RV College of Engineering®

Electronics & Communication Engineering

Bachelor of Engineering (B.E)

Scheme And Syllabus Of V & VI Semester
(2022 Scheme)

B.E. Programs : AS, BT, CH, CS, CS - AI, CS - CD, CS - CY, CV, EC, EE, EI, 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

99TH
NIRF RANKING IN ENGINEERING (2024)

TIMES HIGHER EDUCATION WORLD UNIVERSITY RANKINGS-2023
1501+
TIMES HIGHER EDUCATION WORLD UNIVERSITY RANKINGS-2023 (ASIA)
501-600

EDUFUTURE EXCELLENCE AWARD
BEST PRIVATE ENGINEERING UNIVERSITY (SOUTH)
BY ZEE DIGITAL

1001+
SUBJECT RANKING (ENGINEERING)

801+
SUBJECT RANKING (COMPUTER SCIENCE)

IIRF 2023
ENGINEERING RANKING INDIA
NATIONAL RANK-10
STATE RANK - 2
ZONE RANK - 5

QS-IGUAGE DIAMOND UNIVERSITY RATING (2021-2024)

CURRICULUM STRUCTURE

61 CREDITS PROFESSIONAL CORES (PC)

23 CREDITS BASIC SCIENCE

22 CREDITS ENGINEERING SCIENCE

18 CREDITS PROJECT WORK / INTERNSHIP

12 CREDITS* OTHER ELECTIVES & AEC

12 CREDITS PROFESSIONAL ELECTIVES

12 CREDITS HUMANITIES & SOCIAL SCIENCE

160 CREDITS TOTAL

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

17
Centers of Excellence

11
Centers of Competence

212
Publications On Web Of Science

669
Publications Scopus (2023 - 24)

1093
Citations

70
Patents Filed

39
Patents Granted

61
Published Patents

11
Skill Based Laboratories Across Four Semesters

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

EXECUTED MORE THAN RS.40 CRORES WORTH SPONSORED RESEARCH PROJECTS & CONSULTANCY WORKS SINCE 3 YEARS

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2024

RV College of Engineering®
Mysore Road, RV Vidyaniketan Post,
Bengaluru - 560059, Karnataka, India

Go, change the world®

VISION

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

MISSION

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

QUALITY POLICY

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

CORE VALUES

Professionalism, Commitment, Integrity, Team Work, Innovation

RV College of Engineering®
Mysore Road, RV Vidyaniketan Post,
Bengaluru - 560059, Karnataka, India

Go, change the world®

ELECTRONICS & COMMUNICATION ENGINEERING

DEPARTMENT VISION

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

DEPARTMENT MISSION

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

PROGRAM EDUCATIONAL OBJECTIVES

PEO1: To apply concepts of mathematics, science and computing to Electronics and Communication Engineering

PEO2: To design and develop interdisciplinary and innovative systems.

PEO3: To inculcate effective communication skills, team work, ethics, leadership in preparation for a successful career in industry and R & D organizations.

PROGRAM SPECIFIC OUTCOMES

PSO1: Should be able to clearly understand the concepts and applications in the field of Communication/networking, signal processing, embedded systems, and semiconductor technology.

PSO2: Should be able to associate the learning from the courses related to Microelectronics, Signal processing, Microcomputers, Embedded and Communication Systems to arrive at solutions to real world problems.

PSO3: Should have the capability to comprehend the technological advancements in the usage of modern design tools to analyze and design subsystems/processes for a variety of applications.

PSO4: Should possess the skills to communicate in both oral and written forms, the work already done and the future plans with necessary road maps, demonstrating the practice of professional ethics and the concerns for societal and environmental wellbeing.

LEAD SOCIETY

Institute of Electrical and Electronics Engineers (IEEE)

ABBREVIATIONS

Sl. No.	Abbreviation	Meaning
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	PE	Professional Core Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	PY	Physics
9.	CY	Chemistry
10.	MA	Mathematics
11.	AS	Aerospace Engineering
12.	AI & ML	Artificial Intelligence & Machine Learning
13.	BT	Biotechnology
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	CV	Civil Engineering
17.	EC	Electronics & Communication Engineering
18.	EE	Electrical & Electronics Engineering
19.	EI	Electronics & Instrumentation Engineering
20.	ET	Electronics & Telecommunication Engineering
21.	IM	Industrial Engineering & Management
22.	IS	Information Science & Engineering
23.	ME	Mechanical Engineering

INDEX

2022 SCHEME - CREDITS AND COMPONENTS													
V SEMESTER													
Sl. No.	**Course Code**	**Course Title**	**Credit Allocation**				**BoS**	**Category**	**Max marks CIE**		**SEE Duration (HRS)**	**Max marks SEE**	
			L	**T**	**P**	**Total**			**Theory**	**Lab**		**Theory**	**Lab**
1	HS351TA	Entrepreneurship & Intellectual Property Rights	3	0	0	3	HSS	Theory	100	***	3	100	***
2	EC352IA	Digital VLSI Design (Theory & Practice) (Common to EC & EI)	3	0	1	4	EC	Theory + Lab	100	50	3	100	50
3	EC353IA	Principles of Digital Communication Systems (Theory & Practice)	3	0	1	4	EC	Theory + Lab	100	50	3	100	50
4	EC354TA	Embedded System Design (Common to EC & EI)	3	1	0	4	EC	Theory	100	***	3	100	***
5	EC355TBX	Professional Core Elective-I **(Group-B)**	3	0	0	3	EC	Theory	100	***	3	100	***
6	XX256TCX	Professional Core Elective-II **(Group C)**	2	0	0	2	Respective Dept	**NPTEL**	50	***	***	50	***
		Total				**20**							

2022 SCHEME - CREDITS AND COMPONENTS													
VI SEMESTER													
Sl. No.	**Course Code**	**Course Title**	**Credit Allocation**				**BoS**	**Category**	**Max marks CIE**		**SEE Duration (HRS)**	**Max Marks SEE**	
			L	**T**	**P**	**Total**			**Theory**	**Lab**		**Theory**	**Lab**
1	HS261TA	Principles of Management & Economics	3	0	0	3	HSS	Theory	100	***	3	100	***
2	EC362IA	SystemVerilog for Design & Verification (Theory & Practice)	3	0	1	4	EC	Theory + Lab	100	50	3	100	50
3	EC363IA	Computer Networks & Protocols (Theory & Practice)	3	0	1	4	EC	Theory + Lab	100	50	3	100	50
4	EC364TA	Digital Signal Processing with ML (Common to EC & EI)	3	1	0	4	EC	Theory	100	***	3	100	***
5	EC365TDX	Professional Core Elective-III (**Group – D)**	3	0	0	3	EC	Theory	100	***	3	100	***
6	XX266TEX	Institutional Electives – I **(Group-E)**	3	0	0	3	Respective Dept	Theory	100	***	3	100	***
7	EC367P	Interdisciplinary Project	0	0	3	3	EC	Project	***	50	3	***	50
		TOTAL				**24**							

GROUP-B		
Sl. No.	**Course Code**	**Course Title**
1	EC355TBA	Analog Integrated Circuits Design
2	EC355TBB	Quantum Computing Hardware
3	EC355TBC	Computational Methods for Data Science
4	EC355TBD	Antennas Design and Characterization
5	EC355TBE	Computer Vision and Applications
6	EC355TBF	Computer Architecture

GROUP-C (NPTEL)*		
Sl. No.	**Course Code**	**Course Title**
1	EC256TCA	An Introduction to information Theory
2	EC256TCB	Foundation of Cloud IoT Edge ML
3	EC256TCC	Nano-bio Technology Enabled Point-to-care Devices
4	EC256TCD	Data Science for Engineers
5	ET256TCE	VLSI Signal Processing

GROUP-D		
Sl. No.	**Course Code**	**Course Title**
1	EC365TDA	Low Power VLSI Design
2	EC365TDB	Evolution of Communications: 4G to 6G
3	EC365TDC	Automotive Embedded Systems
4	EC365TDD	Data Structures and Algorithms
5	EC365TDE	Algorithms for VLSI Design Automation
6	EC365TDF	Real-Time Systems

GROUP-E (3 Credit Courses without prerequisites)			
Sl. No.	**Course Code**	**BoS**	**Course Title**
1	AS266TEA	AS	Fundamentals of Aerospace Engineering
2	BT266TEB	BT	Bioinformatics
3	CH266TEC	CH	Industrial Safety Engineering
4	CS266TED	CS	Robotics Process Automation
5	CV266TEE	CV	Intelligent Transport Systems
6	CV266TEF	CV	Integrated Health Monitoring of Structures
7	CM266TEG	CM	Advanced Energy Storage for E-Mobility
8	EC266TEH	EC	Human Machine Interface (HMI)
9	EE266TEJ	EE	Energy Auditing and Standards
10	EI266TEK	EI	Biomedical Instrumentation
11	ET266TEM	ET	Telecommunication Systems
12	ET266TEN	ET	Mobile Communication Networks and Standards
13	IS266TEO	IS	Mobile Application Development
14	IM266TEQ	IM	Elements of Financial Management
15	IM266TER	IM	Optimization Techniques
16	ME266TES	ME	Automotive Mechatronics
17	MA266TEU	MA	Mathematical Modelling
18	MA266TEV	MA	Mathematics of Quantum Computing
19	HS266TEW	HS	Applied Psychology for Engineers
20	HS266TEY	HS	Universal Human Values

Semester: V

ENTREPRENEURSHIP & INTELLECTUAL PROPERTY RIGHTS
Category: Professional Core Course
(Theory)

Course Code	**:**	HS351TA		**CIE**	**:**	100 Marks
Credits: L: T: P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I — **08 Hrs**

Introduction to Entrepreneurship: Definition and Scope of Entrepreneurship, Importance of Entrepreneurship in Engineering Innovation and Economic Growth, Techniques for Identifying Entrepreneurial Opportunities, Types of Entrepreneurs: Innovative, Imitative, Fabian, Characteristics and Traits of Successful Entrepreneurs.

Role in Economic Development- Emerging Trends in Entrepreneurship, Entrepreneur and Entrepreneurship, characteristics of Entrepreneur, Myths about Entrepreneurship, Entrepreneur vs Intrapreneur, Role of Entrepreneurial Teams

Activities: Case study on Entrepreneurship in Indian Scenario, Ideation Workshops and Hackathons

Unit – II — **08 Hrs**

Entrepreneurial Opportunity Evaluation: Identifying Market Opportunities and Trends, Integration of Engineering Principles in Ideation Process, Cross-Disciplinary Collaboration for Technological Innovation, Assessing Market Feasibility and Demand Analysis, Evaluating Technical Feasibility: Prototype Development, Proof of Concept, Financial Feasibility Analysis: Cost Estimation, Revenue Projection, Break-Even Analysis**.**

Business Planning and Strategy Development: Elements of a Business Plan, Executive Summary, Company Description, Market Analysis, writing a Business Plan: Structure and Components, Strategic Planning: Vision, Mission, Goals, Objectives, SWOC Analysis, Competitive Strategy: Porter's Generic Strategies, Differentiation, Cost Leadership, Focus Strategy, Growth Strategies: Organic Growth, Mergers and Acquisitions, Strategic Alliances

Activities: Writing a Business Plan on given templates, Developing Business Models and Prototypes Based on Generated Ideas.

Unit –III — **08 Hrs**

Entrepreneurial Marketing and Sales: Basics of Marketing: Product, Price, Place, Promotion (4Ps), Market Segmentation, Targeting, and Positioning (STP), Branding and Product Development Strategies, Creating a Unique Value Proposition (UVP) Digital Marketing: Social Media Marketing, Content Marketing, SEO, SEM, Sales Techniques and Customer Relationship Management (CRM).

Entrepreneurial Finance and Resource Management: Sources of Financing: Equity Financing, Debt Financing, Venture Capital, Angel Investors, Crowdfunding, Financial Management: Budgeting, Cash Flow Management, Financial Statements Analysis, Risk Management and Insurance, Human Resource Management: Recruitment, Training, Performance Evaluation, Legal and Ethical Issues in Entrepreneurship: Intellectual Property Rights, Contracts, Corporate Governance

Activities: Case Studies and Practical Applications

Unit –IV — **08 Hrs**

Introduction to IP: Types of Intellectual Property

Patents: Introduction, Scope and salient features of patent; patentable and non-patentable inventions, Patent Procedure - Overview, Transfer of Patent Rights; protection of traditional knowledge, Infringement of patents and remedy, Case studies, Patent Search and Patent Drafting, Commercialization and Valuation of IP.

Trade Marks: Concept, function and different kinds and forms of Trade marks, Registrable and non- registrable marks. Registration of Trade Mark; Deceptive similarity; Transfer of Trade Mark, ECO Label, Passing off, Infringement of Trade Mark with Case studies and Remedies.

Unit –V — **08 Hrs**

Trade Secrets: Definition, Significance, Tools to protect Trade secrets in India.

Industrial Design: Introduction of Industrial Designs Features of Industrial, Design. Procedure for obtaining Design Protection, Revocation, Infringement and Remedies, Case studies.

Copy Right: Introduction, Nature and scope, Rights conferred by copy right, Copy right protection, transfer of copy rights, right of broad casting organizations and performer's rights, Exceptions of Copy Right, Infringement of Copy Right with case studies.

Course Outcomes (CO): After going through this course, the student will be able to: -	
CO1	Understand the concepts of entrepreneurship and cultivate essential attributes to become an entrepreneur or Intrapreneur and demonstrate skills such as problem solving, team building, creativity and leadership.
CO2	Comprehend the process of opportunity identification of market potential and customers while developing a compelling value proposition solution.
CO3	Analyse and refine business models to ensure sustainability and profitability and build a validated MVP of their practice venture idea and prepare business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture.
CO4	Apply insights into the strategies and methods employed to attain a range of benefits from these IPs and deliver an investible pitch deck of their practice venture to attract stakeholders
CO5	Knowledge and competence related exposure to the various Legal issues pertaining to Intellectual Property Rights with the utility in engineering perspectives.

Reference Books	
1.	Entrepreneurship: Theory, Process, and Practice, Donald F. Kuratko, South-Western Pub publishers, 10th Edition, 2016,978-ISBN-13: 1305576247.
2.	The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Eric Ries, Crown Currency Publishers,1st Edition, 2011, ISBN-13: 978-0307887894.
3.	Law Relating to Intellectual Property, Dr B L Wadehra, Universal Law Publishers, 5th Edition, ISBN:9789350350300.
4	Intellectual Property Rights: Unleashing Knowledge Economy, Prabuddha Ganguly, 1st Edition, 2001, Tata McGraw Hill Publishing Company Ltd., New Delhi, ISBN: 0074638602.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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 upto 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10**)** Real time problem solving (10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**
RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
DIGITALVLSI DESIGN **Category: Professional Core Course** **(Common to EC & EI)** **(Theory & Practice)**						
Course Code	**:**	EC352IA		**CIE**	**:**	100+50 Marks
Credits: L:T:P	**:**	3:0:1		**SEE**	**:**	100+50 Marks
Total Hours	**:**	40L+ 13 P		**SEE Duration**	**:**	03+03 Hours

Unit-I	**08 Hrs**
VLSI Design Flow: Specification, Design entry, Functional simulation, planning placement and routing, timing simulation. **MOS Transistor:** Introduction, Ideal I-V characteristics, C-V Characteristics, Simple MOS Capacitance Models, Detailed MOS Gate Capacitance Model, Non-ideal I-V Effects, Mobility Degradation and Velocity Saturation, Channel Length Modulation, Threshold Voltage Effects, Junction Leakage, Body effect, Tunneling. **DC Transfer Characteristics:** Static CMOS Inverter DC Characteristics, Beta Ratio Effect, Noise Margin. **Combinational Circuit Design:** CMOS Logic, Inverter, NAND Gate, NOR Gate, Combinational Logic, Compound Gates, Pass Transistors and Transmission Gates, Tristates, Multiplexers.	
Unit – II	**08 Hrs**
Delay: Transient response, RC delay model, linear delay model **Circuit Families:** Static CMOS, Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits, Complementary Pass-Transistor Logic Circuits **Datapath Subsystem:** Single-Bit Addition, Mirror adder, TG based adder, Zhuang Full Adder,Ripple Carry Adder, Carry Look Ahead Adder, Carry Skip Adder, Carry Select Adder, Manchester Carry Chain Adder, Braun, Baugh-Wooley and Booth multipliers.	
Unit –III	**08 Hrs**
Sequential MOS Logic Circuitry: Behavioral of Bistable element, SR Latch Circuitry, Clocked latch and Flip-Flop Circuitry, C-MOS D-Latch and Edge Triggered Flip-Flop. **Sequencing Static Circuits:** Introduction to Clock Skew & Jitter, Sequencing Methods, Max-Delay Constraints, Min-Delay Constraints, Time Borrowing, Clock Skew	
Unit –IV	**08 Hrs**
Array Sub system SRAM: Memory cell Read/Write operation, Decoder, Bit-line conditioning and Column Circuitry, Multi-Ported SRAM, DRAM Subarray Architectures. **Read-Only Memory:** Programmable ROMs, NAND/NOR ROMs. **Content-Addressable Memory**, **PLA**	
Unit –V	**08 Hrs**
CMOS Processing Technology: CMOS Technologies, Wafer Formation, Photolithography, Well and Channel Formation, Silicon Dioxide (SiO_2), Isolation, Gate Oxide, Gate and Source/Drain Formations, Contacts and Metallization, Passivation, Metrology. **CMOS Layout Design Rules**: stick diagrams and Gate layouts. **Transistor Scaling:** Constant Voltage, Constant Field, and Generalized Scaling	

Laboratory Experiments:

1.a MOS device Characterization
.b Practice question :Plot g_mVs$V_{gs}$for NMOS/PMOS
2.a CMOS Inverter Static Characteristics
.b Practice question: Plot the Voltage Transfer Characteristic graph of CMOS inverter and calculate the switching voltage for the given specification.
3.a Design and Analysis of NAND and NOR gates.
.b Practice question: Realization of XOR & AOI32 logic and perform transient analysis.
4.a Realization of CMOS-adder circuits.
.b Practicequestion:Realize4-bitadder/subtractor.
5.a Sequential Circuit Design using Master-Slave configuration.
b Practice question: Realize4-bitRingcounter/Johnson counter.
6.a Layout, DRC, LVS, RCX and post-layout simulation of CMOS Inverter.
b Practice question: Realize NOT gate with 2X the size for PMOS and NMOS.
7. a NAND/NOR gates layout and post simulation.
b Practice question: Realize the layouts of AOI32 logic.
8.a 6T SRAM Verify functionality, read and write stability.
b Practice question: Realize read and write operation 3T DRAM cell and perform the above observations.
9.a Synthesis of 8-bit counter and analyze delay, power, and area.
b. Practice question: Realize the 16-bit counter and analyze delay, power, and area.
10.a Synthesis of serial adder circuit and analyze delay, power, and area.
b. Practice question: Synthesis of 2x2 multiplier and analyze delay, power, and area.
11. Open Ended Experiments.

Course Outcomes (CO): After completing the course, the students will be able to: -	
CO1	Analyze transistor circuits and its impact on VLSI design flow.
CO2	Design VLSI blocks using various architectures.
CO3	Evaluate the different performance parameters of a digital integrated circuits & systems
CO4	Illustrate the application of various circuits and processes in logic families/designs.

Reference Books	
1.	CMOS VLSI Design, Neil H.E. Weste, David Harris, Ayan Banerjee, 3rd Edition, 2006, Pearson Education, ISBN: 0321149017.
2.	CMOS Digital Integrated Circuits, Sung MO Kang, Yousf Leblebici, 3rd Edition, Tata McGraw Hill, ISBN: 0-7923-7246-8.
3.	Basic VLSI Design, Douglas.A.Pucknell, Kamaran Eshraghian, 3rd Edition 2010 ,PHI, ISBN: 0-321-26977-22.
4.	Digital Integrated Circuits: A Design Perspective, Jan M.Rabaey, Anantha Chadrakasan, Borivoje Nikolic, (2/e), Pearson 2016, ISBN-13: 978-0130909961.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10**)** Real time problem solving (10) **ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis **(20 Marks)**, lab test **(10 Marks)** and Innovative Experiment/ Concept Design and Implementation (2**0 Marks)** adding up to 50 Marks.	**50**
	MAXIMUM MARKS FOR THE CIE THEORY	**150**

RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR THE SEMESTER END EXAMINATION (LAB)		
Q. NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Execution	20
3	Viva	20
	TOTAL	**50**

Semester: V						
PRINCIPLES OF DIGITAL COMMUNICATION SYSTEMS **Category: Professional Core Course** **(Theory & Practice)**						
Course Code	**:**	EC353IA		**CIE**	**:**	100 + 50 Marks
Credits: L: T:P	**:**	3:0:1		**SEE**	**:**	100 + 50 Marks
Total Hours	**:**	40 L+ 13 P		**SEE Duration**	**:**	03+03 Hours

Unit-I	**08 Hrs**
Introduction: Digital Communication block diagram, band limited and power limited channels. **Communication through Band Limited Channels**: Digital Transmission through Band limited channels -Inter Symbol Interference, Signal design for Band limited ideal channel with zero ISI – Nyquist Criterion Sinc and Raised pulse shaping, Duo-binary & Modified Duo-binary.	
Unit – II	**08 Hrs**
Linear Equalizers: Zero forcing Equalizer, MSE and MMSE, Baseband Linear Equalizers. SNR and Error Performance of ZFE and MSE with statements only. **Non-Linear Equalizers:** Decision - feedback equalization, SNR and error performance of DFE with statements only, Adaptation of ZFE, MSE and DFE.	
Unit –III	**08 Hrs**
Principles of Spread Spectrum (SS): Concept of Spread Spectrum, Direct Sequence/SS, Frequency Hopped SS, Processing Gain, Interference, and probability of error statement only. PN sequences for Spread Spectrum – M- sequences with Properties; Gold, Kasami sequences with basic properties. Spread Spectrum Synchronization (Block diagram treatment) - Code Acquisition and Tracking.	
Unit –IV	**08 Hrs**
Fading: Large scale, small scale; Statistical characterization of multipath channels – Delay and Doppler spread, classification of multipath channels, scattering function. Binary signalling over frequency non selective Rayleigh ad Rician fading channel, and Frequency selective fading channels. Performance of binary signals over fading channels. **Diversity Concepts:** Frequency, Time and Spatial Diversity to improve performance. Diversity Coefficients Extraction.	
Unit –V	**08 Hrs**
Synchronization: Signal Parameter Estimation - The Likelihood Function for Carrier Recovery and Symbol Synchronization in Signal Demodulation. Carrier Phase Estimation - ML Carrier Phase Estimation, The PLL, Effect of Additive Noise on the Phase Estimate, Decision-Directed and Non-Decision-Directed Loops. Symbol Timing Estimation - ML Timing Estimation, Non-Decision-Directed Estimation.	

Laboratory Experiments:

1.M-PSK transceiver Design using LabVIEW.
2.M-QAM transceiver Design using LabVIEW.
3.ISI with PAM modulation technique using MATLAB.
4.Equalization with QAM Modulation using LabVIEW.
5.Transmitter and Receiver Implementation of Direct Sequence Spread Spectrum and Frequency Hopped Spread Spectrum using MATLAB.
6.Symbol Timing Estimation using MATLAB.
7.Frequency selective and non-selective fading channel simulation using MATLAB.
8.Carrier Phase Estimation: Decision-Directed and Non-Decision-Directed Loops using MATLAB.
9.M-PSK transceiver Design using USRP 2920 Software Defined Radio.
10. M-QAM transceiver Design using USRP 2920 Software Defined Radio.
11. Open Ended Experiments.

Course Outcomes (CO): After completing the course, the students will be able to: -	
CO1	Utilize mathematical tools for signal processing and system modeling to design and optimize communication systems for specific applications.
CO2	Apply knowledge of digital communication theory to design and analyze communication systems for specific applications, considering factors such as bandwidth, data rate, power efficiency, and error performance.
CO3	Analyze the performance of digital communication systems through mathematical analysis and simulation, assessing metrics such as bit error rate, signal-to-noise ratio, and bandwidth efficiency.
CO4	Test and validate digital formatting schemes and block codes under noisy channel conditions to estimate the performance in practical communication systems.

Reference Books	
1.	Fundamentals of Communication Systems, Proakis and Salehi, Pearson Education India; 2nd Edition, 2013, ISBN: 978-0133354850.
2.	Digital Communication Systems, Simon Haykin, Wiley; Special Edition, Standard Edition, 2013, ISBN: 978-8126542314.
3.	Digital Communications: Fundamentals and Applications, Bernard Sklar, Pearson Prentice Hall, 2nd Edition 2001, ISBN: 978-0130847881.
4.	Analog & Digital Communication: Schaum's Outline Series, Hwei Hsu, 3rd Edition,2017, McGraw Hill Education, ISBN: 978-0070151505.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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 upto 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Real time problem solving (10) **ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis **(20 Marks)**, lab test **(10 Marks)** and Innovative Experiment/ Concept Design and Implementation (2**0 Marks)** adding up to 50 Marks.	**50**
	MAXIMUM MARKS FOR THE CIE THEORY	**150**

RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR THE SEMESTER END EXAMINATION (LAB)		
Q. NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Execution	20
3	Viva	20
	TOTAL	**50**

Semester: V						
EMBEDDED SYSTEM DESIGN **Category: Professional Core Course** **(Common to EC & EI)** **(Theory)**						
Course Code	**:**	EC354TA		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:1:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Introduction to Embedded System Design: Introduction, Characteristics of Embedding Computing Applications, Concept of Real time Systems, Challenges in Embedded System Design, Design Process: Requirements, Specifications, Hardware Software Partitioning, Architecture Design. **Embedded System Architecture:** Co-Processor & Hardware Accelerators, Processor performance Enhancement: Pipelining, Superscalar Execution, Multi Core CPUs.	
Unit – II	**08 Hrs**
Designing Embedded System Hardware –I: Memory systems: Memory organization, Error detecting and correcting memories, memory Access times, SRAM, DRAM, Flash, Interfacing program and data memory, Cache, Unified versus Harvard caches, Cache coherency, Cache replacement policies.	
Unit –III	**08 Hrs**
Designing Embedded System Hardware –II: I/O Devices: Watchdog Timers, Interrupt Controllers, Interfacing Protocols: I2C, I3C, CAN: Frame Formats, Interconnect Topology, Reset Circuits, Interfacing RTC, SATA, PCI, PCB design. **Practice:** Wiring and connection of I2C, CAN on STM32F2407VG	
Unit –IV	**08 Hrs**
Designing Embedded System Software-I: Application Software, System Software, Cross-Platform Development Process, Board Support Library, Chip Support Library, Overview of Linkers and the Linking Process, Executable and Linking Format, Mapping Executable Images into Target Embedded Systems, Linker Command Files, Embedded System Initialization, Target System Tools and Image Transfer, Target Boot Scenarios, Target System Software Initialization Sequence, On-Chip Debugging Embedded System Coding Standards: MISRA C.	
Unit –V	**08 Hrs**
Designing Embedded System Software –II: OS based Design, Real Time Kernel, Process& Thread, Inter Process Communications, Synchronization, Kernel services, ISR, Software Timers, Case Study: RTX-ARM/FreeRTOS. **Practice:** Application code development on STM32F407VG with Kernel	

Course Outcomes (CO): After completing the course, the students will be able to: -	
CO1	Describe the architecture of embedded system, functional difference between general purpose system, operational and non-operational attributes of embedded system.
CO2	Interpret hardware and software of embedded systems with suitable processor, architecture, memory and communication interface.
CO3	Developing embedded systems encompassing both software and hardware with the goal of meeting specified constraints.
CO4	Engage in usage of tools to formulate, design and analyze different Applications realized with embedded processors.

Reference Books	
1.	Introduction to Embedded Systems, Shibu K V, 2nd Edition, 2017, Tata McGraw Hill Education Private Limited, ISBN: 13 978-9339219680
2.	Embedded Systems – A contemporary Design Tool, James K Peckol, 2009, John Weily, ISBN-13 978-8126524563
3.	Real-Time Concepts for Embedded Systems, Qing Li and Carolyn Yao, 2003, CMP Books, ISBN:1578201241.
4.	Reference Manuals: I2C, SPI, CAN, Cache Design, MISRA C 2012, RTX-ARM, FreeRTOS.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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 upto 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10**)** Real time problem solving (10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**
RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
ANALOG INTEGRATED CIRCUITS DESIGN **Category: Professional Core Elective** **(GROUP-B)** **(Theory)**						
Course Code	**:**	EC355TBA		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours
Unit-I						**08 Hrs**
Differential Amplifiers: MOS differential pair, small signal operation - half circuit analysis, common mode response, differential amplifier with active load, common mode gain and CMRR. **Current Sources and Current Mirrors:** Basic current mirror, Cascode current mirror, active current mirror – analysis.						
Unit – II						**08 Hrs**
Operational Amplifiers: General considerations – performance parameters, One-Stage Op amps – cascade opamps, telescopic opamps, folded cascade opamps, Two-Stage Op amps, Gain Boosting, Comparison of performance of various opamp topologies.						
Unit –III						**08 Hrs**
Stability and Frequency Compensation: Frequency response of CS amplifier - Miller effect, poles in a system, pole-splitting, Miller compensation. Two stage opamp - Compensation techniques, gain-phase crossovers, closed-loop stability, optimal phase margin. **Noise:** MOSFET noise models, types of noise – thermal, flicker, Representation of noise in circuits, Noise in single stage amplifiers (Common source only). **Bandgap References**: Temperature independent references - Bipolar CTAT, PTAT, Band Gap References (BGR)						
Unit –IV						**08 Hrs**
Introduction to Switched-Capacitor Circuits: Sampling Switches – MOSFETs as switches, Distortion due to switch, Channel Charge injection, Capacitive feed through, bottom plate sampling, Parasitic insensitive Switched Capacitor Integrator. **Data Converter Fundamentals:** Analog Versus Discrete Time signals, Converting Analog Signals to Digital Signals, Sample and Hold Characteristics, Digital-to-Analog Converter Specification, Analog-to-Digital Converter Specifications.						
Unit –V						**08 Hrs**
DAC Architectures: Resistor String, R-2R Ladder networks, Current Steering. **ADC Architectures:** Flash ADC, Successive Approximation ADC, Oversampling ADC.						

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Apply the knowledge of MOSFET & amplifiers to investigate various design trends of analog IC design.
CO2	Analyze the functionality of analog/mixed signal circuits & systems.
CO3	Design and implement analog integrated circuits.
CO4	Evaluate the different performance parameters of analog/mixed signal integrated circuits.

Reference Books	
1.	Design of Analog CMOS Integrated Circuits, Behzad Razavi, 2002, Mc Graw Hill Edition, ISBN: 0-07-238032-2.
2.	CMOS Circuit Design, Layout and Simulation, R. Jacob Baker, Harry W. Li and David E. Boyce, 2002, IEEE Press, ISBN: 81-203-1682-7.
3.	CMOS Mixed-signal Circuit Design, R. Jacob Baker, 2009, IEEE Press, ISBN: 978-81-265-1657-5.
4.	Analysis and Design of Analog Integrated Circuits, Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, 4th Edition, 2008, Wiley India Private Limited, ISBN:978-8126515691.
5.	Fundamentals of Microelectronics, Behzad Razavi, 2nd Edition, 2013, Wiley, ISBN-10: 1118156323.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding up to 150 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
QUANTUM COMPUTING HARDWARE **Category: Professional Core Elective** **(GROUP-B)** **(Theory)**						
Course Code	**:**	EC355TBB		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Fundamental Concepts of Quantum Computing-I: the qubit, superposition, single-qubit quantum gates, Dirac notation, quantum measurement. multi-qubit systems, entanglement, multi-qubit quantum gates, quantum computing notations comparison, no-cloning theorem, measurement of multi-qubit systems.	
Unit – II	**08 Hrs**
Fundamental Concepts of Quantum Computing-II: Random number generation, quantum key distribution, teleportation, superdense coding, phase oracles, Deutsch algorithm, Deutsch-Josza algorithm, Building up to Shor's algorithm: quantum Fourier transform, quantum phase estimation, Shor's algorithm for integer factorization.	
Unit –III	**08 Hrs**
Quantum Error Correction, Fault-Tolerant Quantum Computing: Algorithms for Fault-tolerant QC: Shor's factoring and period finding, Algorithms for Fault-tolerant QC: Grover search, Measurement Based Quantum Computing & Blind Quantum Computing	
Unit –IV	**08 Hrs**
Quantum Computing Hardware-I: Quantum computing with trapped ion qubits, Quantum computing with superconducting qubits, Quantum computing with semiconductor spin qubits, other qubit technologies	
Unit –V	**08 Hrs**
Quantum Computing Hardware-II: System level and hardware aspects, Superconducting quantum circuits: the transmon qubit and circuit QED architecture, atomic systems: the neutral atom and trapped ion qubit, Solid-state spins: the nitrogen-vacancy centre in diamond and the phosphorus donor in silicon	

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Apply their knowledge of engineering to understand the advantages and challenges of different qubit technologies.
CO2	Formulate and solve complex problems in building quantum computer systems by applying principles of quantum physics and technologies.
CO3	Understand the state-of-the-art of quantum computing technologies, identify the challenges.
CO4	Recognize the ongoing need to acquire new knowledge by reading and understanding research papers and doing reviews.

Reference Books	
1.	Quantum Computation and Quantum Information, Nielsen M A, Chuang I. Cambridge University Press, 2002.
2.	Quantum Computing: A Gentle Introduction, Rieffel, Eleanor G., and Wolfgang H. Polak. MIT Press, 2011.
3.	Feynman Lectures on Computation, Feynman RP, CRC Press, 2018.
4.	Exploring the Quantum: Atoms, Cavities, and Photons, S. Haroche and J-M. Raimond, Oxford, ISBN: 978-0198509141.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding up to 150 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
COMPUTATIONAL METHODS FOR DATA SCIENCE **Category: Professional Core Elective** **(GROUP-B)** **(Theory)**						
Course Code	**:**	EC355TBC		**CIE**	**:**	100 Marks
Credits: L: T: P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Introduction to Data Science: Need for Data Science, Data Science Process, Business Intelligence and Data Science, Prerequisites for a Data Scientist, Components of Data Science, Tools and Skills required for Data Science.	
Unit – II	**08 Hrs**
Statistics and Probability for Data Science: Information Gain and Entropy, Probability Theory, Probability Types, Probability Distribution Functions, Bayes' Theorem**,** Inferential Statistics, Implementation of concepts using Python.	
Unit –III	**08 Hrs**
Databases for Data Science: SQL – Tool for Data Science: Basic Statistics with SQL, Data Munging with SQL, Filtering, Joins, and Aggregation, Window Functions and Ordered Data, Preparing Data for Analytics Tool, Implementation of concepts using Python.	
Unit –IV	**08 Hrs**
Data Science Methodology: Descriptive Analytics for Data Science: Examples of Data Analytics, Data Analytics Life Cycle: Data Discovery Data Preparation, Model Planning, Model Building, Communicate Results, Operationalization, Implementation of concepts using Python.	
Unit –V	**08 Hrs**
Machine Learning Algorithms: Types and Applications of ML. Supervised Machine Learning: Univariate and Multivariate Linear Regression, Regression Model Selection Techniques. Classification Techniques: Logistic Regression, Classification Model Selection Techniques, Implementation of concepts using Python.	

Course Outcomes (CO): After completing the course, the students will be able to: -	
CO1	Acquire and demonstrate an understanding of the foundational concepts, tools, and techniques in Data Science.
CO2	Apply SQL techniques for data manipulation and assess their effectiveness in preparing data for analytics
CO3	Demonstrate numerous open-source data science tools to solve real-world problems through industrial case studies.
CO4	Evaluate the performance of machine learning models and recommend appropriate selection techniques for regression and classification

Reference Books	
1.	Fundamentals of Data Science, Sanjeev Wagh, Manisha Bhende, Anuradha Thakare, CRC Press, 1st Edition, 2022.
2.	Foundations of Data Science, Avrim Blum, John Hopcroft, Ravindran Kannan, Cambridge University Press, 1 st Edition, 2020.
3.	Computational and Inferential Thinking: TheFoundations of Data Science, Ani Adhikari and John DeNero, GitBook, 2019.
4.	Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly Media, 1st Edition, 2015.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10**)** Real time problem solving (10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
ANTENNA DESIGN AND CHARACTERIZATION **Category: Professional Core Elective** **(GROUP-B)** **(Theory)**						
Course Code	**:**	EC355TBD		**CIE**	**:**	100 Marks
Credits: L: T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Fundamental Concepts: Physical Concept of Radiation, Radiation Pattern, Near- and Far-Field Regions, Reciprocity, Directivity and Gain, Effective Aperture, Polarization, Input Impedance, Efficiency, Friis Transmission Equation, Radiation Integrals and Auxiliary Potential Functions.	
Unit – II	**08 Hrs**
Dipole Antenna and Arrays: Infinitesimal Dipole, Finite-Length Dipole, Radiated Fields, Radiation Resistance, Field Regions & Directivity. Practice: Design of Half Wave Dipole Antenna and Design of Monopole Antenna. Analysis of Uniformly Spaced Arrays with Uniform and Non-Uniform Excitation Amplitudes, Extension to Planar Arrays.	
Unit –III	**08 Hrs**
Microstrip Antenna: Basic Characteristics of Microstrip Antennas, Feeding Methods, Methods of Analysis, Design of Rectangular and Circular Patch Antennas. Practice: Design of Microstrip Antenna Simulation with two Feeding Techniques and Array Simulations using AF Method, Regular and FADDM Technique.	
Unit –IV	**08 Hrs**
S-Parameters and Measurements: Applications and Importance of Microwave Measurements, Overview of State-of-the-Art Microwave Measurements, S-Parameters and Related Black-Box Representation, Spectra of Commonly Encountered Signals. Vector Network Analyzer-Enhancement of Scalar Measurement, Basic Vector Measurements, Architecture of the Vector Network Analyzer, Network Analyzer Calibration –One Port and Two port.	
Unit –V	**08 Hrs**
Radiation Pattern Measurements: Reciprocity and Antenna Measurements, Pattern Measurements and Ranges, Gain Measurements, Polarization Measurements, Field Intensity Measurements, Application Examples using Anechoic Chamber.	

Course Outcomes (CO): After completing the course, the students will be able to: -	
CO1	Apply antenna design techniques to solve problems in various applications, considering factors such as frequency, bandwidth, and radiation pattern requirements.
CO2	Utilize simulation software tools to model and optimize antenna designs based on specified criteria and constraints.
CO3	Evaluate the impact of design choices on antenna performance, such as the effect of different feeding techniques or materials on radiation characteristics.
CO4	Formulate recommendations for improving antenna designs or addressing performance deficiencies based on analytical and experimental evaluations

Reference Books	
1.	Microwave Engineering: Theory and Techniques, David M Pozar, 4th Edition, An Indian Adaptation, 2020, John Wiley, ISBN: 978-9388991087.
2.	Antenna Theory Analysis and Design, C. A. Balanis, 4th Edition, 2016., John Wiley, ISBN: 978-1-118-64206-1.
3.	Introduction to Microwave Measurements, Ananjan Basu, 2014, CRC Press, ISBN: 9780429067891.
4.	Antenna Theory and Design, Stutzman and Thiele, 3rd Edition, 2012, John Wiley and Sons Inc. ISBN: 978-0-470-57664-9

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10**)** Real time problem solving (10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**
RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
COMPUTER VISION AND APPLICATIONS **Category: Professional Core Elective** **(GROUP-B)** **(Theory)**						
Course Code	**:**	EC355TBE		**CIE**	**:**	100 Marks
Credits: L: T: P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Image Formation Models: Introduction: Overview and applications. **Image Formation:** Digital images for representing 2D, 3D, and moving objects. Human eye and digital camera models. **Photometric Information:** Colour: Physics of Colour, human perception of Colour, Colour models (RGB, HSI). **Geometric-information:** Representation of points, lines, planes, surfaces, and shapes in 3D, nature and structure of medical images. Two-dimensional and three-dimensional geometric transformations of images and 3D scenes	
Unit – II	**08 Hrs**
Image Processing: Image Processing: Point operators, Linear filtering, Fourier Transform, Geometric transformation. **Image filtering:** Gray-level transformations, histograms, convolution, noise reduction, spatial and Fourier domain filtering and convolution, Gaussian filtering, and image resolution pyramids. **Using Open CV:** Smoothing Images, Median Filter, Gaussian Filter, Bilateral Filter, Changing the Shape of Images, Thresholding, Calculating Gradients, Performing Histogram Equalization	
Unit –III	**08 Hrs**
Features Detection and Classification: Feature detection and matching: gradient vector, Canny's edge detection, Harris-corner detector. Contours: Model fitting, Total LSE, Least Median Square Error. RANSAC, Hough transform. Image stitching, clustering techniques, K-mean clustering, PCA Using Open CV: RANSAC Algorithm, SIFT Algorithm	
Unit –IV	**08 Hrs**
Image-based Rendering: Image classification using Artificial Neural Networks and CNN, View-dependent texture maps, Application: Photo Tourism. Video-based rendering, Video-based animation, Video textures, Application: Animating pictures	
Unit –V	**08 Hrs**
Real World Use Cases: Computer Vision Methods for Video Content Analysis: Object detection, Face detection, Pedestrian detection, Face recognition, Eigenfaces, Active appearance and 3D shape models, Application: Personal photo collections. Instance recognition, Geometric alignment, large databases	

Course Outcomes (CO): After completing the course, the students will be able to: -	
CO1	Explore and acquire knowledge on fundamentals of Computer Vision concepts.
CO2	Analyze and interpret the inherent difficulties encountered in Computer Vision.
CO3	Apply Computer Vision techniques to solve problems in the visible world around us.
CO4	Investigate and draw inferences by processing Image in real time applications.

Reference Books	
1.	Computer Vision: Algorithms and Applications, Richard Szeliski, Springer Verlag, 2013 Edition, ISBN-13: 978-1848829343.
2.	Practical Machine Learning and Image Processing: For Facial Recognition, Object Detection, and Pattern Recognition Using Python, Himanshu Singh, 1st Edition, Apress, ISBN:978-1-4842- 4149-3.
3.	Computer Vision: A Modern Approach, David Forsyth and Jean Ponce, 2nd Edition, 2015, Pearson Education India, ISBN-10: 9332550115, ISBN-13: 978-9332550117.
4.	Introductory Computer Vision, Imaging Techniques and Solutions, Adrian Low, 2nd Edition, 2010, BS Publications, ISBN-13 9788178001977.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10**)** Real time problem solving (10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
COMPUTER ARCHITECTURE **Category: Professional Core Elective** **(GROUP-B)** **(Theory)**						
Course Code	**:**	EC355TBF		**CIE**	**:**	100 Marks
Credits: L: T: P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Introduction, Pipelining & Hazards: Introduction to CISC versus RISC, Concept of Load-Store architecture, Architecture versus Microarchitecture, Machine Models, ISA characteristics with RISCV ISA overview, Pipeline basics, Structural Hazards, Data Hazards, Control Hazards - Jumps, Branches & Others, Reducing Branch Costs with Branch Prediction, Overcoming Data Hazards with Dynamic Scheduling	
Unit – II	**08 Hrs**
Instruction Level Parallelism - Superscalar, Out-of-Order: Introduction, Basic Two-way In-order Superscalar, Fetch Logic and Alignment, Baseline Superscalar and Alignment, Introduction to Out-of-Order Processors, Overview of I2O2, I2O1, IO3, IO2I with emphasis on IO2I, RISCV open-source CPU case study, Basic Compiler Techniques for Exposing ILP, Examples and the Algorithm	
Unit –III	**08 Hrs**
Register Renaming & Thread Level Parallelism: Register Renaming Introduction, Register Renaming with pointers to IQ & ROB, Register Renaming with values in IQ and ROB, Introduction to hardware multithreading, Multithreading motivation, fine grain multithreading, coarse grain multithreading, simultaneous multithreading	
Unit –IV	**08 Hrs**
Data Level Parallelism using Vector/SIMD: Vector Processor Introduction, Vector Parallelism, Vector Hardware Optimizations, Vector Software & Compiler Optimizations, RISCV Vector Extension detailed Overview	
Unit –V	**08 Hrs**
Memory Management and Caches: Memory Management Introduction, Base & Bound Registers, Page Based Memory Systems, Address Translation & Protection, Page Table, TLB, Page Walk Cache overview, Cache Performance, Basic Cache Optimizations, Cache Pipelining, Write Buffers, Multilevel Caches, Victim Caches, Prefetching	

Course Outcomes (CO): **After completing the course, the students will be able to: -**	
CO1	Describe fundamental principles of computer architecture, the significance of load-store architecture, and the impact of ISA characteristics on processor design.
CO2	Identify various pipeline hazards and apply appropriate mitigation techniques to enhance pipeline efficiency.
CO3	Analyze program structures and utilize compiler techniques to maximize parallelism and optimize performance.
CO4	Evaluate cache performance metrics and implement cache optimization techniques to improve memory hierarchy efficiency and overall system performance.

Reference Books	
1.	Computer Architecture: A Quantitative Approach, J.L. Hennessy, and D.A. Patterson, 5th Edition, Morgan Kaufman Publication, 2012
2.	Computer Organisation and Design RISCV Edition: The Hardware Software Interface, J.L Hennessy, D.A Patterson, 1st Edition, The Morgan Kaufmann Series, ISBN:13- 978-0128122754
3.	Advanced Computer Architecture, Kai Hwang, Naresh Jotwani, 3rd Edition, Mc Graw Hill Education.
4.	Introduction to Parallel Computing, Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, 2nd Edition, 2013, Pearson Education, ISBN 13: 9788131708071.
5.	Computer Organization and Architecture, William Stallings, 6th Edition, Pearson Education.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10**)** Real time problem solving (10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
PRINCIPLES OF MANAGEMENT & ECONOMICS **Category: Professional Core Course** **(Theory)**						
Course Code	**:**	HS261TA		**CIE**	**:**	100 Marks
Credits: L: T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Introduction to Management: Management Functions – POSDCORB – an overview, Management levels & Skills, Management History **Classical Approach:** Scientific Management, Administrative Theory, **Quantitative Approach:** Operations Research, **Behavioral Approach:** Hawthorne Studies, **Contemporary Approach:** Systems Theory, Contingency Theory. **Caselets / Case studies**	
Unit – II	**08 Hrs**
Foundations of Planning: Types of Goals & Plans, Approaches to Setting Goals & Plans, Strategic Management Process, Corporate strategies – types of corporate strategies, BCG matrix, Competitive Strategies – Porters Five force Model, types of Competitive Strategies. **Caselets / Case studies** **Organizational Structure & Design:** Overview of Designing Organizational Structure -Work Specialization, Departmentalization, Chain of Command, Span of Control, Centralization & Decentralization, Formalization, Mechanistic & Organic Structures. **Caselets / Case studies**	
Unit –III	**08 Hrs**
Motivation: Early Theories of Motivation - Maslow's Hierarchy of Needs Theory, McGregor's Theory X & Theory Y, Herzberg's Two Factor Theory. Contemporary Theories of Motivation: Adam's Equity theory, Vroom's Expectancy Theory. **Caselets / Case studies** **Leadership:** Behavioral Theories: Blake & Mouton's Managerial Grid, Contingency Theories of Leadership: Hersey & Blanchard's Situational Leadership, Contemporary Views of Leadership: Transactional & Transformational Leadership. **Caselets / Case studies**	
Unit –IV	**08 Hrs**
Introduction to Economics: Microeconomics and Macroeconomics, Circular flow model of economics, An Overview of Economic Systems. **Essentials of Microeconomics:** Demand, Supply, and Equilibrium in Markets for Goods and Services, Price Elasticity of Demand and Price Elasticity of Supply, Elasticity and Pricing, Numericals on determining price elasticity of demand and supply. Changes in Income and Prices Affecting Consumption Choices, Monopolistic Competition, Oligopoly.	
Unit –V	**08 Hrs**
Macroeconomic Indicators: Prices and inflation, Consumer Price Index, Exchange rate, Labor Market, Money and banks, Interest rate. Gross Domestic product (GDP) - components of GDP, Measures of GDP: Outcome Method, Income method and Expenditure method, Numericals on GDP Calculations, ESG an overview. **Macroeconomic models**- The classical growth theory, Keynesian cross model, IS-LM-model, The AS-AD model, The complete Keynesian model, The neo-classical synthesis. National Budgeting process in India	

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Elucidate the principles of management theory & recognize the characteristics of an organization.
CO2	Demonstrate the importance of key performance areas in strategic management and design appropriate organizational structures and possess an ability to conceive various organizational dynamics.
CO3	Compare and contrast early and contemporary theories of motivation and select and implement the right leadership practices in organizations that would enable systems orientation.
CO4	Demonstrate an understanding on the usage and application of basic economic principles.
CO5	Appreciate the various measures of macro-economic performance and interpret the prevailing economic health of the nation.

Reference Books:	
1.	Management, Stephen Robbins, Mary Coulter & Neharika Vohra, 15th Edition, 2021, Pearson Education Publications, ISBN: 13: 978-0-13-558185-8
2.	Management, James Stoner, Edward Freeman & Daniel Gilbert Jr, 6th Edition, 2009, PHI, ISBN: 81-203-0981-2.
3.	Principles of Microeconomics, Steven A. Greenlaw, David Shapiro, 2nd Edition, 2017, ISBN:978-1-947172-34-0
4.	Macroeconomics: Theory and Policy, Dwivedi D.N, 5th Edition, 2021, McGraw Hill Education, ISBN: 9789353163334

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding up to 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Some of the Experiential learning topics may include Reading Leadership books and summarizing, Analysis and interpretation of various economic reports, visit to various organizations to understand organizational mechanics. Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
SYSTEMVERILOG FOR DESIGN AND VERIFICATION **Category: Professional Core Course** **(Theory & Practice)**						
Course Code	**:**	EC362AI		**CIE**	**:**	150 Marks
Credits: L: T:P	**:**	3:0:1		**SEE**	**:**	150 Marks
Total Hours	**:**	40 L +13 P		**SEE Duration**	**:**	03+03 Hours

Unit-I	**08 Hrs**

Verilog Design Methodology: Verilog IEEE standards, Overview of Verilog Data Types: Net, Register and Constant. Verilog Operators, Verilog ports, Simulation and Synthesis, Test-benches. Logic Simulation, Design Verification, and Test Methodology. Introduction to Design Methodology: Digital Systems and Embedded Systems, Real-world circuits. Design Methodology: Design Flow-Architecture, Functional design, and verification.

Synthesis of Digital Sub-Systems: Synthesis of Combinational Sub-systems: Introduction to Synthesis, Synthesis of Combinational Logic, Synthesis of Sequential Logic with Latches, Synthesis of Three-state Devices and Bus Interfaces. Synthesis of Sequential Sub-systems: Synthesis of Sequential Logic with Flip-Flops, Synthesis of Explicit State Machines, Registered Logic, State Encoding, Synthesis of Implicit State Machines, Registers and Counters.

Unit – II	**08 Hrs**

Introduction to SystemVerilog: Key SystemVerilog enhancements for hardware design and verification. Data types, Built-In Data Types, Fixed-Size Arrays, Dynamic Arrays, Queues, Associative Arrays, Linked Lists, Array Methods, choosing a Storage Type, Creating New Types with typedef, Creating User-Defined Structures, Type conversion, Enumerated Types, Constants, Strings, Procedural Statements, Interface overview, Tasks, Functions, and Void Functions.

Classes, Interfaces, Clocking: Class Basics, Class Declaration, Class Members and Methods, Class Handles, Class Object Construction, Super and *this* Keyword, Object Handles, User Defined Constructors, Class Extension and Inheritance, Chaining *new()* Constructors, Overriding Class Methods, Extending Class Methods, Local And Protected Keywords. Generic Interfaces, Interfaces Vs Modports, How Interfaces Work, Requirements of Good Interface, Interface Constructs, Interface Modports. Clocking Blocks, Clocking Skews, Clocking Block Scheduling.

Unit –III	**08 Hrs**

Program block, Randomization and Constrained Randomization: Fundamental Test Bench Construction, Program Blocks, Program Block Interaction with Modules, Final Blocks. Constrained Random Variables, Directed Vs Random Testing, Rand and Randc Class Data Types, Randomize Randomizing Class Variables, Randcase, Built-in-Randomization Methods, Randsequence. Randomization Constraints, Constraint Blocks, Constraint Inheritance, Distribution Constraint, Constraint Inside, Constraint Implication, Fork-Join Processes. Structured Flow to Develop a Layered SystemVerilog Testbench.

Unit –IV	**08 Hrs**

SystemVerilog Coverage and Assertions: Cover Groups, Cover Points, Cover Point Bins and Labels, Cross Coverage, Cover Group Options, Coverage Capabilities. Assertion Definition, Assertion Benefits, System Verilog Assertion Types, Immediate Assertions, Concurrent Assertions, Assert and Cover Properties and Labels, Overlapping and Non-Overlapping Implications, Assertion and Coverage Examples.

Unit –V	**08 Hrs**

Universal Verification Methodology: Introduction to Universal Verification Methodology, Overview of UVM Base Classes and Simulation Phases in UVM and UVM macros. UVM environment structure, Connecting DUT and Testbench, Case study.

Laboratory Experiments:
1. Design and implement Comparator and Array-multiplier using Verilog on FPGA. 2. Design and implement Serial-Adder and Linear Feedback Shift Register using Verilog on FPGA. 3. i. SystemVerilog Arrays such as Associative arrays, Dynamic Arrays and Queues. ii. The SystemVerilog assignment handling, Copy methods such as deep copy and shallow copy. 4. Usage of SystemVerilog Inheritance and Polymorphism. 5. Usage of SystemVerilog Random variables, constraints and Randomization. 6. The SystemVerilog Threads, Mailbox and Semaphores, Interface and Transactors to understand the usage of i. The SystemVerilog Threads, Mailbox and Semaphores ii. The SystemVerilog Interface, Transactors such as generator, driver, monitor and reference models. 7. SystemVerilog code to inculcate SV Coverage. 8. SystemVerilog code to inculcate SV Assertion. 9. Developing SystemVerilog Layered Testbench Environment for combinational circuits. 10. Developing SystemVerilog Layered Testbench Environment for Sequential circuits. 11. Open Ended Experiments.

Course Outcomes (CO): After completing the course, the students will be able to: -	
CO1	Analyze the behavior of different digital blocks using SystemVerilog.
CO2	Apply the SystemVerilog verification features for effective and efficient verification.
CO3	Analyze the system through Coverage and Assertion based verification.
CO4	Develop Verification Environment for Digital System.

Reference Books	
1.	SystemVerilog for Verification-A Guide to Learning the Testbench Language Features, Chris Spear, Greg Tumbush, 3rd edition, 2014, Springer New York, ISBN 978-1-4899-9500-1
2.	RTL Modeling with SystemVerilog for Simulation and Synthesis Using SystemVerilog for ASIC and FPGA, Stuart Sutherland, Sutherland HDL, Incorporated, ISBN-9781546776345, 1546776346, 2017.
3.	IEEE Standard for SystemVerilog--Unified Hardware Design, Specification, and Verification Language, IEEE, 2024, doi: 10.1109/IEEESTD.2024.10458102.
4.	The UVM Primer-A Step-By-Step Introduction to the Universal Verification Methodology, Ray Salemi, Boston Light Press, 2013, ISBN:9780974164939, 0974164933
5.	Advanced Digital Design with the Verilog HDL, Michael D. Ciletti, 2nd Edition, 2015, PHI, ISBN: 978–0–07– 338054–4

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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 upto 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10**)** Real time problem solving (10) **ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis **(20 Marks)**, lab test **(10 Marks)** and Innovative Experiment/ Concept Design and Implementation (**20 Marks)** adding up to 50 Marks.	**50**
	MAXIMUM MARKS FOR THE CIE THEORY	**150**

RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR THE SEMESTER END EXAMINATION (LAB)		
Q. NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Execution	20
3	Viva	20
	TOTAL	**50**

Semester: VI						
COMPUTER NETWORKS AND PROTOCOLS **Category: Professional Core Course** **(Theory & Practice)**						
Course Code	**:**	EC363IA		**CIE**	**:**	150 Marks
Credits: L: T:P	**:**	3:0:1		**SEE**	**:**	150 Marks
Total Hours	**:**	40 L+13 P		**SEE Duration**	**:**	03+03 Hours

Unit-I	**08 Hrs**
Computer Networks and the Internet: Internet, Protocol, Network Edge, Network Core, Access Networks and Physical Media, Delay and Loss in Packet-Switched Networks, Protocol Layers and Their Service Models, Internet Backbones, NAPs, and ISPs. Network models, OSI, TCP/IP. Physical Layer: Introduction to Guided and unguided physical media.	
Unit – II	**08 Hrs**
Local Area Networks and Connecting Devices: Data Link layer Services, Data link control-Framing, Flow & error control, Multiple Access Protocols-Random Access protocols**,** LAN Addresses and ARP, IEEE 802.3 LANs, Ethernet, Hubs, Bridges, and Switches, Virtual LAN, PPP: The Point-to-Point Protocol, X.25 and Frame Relay. IEEE 802.11 LANs, Host Configuration (DHCP).	
Unit –III	**08 Hrs**
Network Layer-Logical Addressing& Internet Protocol: Network Layer, Logical Addressing, IPV4 Addresses, Structure, Address Space, Classful Addressing, Classless Addressing, Network Address Translation. IPv6 Addresses, Structure, Address Space of IPV6, Transition from IPV4 to IPV6, IPsec Forwarding. Subnet addressing. Inter- and intra-domain routing. Datagram networks; virtual circuits. RIP, OSPF, BGP, Mobility and Mobile IP.	
Unit –IV	**08 Hrs**
Transport Layer: Process to Process Delivery, Connectionless Versus Connection Oriented Service, UDP, and TCP. Congestion control and resource allocation-Issues in resource allocation, Queuing disciplines congestion control. Slow start. Fast retransmit. Fast recovery. Rate-based congestion control. Congestion avoidance mechanisms. **Application Layer:** Overview of HTTP-User sever interaction-Cookies, FTP, Electronic mail in internet, DNS.	
Unit –V	**08 Hrs**
Multimedia Networking: Properties of Audio, Types of multimedia Network Applications. **Streaming Stored Video:** UDP Streaming, HTTP Steaming, Adaptive steaming and DASH, Content distribution Networks. Case studies: Netflix, You Tube and Kankan. **Network Support for Multimedia:** Dimensioning Best-Effort Networks. Providing multiple classes of service, Diffser Per-connection Quality of Service (QoS).	

Laboratory Experiments:
1. a) Implement Bit stuffing Algorithm. b) Character stuffing algorithms c) Cyclic Redundancy Check codes for error detection using C. 2. Implement Encryption and Decryption algorithms using C. 3. Implement following Minimum Spanning Tree algorithms using C: i) Kruskal's Algorithm ii) Prim's Algorithms 4. Implement STOP and WAIT protocol using socket programming. 5. Implement RSA algorithm using C. 6. Test and verify Network configurations using Packet Tracer. 7. Configure Inter VLAN network using Packet Tracer. 8. Configure and test a given network using Packet Tracer. 9. Simulate & Analyze CSMA/CD and CSMA/CA Protocols. 10. Design an Ethernet network comprising of 25 nodes and calculate Packet delivery ratio given the packet size to be 1024 bytes, consider the following application layer protocols a) FTP b) CBR 11. Open Ended Experiment.

Course Outcomes (CO): After completing the course, the students will be able to: -	
CO1	Acquire the knowledge of network architecture, topologies, and security issues.
CO2	Design a network for given configuration by assigning IP addresses.
CO3	Analyze various aspects involved in network control and traffic management.
CO4	Analyze the performance of various scheduling algorithms.

Reference Books	
1.	Computer Networks- A System Approach, Larry L Peterson, Bruce S Davie, 4th Edition, 2007, Elsevier Publication, ISBN: 978-0123705488.
2.	Data Communication and Networking, B Forouzan, 4th Edition, 2006, TMH, ISBN: 0-07-010829-3.
3.	Computer Networks, James F. Kurose, Keith W. Ross, 2nd Edition, 2003, Pearson Education, ISBN: 0199217637.
4.	Computer Communication Networks, Andrew S Tanenbaum and David J Wetherall, 5th Edition, 2010, Person Education.
5.	Multimedia Networks: Protocols, Design and Application Hans W. Barz, Gregory A. Bassett, Wiley Publication, ISBN: 978-1-119-09013-7.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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 upto 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10**)** Real time problem solving(10) **ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis **(20 Marks)**, lab test **(10 Marks)** and Innovative Experiment/ Concept Design and Implementation **(20 Marks)** adding up to 50 Marks.	**50**
	MAXIMUM MARKS FOR THE CIE THEORY	**150**

RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR THE SEMESTER END EXAMINATION (LAB)		
Q. NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Execution	20
3	Viva	20
	TOTAL	**50**

Semester: VI						
DIGITAL SIGNAL PROCESSING AND MACHINE LEARNING **Category: Professional Core Course** **(Theory)** **(Common to EC & EI)**						
Course Code	**:**	EC364TA		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Digital Filters: Introduction, ideal frequency selective filter, non-ideal frequency selective filter, discrete time frequency selective filter described by difference equation. **IIR Filter:** Characteristic of Analog filter: Butterworth (derivation), comparison of Butterworth, Chebyshev, Elliptic, Bessel filter. Analog to digital filter transformation technique: BLT (derivation), Comparisons of bilinear transformation, impulse invariance, backword difference equation, Digital filter design for Butterworth (LP, HP, BP, BS) using Bilinear Transformation.	
Unit – II	**08 Hrs**
Design of FIR Filters: Symmetric and anti-symmetric FIR Filters, Design of Linear phase FIR Filters using Windows, Design of Linear phase FIR filters by frequency Sampling method. Comparison of Design Methods for Linear -Phase FIR filters, Applications of IIR and FIR filters. Introduction to multirate filter and adaptive filter and adaptive systems.	
Unit –III	**08 Hrs**
Machine learning algorithms: Overview of Probability Theory, Types and applications of Machine Learning, Basic types of data in machine learning, exploring structure of data, Data pre-processing, Model Selection, Stochastic gradient Descent, learning algorithms, Boosting and Regularization Paths **Supervised Learning Algorithm:** Linear Regression, logistic regression, Bayesian Linear Regression, Classification Model**,** Linear and logistic classifier, Support vector machines, k-Nearest Neighbour	
Unit –IV	**08 Hrs**
Supervised Learning Algorithm: Decision tree**,** Random Forest model, Naïve Bayes classifier. Application of Supervised Learning, Clustering, case studies on supervised machine learning. **Unsupervised Learning Algorithms:** Unsupervised vs Supervised Learning, Application of Unsupervised Learning, Clustering, K-means Clustering, Principal Component Analysis, case studies on unsupervised machine learning.	
Unit –V	**08 Hrs**
Deep Learning techniques: Introduction of Neural Network, Deep Neural Network, Various architecture of CNN, LeNet,AlexNet, ZF-Net, VGGNet, Object Detection: RCNN, Faster RCNN , YOLO, Backpropagation. Recurrent Neural Network, Long Short-Term Memory (LSTM) Cells, Generative Adversarial Networks (GANs)	

Course Outcomes (CO): After completing the course, the students will be able to: -	
CO1	Know the characteristics and structures of IIR, FIR and adaptive systems
CO2	Use the concept of filter design, machine learning to analyse and acquire knowledge about the system and select proper tools for further analysis.
CO3	Design, implementation, analysis and comparison of digital filters for processing of discrete time signals and also various machine learning algorithms.
CO4	Assess the techniques, skills, and modern engineering tools necessary for analysis of different signals and filtering out noise signals in engineering practice

Reference Books	
1.	Digital Signal Processing, Proakis G, Dimitris G. Manolakis; PHI, 4th Edition; 2007; ISBN: 978-0131873742.
2.	Discrete Time Signal Processing, Alan. V.Oppemheim, PHI, 2nd Edition, 1998; ISBN:0-13-754920-2.
3.	Pattern Recognition and Machine Learning, Christopher M Bishop, Springer, 2006, ISBN-13: 978-0387-31073-2.
4.	The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani, and Jerome Friedman, Springer, 2008, ISBN 978-0387848570.
5.	Deep Learning, Goodfellow, Y, Bengio, A. Courville, MIT Press, 2016, ISBN-0262035618.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10**)** Real time problem solving (10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
LOW POWER VLSI DESIGN **Category: Professional Core Elective** **(GROUP-D)** **(Theory)**						
Course Code	**:**	EC365TDA		**CIE**	**:**	100 Marks
Credits: L: T: P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Introduction: Need For Low Power VLSI Design, Sources of Power Dissipation, Power Dissipation in CMOS Circuits: Short Circuit Power, Dynamic Power, Load Capacitance Charging and Discharging, Static Power: Leakage Currents, Static Currents, Emerging Low Power Approaches and Limits. Physics of Power Dissipation in CMOS Devices, MIS Structure, Long Channel Effect, Sub-Micron MOSFET, Gate Induced Drain Leakage.	
Unit – II	**08 Hrs**
Power Estimation: Signal Modeling and Probability Calculation, Probabilistic Techniques for Signal Activity Estimation, Statistical Techniques, Estimation of Glitching Power, Power Estimation using Input Vector Compaction, Power Estimation at Circuit Level, Information Theory-based Approach	
Unit –III	**08 Hrs**
Device and Technology Impact on Low Power Electronics: Introduction, Dynamic Dissipation in CMOS, Effects of VDD and Vt on speed, Constraints on Vt Reduction, Transistor and Gate Sizing, Transistor Sizing and Optimal Gate Oxide Thickness (Quantitative analysis only) Impact of Technology Scaling. **Power Estimation at Logic Level:** Equivalent Pin Ordering, Network Restructuring and Reorganization, Technology and Device Innovations, Gate Reorganization, Signal Gating, Logic Encoding, State Machine Encoding, Pre-computational Logic, Power gating Techniques, Clock Gating Techniques, Power Gating Technique.	
Unit –IV	**08 Hrs**
Low Power Circuit Techniques: Introduction, Power consumption in circuits, Circuit design styles, Analysis of adders, multipliers, Flip- Flops and Latches, Low Power Cell Library. Low power SRAM architectures: SRAM organization, MOS SRAM cells-4T and 6T, Banked organization of SRAMs, Reducing voltage swings on bit-lines, Reducing power in write driver circuits, Reducing power in sense amplifier circuits.	
Unit –V	**08 Hrs**
Synthesis for Low Power: Behavioral level transforms: Architecture-Driven Voltage Scaling, Power reduction using Operation**,** Reduction and Substitution, logic level optimizations: circuit level transforms, CMOS gates, Power Reduction in Clock Networks: power dissipation in clock distribution, single driver Vs distributed buffers, zero skew Vs tolerable skew, CMOS Floating Nodes, Low Power Bus, Delay Balancing, Energy recovery CMOS and Adiabatic computation.	

Reference Books	
1.	Low-Power CMOS VLSI Circuit Design, Kaushik Roy and Sharat Prasad, 2009, John Wiley India press, ISBN: 978-81-265-2023-7.
2.	Practical Low Power Digital VLSI Design, Gary K. Yeap, 2009, Kluwer Academic Publishers, ISBN: 978-1-4613-77778-8.
3.	Low Power Design Methodologies, Jan M. Rabaey and Massoud Pedram, 5th Reprint, Kluwer Academic Publishers, ISBN: 978-1-4613-5975-3, 2002.
4.	Low Power CMOS design, Anantha Chandrakasan and Robert W. Brodersen, 1998, Wiley-IEEE press, ISBN: 0-7803-3429-9.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding up to 150 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
EVOLUTION OF COMMUNICATIONS: 4G TO 6G **Category: Professional core Elective** **(GROUP- D)** **(Theory)**						
Course Code	**:**	EC365TDB		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Introduction of Wireless Communications: Introduction to 3GPP Specs. Introduction to wireless communications; Evolution: 1G, 2G, 3G, 4G and 5G. Fundamentals of mm Wave and cm Wave. List of 3GPP. Road map for 5G. **4th Generations:** Basics to Advanced LTE concepts. History and Futures of wireless communications. Multiple access, Duplexing techniques. Functionality of SIM. Access and Non-Access Stratum, LTE Evaluation and network architecture, Interfaces, Basics of eNB, MME, gateway, policy and charging rules, HSS, User plane and Control Plane, LTE protocol stack. LTE mobility, definition of cell, tracking area, cell identifications, NAS procedures, EMM and ESM procedure. EMM and RRC states. UE Identifiers. LTE use cases and features, Carrier aggregation, multiple antenna techniques, support of relay nodes. LTE with MIMO.	
Unit – II	**08 Hrs**
Use cases of 5G: Use cases of 5G as per standards, example eMBB, mMTC, URLLC,V2X.Network Architecture; Reference Point System Architecture, Service Based System Architecture and Network Functions. **5G Fundamentals Base Station:** Base Station Architecture, CU-DU Split Base Station and CP-UP, Standalone Base Station and Non-Standalone Base Station. Basics of antennas in bases stations and Base station classes; Antenna Architecture basics and Base Station Classes.	
Unit –III	**08 Hrs**
Network Interfaces: Xn interface, F1 interface, E1 interface, NG interface and X2 interface. **Protocol stack:** Protocol Stacks, User Plane and Control Plane. **RRC states:** RRC Idle, RRC Connected and RRC Inactive.	
Unit –IV	**08 Hrs**
Call Management in NR & 5G Signalling: Call Management; Registration Management, Connection Management, Access Control. **5G Signalling;** Signalling Radio Bearers, PDU Sessions, QoS **MIMO & Beam:** Introduction to MIMO and Beam forming, ABF, DBF. Beam Types Analog, digital and hybrid beamforming.	
Unit –V	**08 Hrs**
5G V2X:5G Core functions and V2X application, server,5G V2X Landscape, 3GPP NR-V2X Architecture,NR-V2X Registration and V2X PDU establishment,NR-V2X PC5 communications,NR-V2X PQI, 5QI and V2X Network Slicing,5G V2X Mobility and Mobile Edge Computing,5G V2X use cases	

Course Outcomes (CO): **After completing the course, the students will be able to:-**	
CO1:	Recall the requirements and key functionalities of 4G LTEA/5G NR technology
CO2:	Compare various channel access technologies and modulation techniques used in 5G wireless systems
CO3:	Illustrate the architecture of 5G and its NextGen core network.
CO4:	Apply the 5G concepts to D2D communications. Demonstrate the concept of massive MIMO, V2X & THz

Reference Books	
1.	5G Mobile Communications Concepts and Technologies, Saad Z. Asif, CRC Press, 2019.
2.	Evolution of Air Interface Towards 5G: Radio Access Technology and Performance Analysis, Suvra Sekhar Das and Ramjee Prasad, Denmark: River Publishers series in Communication, 2018.
3.	5G Mobile Communications, Wei Xiang, Kan Zheng, Xuemin (Sherman) Shen, Springer publications,2016
4.	5G Wireless: A Comprehensive Introduction, William Stallings, Pearson Education, 2021.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10**)** Real time problem solving (10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
AUTOMOTIVE EMBEDDED SYSTEM DESIGN **Category: Professional Core Elective** **(GROUP-D)** **(Theory)**						
Course Code	**:**	EC365TDC		**CIE**	**:**	100 Marks
Credits: L: T: P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Automotive Systems Overview: Automotive Vehicle Technology, Overview of Vehicle Categories, Various Vehicle Sub Systems like Chassis, Body, Driveline, Engine technology, Fuelling technology, vehicle Emission, Brakes, Suspension, Emission, Doors, Dashboard instruments, Wiring Harness, Safety & Security, Comfort &Infotainment, Communication & Lighting, Future Trends in Automotive Embedded Systems: Hybrid Vehicles, Electric Vehicles.	
Unit – II	**08 Hrs**
Automotive Sensors and Actuators: Automotive Control System Applications of Sensors and Actuators. **Sensors:** Air Flow Sensor, Engine Crankshaft Angular Position Sensor, Throttle Angle Sensor, Temperature Sensor, Sensors for Feedback Control, Sensors for Driver Assistance System: Radar, Lidar,Video Technology. **Actuators:** Solenoids, Piezo Electric Force Generators, Fluid mechanical Actuators, Electric Motors and Switches.	
Unit –III	**08 Hrs**
Automotive Control System Design-I: Digital Engine Control, Features, Control Modes for Fuel Control, Discrete Time Idle Speed Control, EGR Control, Variable Valve Timing Control, Electronic Ignition Control, Integrated Engine Control System.	
Unit –IV	**08 Hrs**
Automotive Control System Design-II: Cruise Control System, Cruise Control Electronics, Anti-locking Braking System, Electronic Suspension System, Electronic Steering Control, Four-Wheel Steering, ADAS Systems, Autonomous Vehicles, Application of IoT in automotives	
Unit –V	**08 Hrs**
Automotive Protocols: LIN, MOST, Flex Ray, Test, Calibration and Diagnostics tools for networking of electronic systems like ECU Software and Testing Tools, ECU Calibration Tools, Vehicle Network Simulation, Advanced Trends in Automotive Electronics: AUTOSAR Architecture.	

Course Outcomes (CO):
After completing the course, the students will be able to: -

CO1	Understand the fundamentals of different Automotive Systems.
CO2	Integrate various sensors and actuators into automotive systems, and understanding their functionalities in vehicle control and monitoring.
CO3	Design control systems specifically applied to automotive engineering, including engine control, transmission control, chassis control, and vehicle dynamics control.
CO4	Provide technical embedded solutions for the development of automotive Systems.

Reference Books

1. Understanding Automotive Electronics-An Engineering Perspective, William B. Ribbens, 7th Edition, Butterworth-Heinemann Publications.
2. Automotive Electronics Handbook, Robert Bosch, 2004, John Wiley and Sons, ISBN-0471288357

3.	Automotive Control Systems for Engine Driveline and Vehicle, Kiencke, Uwe, Nielsen, Lars, 2nd Edition, Springer Publication.
4.	Vehicle Safety Communications: Protocols, Security and Privacy, Tao Zhang, Luca Delgrossi, Wiley Publication.
5.	Automobile Electrical and Electronic Systems, Tom Denton, 4th Edition, Routledge, 2012.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
	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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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 upto 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10**)** Real time problem solving(10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**
RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
DATA STRUCTURES AND ALGORITHMS **Category: Professional Core Elective** **(GROUP-D)** **(Theory)**						
Course Code	**:**	EC365TDD		**CIE**	**:**	100 Marks
Credits: L: T: P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Introduction to Data Structures: Introduction to OOP concepts with C++, Introduction to data representation, Linear Lists, Linked Representation. **Algorithms:** Definition, Properties, Performance Analysis-Space Complexity, Time Complexity, Asymptotic Notations	
Unit – II	**08 Hrs**
Stack and Queue: Stack and queue implementation using linear list and linked list. Stack application- Parenthesis matching. Time Complexity Analysis of stack and Queue operations. **Maps and Dictionaries:** Map ADT – List based Implementation – Hash Tables – Dictionary ADT – Complexity.	
Unit –III	**08 Hrs**
Binary Trees: Trees, Binary Trees, Properties and Representation of Binary Trees-Formula Based Representation, Linked Representation, Common Binary Tree Operations. **Binary Search Tree (BST):** Organizing data in a BST, Inserting and deleting items in a BST, Time complexity analysis of Binary and Binary search trees.	
Unit –IV	**08 Hrs**
Priority Queues (Heaps): Model, Simple Implementations, Binary Heap, Leftist Heaps, Time complexity analysis of heaps and leftist trees. **Graph Algorithms:** Definitions, Properties of graphs, Representation of Graphs, Shortest-Path Algorithms, Network Flow Problems, Minimum Spanning Tree, Depth-First Search, Breadth-First Search.	
Unit –V	**08 Hrs**
Algorithm Design Techniques: Greedy Algorithms, Divide and Conquer. Analysis of Bubble sort, Merge sort, Binary Searching based on the design techniques. Time Complexity Analysis of Design Techniques. **Dynamic Programming:** Basics, matrix chain multiplication, DP solution for traveling salesman and 0/1 Knapsack problems	

Course Outcomes (CO): **After completing the course, the students will be able to: -**	
CO1	Acquire the knowledge of importance of data structures in computer programs.
CO2	Implement classic data structures: array lists, linked lists, stacks, queues, heaps, binary trees, graphs
CO3	Choose the appropriate data structure and algorithm design method for a specified application.
CO4	Evaluate the performance of various algorithms built using different data structures.

Reference Books	
1.	Data Structures, Algorithms, and Applications in C++, Sartaj Sahni, 2nd Edition, University Press, ISBN: 9788173715228, 9788173715228.
2.	Data Structures Through C++, Yashwanth Kanitkar, 4th Edition, BPB Publications, ISBN: 9789355511881.
3.	Data Structure and Algorithm in C++, Adam Drozdek, 4th Edition, Course Technology Ptr, ISBN-13: 978-1133608424.
4.	Algorithms in a Nutshell, George T. Heineman, Gary Pollice, and Stanley Selkow., 1st Edition, Oreilly & Associates Inc, ISBN-13: 978-0596516246.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
	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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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 upto 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10**)** Real time problem solving(10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**
RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
ALGORITHMS FOR VLSI DESIGN AUTOMATION **Category: Professional Core Elective** **(GROUP-D)** **(Theory)**						
Course Code	**:**	EC365TDE		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Architectural Level Synthesis and Scheduling Algorithms: Introduction, Circuit specification for architectural level synthesis, A model for scheduling problems, Scheduling without and with resource constraints, Scheduling algorithms for extended sequencing models, Scheduling pipelined circuits, Resource sharing and binding.	
Unit – II	**08 Hrs**
Data Structure and Basic Algorithms: Basic Terminology, Graph Search Algorithms, Computational Geometry Algorithms, Basic Data structures. **Partitioning:** Problem Formulation, Classification of Partitioning Algorithms, Group migration Algorithms, Simulated Annealing and evolution algorithm, other partitioning algorithms	
Unit –III	**08 Hrs**
Floor Planning and Pin Assignment: Problem formulation, classification, Constraint based, Integer programming based, rectangular Dualization, simulated evolution floor planning algorithms. **Placement:** Problem formulation, Classification, Simulation based, Partitioning based Placement Algorithms	
Unit –IV	**08 Hrs**
Global Routing: Problem formulation, Classification, Maze routing Algorithms, Line Probe Algorithms, shortest path-based Algorithms, Steiner tree-based Algorithms **Detailed Routing:** Problem formulation, Classification single Layer routing, General River routing, Single row routing	
Unit –V	**08 Hrs**
Channel, Clock and Power Routing: Two-layer channel routing Algorithms, Design considerations for the clocking system, delay calculation for clock trees, Problem formulation, Clock routing Algorithms, H-tree based Algorithms, MMM Algorithms, Geometric matching based Algorithms, Introduction to compaction, shadow propagation algorithm.	

Course Outcomes: **After completing the course, the students will be able to: -**	
CO1	Analyze each stage of VLSI design flow to develop a CAD tool for physical design.
CO2	Apply design knowledge to develop algorithms for VLSI design automation.
CO3	Evaluate the algorithms for optimizing VLSI design with respect to speed, power and area.
CO4	Create an optimized VLSI IC design technique using various algorithms.

Reference Books	
1.	Synthesis and Optimization of Digital Circuit, 1994, Giovanni De Micheli, McGraw- Hill, ISBN: 10- 0070163332.
2.	Algorithms for VLSI Physical Design Automation, N.A. Sherwani, 2002, Kluwar Academic Publishers, ISBN: 0-7923-8393-1.
3.	An Introduction to VLSI Physical Design, M Sarraf Zadeh, C K Wong, 1996, McGraw Hill, ISBN:0070571945.
4.	Algorithms for VLSI Design Automation, S.H. Gerez, 1998, John Wiley & Sons, ISBN: 978-0-471 98489-4.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
	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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10**)** Real time problem solving (10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**
RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
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3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
REAL TIME SYSTEMS **Category: Professional Core Elective** **(GROUP-D)** **(Theory)**						
Course Code	**:**	EC365TDF		**CIE**	**:**	100 Marks
Credits: L: T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Tota Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Introduction: Real-Time Systems, Application of Real Time Systems, Basic Model Real Time Systems, Characteristics of Real Time Systems, Safety & Reliability, Types of Real Time Tasks, Timing Constraints, Modelling Timing Constraints.	
Unit – II	**08 Hrs**
Real-Time Task Scheduling-I: Types of Real Time Tasks & Characteristics, Task Scheduling, Clock-Driven Scheduling: Table Driven Scheduling, Cyclic Schedulers, A Generalized Task Schedulers, Comparison of Cyclic with Table Driven Scheduling, Hybrid Schedulers, Event Driven Scheduling, Earliest Dead Line First (EDF) Scheduling, Implementation of EDF, Shortcoming of EDF.	
Unit –III	**08 Hrs**
Real-Time Task Scheduling-II: Rate Monotonic Algorithm (RMA), Advantages & Disadvantages of RMA, Deadline Monotonic Algorithm (DMA), Context Switching Overhead, Self-Suspension, Self-Suspension with Context Switching Overhead, Issues in RMA for Practical Situations: Handling Tasks with Long Periods, Handling Aperiodic & Sporadic Tasks, Coping with Limited Priority Levels, Dealing with Task Jitter.	
Unit –IV	**08 Hrs**
Handling Resource Sharing & Dependencies: Introduction, Priority Inversion, Priority Inversion Protocol(PIP), Highest Locker Protocol(PLP),Priority Ceiling Protocol(PCP), Different Types of priority Inversion under PCP, Important Features of PCP, Issues in using a Resource Sharing Protocol: Using PCP in Dynamic Priority Systems, Comparison of Resource Sharing Protocol, Handling Task Dependencies.	
Unit –V	**08 Hrs**
Commercial Real Time Operating Systems: Time Services: Clock Interrupt Processing, Providing High Clock Services, Timers, Features of RTOS, UNIX as RTOS: Non-Pre-emptive Kernels, Dynamic Priority Kernel, POSIX: Overview, Task Management, Synchronization, IPC, Survey of Contemporary RTOSs: FreeRTOS, VxWorks, QNX Neutrino RTOS, Micrium OS (µC/OS), NuttX, Lynx, Benchmarking Real Time Systems: Rhealstone Metric, Interrupt Processing Overhead, Tri dimensional Measure, Determining Kernel Pre-emptability	

Course Outcomes (CO): After completing the course, the students will be able to: -	
CO1	Explain the fundamental concepts of real-time systems, importance of timing constraints and the consequences of failing to meet them.
CO2	Understand various real-time scheduling algorithms and apply these algorithms to ensure that tasks are completed within their deadlines.
CO3	Analyze the timing behavior of real-time systems and verify that they meet their timing constraints.
CO4	Apply RTOS in embedded systems and select suitable RTOS requirements of embedded real-time applications.

Reference Books	
1.	Real-Time Systems: Theory & Practice, Rajib Mall, Pearson Education,2007, ISBN:8131700690
2.	Real-Time Embedded Systems and Components, Sam Siewert, 2007, Cengage Learning India Edition, ISBN: 9788131502532
3.	Real time systems, Krishna CM and Kang Singh G, 2003, Tata McGraw Hill, ISBN: 0-07-114243-64.
4.	Real-Time Concepts for Embedded Systems, Qing Li and Carolyn Yao, 2003 CMP Books, ISBN:1578201241.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10**)** Real time problem solving (10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**
RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
FUNDAMENTALS OF AEROSPACE ENGINEERING **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	AS266TEA		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	45 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Basics of Flight Vehicles: History of aviation, International Standard atmosphere (ISA), Temperature, pressure and altitude relationships, Simple Problems on Standard Atmospheric Properties, Classification of aircrafts, Anatomy of an aircraft & Helicopters, Basic components and their functions.	
Unit – II	**08 Hrs**
Aircraft Aerodynamics: Bernoulli's theorem, Centre of Pressure, Lift and Drag, Types of Drag, Aerodynamic Coefficients, Aerodynamic Centre, Wing Planform Geometry, Airfoil Nomenclature, Basic Aerodynamic characteristics of Airfoil, Simple Numericals on Lift and Drag.	
Unit –III	**08 Hrs**
Aerospace Propulsion: Introduction, Turbine Engines: Brayton Cycle, Operation of Turbojet, Turboprop, Turbofan, Turboshaft, RAMJET and SCRAMJET Engines, Rocket Engines: Principles of operation of Solid, Liquid, Hybrid, Nuclear and Electric Rockets. **Introduction to Space Mechanics:** Basic Orbital Mechanics-Types of Trajectories, Escape and Orbital Velocities, Kepler's Laws of Planetary Motion, Simple Numericals.	
Unit –IV	**08 Hrs**
Aerospace Structures and Materials: General types of construction-Monocoque, Semi-Monocoque & Geodesic, Structure of Wing and Fuselage, Metallic and Composite Materials.	
Unit –V	**08 Hrs**
Aircraft Systems & Instruments: Instrument Displays, Basic Air data systems & Pitot Probes-Mach meter, Air speed indicator, Vertical speed indicator, Altimeter. **Basics of Aircraft Systems:** Hydraulic and pneumatic systems, Electrical System, Aircraft Fuel System, Environmental Control System.	

Course Outcomes: At the end of this course the student will be able to: -	
CO1	Identify the fundamental nuances of Aerospace Engineering and appreciate their significance on the Flight Vehicles design and performance
CO2	Interpret the design parameters that influence the design of the Aerospace Vehicles systems and its sub-systems.
CO3	Evaluate critically the design strategy involved in the development of Aerospace vehicles
CO4	Categorically appraise the operation of the Aerospace Vehicles for different operating conditions.

Reference Books	
1.	Introduction to Flight, John D. Anderson, 7th Edition, 2011, McGraw-Hill Education, ISBN 9780071086059.
2.	Fundamentals of Aerodynamics, Anderson J. D, 5th Edition, 2011, McGraw-Hill International Edition, New York ISBN:9780073398105.
3.	Rocket Propulsion Elements, Sutton G.P., 8th Edition, 2011, John Wiley, New York, ISBN: 1118174208, 9781118174203.
4.	Aircraft structural Analysis, T.H.G Megson, 2010, Butterworth-Heinemann Publications, ISBN: 978-1-85617-932-4.
5.	Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, Ian Moir, Allan Seabridge, John Wiley & Sons, 3rd Edition, 2011, ISBN: 9781119965206.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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 upto 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
HEALTHCARE ANALYTICS **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	BT266TEB		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Introduction to tools and databases: Introduction to Bioinformatics, Goals, Scope, Applications, Sequence databases, Structure databases, Special databases – genome and microarray, Applications of these databases, examples, Database similarity search: Unique requirements of database searching, Heuristic Database Searching, Basic Local Alignment Search Tool (BLAST), FASTA, Comparison of FASTA and BLAST, Database Searching with Smith-Waterman Method	
Unit – II	**08 Hrs**
Sequence Analysis: Types of Sequence alignment -Pairwise and Multiple sequence alignment, Alignment algorithms, Scoring matrices, Statistical significance of sequence alignment. Multiple Sequence Alignment: Scoring function, Exhaustive algorithms, Heuristic algorithms, Profiles and Hidden Markov Models: Position-Specific scoring matrices, Profiles, Markov Model and Hidden Markov Model, Scoring matrices – BLOSSUM and PAM **Molecular Phylogenetics:** Introduction, Terminology, Forms of Tree Representation. Phylogenetic Tree Construction Methods - Distance-Based, Character-Based Methods and Phylogenetic Tree evaluation.	
Unit –III	**08 Hrs**
Introduction to Next-Generation Sequencing (NGS) analysis: Sanger sequencing principles - history and landmarks, of Sequencing Technology Platforms, A survey of next-generation sequencing technologies, A review of DNA enrichment technologies, Base calling algorithms, Base quality, phred values, Reads quality checks, Interpretations from quality checks. Adapter and primer contamination. Processing reads using clipping of reads-Advantages and disadvantages of processing of reads, automation in NGS analysis and advantages (shell scripting)	
Unit –IV	**08 Hrs**
Structural analysis & Systems Biology: Gene prediction programs – ab initio and homology-based approaches. ORFs for gene prediction. Detection of functional sites and codon bias in the DNA. Predicting RNA secondary structure, Protein structure basics, structure visualization, comparison and classification. Protein structure predictive methods using protein sequence, Protein identity based on composition. Structure prediction - Prediction of secondary structure, tertiary structure prediction methods, Scope, Applications. Concepts, implementation of systems biology, Mass spectrometry and Systems biology, Flux Balance analysis.	
Unit –V	**08 Hrs**
Drug Screening: Introduction to Computer-aided drug discovery, target selection, ligand preparation and enumeration, molecular docking, post-docking processing, molecular dynamics simulations, applications and test cases, AI/ML in Drug discovery	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Gain proficiency in utilizing a range of bioinformatics tools and databases for comprehensive sequence and structural analysis.
CO2	Investigate and apply innovative sequencing technologies and analytical methods to solve complex biological questions and advance research in genomics and molecular biology.
CO3	Demonstrate expertise in NGS technologies, including performing data quality assessments, read processing, and managing large-scale data.
CO4	Apply bioinformatics tools for modeling and simulating biological processes, with a focus on gene prediction using both ab initio and homology-based approaches.

Reference Books	
1	Essential bioinformatics, Xiong J, Cambridge University Press, 2006 Mar 13.
2.	Bioinformatics basics: Applications in Biological Science and Medicine, Buehler LK, Rashidi H H, CRC Press; 2005 Jun 23.
3.	Bioinformatics Principles and Applications, Ghosh Z, Mallick B M, Oxford University Press; 2018 Jun 13.
4.	Introduction to Next Generation Sequencing Technologies Bioinformatics, Low L, Tammi M T. World Scientific. 2017 Jul 26:1-21.
5.	Bioinformatics: Sequence and Genome Analysis, D W Mount, CSHL Press, 2nd Edition, ISBN: 9780879697129,2014.
6.	Computational Systems Biology; A Kriete and R Eils, Academic Press; Illustrated Edition, ISBN: 978-01-208-87866,2006.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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 upto 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
INDUSTRIAL SAFETY ENGINEERING **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	CH266TEC		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	45L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Introduction Safety: Introduction to industrial safety engineering, major industrial accidents, safety and health issues, key concepts and terminologies, Hazard theory, Hazard triangle, Hazard actuation, Actuation transition, Causal factors, problems on OSHA	
Unit – II	**08 Hrs**
Risk assessment and control: Risk assessment, Risk perception, acceptable risk, problems on net present value, internal rate of return, payback period concepts including real life examples. **Hazard Identification Methods:** Preliminary Hazard List (PHL), worksheets, case study. Preliminary Hazard Analysis (PHA), Fault tree and Event tree analysis. Design and development of fault tree and event tree for high pressure reactor system.	
Unit –III	**08 Hrs**
Hazard analysis: Hazard and Operability Study (HAZOP): Guide words, HAZOP matrix, Procedure, HAZOP studies on reactors, heat exchanger, design of HAZOP table, Failure Modes and Effects Analysis (FMEA) concept, methodology, problems of FMEA, examples.	
Unit –IV	**08 Hrs**
Risk analysis on capital budgeting: Risk adjusted discount rate (RADAR) method, certainty equivalent approach, scenario analysis, probability distribution, quantification of risk using statistical parameters and associated problems.	
Unit –V	**08 Hrs**
Safety in process industries and case studies: Personnel Protection Equipment (PPE): Safety glasses, face shields, welding helmets, absorptive lenses, hard hats, types of hand PPE, types of foot PPE, types of body PPE. Bhopal gas tragedy, Chernobyl nuclear disaster, Chemical plant explosion and fire.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the risk assessment techniques used in process industry
CO2	Interpret the various risk assessment tools.
CO3	Use hazard identification tools for safety management.
CO4	Analyze tools and safety procedures for protection in process industries.

Reference Books	
1.	Functional Safety in the Process Industry: A Handbook of practical Guidance in the application of IEC61511 and ANSI/ISA-84, Kirkcaldy K.J.D Chauhan, 2012, North corolina, Lulu publication, ISBN:1291187235.
2.	Safety Instrumented Systems Verification Practical probabilistic calculations, Goble and William M., 2005, Pensulvania ISA publication, ISBN:155617909X.
3.	Industrial safety and risk Management, Laird Wilson and Doug Mc Cutche, 1st Edition, 2003, The University of alberta press,Canada, ISBN: 0888643942.
4.	Industrial Safety, Health and Environment Management Systems, R K Jain, Sunil S Rao, 4th Edition, 2005, Khanna Publishers, New Delhi, ISBN: 8174092102.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
ROBOTIC PROCESS AUTOMATION **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	CS266TED		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Duration	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit – I	**08 Hrs**
RPA Concepts: RPA Basics, History of Automation, what is RPA? RPA vs Automation, Processes & Flowcharts, Programming Constructs in RPA, What Processes can be Automated? Types of Bots, Workloads that can be automated. **RPA Advanced Concepts**: Standardization of processes, Setting up the Centre of Excellence, RPA Development methodologies, Difference from SDLC, RPA journey, RPA business case, RPA Team, Process Design Document/Solution Design Document, Industries best suited for RPA, Risks & Challenges with RPA, RPA and emerging ecosystem.	
Unit – II	**07 Hrs**
RPA Tool Introduction: Introduction to UiPath - the User Interface, Types of Variables, Variables in UiPath, Managing Arguments, The Arguments Panel, Namespaces; Control flow statements in UiPath, Sequences and Flowcharts, Control Flow Activities Data Manipulation Introduction, Data Manipulation Operations, Types of data storing variables, Text Manipulation, main string methods. **UiPath Recording:** Basic, Desktop and Web Recording, Image and Native Citrix Recording, Input/output methods, Types of OCR, Data Scraping, Advanced Scraping techniques.	
Unit – III	**07 Hrs**
Advanced Automation Concepts: Selectors, Types of Selectors (Full, partial, dynamic), Defining and Assessing Selectors, Customization, Debugging. Image, Text & Advanced Citrix Automation – Introduction, Keyboard based automation, Information Retrieval, Best Practices Excel Data Tables & PDF, Data Tables in RPA, Excel and Data Table, Extracting Data from Data Table, Anchors, Using anchors in PDF.	
Unit – IV	**07 Hrs**
Email Automation, Exceptions and Deploying Bots: Introduction to Email Automation, Key concepts of email, email protocols, email automation in UiPath, email as input and output. Debugging and Exception Handling, Types of exception, Debugging Tools, Strategies for solving issues, Catching errors. Overview of orchestration Server, orchestrator functionalities, Connecting Bot to orchestrator.	
Unit – V	**07 Hrs**
Hyper automation: Components and application of Hyper automation, Automation versus hyper automation, Benefits and challenges of hyper automation, use cases, Phases (Integration, Discover, Orchestration and Governance), Trends in Hyper automation (low-code/no-code platform, HaaS)	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand RPA principles, its features and applications
CO2	Demonstrate proficiency in handling variables and decision making inside a workflow and data manipulation techniques
CO3	Gain insights into recording, Email Automation and exception handling and orchestrator.
CO4	Analyze the trends in automation and chose business strategy to design a real-world automation workflow.

Reference Books:	
1.	Alok Mani Tripathi, "Learning Robotic Process Automation, Publisher: Packt Publishing, Release Date: March 2018 ISBN: 9781788470940
2.	PASCAL BORNET, Intelligent automation: Welcome to the world of hyperautomation, World Scientific Publishing Company, ISBN-13: 978-9811235481 December 2020
3.	UiPath pdf manuals
4.	https://www.uipath.com/rpa/robotic-process-automation
5.	https://www.ibm.com/topics/hyperautomation
6.	https://www.pega.com/hyperautomation

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
INTELLIGENT TRANSPORTATION SYSTEMS **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	CV266TEE		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	45L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Introduction to Intelligent Transportation Systems **(**ITS): Historical background, Urbanisation, Motorisation, Transport system characteristics, Transport problems and issues, Challenges and opportunities in ITS: ITS-Today and tomorrow, ITS training and education needs, Role and importance of ITS in context of Indian Transport system and opportunity for sector growth of ITS.	
Unit – II	**08 Hrs**
ITS Architecture: introduction, Functionalities required for User service, Logical architecture, Physical architecture, Equipment and Market packages, Need of ITS Architecture to solve problems in Urban area. Technology building blocks for ITS: Introduction, Data acquisition, Communication tools, Data analysis and Traveller information. Various detection, Identification and collection methods for ITS.	
Unit –III	**08 Hrs**
Traffic management system components and ITS: Introduction, objectives, traffic management measures, ITS for traffic management, Development of traffic management system, Traffic Management Centre, Advance Traffic Management System, Advanced Traveller Information System, Advance Vehicle Control Systems, Advance Public Transport System, Commercial Vehicle Operations, ITS For Intermodal Freight Transport.	
Unit –IV	**08 Hrs**
ITS Evaluation – Project selection at the planning level, Deployment Tracking, Impact Assessment, Benefits by ITS components, Evaluation Guidelines. ITS for Law Enforcement: Introduction, Enhance and support the enforcement traffic rules and regulations, ITS Funding options.	
Unit –V	**08 Hrs**
ITS Standards-Standard development process, National ITS architecture and standards, ITS standards application areas, National Transportation Communications for ITS Protocol, Standards testing. ITS for smart cities and Case studies.	

Course Outcomes: After completing the course, the students 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.	Intelligent Transport Systems, Pradip Kumar Sarkar and Amit Kumar Jain, PHI Learning Private Limited, Delhi,2018, ISBN-9789387472068
2.	Fundamentals of Intelligent Transportation Systems Planning, Choudury M A and Sadek A, Artech House publishers (31 March 2003); ISBN-10: 1580531601
3.	Intelligent transportation systems standards, Bob Williams, Artech House, London, 2008. ISBN-13: 978-1-59693-291-3

4.	Intelligent Transport Systems: Technologies and Applications, Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio García Zuazola, Wiley Publishing, 2015, ISBN:1118894782 9781118894781,
5	Traffic Engineering, Pearson Educational International, R.P Roess, E.S. Prassas, W.R. McShane, 3rd Edition, 2004, ISBN-13: 978-0-13-459971-7.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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 upto 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
INTEGRATED HEALTH MONITORING OF STRUCTURES **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	CV266TEF		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Structural Health: Factors affecting Health of Structures, Causes of Distress, Regular Maintenance, Importance of maintenance **Structural Health Monitoring**: Concepts, Various Measures, Analysis of behavior of structures using remote structural health monitoring, Structural Safety in Alteration.	
Unit – II	**08 Hrs**
Materials: Piezo–electric materials and other smart materials, electro–mechanical impedance (EMI) technique, adaptations of EMI technique, Sensor technologies used in SHM **Structural Audit**: Assessment of Health of Structure, Collapse and Investigation, Investigation Management, SHM Procedures, SHM using Artificial Intelligence	
Unit –III	**08 Hrs**
Static Field Testing: Types of Static Tests, Simulation and Loading Methods, sensor systems and hardware requirements, Static Response Measurement.	
Unit –IV	**08 Hrs**
Dynamic Field Testing: Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods, Hardware for Remote Data Acquisition Systems, Remote Structural Health Monitoring.	
Unit –V	**08 Hrs**
Remote Structural Health Monitoring: Introduction, Hardware for Remote Data Acquisition Systems, Advantages, Case studies on conventional and Remote structural health monitoring **Case studies:** Structural Health Monitoring of Bridges, Buildings, Dams, Applications of SHM in offshore Structures- Methods used for non-destructive evaluation (NDE) and health monitoring of structural components	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Diagnose the distress in the structure understanding the causes and factors.
CO2	Understand safety aspects, components and materials used in Structural Health Monitoring.
CO3	Assess the health of structure using static field methods and dynamic field tests.
CO4	Analyse behavior of structures using remote structural health monitoring

Reference Books	
1.	Structural Health Monitoring, Daniel Balageas, Claus Peter Fritzen, Alfredo Güemes,2006, John Wiley and Sons, ISBN: 978-1905209019
2.	Health Monitoring of Structural Materials and Components Methods with Applications, Douglas E Adams, 2007, John Wiley and Sons, ISBN:9780470033135
3.	Structural Health Monitoring and Intelligent Infrastructure, J. P. Ou, H. Li and Z. D. Duan, Vol1,2006, Taylor and Francis Group, London, UK. ISBN: 978-0415396523
4.	Structural Health Monitoring with Wafer Active Sensors, Victor Giurglutiu, 2007, Academic Press Inc, ISBN: 9780128101612

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
ADVANCED ENERGY STORAGE FOR E-MOBILITY **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	CM266TEG		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	45L		**SEE Duration**	**:**	03 Hours

Unit-I	**07 Hrs**
Energy storage in electric vehicles: Introduction to E-mobility, background of alternative energy sources and sustainability. Types of electric vehicles and their salient features along with their energy requirement. Fundamentals of advanced battery technology. Battery characteristics. Specification of advanced battery for e mobility.	
Unit – II	**08 Hrs**
Advanced lithium-ion batteries: Basic concepts of lithium batteries. Types of advanced cathode and anode materials employed in lithium batteries. Construction, working and future applications of lithium cobalt oxide, lithium iron phosphate, Lithium air, lithium sulfur and lithium polymer batteries with their advancement in vehicle electrification.	
Unit –III	**08 Hrs**
Non lithium batteries for e-mobility: Limitations of lithium batteries. Overview of non-lithium battery technology. Construction and working of advanced non-Lithium batteries such as Lead acid, Nickel Metal Hydride, Redox flow, Zebra, Sodium and Magnesium batteries. Electrode materials and electrolyte considerations in non-lithium batteries. Performance comparison with lithium-ion batteries. Battery requirement in charging infrastructure.	
Unit –IV	**08 Hrs**
Chemistry of alternative storage devices: Introduction to super capacitor. Construction, working and applications of supercapacitors along with the materials used in electrodes. Types of advanced supercapacitors. Application of supercapacitors in regenerative braking. Advancement in battery-supercapacitor hybrid, Battery-fuel cell hybrid, and Battery-solar cell hybrid electric vehicles with their advantages and limitations.	
Unit –V	**08 Hrs**
Battery management and recycling: Battery management systems (BMS): Fundamentals of battery management systems and controls, State-of-charge (SoC), state-of-health (SoH) and Cell balancing techniques. Battery Thermal Management: Passive and active cooling systems. Safety mechanisms, thermal runaway and thermal management. Battery recycling: Economic aspects, environmental safety and process of recycling of advanced batteries.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Implement the fundamentals of chemistry in advanced energy storage and conversion devices.
CO2	Apply the chemistry knowledge used for hybridization of various energy storage and conversion devices.
CO3	Analyze the different battery system for achieving maximum energy storage for vehicle electrification
CO4	Evaluation of efficiency of a battery with respect to cost, environmental safety, material, energy consumption and recycling.

Reference Books	
1.	Battery reference book, T. R. Crompton., 3rd Edition, NEWNES Reed Educational and Professional Publishing Ltd 2000, ISBN: 07506 4625 X.
2.	Batteries for Electric Vehicles, D. A. J. Rand, R. Woods, and R. M. Dell, Society of Automotive Engineers, Warrendale PA, 2003. ISBN 10: 0768001277.
3.	Lithium Batteries, Science and Technology, GA. Nazri and G. Pistoa, Kluwer Academic Publisher, 2003, ISBN 978-0-387-92675-9.
4.	Battery Technology Handbook, H. A. Kiehne, Marcel Dekker, NYC, 2003. ISBN: 0824742494 9780824742492.
5.	Electric Vehicle Technology Explained, James Larminie and John Lowry. 2nd Edition, Wiley, ISBN-13: 978-1118505429.
6.	Electric Vehicle Technology and Design, Antoni Gandia. CRC Press, ISBN-13: 978-1138551912.
7.	Sustainable Transportation: Problems and Solutions. William R. Black, The Guilford Press, ISBN-13: 978-1462532072.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
HUMAN MACHINE INTERFACE (HMI) **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	EC266TEH		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	45L		**SEE Duration**	**:**	03 Hours

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 DevelopmentSuites.	
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 MultimodalHMI, Automotive Use-Cases **HMI Testing**: Limitations of Traditional Test Solutions, Case - Study: Bosch's HMI validation tool - GraphicsTest Systems (GTS). **UI analytics**: Usage patterns, Debugging, Performance Profiling, Use Cases.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understanding the application of HMIs in various domain.
CO2	Comparison of various communication protocols used in HMI development.
CO3	Apply and analyse the car multimedia system free software and hardware evolution.
CO4	Design and evaluate the graphic tools and advanced techniques for creating car dashboard multimedia systems.

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

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will beconducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
ENERGY AUDITING & STANDARDS **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	EE266TEJ		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**06 Hrs**
Types of Energy Audit and Energy-Audit Methodology: Definition of Energy Audit, Place of Audit, Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, Energy Monitoring and Training. **Survey Instrumentation:** Electrical Measurement, Thermal Measurement, Light Measurement, Speed Measurement, Data Logger and Data Acquisition System, **Energy Audit of a Power Plant:** Indian Power Plant Scenario, Benefit of Audit, Types of Power Plants, Energy Audit of Power Plant.	
Unit – II	**10 Hrs**
Electrical-Load Management: Electrical Basics, Electrical Load Management, Variable Frequency Drives, Harmonics and its Effects, Electricity Tariff, Power Factor, Transmission and Distribution Losses. **Energy Audit of Motors:** Classification of Motors, Parameters related to Motors, Efficiency of a Motor, Energy Conservation in Motors, BEE Star Rating and Labelling. **Energy Audit of Pumps, Blowers and Cooling Towers:** Pumps, Fans and Blowers, Cooling Towers	
Unit –III	**08 Hrs**
Communication & Standards: **Wireless technologies:** WPANs, LAN, Wireless metropolitan area network, cellular network, satellite communication, Zigbee, Bluetooth, LAN, NAN **Wireline communication:** Phone line technology, powerline technology, coaxial cable technology; Optical communication, TCP/IP networks	
Unit –IV	**08 Hrs**
Energy Audit of Boilers: Classification of Boilers, Parts of Boiler, Efficiency of a Boiler, Role of excess Air in Boiler Efficiency, Energy Saving Methods. **Energy Audit of Furnaces:** Parts of a Furnace, classification of Furnaces, Energy saving Measures in Furnaces, Furnace Efficiency **Energy Audit of Steam-Distribution Systems:** S team as Heating Fluid, Steam Basics, Requirement of Steam, Pressure, Piping, Losses in Steam Distribution Systems, Energy Conservation Methods	
Unit-V	**08 Hrs**
Energy Audit of Lighting Systems: Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures (Luminaries), Reflectors, Lenses and Louvres, Lighting Control Systems, Lighting System Audit, Energy Saving Opportunities. **Energy Audit Applied to Buildings:** Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings.	

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Explain the need for energy audit, prepare a flow for audit and identify the instruments needed.
CO2	Design and perform the energy audit process for electrical systems.
CO3	Design and perform the energy audit process for mechanical systems
CO4	Propose energy management scheme for a building
Reference Books	

1.	Handbook of energy audit, Sonal Desai, Kindle Edition, 2015, McGraw Hill Education, ISBN: 9339221346, 9789339221348.
2	Energy management handbook, Wayne C Turner and Steve Doty, 6th Edition, 2015, CRC Press, ISBN: 0-88173-542-6.
3	Energy management, Sanjeev Singh and Umesh Rathore, 1st Edition, 2016, Katson Books, ISBN 10: 9350141019, ISBN 13: 9789350141014.
4	Energy audit of building systems, Moncef Krarti, 2nd Edition, 2010, CRC Press ISBN: 9781439828717

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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 upto 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
BIOMEDICAL INSTRUMENTATION **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	:	EI266TEK		**CIE**	:	100 Marks
Credits: L:T:P	:	03:00:00		**SEE**	:	100 Marks
Total Hours	:	45L		**SEE Duration**	:	03 Hours

Unit-I	**08 Hrs**
Fundamentals: Sources of Biomedical signals, Basic medical instrumentation system, General constraints in design of medical instrumentation systems. **Bioelectric Signals and Electrodes**: Origin of bioelectric signals, Types of bioelectric signals, Recording electrodes, Electrode-tissue interface, Polarization, Skin contact impedance, Silver-silver chloride electrodes, Electrodes for ECG, EEG, EMG, Microelectrodes.	
Unit – II	**08 Hrs**
Electrocardiograph: Electrical activity of heart, Genesis and characteristics of Electrocardiograph (ECG), Block diagram description of an Electrocardiograph, ECG lead systems, Multi-channel ECG machine. **Electroencephalograph:** Genesis of EEG, Block diagram description of an EEG, 10-20 Electrode system, Computerized analysis of EEG.	
Unit –III	**08 Hrs**
Patient Monitoring System: Bedside monitors, Central Monitors, Measurement of Heart Rate, Average Heart Rate meter, Instantaneous heart rate meter, Measurement of pulse rate, Blood Pressure measurement, Direct and indirect method, Automatic blood pressure measuring apparatus using Korotkoff's method. **Oximeters:** Oximetry, ear oximeter, pulse oximeter, skin reflectance oximeter and intravascular oximeter.	
Unit –IV	**08 Hrs**
Blood Flow Meters: Electromagnetic blood flow meter, Types of electromagnetic blood flow meters, Ultrasonic blood flow meters, NMR blood flow meters, Laser Doppler blood flow meters. **Cardiac Pacemakers and Defibrillators:** Need for Cardiac pacemaker, External Pacemaker, Implantable Pacemaker, Types of Implantable Pacemaker, Ventricular Synchronous Demand Pacemaker and Programmable Pacemaker. Need for a defibrillator, DC defibrillator, Defibrillator electrodes, DC defibrillator with synchronizer.	
Unit –V	**08 Hrs**
Advances in Radiological Imaging: X-rays-principles of generation, Conventional X-ray radiography, Fluoroscopy, Angiography, Digital radiography, Digital subtraction angiography (DSA). Basic principle of computed tomography, magnetic resonance imaging system and Ultrasonic imaging system.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the sources of biomedical signals and basic biomedical instruments.
CO2	Apply concepts for the design of biomedical devices
CO3	Analyze the methods of acquisition and signal conditioning to be applied to the physiological parameters.
CO4	Develop instrumentation for measuring and monitoring biomedical parameters.

Reference Books	
1.	Handbook of Biomedical Instrumentation, R. S. Khandpur,3rd Edition, Reprint 2016, Tata McGraw-Hill, ISBN: 9780070473553.
2.	Biomedical Instrumentation and Measurements, Leslie Cromwell & others, 2nd Edition, Reprint 2015, ISBN: 9780130771315.
3.	Medical instrumentation: Application and Design, J. G. Webster, 3rd Edition, Reprint 2015, Wiley Publications, ISBN: 9788126511068.
4.	Principles of Medical Imaging, K.Kirk Shung, Michael B. Smith and Banjamin Tsui, Academic Press, 2016, ISBN: 978-0126409703.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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 upto 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**). Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
TELECOMMUNICATION SYSTEMS **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	ET266TEM		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	45 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Introduction to Electronic Communication: The Significance of Human Communication, Communication Systems, Types of Electronic Communication, Modulation and Multiplexing, Electromagnetic Spectrum, Bandwidth, A Survey of Communication Applications. **The Fundamentals of Electronics:** Gain, Attenuation, and Decibels. **Radio Receivers:** Super heterodyne receiver.	
Unit – II	**10 Hrs**
Modulation Schemes: Analog Modulation: AM, FM and PM- brief review. **Digital Modulation:** PCM, Line Codes, ASK, FSK, PSK & QAM (Architecture). **Wideband Modulation:** Spread spectrum, FHSS, DSSS. **Multiple Access:** FDMA, TDMA, CDMA.	
Unit –III	**10 Hrs**
Satellite Communication: Satellite Orbits, Satellite Communication Systems, Satellite Subsystems,Ground Stations, Satellite Applications, Global Positioning System.	
Unit –IV	**08 Hrs**
Optical Communication: Optical Principles, Optical Communication Systems, Fiber-Optic Cables, Optical Transmitters and Receivers, Wavelength-Division Multiplexing, Passive Optical Networks.	
Unit –V	**08 Hrs**
Cell Phone Technologies: Cellular concepts, Frequency allocation, Frequency reuse, Internet Telephony. **Wireless Technologies:** Wireless LAN, PANs and Bluetooth, Zig Bee, Mesh Wireless Networks, WiMax, and Wireless Metropolitan Area Networks.	

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Describe the basics of communication systems.
CO2	Analyze the importance of modulation and multiple access schemes for communication systems.
CO3	Analyze the operational concept of cell phone and other wireless technologies.
CO4	Justify the use of different components and sub-system in advanced communication systems.

Reference Books	
1.	Principles of Electronic Communication Systems, Louis E. Frenzel, 4th Edition, 2016, Tata McGraw Hill, ISBN: 978-0-07-337385-0.
2.	Electronic Communication Systems, George Kennedy,3rd Edition, 2008, Tata McGraw Hill, ISBN: 0-02-800592-9.
3.	Introduction to Telecommunications, Anu A. Gokhale, 2nd Edition, 2008, Cengage Learning ISBN: 981-240-081-8

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
MAXIMUM MARKS FOR THE CIE THEORY		**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
TOTAL		**100**

Semester: VI						
MOBILE COMMUNICATION NETWORKS AND STANDARDS **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	ET266TEN		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Principle of Cellular Communication: Cellular Terminology, Cell Structure and Cluster, Frequency Reuse Concept, Cluster size and System Capacity, Method of Locating Co-channel cells, Frequency Reuse distance, Co-channel Interference and Signal Quality, Co-channel interference Reduction Methods.	
Unit – II	**08 Hrs**
Basic Cellular system: Consideration of components of a cellular system- A basic cellular system connected to PSTN, Main parts of a basic cellular system, Operation of a Cellular system, Performance criteria- Voice quality, Trunking and Grade of Service, Spectral Efficiency of FDMA and TDMA systems	
Unit –III	**08 Hrs**
Second generation Cellular Technology: GSM: GSM Network Architecture, Identifiers used in GSM System, GSM channels, Authentication and Security in GSM, GSM Call Procedure, GSM Hand-off Procedures.	
Unit –IV	**08 Hrs**
3G Digital Cellular Technology: GPRS: GPRS technology, GPRS Network Architecture, GPRS signalling, Mobility Management in GPRS. **UMTS:** UMTS Network Architecture, UMTS Interfaces, UMTS Air Interface Specifications, UMTS Channels**.**	
Unit –V	**08 Hrs**
Wireless Personal Area Networks: Network architecture, components, Bluetooth, Zigbee, Applications. **Wireless Local Area networks:** Network Architecture, Standards, Applications. Wireless Metropolitan Area Networks: IEEE 802.16 standards, advantages, WMAN Network architecture, Protocol stack	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Describe the concepts and terminologies for Cellular Communication.
CO2	Analyze the Architecture, Hand-off and Security aspects in 2G and 3G Networks.
CO3	Compare the performance features of 2G and 3G Cellular Technologies.
CO4	Analyze and compare the architectures of various Wireless technologies and standards.

Reference Books	
1.	Wireless Communications, T.L. Singal, 2nd Reprint 2011, Tata McGraw Hill Education Private Limited, ISBN: 978-0-07-068178-1
2.	Wireless and Mobile Networks Concepts and Protocols, Dr.Sunil Kumar S Manvi, 2010, Willey India Pvt. Ltd., ISBN: 978-81-265-2069-5.
3.	Wireless Communication, Upena Dalal, 1st Edition, 2009, Oxford higher Education, ISBN-13:978-0-19-806066-6.
4.	Wireless Communications Principles and Practice, Theodore S Rappaport, 2nd Edition, Pearson, ISBN 97881-317-3186-4.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
MAXIMUM MARKS FOR THE CIE THEORY		**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
MOBILE APPLICATION DEVELOPMENT **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	IS266TEO		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	45L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Introduction: Smart phone operating systems and smart phones applications. Introduction to Android, Installing Android Studio, creating an Android app project, deploying the app to the emulator and a device. UI Design: Building a layout with UI elements, Layouts, Views and Resources, Text and Scrolling Views. Activities and Intents, The Activity Lifecycle, Managing State, Activities and Implicit Intents, The Android Studio Debugger, Testing the Android app, The Android Support Library.	
Unit–II	**08 Hrs**
User experience: User interaction, User Input Controls, Menus, Screen Navigation, Recycler View, Delightful user experience, Drawables, Styles, and Themes, Material Design, Testing app UI, Testing the User Interface	
Unit–III	**08 Hrs**
Working in the background: Async Task and Async Task Loader, Connect to the Internet, Broadcast Receivers and Services. Scheduling and optimizing background tasks – Notifications, Scheduling Alarms, and Transferring Data Efficiently	
Unit–IV	**08 Hrs**
All about data: Preferences and Settings, Storing Data, Shared Preferences. Storing data using SQLite, SQLite Database. Sharing data with content providers. Advanced Android Programming: Internet, Entertainment and Services. Displaying web pages and maps, communicating with SMS and emails, Sensors.	
Unit–V	**08 Hrs**
Hardware Support & devices: Permissions and Libraries, Performance and Security. Fire base and AdMob, Publish and Polish, Multiple Form Factors, Using Google Services.	

Course Outcomes: After completing the course, the students will be able to :-	
CO1	Comprehend the basic features of android platform and the application development process. Acquirefamiliarity with basic building blocks of Android application and its architecture.
CO2	Apply and explore the basic framework, usage of SDK to build Android applications incorporating Android features in developing mobile applications.
CO3	Demonstrate proficiency in coding on a mobile programming platform using advanced Android technologies, handle security issues, rich graphics interfaces, using debugging and troubleshooting tools.
CO4	Create innovative applications, understand the economics and features of the app marketplace by offering the applications for download.

Reference Books	
1.	Android Programming, Phillips, Stewart, Hardyand Marsicano, Big Nerd Ranch Guide, 2nd Edition, 2015, ISBN-13 978-0134171494
2.	AndroidStudioDevelopmentEssentials-Android6, NeilSmyth,2015, Create space Independent Publishing Platform, ISBN:9781519722089

3.	Android Programming–Pushing the limits, EricHellman,2013, Wiley, ISBN-13:978-1118717370
4.	Professional Android2ApplicationDevelopment, RetoMeier, Wiley India Pvt. Ltd, 1st Edition, 2012, ISBN-13:9788126525898
5.	BeginningAndroid3, Mark Murphy, A press Springer India Pvt Ltd,1st Edition,2011, ISBN-13:978-1-4302-3297-1
6.	AndroidDeveloperTraining-https://developers.google.com/training/android/ AndroidTestingSupportLibrary-https://google.github.io/android-testing-support-library/

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, 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 upto 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
ELEMENTS OF FINANCIAL MANAGEMENT **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	IM266TEQ		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	45L		**SEE Duration**	**:**	03 Hours

Unit-I	**06 Hrs**
Financial Management-An overview: Financial Decisions in a firm, Goals of a firm, Fundamental principle of finance, Organization of finance function and its relation to other functions, Regulatory framework. **The financial System:** Functions, Assets, Markets, Market returns, Intermediaries, regulatory framework, Growth and trends in Indian financial system.	
Unit – II	**10 Hrs**
Financial statements, Taxes and cash flow: Balance sheet, statement of profit and loss, items in annual report, manipulation of bottom line, Profits vs Cash flows, Taxes. **(Conceptual treatment only)** **Time Value of Money:** Future value of a single amount, future value of an annuity, present value of a single amount, present value of an annuity. **Valuation of securities:** Basic valuation model, bond valuation, equity valuation-dividend capitalization approach and other approaches.	
Unit –III	**10 Hrs**
Risk and Return: Risk and Return of single assets and portfolios, measurement of market risk, relationship between risk and return, implications. **Techniques of Capital Budgeting:** Capital budgeting process, project classification, investment criteria, Net present value, Benefit-Cost ratio, Internal Rate of return, Payback period, Accounting rate of return.**(Conceptual and Numerical treatment)**	
Unit –IV	**10 Hrs**
Long term finance: Sources- Equity capital, Internal accruals, preference capital, term loans, debentures. Raising long term finance- Venture capital, Initial Public Offer, Follow on Public Offer, Rights Issue, Private Placement, Term Loans, Investment Banking **Securities Market:** Primary market vs Secondary market, Trading and Settlements, Stock market quotations and Indices, Govt. securities market, Corporate debt market.	
Unit –V	**08 Hrs**
Working Capital – Policy and Financing: Factors influencing working capital requirements, Current assets financing policy, operating cycle and cash cycle. Accruals, trade credit, banks, public deposits, inter-corporate deposits, short term loans, right debentures, commercial paper, Factoring **(Conceptual treatment only)**	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Explain the features and elements of a financial system.
CO2	Recognize the relevance basic principles of financial management in decision making.
CO3	Describe the processes and techniques of capital budgeting and working capital financing by organizations.
CO4	Demonstrate an understanding of various sources of finance.

Reference Books:	
1.	Fundamentals of Financial Management, Prasanna Chandra, 6th Edition, 2018, McGraw Hill Education(India) Pvt. Ltd, ISBN: 978-93-392-0313-9, 93-392-0313-5
2.	Financial Management, I M Pandey, 12th Edition, 2021, Pearson, ISBN-939057725X, 978-9390577255
3.	Financial Management-Text, Problems and Cases, Khan M Y & Jain P K, 8th Edition, 2018, McGraw Hill Education (India) Pvt. Ltd, ISBN: 9353162181, 9789353162184
4.	Fundamentals of Financial Management, Eugene F Brigham, Joel F Houston, 8th Edition, 2014, Cengage Learning, ISBN: 9781285065137, 1285065131.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, 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 upto 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. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
OPTIMIZATION TECHNIQUES **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	IM266TER		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	45L		**SEE Duration**	**:**	03 Hours

Unit – I	**08 Hrs**
Introduction: OR Methodology, Definition of OR, Application of OR to Engineering and Managerial problems, Features of OR models, Limitations of OR. **Linear Programming:** Definition, Mathematical Formulation, Standard Form, Solution Space, Types of solution – Feasible, Basic Feasible, Degenerate, Solution through Graphical Method. Problems on Product Mix, Blending, Marketing, Finance, Agriculture and Personnel. **Simplex methods:** Variants of Simplex Algorithm – Use of Artificial Variables.	
Unit – II	**08 Hrs**
Simplex Algorithm: How to Convert an LP to Standard Form, Preview of the Simplex Algorithm, Direction of Unboundedness, Why Does an LP Have an Optimal basic feasible solution, The Simplex Algorithm, Using the Simplex Algorithm to Solve Minimization Problems, Alternative Optimal Solutions, Degeneracy and the Convergence of the Simplex Algorithm, The Big M Method, The Two-Phase Simplex Method.	
Unit – III	**08 Hrs**
Transportation Problem: Formulation of Transportation Model, Basic Feasible Solution using North-West corner, Least Cost, Vogel's Approximation Method, Optimality Methods, Unbalanced Transportation Problem, Degeneracy in Transportation Problems, Variants in Transportation Problems. **Assignment Problem:** Formulation of the Assignment problem, solution method of assignment problem-Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP).	
Unit – IV	**08 Hrs**
Project Management Using Network Analysis: Network construction, CPM & PERT, Determination of critical path and duration, floats. Crashing of Network. Usage of software tools to demonstrate N/W flow problems	
UNIT – V	**08 Hrs**
Game Theory: Introduction, Two person Zero Sum game, Pure strategies, Games without saddle point - Arithmetic method, Graphical Method, The rules of dominance	

Course Outcomes: After going through this course, the student will be able to:-	
CO1	Understand the characteristics of different types of decision – making environments and the appropriate decision-making approaches and tools to be used in each type.
CO2	Build and solve Transportation Models and Assignment Models.
CO3	Design new simple models, like: CPM, PERT to improve decision –making and develop critical thinking and objective analysis of decision problems.
CO4	Implement practical cases, by using TORA, WinQSB, Excel, GAMS.

Reference Books:	
1.	Operation Research an Introduction, Taha H A, 10th Global Edition, 2017, Pearson Education Limited, ISBN 13: 978-1-292-16554-7
2.	Principles of Operations Research – Theory and Practice, Philips, Ravindran and Solberg, 2nd Edition, 2007, John Wiley & Sons (Asia) Pvt Ltd, ISBN 13: 978-8126512560
3.	Introduction to Operation Research, Hiller, Liberman, Nag, Basu, 10th Edition, 2017, McGraw Hill Education, ISBN 13: 978-9339221850
4.	Operations Research Theory and Application, J K Sharma, 6th Edition, 2009, Trinity Press, ISBN: 978-93-85935-14-5

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	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. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, 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 upto 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. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
AUTOMOTIVE MECHATRONICS **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	ME266TES		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Automobile Engines: Classifications of Internal Combustion Engines**.** Engine nomenclature and mechanics. Mixture formation – External, internal, quality and quantity control – homogeneous and stratified injection. Thermodynamic principles of Otto and Diesel cycle. Characteristics – pressure curve and energy yield, engine speed, torque, and power	
Unit-II	**10 Hrs**
Engine Auxiliary Systems: Turbocharger, Intercooler, Exhaust manifold, 3-way catalytic convertor, Exhaust Gas Recirculation system. **Common Rail Fuel Injection system**: Low pressure and high-pressure fuel systems, Return line, Quantity control valve and Injectors.	
Unit-III	**10 Hrs**
Vehicular Auxiliary Systems: Vehicle frame and body classification- Hatchback, Sedan, SUV, Coupe, Roadster. Adaptive Brakes - Disc and drum brakes, Antilock Braking Systems, ESP, TCS. Wheels and Tyres- Toe-In, Toe-Out, Caster and Camber angle. Classification of tyres, Radial, Tubeless. **Supplemental Restraint System**: Active and passive safety, Vehicle structure, Gas generator and air bags, Belt Tensioner, Acceleration sensor, Rollover sensor, Seat occupancy recognition.	
Unit-IV	**08 Hrs**
EV Technology: Types of EV's, ICE vs EV torque output, Architecture and Working of EV's. Battery Thermal Management System, Regenerative braking, Safety system and Impacts of EV on the environment.	
Unit-V	**07 Hrs**
Telematics in vehicles: Radio Transmission, Exchange of information, signal path & properties, Concept of radio waves. **Sensors:** Oxygen sensors, Crankshaft/Cam shaft Sensor, Boost Pressure Sensor, Coolant Temperature Sensor, Hot Film Air Mass flow Sensor, Throttle Position Sensor, Rain/Light sensor	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Describe the functions of Mechatronic systems in a modern automobile
CO2	Evaluate the performance of an engine by its parameters
CO3	Analyse the automotive exhaust pollutants as per emission norms
CO4	Demonstrate communication of control modules using an On-Board Diagnostic kit

Reference Books	
1.	Automotive Technology – A systems approach, Jack Erjavec, 5th Edition, Delamr Cengage Learning, ISBN-13: 978-1428311497
2.	Automotive Engineering Fundamentals, Richard Stone and Jeffrey K. Ball, 2004, SAE International, ISBN: 0768009871
3.	Bosch Automotive Handbook, Robert Bosch, 9th Edition, 2004, ISBN: 9780768081527
4.	Understanding Automotive Electronics, William B Ribbens, 5th Edition, Butterworth–Heinemann, ISBN 0-7506-7008-8

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding up to 150 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

Semester: VI						
MATHEMATICAL MODELLING **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	MA266TEU		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	45L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Continuous Models Using Ordinary Differential Equations: Basic concepts, Real world problems (Science and Engineering), Approximation of the problem, Steps involved in modelling, Formation of various continuous models.	
Unit – II	**08 Hrs**
Mathematically Modelling Discrete Processes: Difference equations - first and second order, Introduction to Difference equations, Introduction to discrete models-simple examples, Mathematical modelling through difference equations in economics, finance, population dynamics, genetics and other real world problems.	
Unit –III	**08 Hrs**
Markov modelling: Mathematical foundations of Markov chains, application of Markov Modelling to problems.	
Unit –IV	**08 Hrs**
Modelling through graphs: Graph theory concepts, Modelling situations through different types of graphs.	
Unit –V	**08 Hrs**
Variational Problem and Dynamic Programming: Optimization principles and techniques, Mathematical models of variational problem and dynamic programming, Problems with applications.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Explore the fundamental concepts of mathematical models arising in various fields engineering.
CO2	Apply the knowledge and skills of discrete and continuous models to understand various types of analysis.
CO3	Analyze the appropriate mathematical model to solve the real-world problem and to optimize the solution.
CO4	Distinguish the overall knowledge gained to demonstrate the problems arising in many practical situations.

Reference Books	
1.	Mathematical Modeling, J. N. Kapur, 1st Edition, 1998, New Age International, New Delhi, ISBN: 81-224-0006-X.
2.	Mathematical Modeling: Models, Analysis and Applications, Sandip Banerjee, 2014, Chapman and Hall/CRC Textbook, ISBN 9781439854518.
3.	Case studies in mathematical modeling, D. J. G. James and J. J. Mcdonald, 1981, Stanly Thames, Cheltonham, ISBN: 0470271779, 9780470271773.
4.	Modeling with difference equations, D. N. Burghes, M. S. Borrie, Ellis Harwood, 1981, ISBN 13: 9780853122869.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
	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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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 upto 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only; wherein one sub division will be a caselet in the related topics)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
MATHEMATICS FOR QUANTUM COMPUTING **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	MA266TEV		**CIE**	**:**	100 Marks
Credits: L: T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	45L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Introduction to Quantum Computing: Quantum superposition, Qubits, Linear algebra for quantum computing, Inner products and Tensor products of vector spaces, Quantum states in Hilbert space, The Bloch sphere, Generalized measurements, No-cloning theorem.	
Unit – II	**08 Hrs**
Quantum Gates: Universal set of gates, quantum circuits, Dirac formalism, superposition of states, entanglement Bits and Qubits. Qubit operations, Hadamard Gate, CNOT Gate, Phase Gate, Z-Y decomposition, Quantum Circuit Composition, Basic Quantum circuits.	
Unit –III	**08 Hrs**
Quantum Algorithm - I: Quantum parallelism, Quantum Evolution, Deutsch Algorithm, Deutsch-Jozsa Algorithm, Simon periodicity algorithm, Phase evaluation algorithm, Quantum Fourier transform.	
Unit –IV	**08 Hrs**
Quantum Algorithm - II: Bell inequalities and entanglement, Schmidt decomposition, Grover search algorithm, Shor Factoring algorithm. Application of entanglement, teleportation, Superdense coding.	
Unit –V	**08 Hrs**
Applications of Quantum Computing: Quantum programming languages, Probabilistic and Quantum computations, introduction to quantum cryptography and quantum information theory.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Explore the fundamental concepts of quantum computing.
CO2	Apply the knowledge and skills of quantum computing to understand various types of problems arising in various fields engineering
CO3	Analyze the appropriate quantum algorithm to solve the real-world problem and to optimize the solution.
CO4	Distinguish the overall knowledge gained to demonstrate the problems arising in many practical situations.

Reference Books	
1.	An introduction to Quantum Computing, Phillip Kaye, Raymond Laflamme, 2007, Oxford University press.
2.	Quantum Computing for Everyone, Chris Bernhardt, 2020, The MIT Press, Cambridge.
3.	Quantum Computation and Quantum Information, M. A. Nielsen & I. Chuang, 2013, Cambridge University Press.
4.	Quantum Computing for the quantum curious, Cirian Hughes et. al., 2021, Springer, ISBN 978-3-030-61600-7.
5.	Concise guide to quantum computing, Sergei Kurgalin, Sergei Borzunov, 2021, Springer, ISBN 978-3-030-65051-3, ISBN 978-3-030-65052-0 (eBook).

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
	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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, 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 upto 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
APPLIED PSYCHOLOGY FOR ENGINEERS **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	HS266TEW		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40 L		**SEE Duration**	**:**	03 Hours

Unit-I	**08 Hrs**
Introduction to Psychology: Definition and goals of Psychology: Role of a Psychologist in the Society: Today's Perspectives (Branches of psychology- Clinical, Industrial). Psychodynamic, Behavioristic, Cognitive, Humanistic, Psychological Research and Methods to study Human Behavior: Experimental, Observation, Questionnaire and Clinical Method.	
Unit – II	**08 Hrs**
Intelligence and Aptitude: Concept and definition of Intelligence and Aptitude, Nature of Intelligence. Theories of Intelligence – Spearman, Thurston, Guilford Vernon. Characteristics of Intelligence tests, Types of tests. Measurement of Intelligence and Aptitude, Concept of IQ, Measurement of Multiple Intelligence – Fluid and Crystallized Intelligence.	
Unit –III	**10 Hrs**
Personality: Concept and definition of personality, Approaches of personality- psychoanalytical, Socio-Cultural, Interpersonal and developmental, Humanistic, Behaviorist, Trait and type approaches. Assessment of Personality: Self- report measures of Personality, Questionnaires, Rating Scales and Projective techniques, its Characteristics, advantages & limitations, examples. Behavioral Assessment.	
Unit –IV	**10 Hrs**
Learning: Definition, Conditioning – Classical Conditioning, Basics of Classical Conditioning (Pavlov), the process of Extinction, Discrimination and Generalization. Operant Conditioning (Skinner expt). The basics of operant conditioning, Schedules of reinforcement. Cognitive – Social approaches to learning – Latent Learning, Observational Learning, Trial and Error Method, Insightful Learning.	
Unit –V	**08 Hrs**
Application of Psychology in Working Environment: The present scenario of information technology, the role of psychologist in the organization, Selection and Training of Psychology Professionals to work in the field of Information Technology. **Psychological Stress**: a. Stress- Definition, Symptoms of Stress, Extreme products of stress v s Burnout, Work Place Trauma. Causes of Stress – Job related causes of stress. Sources of Frustration, Stress and Job Performance, Stress Vulnerability-Stress threshold, perceived control. Type A and Type B. **Psychological Counselling** - Need for Counselling, Types – Directed, Non- Directed, Participative Counselling.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Describe the basic theories, principles, and concepts of applied psychology as they relate to behaviors and mental processes.
CO2	Define learning and compare and contrast the factors that cognitive, behavioural, and Humanistic theorists believe influence the learning process.
CO3	Develop understanding of psychological attributes such as intelligence, aptitude, creativity, resulting in their enhancement and apply effective strategies for self-management and self-improvement.
CO4	Apply the theories into their own and others' lives in order to better understand their personalities and experiences.
CO5	Understand the application of psychology in engineering and technology and develop a route to accomplish goals in their work environment.

Reference Books	
1.	Understanding Psychology Feldman R. S, 4th Edition, (1996) McGraw Hill India
2.	Psychology Robert A. Baron, 3rd Edition (1995) Prentice Hall India.
3.	Organizational Behaviour, Stephen P Robbins Pearson Education Publications, 13th Edition, ISBN – 81-317 – 1132 – 3
4.	Organisational Behaviour: Human Behaviour at Work, John W. Newstrem and Keith Davis. Tata McGraw Hill India, 10th Edition, ISBN 0-07-046504-5
5	Psychology-themes and variations, Wayne Weiten, 4th Edition, Brooks / Cole Publishing Co.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
UNIVERSAL HUMAN VALUES - II **Category: Institutional Electives-I** **GROUP-E** **(Theory)**						
Course Code	**:**	HS266TEY		**CIE**	**:**	100 Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	45L		**SEE Duration**	**:**	03 Hours

Unit-I	**10 Hrs**
Introduction-Basic Human Aspiration, its fulfilment through All-encompassing Resolution. The basic human aspirations and their fulfilment through Right understanding and Resolution, Right understanding and Resolution are the activities of the Self, Self is central to Human Existence; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution.	
Unit – II	**10 Hrs**
Right Understanding (Knowing)- Knower, Known & the Process. The domain of right understanding starts from understanding the human being (the knower, the experiencer and the doer); and extends up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct).	
Unit –III	**08 Hrs**
Understanding Existence (including Nature). A comprehensive understanding (knowledge) about the existence, which certainly includes the Nature. The need and the process of inner evolution (through self-exploration, self-awareness and self-evaluation)- particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence).	
Unit –IV	**08 Hrs**
Understanding Human Being. Understanding the human being comprehensively is the first step and the core theme of this course; human being as co-existence of the self and the body, the activities and potentialities of the self, Reasons for harmony/contradiction in the self.	
Unit –V	**08 Hrs**
Understanding Human Conduct, All-encompassing Resolution & Holistic Way of Living. Understanding Human Conduct, Understanding different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All-encompassing Resolution covering all four dimensions of human endeavour viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from self to Nature and entire Existence.	

Course Outcomes: After completion of the course the students will be able to	
CO1	Understand the basic human aspiration with program of its fulfilment and meaning of resolution in the complete expanse of human living.
CO2	Understand human being in depth and see how self is central to human being
CO3	Understand existence in depth and see how coexistence is central to existence
CO4	Understand human conduct and the holistic way of living leading to human tradition

Reference Books	
1.	A foundation course in human values and professional ethics, R. R. Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, excel books, New Delhi – 2019, ISN 978-93-87034-47-1
2.	Avartansheel Arthshastra, A Nagraj, Divya Path Sansthan, Amarkantak, India, ISBN 978-8-174-46781-2
3.	Economy of Performance- a quest for social order based on non – violence, J C Kumarappa, 2010, Sarva-Seva-Sangh-Prakashan, Varanasi, India
4.	Energy and Equity, Ivan Illich, 1974, The Trinity Press, Worcester & Harper Collins, USA, ISBN, 0060803274, 9780060803278

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester VI						
INTERDISCIPLINARY PROJECT						
Course Code	**:**	EC367P		**CIE**	**:**	50 Marks
Credits: L:T:P	**:**	0:0:3		**SEE**	**:**	50 Marks
Total Hours	**:**	15 P		**SEE Duration**	**:**	02 Hours

Major Project Guidelines:

1. The project topic, title and synopsis have to be finalized and submitted to their respective internal guide(s) before the beginning of the VI semester.
2. The detailed Synopsis (approved by the department ***Project Review Committee***) has to be submitted during the 1st week after the commencement of VI semester.

Batch Formation:

- Students are free to choose their project partners from any other program.
- Each student in the team must contribute towards the successful completion of the project. The project may be carried out In-house only.
- ***The project work is to be carried out by a team of two to four students.***

Project Topic Selection:

The topics of the project work must be in the ***field of Sustainable Development goals areas or in line with CoE's(Centre of Excellence) identified by the college*** or **List of project areas as given by Faculty. The projects as far as possible should have societal relevance with focus on sustainability.**

Project Evaluation:

Continuous monitoring of project work will be carried out and cumulative evaluation will be done.

- The students are required to meet their guides once in a week to report their progress in project work.
- **Weekly Activity Report** (WAR) has to be maintained in the form of a diary by the project batch and the same has to be discussed with the Guide regularly.
- For CIE assessment the project groups must give a final presentation with the draft copy of the project report.
- The presentation by each group will be for 20-30 minutes and every member of the team needs to justify the contributions to the project.
- The project team is required to submit Hard copies of the detailed Project Report in the prescribed format to the department.
- For CIE 50% weightage should be given to the project guide and 50% weightage to the project evaluation committee.

Course Outcomes:	
1	Identifying critical thinking and problem-solving abilities by analyzing and addressing interdisciplinary challenges, utilizing creative approaches and innovative solutions.
2	Exhibit proficiency in conducting comprehensive research, including literature review, data collection, modelling, simulation, and analysis, to address significant technical challenges and propose innovative solutions.

3	Demonstrate the ability to do effective teamwork, leadership, project management, and communication skills, while adhering to ethical standards and professional responsibility in delivering the project outcomes within time and budget constraints.
4	Utilize appropriate engineering tools, technologies, and software to design, test, and implement project solutions, ensuring adherence to technical specifications, safety standards, and industry best practices.

CIE Assessment:

The following are the weightings given for the various stages of the project.

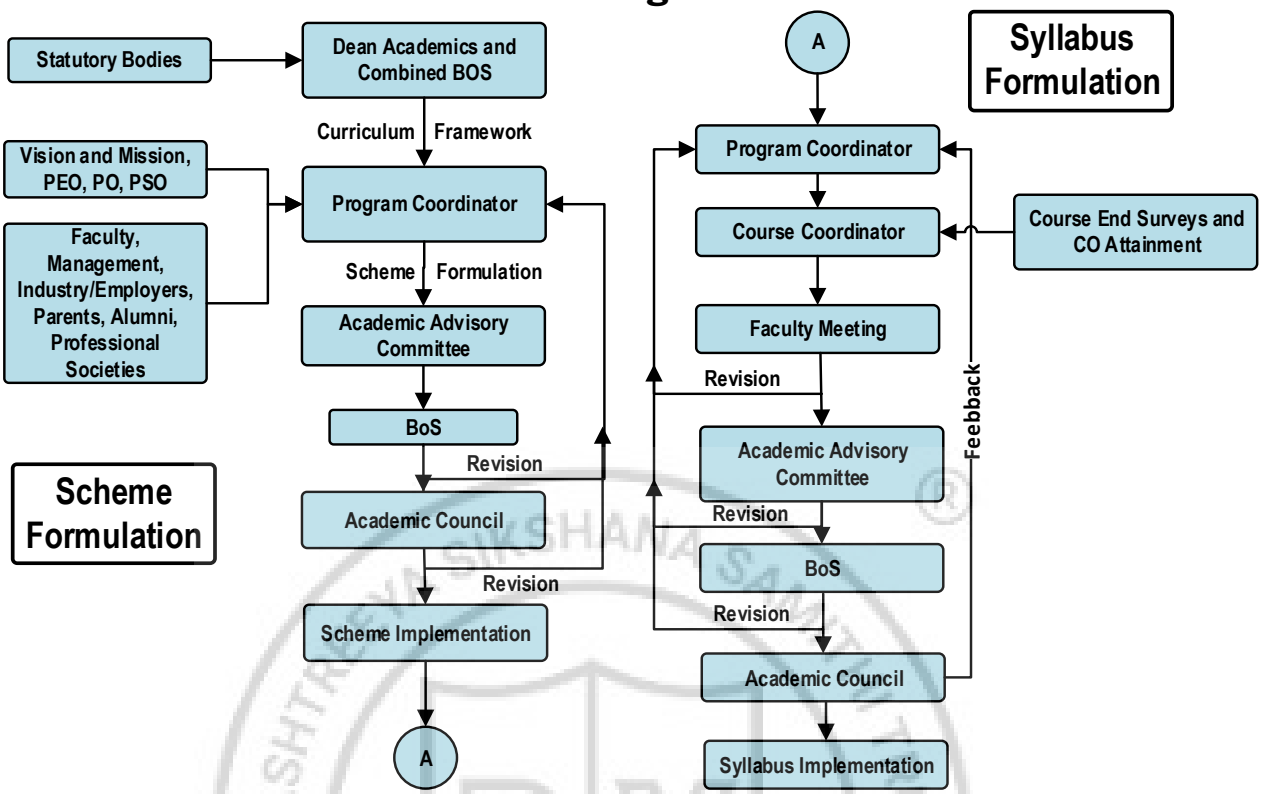
1.	Selection of the topic and formulation of objectives	10%
2.	Design and Development of Project methodology	25%
3.	Execution of Project	25%
4.	Presentation, Demonstration and Results Discussion	30%
5.	Report Writing & Publication	10%

SEE Assessment:

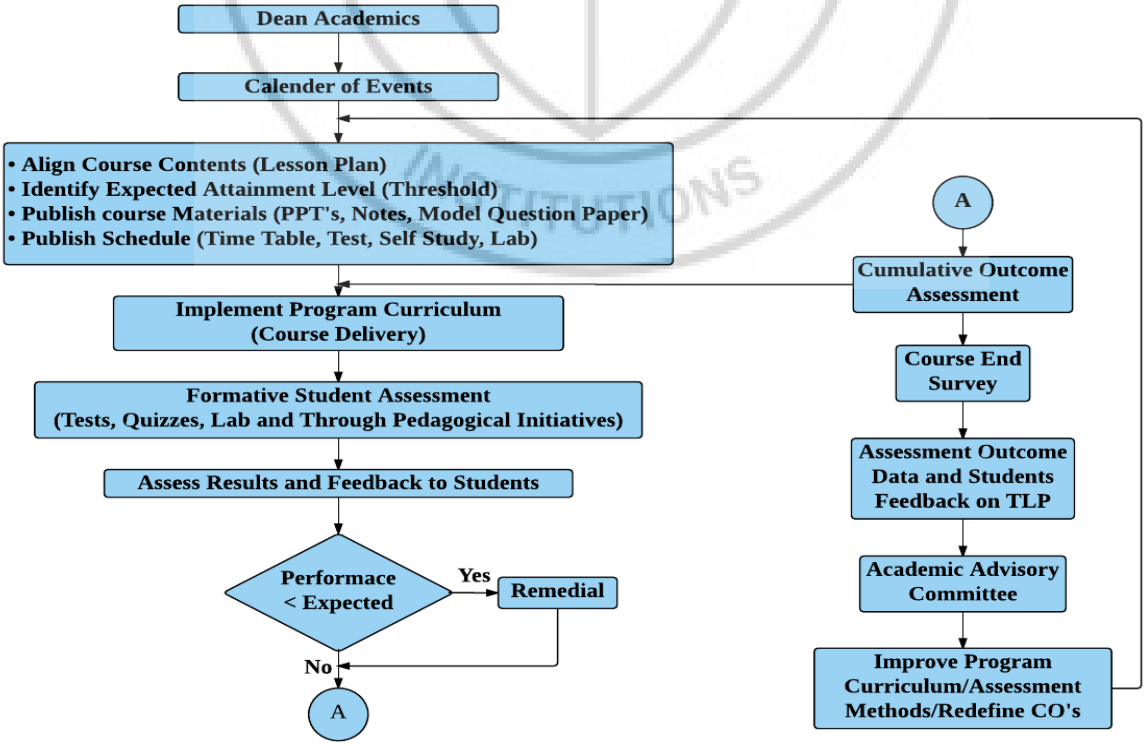
The following are the weightages given during Viva Examination.

1.	Written presentation of synopsis	10%
2.	Presentation/Demonstration of the project	30%
3.	Methodology and Experimental Results & Discussion	30%
4.	Report	10%
5.	Viva Voce	20%

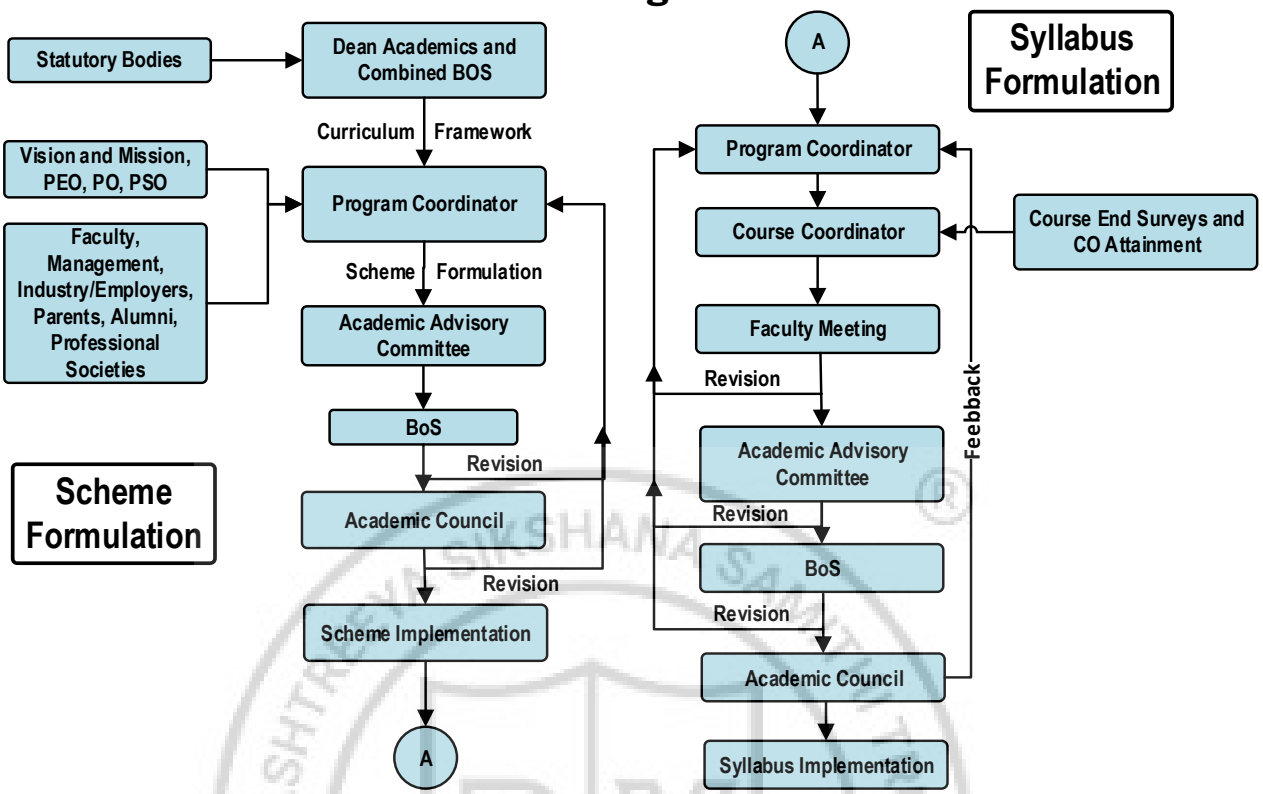
Curriculum Design Process



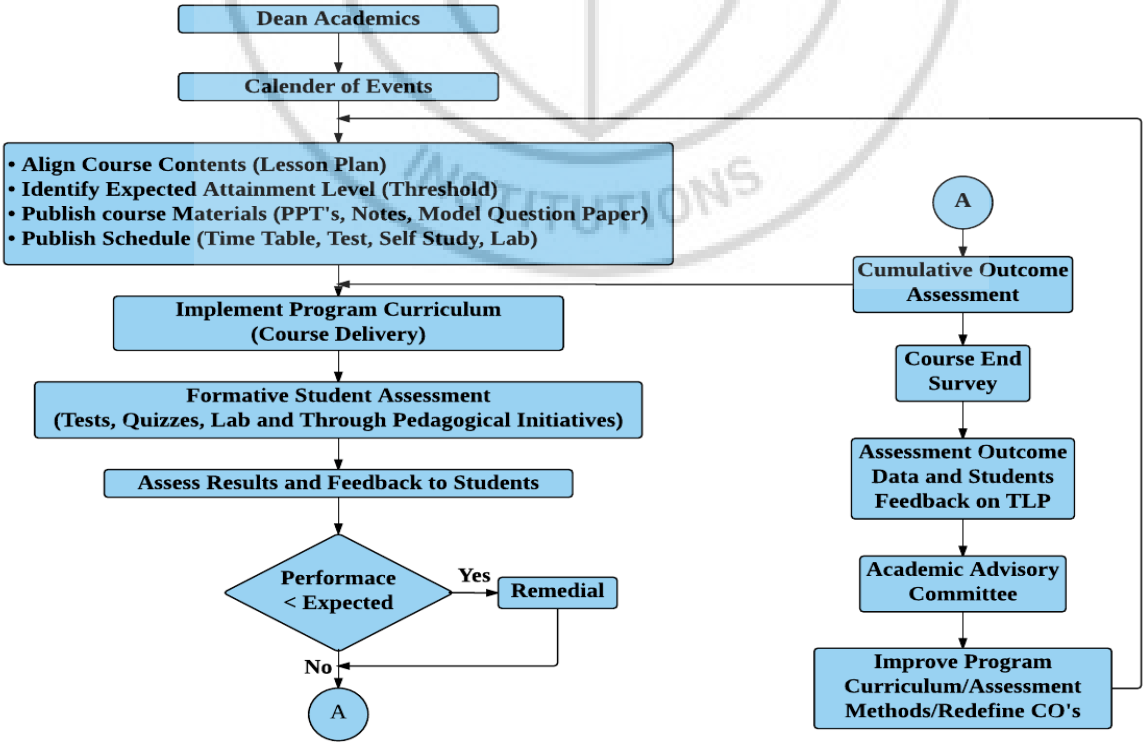
Academic Planning and Implementation



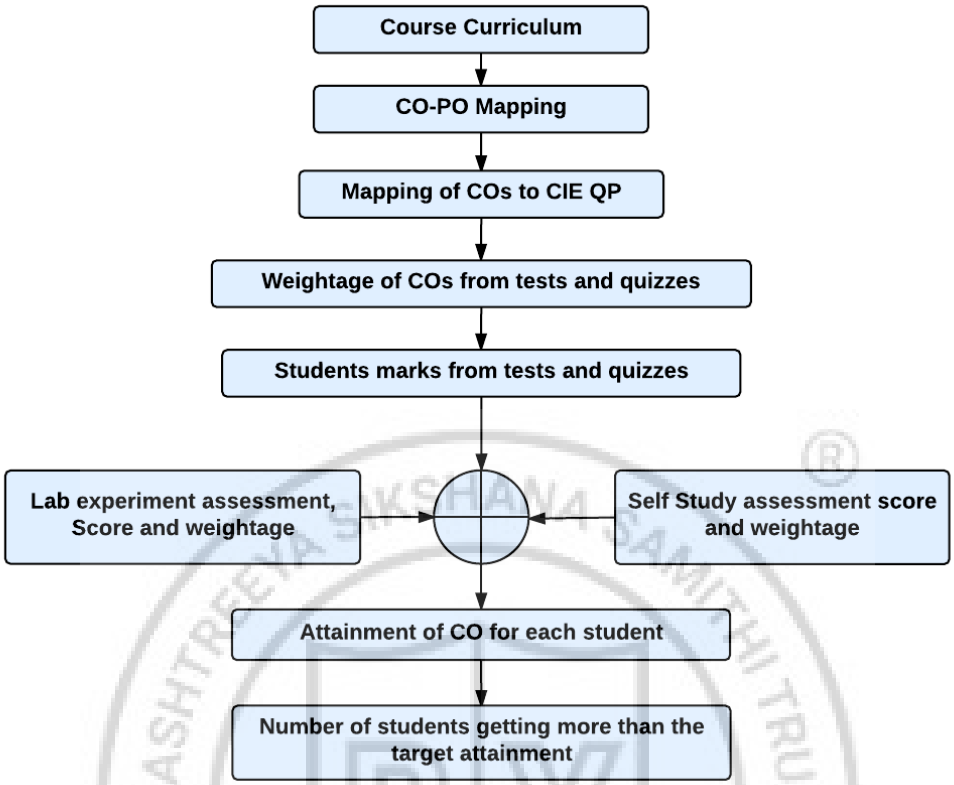
Curriculum Design Process



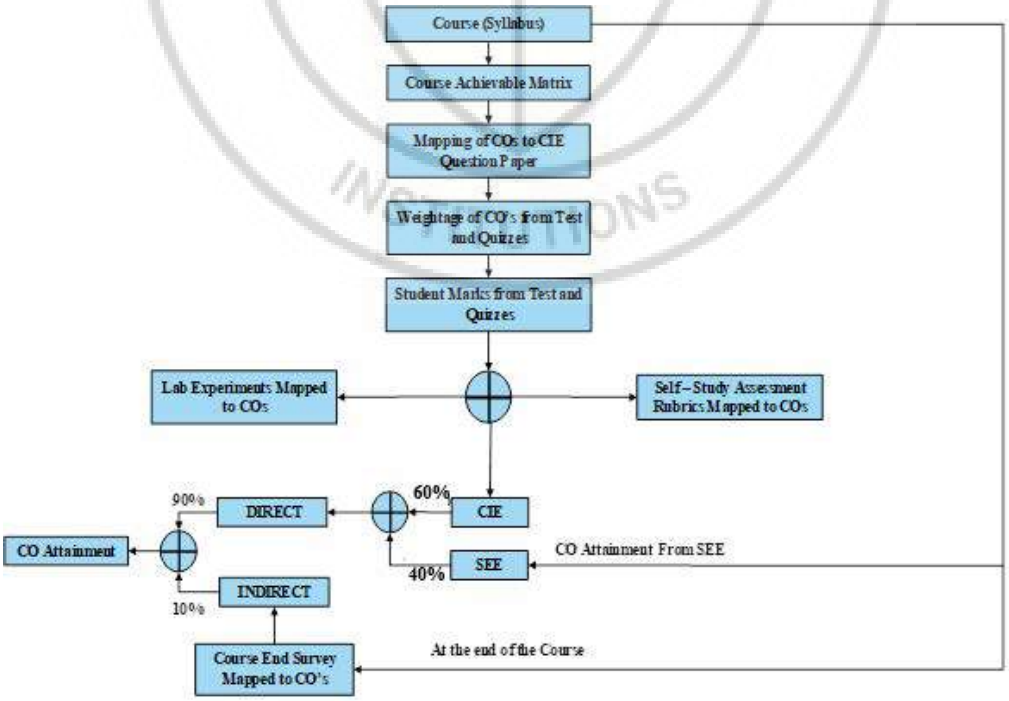
Academic Planning and Implementation



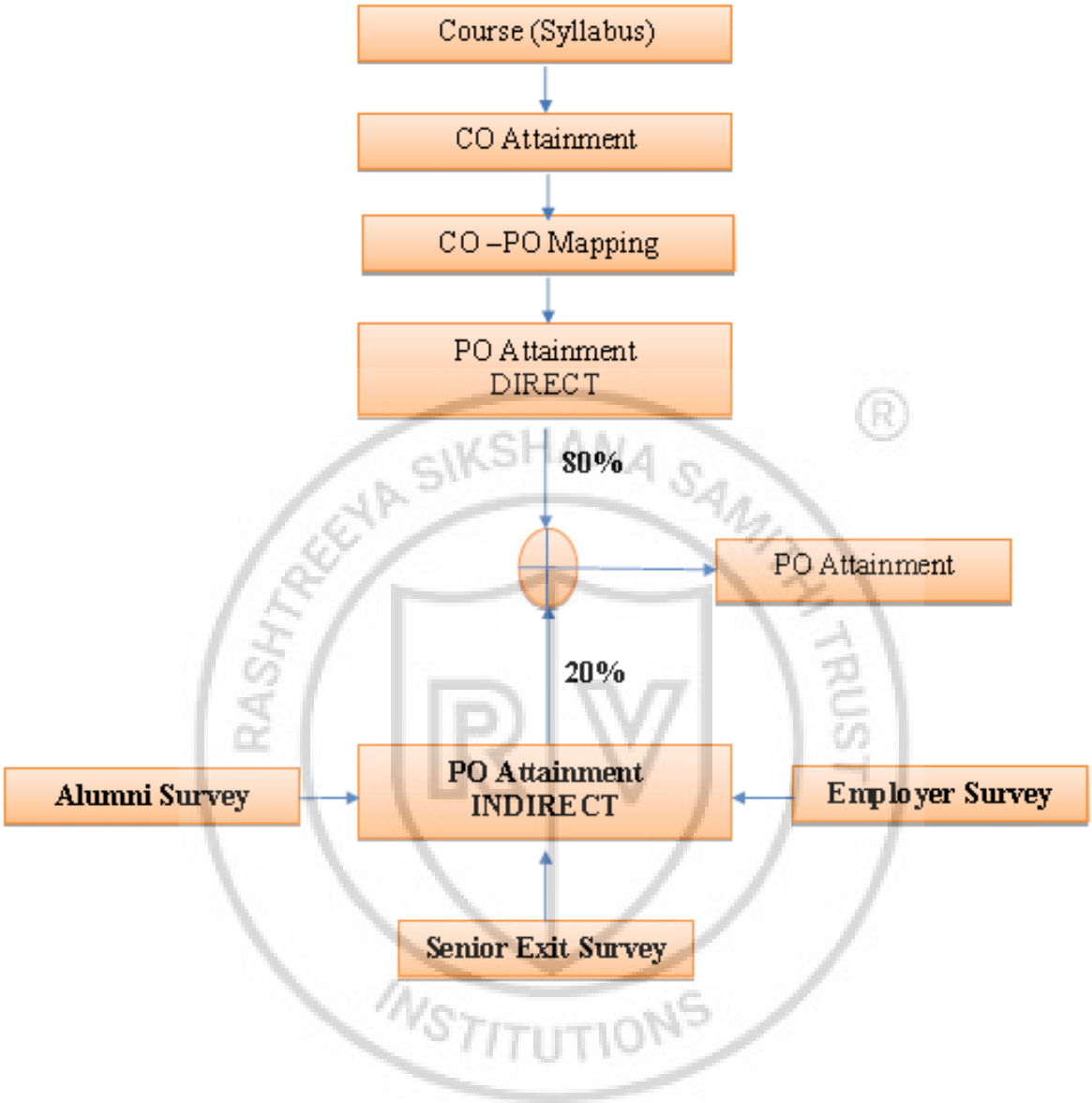
Process For Course Outcome Attainment



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.

PROGRAM OUTCOMES (POs)

- **PO1:** Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
- **PO2:** Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
- **PO3:** Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
- **PO4:** Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
- **PO5:** Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
- **PO6**: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
- **PO7:** Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
- **PO8:** Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
- **PO9:** Communication: Communicate effectively and inclusively within the community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
- **PO10:** Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
- **PO11:** Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

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