular Manufacturing
Part Family, Intuitive Grouping, Parts Classification and Coding, Production Flow Analysis, cellular manufacturing - Composite Part Concept, Machine Cell Design, applications of group technology, Opitz Part Coding System, Machine Cell Organization and Design Rank-Order Clustering - Numericals

UNIT - IV — **8 Hours**

Industrial Networking
Introduction, Hierarchy of Industrial Networks, Network Topologies, Data Flow Management, Transmission Hardware, Network Backbones, Network Communication Standards, Fieldbus Networks

Simulating Industrial Processes
Queues and Queueing – waiting time, service time, machine utilisation, Modelling an Industrial Process Designing a Process Simulation, managing resource utilisation, product mixes, Queuing network models.

UNIT - V — **8 Hours**

Clustering
Similarity measures, hierarchical clustering – single linkage, complete linkage, average linkage Non heirerchial clustering – Numericals, multidimensional scaling correspondence analysis - Numericals

Prediction Models
K- Nearest neighbour, RMS Error and Mean Absolute Error, Mean Absolute Percentage Error, Coefficient of Determination, Underfitting and Overfitting, Cross-Validation, multiple regression – Numericals.

Course Outcomes:		
After going through this course the student will be able to:		
CO1	:	***Analyze*** the differences between IoT and IIoT, and evaluate the challenges, architectures, and sensing layers involved in the deployment of IIoT for manufacturing and industrial applications.
CO2	:	***Demonstrate*** the ability to interface sensors in IIoT systems, and apply automatic identification techniques for process automation.
CO3	:	***Design*** machine cells using group technology principles, and implement cellular manufacturing systems for optimized production workflows.
CO4	:	***Develop*** simulation models for industrial processes, and predict outcomes to optimize industrial system performance.

Reference Books

1. Jeschke, S., Brecher, C., Song, H., & Rawat, D. B. (Eds.). (2017). Industrial Internet of Things: Cyber manufacturing Systems. Springer. ISBN: 978-3-319-42559-7.
2. Groover, M. P. (2018). Automation, Production Systems, and Computer-Integrated Manufacturing (5th ed.). Pearson. ISBN: 978-0134605463.
3. Johnson, R. A., & Wichern, D. W. (2007). Applied Multivariate Statistical Analysis (6th ed.). Pearson Prentice Hall. ISBN: 978-0131877153.
4. Hill, R., & Berry, S. (2021). Guide to Industrial Analytics: Solving Data Science Problems for Manufacturing and the Internet of Things. Springer. ISBN: 978-3-030-79103-2

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
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3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	**:**	**MIM426RT**	**Research Methodology (NPTEL)**	**CIE Marks**	**:**	**NA**
Credits L-T-P	**:**	**2-0-0**	***(Theory - NPTEL Online Course)***	**SEE Marks**	**:**	**50**
Hours	**:**	**16L**	***(Common Course to all M.Tech Programs)***	**SEE Duration**	**:**	**2 Hours**

This course is indicative only and it is subject to change based on the courses running at that time by NPTEL

Duration of the ONLINE Course - 8 Weeks

Week 1: A group discussion on what is research; Overview of research
Week 2: Literature survey, Experimental skills
Week 3: Data analysis, Modelling skills
Week 4: Technical writing; Technical Presentations; Creativity in Research
Week 5: Creativity in Research; Group discussion on Ethics in Research
Week 6: Design of Experiments
Week 7: Intellectual Property
Week 8: Department specific research discussions

Reference Books:

1. Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Management Research Methodology, Integration of Principles, Methods and Techniques, 17th Impression, Pearson India Education Services Pvt. Ltd, 2018. ISBN: 978-81-7758-563-6
2. William M. K. Trochim, James P. Donnelly, The Research Methods Knowledge Base, 3rd Edition, Atomic Dog Publishing, 2006, ISBN: 978-1592602919
3. Kothari C.R., Research Methodology Methods and Techniques, 4th Edition, New Age International Publishers, 2019, ISBN: 978-93-86649-22-5.
4. Levin, R.I. and Rubin, D.S., Statistics for Management, 8th Edition, Pearson Education: New Delhi, 2017, ISBN-13- 978-8184957495.

GENERAL GUIDELINES

1. NPTEL is an acronym for National Programme on Technology Enhanced Learning which is an initiative by seven Indian Institutes of Technology (IIT Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and Indian Institute of Science (IISc) for creating course contents in engineering and science.
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7. Exam is conducted by NPTEL.

SEMESTER: II						
Course Code	**:**	**MCN427SL**	**Skill Lab**	**CIE Marks**	**:**	**50**
Credits L-T-P	**:**	**0-0-2**	**(Network simulation lab)**	**SEE Marks**	**:**	**50**
Hours/Week	**:**	**5**	***(Practice)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I

Experiments to be carried out using NetSim simulator tool

1. Create a suitable wired network topology, Simulate wired traffic loads and evaluate performance metrics such as throughput and latency.
2. Simulate IEEE 802.11 (WLAN), create traffic patterns and monitor wireless client performance. Analyse QoS metrics.
3. Set up multiple routing protocols for wired and wireless network. Change topology and observe the performance.
4. Create a IEEE 802.11 topology, vary the distances between wireless clients and Access Points (AP). Adjust the signal strength, channel size and assess the performance.
5. Build a mesh network with both wired and wireless nodes. Vary the node count, induce fault and observe performance.
6. Simulate various attack scenarios (e.g., DoS or MITM) across wired and wireless segments. Test security protocols and measure their effectiveness.
7. Create failure scenarios by disabling specific nodes or links in the simulation. Measure recovery times and network stability.
8. Create a network of clients and servers, apply load balancing algorithms and observe network performance.
9. Use traffic generation tools to simulate application traffic patterns across wired and wireless networks. Apply TCP congestion control algorithms and observe.
10. Setup an IoT network, vary the topology and nodes. Assess performance.

Open ended experiments

1. Create a large-scale network topology with hundreds of hosts connected to various routers and switches. Gradually increase the number of devices and simulate various types of traffic (such as video, VoIP, and file transfers). Measure performance metrics (throughput, latency, and packet loss) and investigate how they change as the network scales.

2. Compare the performance of Software-Defined Networking (SDN) to traditional networking models. Create two networks, one using traditional routing protocols and the other using an SDN controller. Simulate a variety of traffic patterns and network failures. Monitor recovery times, packet delivery ratios, and overall network performance. Evaluate the advantages and disadvantages of each approach in terms of efficiency and flexibility.

Course Outcomes:		
After going through this course the student will be able to:		
CO1	:	Understand how discrete-event simulation works and apply this knowledge to simulate modern computer networks
CO2	:	Apply protocols, topologies, traffic patterns and obtain meaningful results for standard network architectur
CO3	:	Analyze the network performance by varying parameters such as device counts, traffic, topology, data rate, bandwidth, distance
CO4	:	Simulate, evaluate and test the computer network depending on requirement and real world scenarios.
Reference Books		
1. Vijay Garg, "Wireless Communications and Networking", Morgan Kaufmann Publishers, Indian Reprint, 2009, ISBN: 978-81-312-1889-1		
2. Andrew S Tanenbaum, "Computer Networks", 5th edition, 2010, *Pearson* Education, *ISBN*-13: 978-0132126953		
3. NetSim User Manual		
4. Basics of Network Simulation, http://vlabs.iitkgp.ac.in/ant/1/theory/		

RUBRIC FOR CONTINUOUS INTERNAL EVALUATION (CIE-Lab)		
1	Conduction of the experiments relevant to the modules & Report	15
2	Design and testing of the Prototype / Projects / Modules	20
3	Final presentation and report	15
	MAXIMUM MARKS FOR THE SEE	**50**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Lab)

The evaluation will be carried out by Internal and External examiners through Exhibition Mode.
The following weightage would be given for the exhibition.

Q. NO.	CONTENTS	MARKS
1	Presentation through posters	15
2	Demonstration of the Prototype / Projects / Modules	25
3	Vivavoce	10
	MAXIMUM MARKS FOR THE SEE	**50**

SEMESTER: III						
Course Code	**:**	**MCN331TA**	**Network Automation and Software defined Networks**	**CIE Marks**	**:**	**100**
Credits L-T-P	**:**	**3-1-0**	***(Theory)***	**SEE Marks**	**:**	**100**
Hours	**:**	**45L+45EL**	***(Professional Core Course)***	**SEE Duration**	**:**	**3 Hours**

UNIT - I	**9 Hours**
Introduction. Centralized and Distributed Control and Data Planes. Introduction -Evolution versus Revolution. What Do They Do? - The Control Plane, Data Plane, Moving Information Between Planes, Why Can Separation Be Important? Distributed Control Planes - IP and MPLS, Creating the IP Underlay, Convergence Time, Load Balancing, High Availability, Creating the MPLS Overlay, Replication. CentralizedControl Planes - Logical Versus Literal, ATM/LANE, Route Servers, Segment routing, Overlays – VXLAN, NVERGE.	
UNIT - II	**9 Hours**
How SDN Works: Fundamental Characteristics of SDN, SDN Operation, SDN Devices, SDN Controller, SDN Applications, Alternate SDN Methods The OpenFlow Specification - OpenFlow Overview, OpenFlow 1.0 and OpenFlow Basics, OpenFlow 1.1 Additions, OpenFlow 1.2 Additions, OpenFlow 1.3 Additions, OpenFlow Limitations.	
UNIT - III	**9 Hours**
Alternative Definition of SDN: Potential drawbacks of Open SDN, SDN via APIs, SDN via Hypervisor based overlays, SDN via Opening up the Device. Network function virtualization. Alternative overlap and rakning.	
UNIT - IV	**9 Hours**
SDN in the Data Center- Data Center Definition, Data Center Demands, Tunneling Technologies for the DataCenter, Path Technologies in the Data Center, Ethernet Fabrics in the Data Center, SDN Use Cases in the Data Center, Open SDN versus Overlays in the Data Center, Real-World Data Center Implementations. SDN in Other Environments - Consistent Policy Configuration, Global Network View, Wide Area Networks, Service Provider and Carrier Networks, Campus Networks, Hospitality Networks, Mobile Networks.	
UNIT - V	**9 Hours**
Intelligent Software Defined Network: Artificial intelligence enabled softwaredefined networking: a comprehensive overview, Network AI: An Intelligent Network Architecture for Self-Learning Control Strategies in Software Defined Networks, Intelligent Routing based on Reinforcement Learning for Software-Defined Networking	

Course Outcomes:

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

CO1	:	Understand and explain the architecture of centralized and distributed control planes in networking, and analyze their impact on network performance, scalability, and reliability.
CO2	:	Demonstrate knowledge of Software Defined Networking (SDN) fundamentals, including the operation of SDN controllers, devices, and applications, and evaluate the role of OpenFlow in SDN.
CO3	:	Analyze alternative SDN approaches, such as API-based SDN, hypervisor overlays, network function virtualization, and network automation, and assess their potential benefits and limitations.
CO4	:	Explore the application of SDN in data centers and other network environments, and evaluate the use of artificial intelligence in SDN for intelligent routing and network optimization strategies.

Reference Books
1. SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies, By Thomas D. Nadeau, Ken Gray Publisher: O'Reilly Media, August 2013, ISBN: 978-1-4493-4230-2, ISBN 10:1-4493-4230-2. (UNIT 1)
2. Software Defined Networks: A Comprehensive Approach, by Paul Goransson and Chuck Black, Morgan Kaufmann, June 2014, Print Book ISBN: 9780124166752, eBook ISBN : 9780124166844.
3. Network Innovation through OpenFlow and SDN: Principles and Design, Edited by Fei Hu, CRC Press,ISBN-10: 1466572094, 2014.
4. Network Innovation through OpenFlow and SDN: Principles and Design, Edited by Fei Hu, CRC Press,ISBN-10: 1466572094, 2014.

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	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: III						
Course Code	**:**	**MCN332E1**	**Database Management System**	**CIE Marks**	**:**	**NA**
Credits L-T-P	**:**	**2-0-0**	***(Theory - NPTEL Course online)***	**SEE Marks**	**:**	**50**
Hours	**:**	**16L**	***Professional Basket Course-E (NPTEL-Online)***	**SEE Duration**	**:**	**2 Hours**

This course is indicative only and it is subject to change based on the courses running at that time by NPTEL

Duration of the ONLINE Course - 8 Weeks

Week 1: Course Overview. Introduction to RDBMS
Week 2: Structured Query Language (SQL)
Week 3: Relational Algebra. Entity-Relationship Model
Week 4: Relational Database Design
Week 5: Application Development. Case Studies. Storage and File Structure
Week 6: Indexing and Hashing. Query Processing
Week 7: Query Optimization. Transactions (Serializability and Recoverability)
Week 8: Concurrency Control. Recovery Systems. Course Summarization.

Reference Books

Text Books / Basic Material

– Database System Concepts by Abraham Silberschatz, Henry F. Korth, and S. Sudarshan, 6th Edition, McGraw-Hill Education, 2010.

– Presentations used in the Course

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   Equivalent course for the same.

SEMESTER: III						
Course Code	**:**	**MCE332E2**	**Data Science for Engineers**	**CIE Marks**	**:**	**NA**
Credits L-T-P	**:**	**2-0-0**	***(Theory - NPTEL Course online)***	**SEE Marks**	**:**	**50**
Hours	**:**	**16L**	***Professional Basket Course-E (NPTEL-Online)***	**SEE Duration**	**:**	**2 Hours**

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Duration of the ONLINE Course - 8 Weeks

Week 1: Course philosophy and introduction to R

Week 2: Linear algebra for data science

1. Algebraic view - vectors, matrices, product of matrix & vector, rank, null space, solution of over-determined set of equations and pseudo-inverse)
2. Geometric view - vectors, distance, projections, eigenvalue decomposition

Week 3: Statistics (descriptive statistics, notion of probability, distributions, mean, variance, covariance, covariance matrix, understanding univariate and multivariate normal distributions, introduction to hypothesis testing, confidence interval for estimates)

Week 4: Optimization

Week 5:
1. Optimization
2. Typology of data science problems and a solution framework

Week 6:
1. Simple linear regression and verifying assumptions used in linear regression
2. Multivariate linear regression, model assessment, assessing importance of different variables, subset selection

Week 7: Classification using logistic regression

Week 8: Classification using kNN and k-means clustering

Reference Books

1. INTRODUCTION TO LINEAR ALGEBRA - BY GILBERT STRANG
2. APPLIED STATISTICS AND PROBABILITY FOR ENGINEERS – BY DOUGLAS MONTGOMERY

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7. Exam is conducted by NPTEL
   Equivalent course for the same.

SEMESTER: III						
Course Code	**:**	**MCE332E3**	**Introduction To Soft Computing**	**CIE Marks**	**:**	**NA**
Credits L-T-P	**:**	**2-0-0**	***(Theory - NPTEL Course online)***	**SEE Marks**	**:**	**50**
Hours	**:**	**16L**	***Professional Basket Course-E (NPTEL-Online)***	**SEE Duration**	**:**	**2 Hours**

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Duration of the ONLINE Course - 8 Weeks

Week 1: Introduction to Soft Computing, Introduction to Fuzzy logic, Fuzzy membership functions, Operations on Fuzzy sets
Week 2: Fuzzy relations, Fuzzy propositions, Fuzzy implications, Fuzzy inferences
Week 3: Defuzzyfication Techniques-I, Defuzzyfication Techniques-II, Fuzzy logic controller-I, Fuzzy logic controller-II
Week 4: Solving optimization problems, Concept of GA, GA Operators: Encoding, GA Operators: Selection-I
Week 5: GA Operators: Selection-II, GA Operators: Crossover-I, GA Operators: Crossover-II, GA Operators: Mutation
Week 6: Introduction to EC-I, Introduction to EC-II, MOEA Approaches: Non-Pareto, MOEA Approaches: Pareto-I
Week 7: MOEA Approaches: Pareto-II, Introduction to ANN, ANN Architecture
Week 8: ANN Training-I, ANN Training-II, ANN Training-III, Applications of ANN

Reference Books

1. An Introduction to Genetic Algorithm Melanic Mitchell (MIT Press)
2. Evolutionary Algorithm for Solving Multi-objective, Optimization Problems (2nd Edition), Collelo, Lament, Veldhnizer (Springer)
3. Fuzzy Logic with Engineering Applications Timothy J. Ross (Wiley)
4. Neural Networks and Learning Machines Simon Haykin (PHI)

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7. Exam is conducted by NPTEL equivalent course for the same.

SEMESTER: III						
Course Code	**:**	**MCE332E4**	**Design and Engineering of Computer Systems**	**CIE Marks**	**:**	**NA**
Credits L-T-P	**:**	**2-0-0**	***(Theory - NPTEL Course online)***	**SEE Marks**	**:**	**50**
Hours	**:**	**16L**	***Professional Basket Course-E (NPTEL-Online)***	**SEE Duration**	**:**	**2 Hours**
This course is indicative only and it is subject to change based on the courses running at that time by NPTEL						
Duration of the ONLINE Course - 8 Weeks						

Week 1 - Introduction to computer systems.
• Introduction and overview of the course
• Principles for designing computer systems
• Overview of computer system hardware and software
Week 2 - Process management and CPU virtualization
• Process abstraction and process management in operating systems
• Threads and concurrency
• Virtual machines and containers
Week 3 - Memory management
• Memory management in operating systems
• Virtual memory and paging
• Optimizing memory access in user programs
Week 4 - Disk and network I/O
• Filesystem data structures and implementation
• Synchronous and event-driven APIs for socket-based network communication
• Network I/O subsystem in operating systems
Week 5 - Computer networking
• Architecture of the Internet
• Internet routing, transport and applications
• Network security
Week 6 - End-to-end application design
• Inter-process and inter-thread synchronization
• Architecture of multi-tier applications
• Case studies and examples of systems design
Week 7 - Performance engineering
• Performance measurement and analysis
• Techniques to improve performance of computer systems
• Caching, horizontal and vertical scaling, load balancing
Week 8 - Reliability engineering
• Techniques for fault tolerance in computer systems
• Replication, consistency, and atomicity
• Case studies of designing reliable computer systems

Reference Books

1.“Operating Systems: Three Easy Pieces”, https://pages.cs.wisc.edu/~remzi/OSTEP/
2. https://www.cse.iitb.ac.in/~mythili/os/

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7. Exam is conducted by NPTEL, Equivalent course for the same.

SEMESTER: III						
Course Code	:	**MCN433P**	**MINOR PROJECT**	**CIE Marks**	:	**50**
Credits L-T-P	:	**0-0-6**		**SEE Marks**	:	**50**
Hours/Week	:	**12**		**SEE Duration**	:	**3 Hours**

Guidelines

1. Student can form group of two to execute the Minor Project.
2. Students are required to select topics related to their PG Program Specialization after extensive Literature Survey and analyzing the Research gaps.
3. Students will be assigned to guides in accordance with the expertise of the faculty.
4. Minor project topics could also be aligned to be implemented/executed based on any of the 16 Centre of Excellence (CoE)/ 06 Center of Competence (CoC) domain. The details of these could be obtained by visiting the website https://rvce.edu.in/rvce-center-excellence
5. Minor project has to be implemented/executed in-house, using the resources available in the department/college/CoE/CoC.
6. Students have to note the periodic progress in the Minor Project Diary and report the work carried to their respective guides.
7. Students have to present the Minor project work to the departmental committee and only upon approval by the committee, the student can proceed to prepare and submit the hard copy of the final Minor project report.
8. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be softbound in Ivory/White color for PG circuit Programs and Light Blue for Non-Circuit Programs.

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

CO1	:	Analyze the research gaps, formulate the problem definition, conceptualize the objectives and design solution to cater to specific problems.
CO2	:	Apply higher order thinking skills and develop skill competencies specific to program specialization to implement real world problems with professional ethical standards.
CO3	:	Demonstrate the skill and knowledge by applying appropriate tools and techniques specific to their domain.
CO4	:	Communicate, work in teams and demonstrate the learning through oral presentations and report writing.

Scheme of Continuous Internal Evaluation (CIE):

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

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

Reviews	Activity	Weightage
I	Approval of the selected topic, formulation of Problem Statement and Objectives along with Synopsis submission	10%
II	Demonstrate the skill and knowledge by applying appropriate tools/techniques to design solution specific to the problem.	30%
III	Demonstrates the work carried out through experimental results, analysis and testing. Exhibits writing and communication skills through presentations and report writing.	60%

Scheme for Semester End Evaluation (SEE):

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

RUBRICS FOR SEMESTER END EXAMINATION

The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner.

Q.NO.	CONTENTS	MARKS
1	Write Up	**20%**
2	Demonstration of Minor Project Work	**60%**
3	Viva voce	**20%**

SEMESTER: III						
Course Code	:	**MCN434N**	**INTERNSHIP**	**CIE Marks**	:	**50**
Credits L-T-P	:	**0-0-6**		**SEE Marks**	:	**50**
Hours/Week	:	**12**		**SEE Duration**	:	**3 Hours**

Guidelines

1. Students can opt for undergoing internship at the industry or research organizations like BEL, DRDO, ISRO, NAL, etc.
2. Students must submit letter from the industry/research organizations clearly specifying the candidate's name and the duration of the internship on the company letter head with authorized signature.
3. The duration of the internship shall be for a period of 6 weeks on full time basis after II semester final exams and before the commencement of III semester.
4. RVCE hosts around 16 Centre of Excellence (CoE) in various domains and around 06 Center of Competence (CoC). The details of these could be obtained by visiting the website https://rvce.edu.in/rvce-center-excellence
5. Students can approach the CoE/CoC for registering and working on relevant domain for training/internship at the CoE/CoC.
6. Internship must be related to the field of specialization of the respective PG program in which the student has enrolled.
7. Students undergoing internship training are advised to report their progress and submit periodic progress reports/diary to their respective guides.
8. Students have to present the internship activities carried out to the departmental committee and only upon approval by the committee, the student can proceed to prepare and submit the hard copy of the final internship report.
9. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be softbound in Ivory/White color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes:

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

CO1	:	Explore the workplace, operating procedures of the department/company and its products, and other organizational concepts.
CO2	:	Learn and improve writing and communication skills, research and technology, work in a team, and develop leadership skills.
CO3	:	Apply higher order thinking skills - critical thinking, analysis, synthesis and evaluate complex problems to solve real world problems with professional ethical standards.
CO4	:	Develop and demonstrate skill competencies and knowledge specific to program specialization by applying appropriate tools and techniques.

Scheme of Continuous Internal Evaluation (CIE):
The evaluation committee shall consist of Guide, Professor, Associate Professor/Assistant Professor. The committee shall assess and evaluate the presentation and the progress reports.

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

Reviews	Activity	Weightage
I	Ability to comprehend the functioning/operating procedures of the Organization/Departments. Application of Engineering knowledge, Critical thinking and analysis to solve problems.	**40%**
II	Demonstrates skill competencies, Resource Management and Sustainability. Exhibits writing and communication skills through presentations and report writing.	**60%**

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

RUBRICS FOR SEMESTER END EXAMINATION

The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner.

Q.NO.	CONTENTS	MARKS
1	Write Up	**20%**
2	Demonstration of Internship Work	**60%**
3	Viva Voce	**20%**

SEMESTER: IV						
Course Code	**:**	**MCN341F1**	**Edge Computing**	**CIE Marks**	**:**	**NA**
Credits L-T-P	**:**	**2-0-0**	***(Theory - NPTEL Course online)***	**SEE Marks**	**:**	**50**
Hours	**:**	**16L**	***Professional Basket Course-F (NPTEL-Online)***	**SEE Duration**	**:**	**2 Hours**

This course is indicative only and it is subject to change based on the courses running at that time by NPTEL

Duration of the ONLINE Course - 8 Weeks

Week 1 : Introduction to Cloud and its limitations to support low latency and RTT. From Cloud to Edge computing: Waves of innovation
Week 2 : Introduction to Edge Computing Architectures
Week 3 : Edge Computing to support User Applications (5G-Slicing, self-driving cars and more)
Week 4 : Concepts of distributed systems in edge computing such as time ordering and clock synchronization, distributed snapshot, etc.
Week 5 : Introduction to Edge Data Center, Lightweight Edge Clouds and its services provided by different service providers.
Week 6 : Introduction to docker container and Kubernetes in edge computing. Design of edge storage systems like key-value stores
Week 7 : Introduction to MQTT and Kafka for end-to-end edge pipeline. Edge analytics topologies for M2M and WSN network (MQTT)
Week 8 : Use cases of machine learning for edge sensor data in predictive maintenance, image classifier and self-driving cars. Deep Learning On-Device inference at the edge to support latency-based application

Reference Books

1. "Fog and Edge Computing: Principles and Paradigms", Rajkumar Buyya (Editor), Satish Narayana Srirama (Editor), Wiley, 2019
2. Cloud Computing: Principles and Paradigms", Editors: Rajkumar Buyya, James Broberg,Andrzej M. Goscinski, Wiley, 2011
3. "Cloud and Distributed Computing: Algorithms and Systems", Rajiv Misra, Yashwant Patel, Wiley 2020.

GENERAL GUIDELINES

1. NPTEL is an acronym for National Programme on Technology Enhanced Learning which is an initiative by seven Indian Institutes of Technology (IIT Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and Indian Institute of Science (IISc) for creating course contents in engineering and science.
2. NPTEL is offering online certification courses through its portal - https://swayam.gov.in/nc_details/NPTEL
3. Enrollment to courses and exam registration can be done in ONLINE mode only. The link is available on NPTEL website http://nptel.ac.in/
4. Students need to enroll for the NPTEL course and clear the exam.
5. In case students fail to get the certificate, they need to enroll for the same course once again, in the subsequent NPTEL semester and clear the exam.
6. If the same course is not offered by NPTEL (i.e. if the same course is not re-run) in the subsequent semester by NPTEL, the students need to write letter seeking permission from the Counsellor, HoD and Dean Academics with further approval from BoS Committee to take alternative course from the list announced by NPTEL.
7. Exam is conducted by NPTEL. Equivalent course for the same.

SEMESTER: IV						
Course Code	**:**	**MCE341F2**	**Embedded System Design with ARM**	**CIE Marks**	**:**	**NA**
Credits L-T-P	**:**	**2-0-0**	***(Theory - NPTEL Course online)***	**SEE Marks**	**:**	**50**
Hours	**:**	**16L**	***Professional Basket Course-F (NPTEL-Online)***	**SEE Duration**	**:**	**2 Hours**
This course is indicative only and it is subject to change based on the courses running at that time by NPTEL						
Duration of the ONLINE Course - 8 Weeks						

Week 1 : Introduction to embedded systems and microcontrollers
Week 2 : Instruction set architecture of ARM microcontroller, and assembly language programming
Week 3 : D/A and A/D converter, sensors, actuators and their interfacing
Week 4 : Microcontroller development boards and embedded programming platforms
Week 5 : Hands-on and demonstration I: Temperature sensing unit, Light sensing unit, Sound sensing unit
Week 6 : Hands-on and demonstration II: Feedback control system, relay control unit, driving electrical appliances like motors, bulb, pump, etc.
Week 7 : Hands-on and demonstration III: Object tracking using GPS and GSM
Week 8 : Hands-on and demonstration IV: Introduction to Internet of Things, smart home concepts, motion sensing using accelerometer, control of appliances over SMS

Reference Books

1.F. Vahid and T. Givargis, “Embedded System Design: A Unified Hardware/Software Introduction”, Wiley India Pvt. Ltd., 2002.

2. A.N. Sloss, D. Symes and C. Wright, “ARM System Developer’s Guide: Design and Optimizing System Software”, Morgan Kaufman Publishers, 2004.

3. W. Wolf, “Computers as Components: Principles of Embedded Computing System Design”, Morgan Kaufman Publishers, 2008.

GENERAL GUIDELINES

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7. Exam is conducted by NPTEL equivalent course for the same.

SEMESTER: IV						
Course Code	**:**	**MCE341F3**	**Information Security - 5 Secure Systems Engineering**	**CIE Marks**	**:**	**NA**
Credits L-T-P	**:**	**2-0-0**	***(Theory - NPTEL Course online)***	**SEE Marks**	**:**	**50**
Hours	**:**	**16L**	***Professional Basket Course-F (NPTEL-Online)***	**SEE Duration**	**:**	**2 Hours**

This course is indicative only and it is subject to change based on the courses running at that time by NPTEL

Duration of the ONLINE Course - 8 Weeks

Week 1 : Introduction / gdb / buffer overflow
Week 2 : Preventing buffer overflow based malware
Week 3 : Integer overflow and buffer overread and heap overflow
Week 4 : More on heap overflow; Access Control
Week 5 : Confinement
Week 6 : SGX and Trustzone
Week 7 : Micro-architectural Attacks
Week 8 : Hardware Security.

Reference Books

1. "Security Engineering: A Guide to Building Dependable Distributed Systems", Author: Ross J. Anderson.
2. "Computer Security: Art and Science", Matt Bishop

GENERAL GUIDELINES

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7. Exam is conducted by NPTEL equivalent course for the same.

SEMESTER: IV						
Course Code	**:**	**MCE341F4**	**User-centric Computing for Human Computer Interaction**	**CIE Marks**	**:**	**NA**
Credits L-T-P	**:**	**2-0-0**	***(Theory - NPTEL Course online)***	**SEE Marks**	**:**	**50**
Hours	**:**	**16L**	***Professional Basket Course-F (NPTEL-Online)***	**SEE Duration**	**:**	**2 Hours**

This course is indicative only and it is subject to change based on the courses running at that time by NPTEL

Duration of the ONLINE Course - 8 Weeks

Week 1 : Introduction to user-centric design – case studies, historical evolution, issues and challenges and current trend
Week 2 :Engineering user-centric systems – relation with software engineering, iterative life-cycle, prototyping, guidelines, case studies
Week 3 :User-centric computing – framework, introduction to models, model taxonomy
Week 4 :Computational user models (classical) – GOMS, KLM, Fitts' law, Hick-Hymans law
Week 5 :Computational user models (contemporary) – 2D and 3D pointing, constrained navigation, mobile typing, touch interaction
Week 6 :Formal models – case study with matrix algebra, specification and verification of properties, formal dialog modeling
Week 7 :Empirical research – research question formulation, experiment design, data analysis, statistical significance test
Week 8 :User-centric design evaluation – overview of evaluation techniques, expert evaluation, user evaluation, model-based evaluation with case studies

Reference Books

1. Samit Bhattacharya (July, 2019). Human-Computer Interaction: User-Centric Computing for Design, McGraw-Hill India, Print Edition: ISBN-13: 978-93-5316-804-9; ISBN-10: 93-5316-804-X, E-book Edition: ISBN-13: 978-93-5316-805-6; ISBN-10: 93-5316-805-8
2. Alan Dix, Janet E. Finlay, Gregory D. Abowd and Russel Beale. (2003). Human-Computer Interaction (3rd Edition), Pearson.
3. Ben Shneiderman, Catherine Plaisant, Maxine Cohen and Steven Jacobs. (2009). Designing the User Interfaces: Strategies for Effective Human-Computer Interaction (5th Edison), Pearson

GENERAL GUIDELINES

1. NPTEL is an acronym for National Programme on Technology Enhanced Learning which is an initiative by seven Indian Institutes of Technology (IIT Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and Indian Institute of Science (IISc) for creating course contents in engineering and science.
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7. Exam is conducted by NPTEL equivalent course for the same.

SEMESTER: IV						
Course Code	:	**MCN442P**	**MAJOR PROJECT**	**CIE Marks**	:	**100**
Credits L-T-P	:	**0-0-18**		**SEE Marks**	:	**100**
Hours/Week	:	**36**		**SEE Duration**	:	**3 Hours**

Guidelines

1. Major Project is to be carried out for a duration of 18 weeks
2. Student have to implement the Major Project individually.
3. Students are required to select topics related to their PG Program Specialization after extensive Literature Survey and analyzing the Research gaps.
4. Students will be assigned to guides in accordance with the expertise of the faculty.
5. Major project topics could also be chosen to be implemented/executed based on any of the 16 Centre of Excellence (CoE)/ 06 Center of Competence (CoC) domain. The details of these could be obtained by visiting the website https://rvce.edu.in/rvce-center-excellence
6. Major Project could be implemented in Industry/Research organizations after providing the letter of approval. Students can also implement Major Project, in-house using the resources available in the department/college/CoE/CoC.
7. Students have to adhere to the Project Presentation Schedule note the periodic progress in the Major Project Diary and report the work carried to their respective guides.
8. It is mandatory for the students to present/publish their project work in National/International Conferences/Journals
9. Students have to present the Major Project work to the departmental committee and only upon approval by the committee, the student can proceed to prepare and submit the hard copy of the final Major Project report.
10. Major Project report has to be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be softbound in Ivory/White color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes:

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

CO1	:	Analyze the research gaps, formulate the problem definition, conceptualize the objectives and design solution to cater to specific problems.
CO2	:	Apply higher order thinking skills and develop skill competencies specific to program specialization to implement real world problems with professional ethical standards.
CO3	:	Demonstrate the skill and knowledge by applying appropriate tools and techniques specific to their domain.
CO4	:	Communicate, work in teams and demonstrate the learning through oral presentations and report writing.

Scheme of Continuous Internal Evaluation (CIE):

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

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

Reviews	Activity	Weightage
I	Approval of the selected topic, formulation of Problem Statement and Objectives along with Synopsis submission	10%
II	Demonstrate the skill and knowledge by applying appropriate tools/techniques to design solution specific to the problem.	30%
III	Demonstrates the work carried out through experimental results, analysis and testing. Exhibits writing and communication skills through presentations, report writing and paper publication.	60%

Scheme for Semester End Evaluation (SEE):

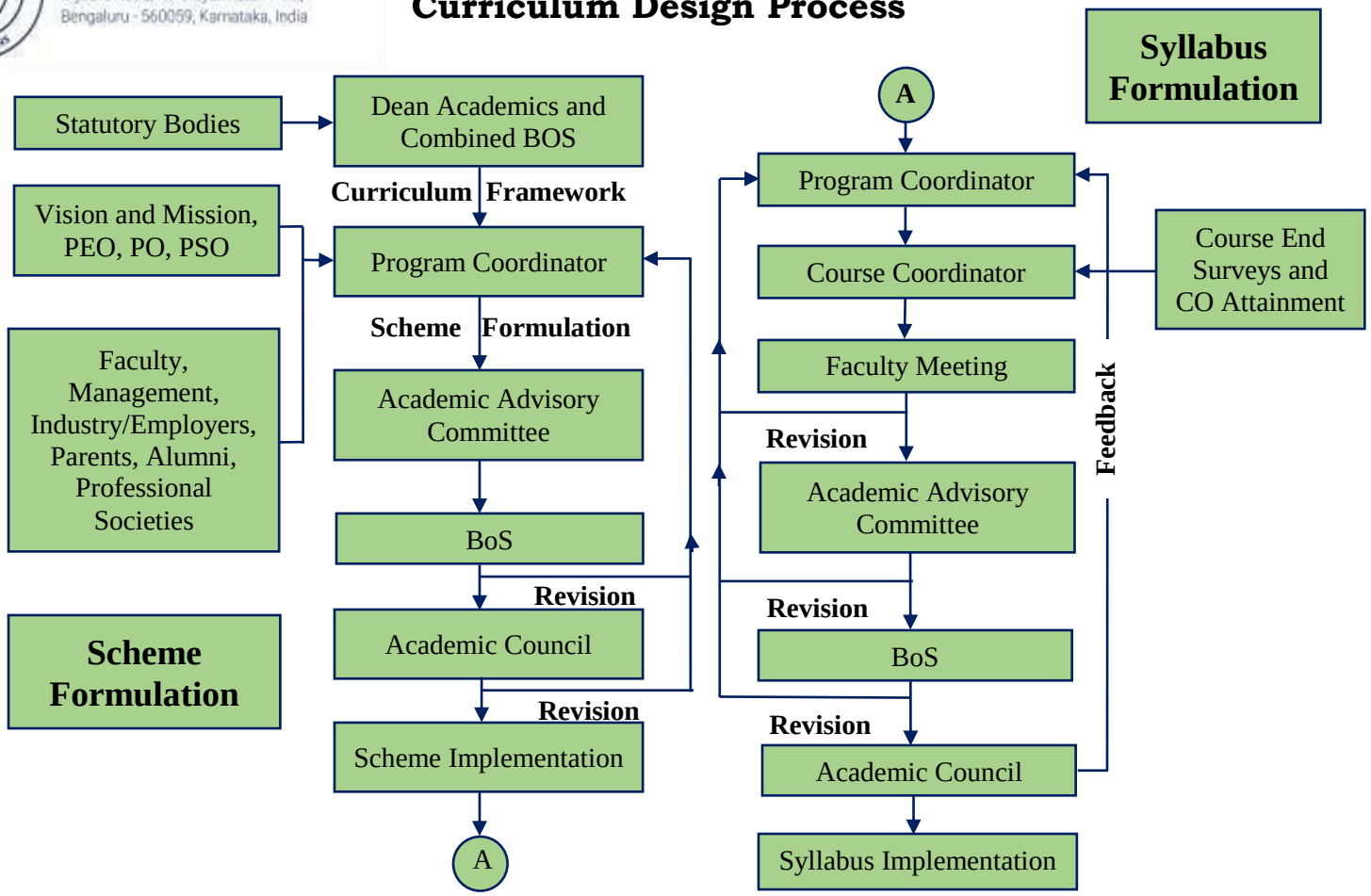
Major Project SEE evaluation shall be conducted in two stages. This is initiated after fulfilment of submission of Project Report and CIE marks.

Stage-1 Report Evaluation: Evaluation of Project Report shall be done by the Guide and an External examiner.

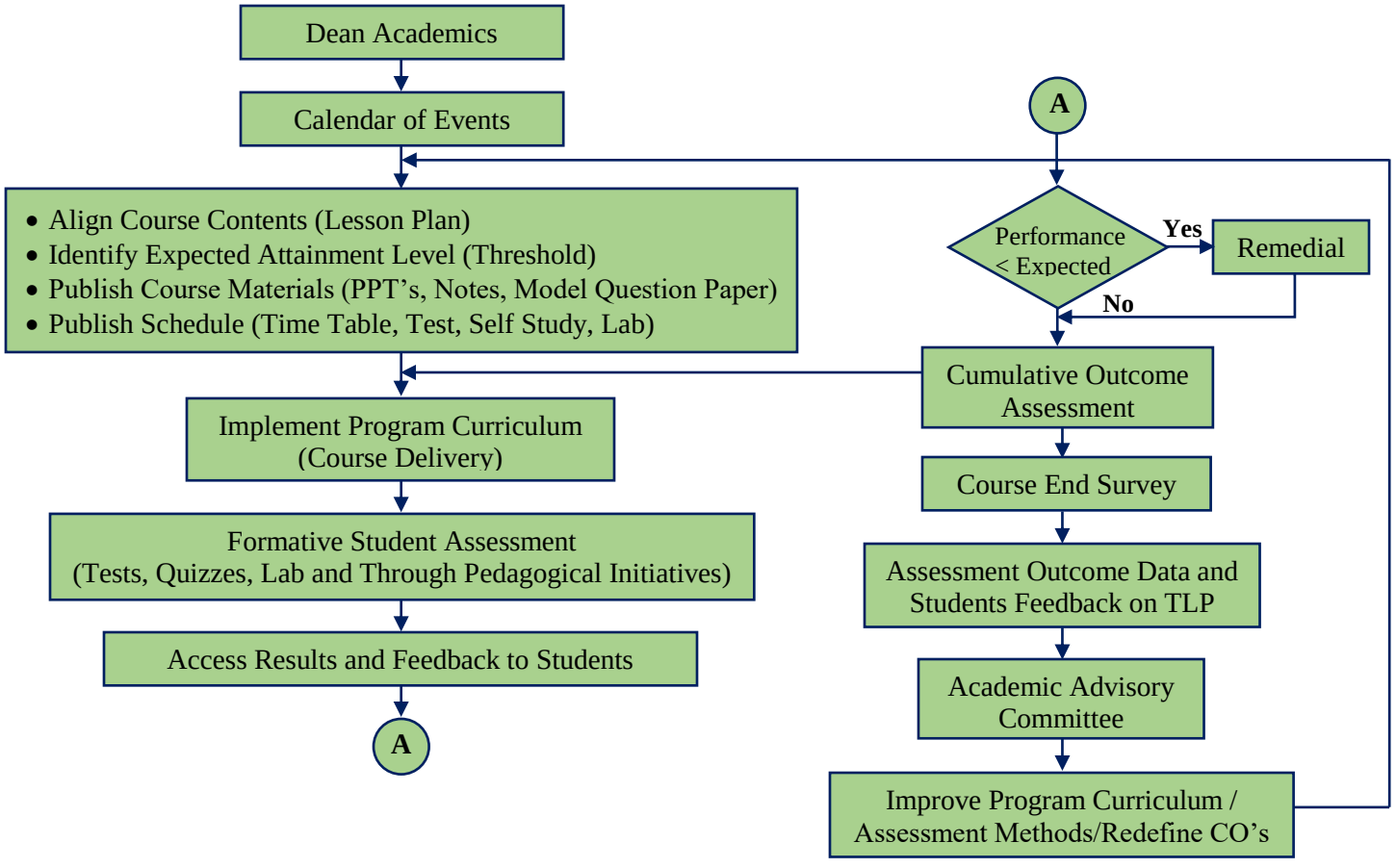
Stage-2 Project Viva-voce: Major Project Viva-voce examination is conducted after receipt of evaluation reports from Guide and External examiner.

RUBRICS FOR SEMESTER END EXAMINATION		
SEE procedure is as follows:		
Report Evaluation	Internal Examiner: 100 Marks **(A)**	**Report Evaluation (A) + (B) = 200/2 = 100 (C)**
	External Examiner: 100 Marks **(B)**	
Viva-Voce	Jointly evaluated by Internal Guide & External Examiner	**100 (D)**
Total Marks = **(C+D)/2** = 200/2 =100		**100 Marks**

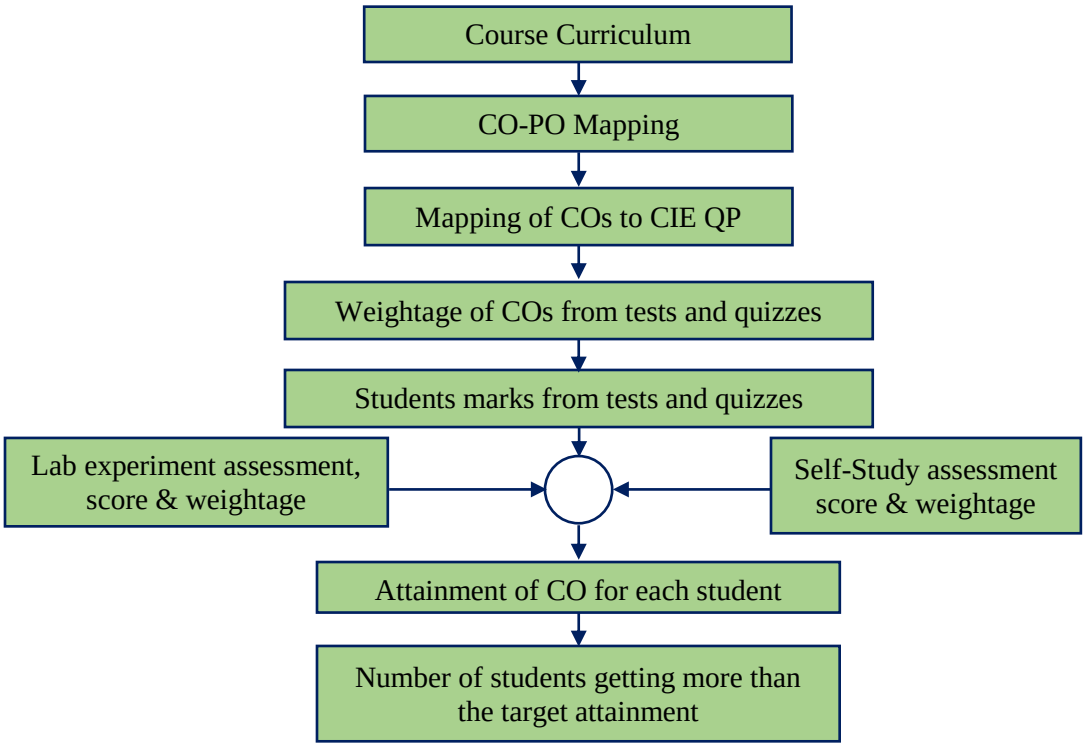
Curriculum Design Process



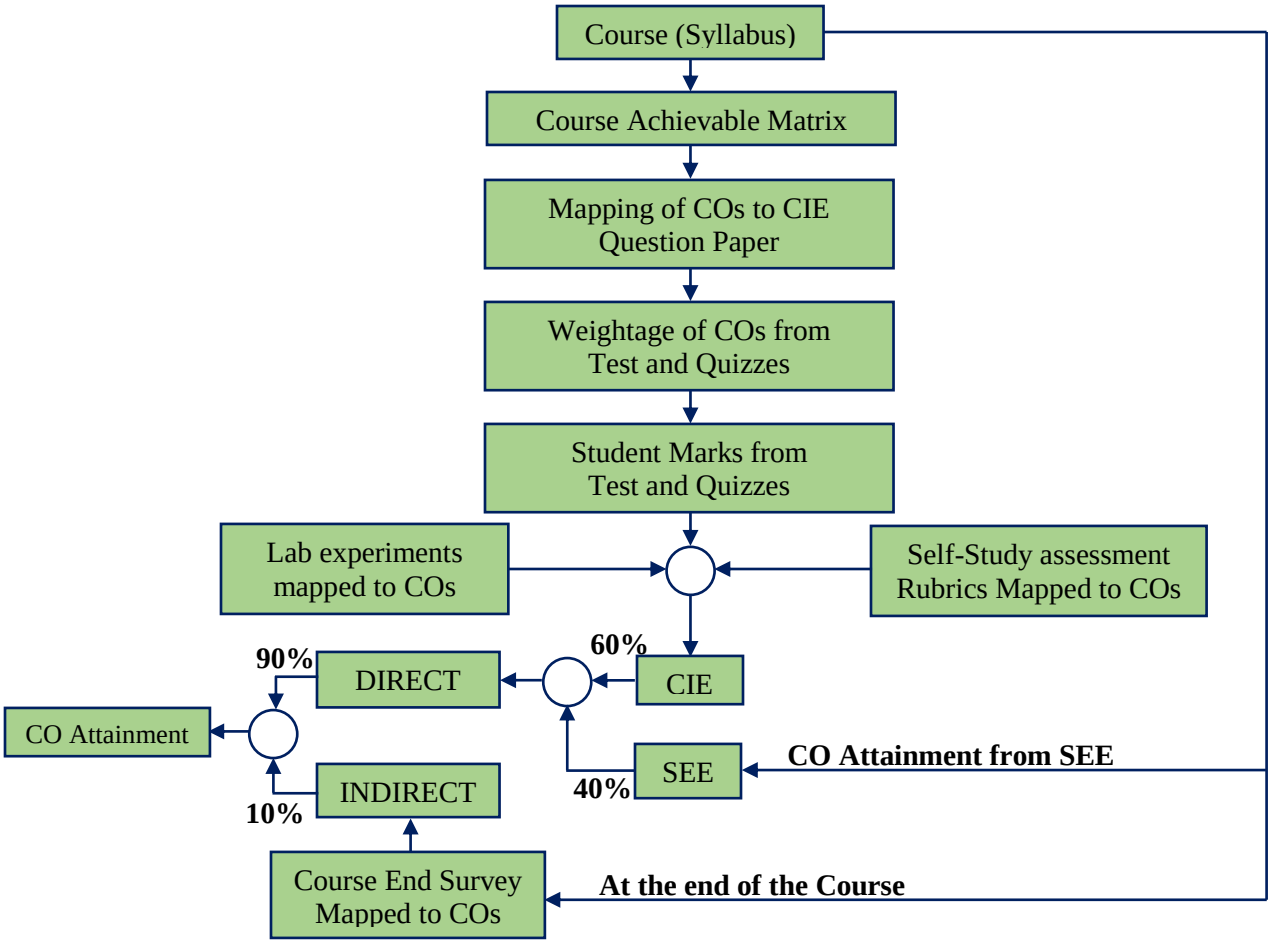
Academic Planning and Implementation



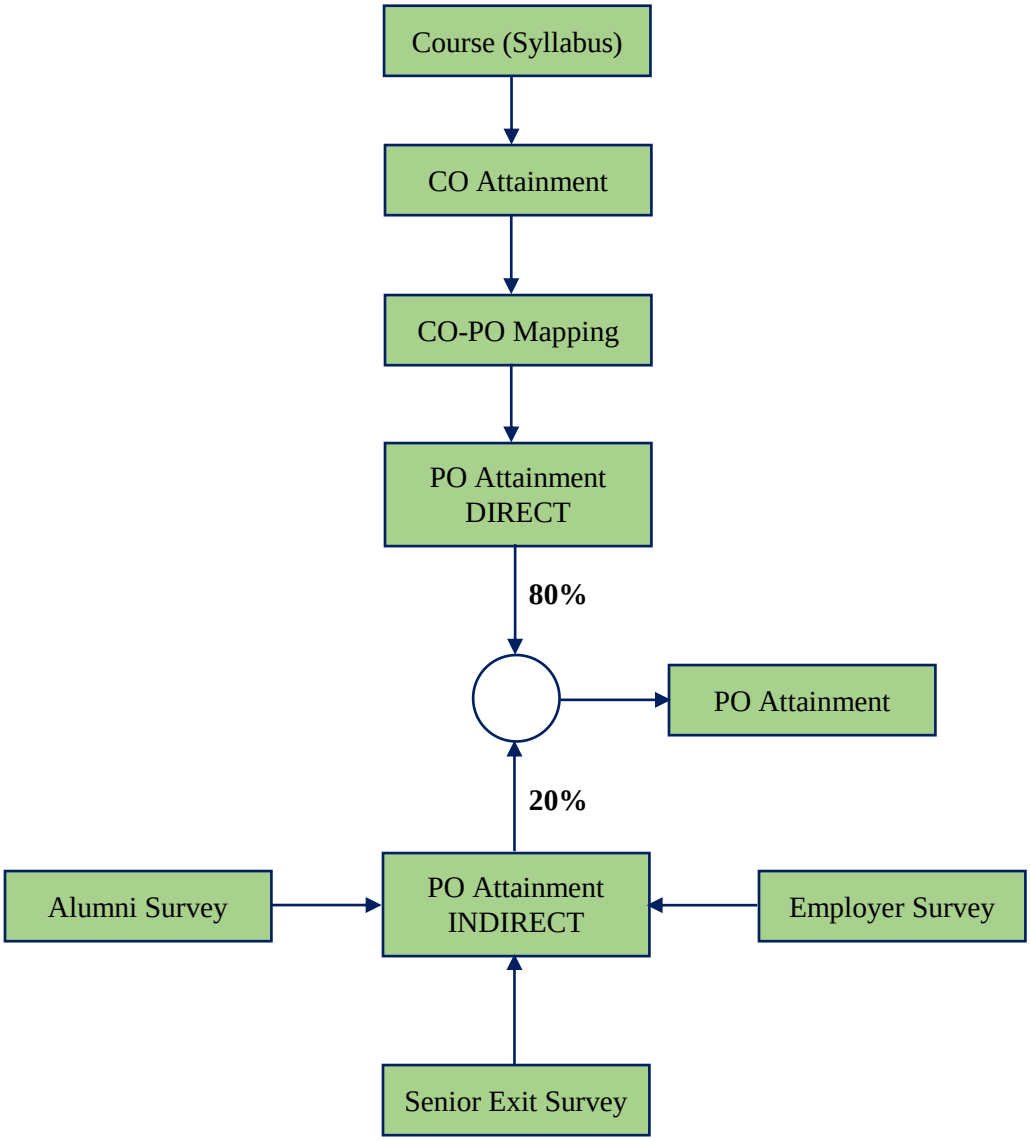
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



KNOWLEDGE & ATTITUDE PROFILE

- **WK1:** A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
- **WK2:** Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
- **WK3:** A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
- **WK4:** Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
- **WK5:** Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
- **WK6:** Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
- **WK7:** Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
- **WK8:** Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
- **WK9:** Ethics, inclusive behaviour and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

INNOVATIVE TEAMS OF RVCE

Ashwa Mobility Foundation (AMF): Designs and fabricates Formula-themed race cars and mobility solutions to address urban transportation issues.

Astra Robotics Team: Focuses on designing and building application-specific robots.

Coding Club: Helps students gain coding skills and succeed in competitions like GSoC and ACM-ICPC.

Entrepreneurship Development Cell (E-Cell): Promotes entrepreneurship through workshops, speaker sessions, and mentoring for startups.

Frequency Club Team: Works on software and hardware, emphasizing AI and Machine Learning.

Team Garuda: Develops a supermileage urban concept electric car and E-mobility products.

Team Jatayu: Builds low-cost UAVs with autonomous capabilities for various tasks.

Solar Car Team: Aims to create a solar electric vehicle for sustainable transportation.

Team Antariksh: Focuses on space technology and the development of operational rockets.

Team Chimera: Builds a Formula Electric Car through R&D in E-Mobility.

Helios Racing Team: Designs and tests All-Terrain Vehicles, participating in SAE's BAJA competitions.

Team Hydra: Develops autonomous underwater vehicles for tasks like water purification.

Team Krushi: Creates low-cost farming equipment to assist farmers in cultivation and harvesting.

Team Vyoma: Designs and tests radio-controlled aircraft and UAVs.

Team Dhruva: Engages in astronomy-related activities and collaborates on projects with organizations like ICTS and IIA.

Ham Club: Promotes Amateur Radio and explores technical innovations in communications, especially for disaster response.

Cultural Activity Teams

1. AALAP (Music club)
2. DEBSOC (Debating society)
3. CARV (Dramatics club)
4. FOOTPRINTS (Dance club)
5. QUIZCORP (Quizzing society)
6. ROTARACT (Social welfare club)
7. RAAG (Youth club)
8. EVOKE (Fashion team)
9. f/6.3 (Photography club)
10. CARV ACCESS (Film-making

NSS of RVCE

NCC of RVCE

VISION

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

MISSION

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

QUALITY POLICY

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

CORE VALUES

Professionalism, Commitment, Integrity, Team Work, Innovation