RV Educational Institutions ®
RV College of Engineering ®

Autonomous
Institution Affiliated
to Visvesvaraya
Technological
University, Belagavi

Approved by AICTE,
New Delhi

SCHEME & SYLLABUS
V/VI SEMESTER B.E. PROGRAMS

ELECTRONICS & COMMUNICATION ENGINEERING

2021 SCHEME
(W.E.F 2021 Admission Students)

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

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

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Bachelor of Engineering in

ELECTRONICS AND COMMUNICATION ENGINEERING

2021 SCHEME - CREDITS AND COMPONENTS												
V SEMESTER												
Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Marks		SEE Duration	SEE Marks	
			L	T	P	Total			Theory	Lab		Theory	Lab
1	21HS51A	Intellectual Property Rights & Entrepreneurship	3	0	0	**3**	HSS	Theory	100	***	3	100	***
2	21EC52	Principles of Communication and Signal Processing	3	0	1	**4**	EC	Theory + Lab	100	50	3 + 3	100	50
3	21EC53	Digital VLSI Design (Common to EC and EI)	3	0	1	**4**	EC	Theory + Lab	100	50	3 + 3	100	50
4	21EC54	Embedded System Design (Common to EC and EI)	3	1	0	**4**	EC	Theory	100	***	3	100	***
5	21EC55BX	Professional Core Elective-I (Group-B)	3	0	0	**3**	EC	Theory	100	***	3	100	***
6	21EC56CX	Professional Core Elective-II (Group C)	2	0	0	**2**	EC	NPTEL	50	***	***	50	***
7	21ECI57	Summer Internship- II	0	0	2	**2**	EC	Internship	***	50	2	***	50
		Total				**22**							

VI SEMESTER													
Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Marks		SEE Duration	SEE Marks	
			L	T	P	Total			Theory	Lab		Theory	Lab
1	21HS61B	Principles of Management & Economics	3	0	0	3	HSS	Theory	100	***	3	100	***
2	21EC62	Communication Systems	3	0	1	4	EC	Theory + Lab	100	50	3 + 3	100	50
3	21EC63	Computer Networks and Protocols	3	0	1	4	EC	Theory + Lab	100	50	3 + 3	100	50
4	21EC64DX	Professional Core Elective-III (Group – D)	3	0	0	3	EC	Theory	100	***	3	100	***
5	21EC65EX	Professional Core Elective (Cluster Elective) (Group- E)	3	0	0	3	EC	Theory	100	***	3	100	***
6	21IE66FX	Institutional Electives – I (Group F)	3	0	0	3	Respective BoS	Theory	100	***	3	100	***
Total						**20**							

GROUP-B		
Sl. No.	**Course Code**	**Course Title**
1.	21EC55B1	Analog Integrated Circuits Design
2.	21EC55B2	Quantum Computing Hardware
3.	21EC55B3	Computer Vision
4.	21EC55B4	Database Management System
5.	21EC55B5	Signal Processing with AI

GROUP-C			
Sl. No.	**Course Code**	**Course Title**	**Duration**
1.	21IM56C1	Data Science for Engineers	08 Weeks
2.	21ET56C2	An Introduction to information Theory	08 Weeks
3.	21IS56C3	Foundation of Cloud IoT Edge ML	08 Weeks
4.	21EC56C4	Nano bio Technology Enabled Point- to - care Devices	08 Weeks
5.	21EC56C5	VLSI Signal Processing	08 Weeks

GROUP-D		
Sl. No.	**Course Code**	**Course Title**
1.	21EC64D1	Optical Fiber Communication and Networking
2.	21EC64D2	Antennas for Wireless Communication
3.	21EC64D3	Low Power VLSI Design
4.	21EC64D4	Deep Learning
GROUP-E		
Sl. No.	**Course Code**	**Course Title**
1.	21EC65E1	Real Time Systems
2.	21EC65E2	Digital System Design with FPGA
3.	21EE65E1	Smart Grid Technology
4.	21EE65E2	Modern Control Theory
5.	21EI65E1	Electronics Equipment Integration and Prototype Building
6.	21EI65E2	Virtual Instrumentation
7.	21ET65E1	Smart Antennas
8.	21ET65E2	Satellite Communication

GROUP-F			
Sl. No.	**Course Code**	**BoS**	**Course Title**
1.	21IE6F1	CH	Industrial Safety and Risk Management
2.	21IE6F2	EE	Renewable Energy Systems
3.	21IE6F3	IM	Systems Engineering
4.	21IE6F4	ME	Mechatronics
5.	21IE6F5	MA	Mathematical Modelling
6.	21IE6F6	ME	Industry 4.0 – Smart Manufacturing for The Future
7.	21IE6F7	HSS	Industrial Psychology for Engineers
8.	21IE6F8	IM	Elements of Financial Management
9.	21IE6F9	HSS	Universal Human Values-II
10.	21IE6F10	EC	Human Machine Interface (HMI)

Semester: V						
INTELLECTUAL PROPERTY RIGHTS AND ENTREPRENEURSHIP (Common to all Programs) (Theory)						
Course Code	**:**	**21HS51A**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Introduction: 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. Case examples.	
Unit – II	**08 Hrs**
Trade Secrets: Definition, Significance, Tools to protect Trade secrets in India. **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. Case Examples.	
Unit –III	**08 Hrs**
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. **Introduction to Cyber law**: Information Technology Act, cybercrime and e-commerce, data security, confidentiality, privacy, international aspects of computer and online crime.	
Unit –IV	**09 Hrs**
Entrepreneurship: Introduction**,** Evolution of the Entrepreneurship, Importance of Entrepreneurship, Concept of Entrepreneurship, Characteristics of a successful Entrepreneur, Classification of Entrepreneur, Myths of Entrepreneurship, Entrepreneurial Development Models, Problems Faced by Entrepreneurs and Capacity Building for Entrepreneurship. Women Entrepreneurship in Asia, Women Entrepreneurship in India, Challenges Faced by Women Entrepreneurs. Case studies. **Entrepreneurship in the New Age**: Getting to know your Business, it's Eco-system and Environment, Passion and Values driving, building and growing Family businesses, Challenges and suggested management approaches.	
Unit –V	**11 Hrs**
Business Plans: Introduction, Purpose of a Business Plan, Contents of a Business Plan, Business Concept, Business Strategy, Marketing Plan, Operations Plan, Financial Plan, presenting a Business Plan, Oral and Visual Presentation, Why Do Some Business Plans Fail? Procedure for Setting Up an Enterprise, Business Models and Business Model Innovation Creating a Business Plan. Case lets/Case studies. **Preparation of project**: Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of. Business Opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. Use of standard templates for preparation of project report.	

Reference Books	
1.	Intellectual Property Rights: Unleashing Knowledge Economy, Prabuddha Ganguly, 1st Edition, 2001, Tata McGraw Hill Publishing Company Ltd., New Delhi, ISBN: 0074638602.
2.	Intellectual Property and the Internet, Rodney Ryder, 2002, Lexis Nexis U.K., ISBN: 8180380025, 9788180380020.
3.	Entrepreneurship Development and Small Business Enterprise, Poornima M. Charantimath, Pearson Education, 2005, ISBN: 9788177582604.
4.	Dynamics of Entrepreneurial Development & Management-Vasant Desai, Himalaya Publishing House, 6th Edition, 2018, ISBN - 978-93-5299-133-4.
5	Entrepreneurial development, Khanka, Shobhan Singh, S. Chand Publishing, 2006, ISBN - 8121918014, 9788121918015.

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Comprehend the applicable source, scope and limitations of Intellectual Property within the purview of engineering domain.
CO2	Knowledge and competence related exposure to the various Legal issues pertaining to Intellectual Property Rights with the utility in engineering perspectives.
CO3	Enable the students to have a direct experience of venture creation through a facilitated learning environment.
CO4	It allows students to learn and apply the latest methodology, frameworks and tools that entrepreneurs use to succeed in real life.

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 (20**) 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) * (Small case lets and case example in one subdivision)	
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						
PRINCIPLES OF COMMUNICATION AND SIGNAL PROCESSING (Theory and Practice)						
Course Code	:	**21EC52**		**CIE**	:	**100+50 Marks**
Credits: L:T:P	:	**3:0:1**		**SEE**	:	**100+50 Marks**
Total Hours	:	**45L+30P**		**SEE Duration**	:	**03+03 Hrs**

Unit-I	**09 Hrs**
Random Processes: Ensemble, PDF, Independence, Expectations, Stationarity, Correlation Functions (ACF, CCF, Addition, and Multiplication), Ergodic Random Processes, Power Spectral Densities (Wiener Khinchine, Addition and Multiplication of RPs, Cross spectral densities), Linear Systems (output Mean, Cross correlation and Autocorrelation of Input and output), Exercises with Noise. Discrete form statement of Wiener – Khinchine Theorem – Applications.	
Unit – II	**09 Hrs**
Sampling and Analog to Digital Conversion: Low Pass Sampling Theorem (Impulse, Pulse and Flat top). Pulse-Code Modulation (PCM) – Uniform Quantization, Non uniform Quantization – Optimal quantizer and Robust quantizer (μ-law and A-law), SNR derivations for all types. Differential Pulse Code Modulation (DPCM), Delta Modulation with SNR derivation, Adaptive DM with SNR statement only. Sigma-delta Modulation concept. Applications to Channel Vocoders and LPC Vocoders.(Conceptual treatment).	
Unit –III	**09 Hrs**
Baseband Pulse Transmission: Line Codes: (RZ and NRZ) Unipolar, Polar, Bipolar, Manchester signaling, PSD derivations for these pulses. Highlights of other baseband pulses HDB3, B6ZS. Digital communication blocks and impediments. Bandpass and equivalent low pass signal representation, Quadrature Sampling of bandpass signals, Bandpass Sampling Theorem statement with Applications.	
Unit –IV	**09 Hrs**
Digital Multiplexing and demultiplexing: Framing with overheads, Types- Synchronous, Asynchronous, Quasi-Synchronous. Demultiplexing FSM, Retiming FSM with Plesiochronous buffering. **IIR Filter Design**: Structures of IIR: Direct form structure, Analog filter design using Butterworth and Chebyshev filter. IIR Filter design by Bilinear Transformation, digital filter designs based on the Bilinear Transformation using analog filter	
Unit –V	**09 Hrs**
FIR Filter Design: Symmetric and anti-symmetric FIR Filters, FIR Filter structure: Direct form structure, cascade form structures, Design of Linear phase FIR Filters using Windows, Design of Linear phase FIR filters by frequency Sampling method.	

Practical's: Communication Lab

1. a. Autocorrelation and Power Spectrum of a discrete time sequence and a random process
   b. Generation of Samples of lowpass random process and Bandpass Random Process
2. Demonstration of Central Limit Theorem
3. Illustration of Lowpass Sampling theorem for various cases
4. Illustration of Uniform and Non-Uniform PCM for Quantization Error and SQNR
5. Illustration of Delta Modulation and Adaptive Delta Modulation
6. Sigma-Delta Modulation and Demodulation
7. Generation of Line codes, PSD and Probability of Error Calculation
8. Illustration of Bandpass Sampling Theorem for various cases
9. Realize an LOW Pass FIR filter with cutoff 800 Hz, sampling frequency 8000 Hz and filter length of 50 using Hamming Window.
10. Design and implementations of IIR Elliptic Band stop filter using Direct form-II structure for the given specification on DSP board.

Open ended Experiments:

1. Special codes generation and PSD analysis for B3ZS, HDB3 and B8ZS
2. Realize an LOW Pass FIR filter with specified cutoff frequencies using different window functions.

Course Outcomes: After completing the course, the students will be able to	
CO1	Associate and apply the concepts of digital formatting, reconstruction to digital transmitter and receivers used in cellular and other communication devices.
CO2	Analyze and compute performance of continuous wave modulation, digital formatting schemes.
CO3	Test and validate digital formatting schemes and block codes under noisy channel conditions to estimate the performance in practical communication systems.
CO4	Design/Demonstrate by way of simulation or emulation of different functional blocks of digital formatting and block error correction

Reference Books	
1.	Modern Digital and Analog communication Systems, B.P.Lathi and Zhi Ding, 4th Edition, 2010, Oxford University Press, ISBN: 9780198073802.
2.	Analog & Digital Communication Systems, Simon Haykin, 1st Edition, 2014, John Wiley & sons, ISBN 978-0-471-64735-5.
3.	Communication Systems, Simon Haykin, 4th Edition, 2004, John Wiley, India Pvt. Ltd, ISBN 0471178691.
4	Analog & Digital Communication: Schaum's Outline Series, Hwei Hsu, 3rd Edition,2017, McGraw Hill Education, ISBN: 978-0070151505.

RUBRICFOR 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 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) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). 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. **THE FINAL MARKS WILL BE 50 MARKS**	**50**
	MAXIMUM MARKS FOR THE CIE	**150**

RUBRIC FOR 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						
DIGITAL VLSI DESIGN (Theory and Practice) (Common to EC and EI)						
Course Code	:	**21EC53**		**CIE**	:	**100+50 Marks**
Credits: L:T:P	:	**3:0:1**		**SEE**	:	**100+50 Marks**
Total Hours	:	**45L+30P**		**SEE Duration**	:	**03+03 Hrs**

Unit-I — **09 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 — **09 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, Ripple Carry Adder, Manchester Carry chain adder, Carry Skip adder, Carry Select Adder, Braun, Baugh-wooley and Booth multipliers.

Unit –III — **09 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: Sequencing Methods, Max-Delay Constraints, Min-Delay Constraints, Time Borrowing, Clock Skew

Unit –IV — **09 Hrs**

Array Sub system SRAM: Memory cell Read/Write operation, Decoder, Bit-line conditioning and column circuitry and Column Circuitry, Multi-Ported SRAM. DRAM Subarray Architectures, Column Circuitry
Read-Only Memory: Programmable ROMs, NAND/NOR ROMs. Content-Addressable Memory, PLA

Unit –V — **09 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
Introduction to FinFET: Brief History, Construction of FinFET, Multigate FinFET, Advantages and Disadvantages, Applications.

Practical's:

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	Realize 2-bit multiplier circuit using Mixed mode.
b.	Practice question: Verify the functionality of the multiplier using trans analysis.
10.a	Synthesis of 8-bit counter and analysis for the parameters delay, power and area.
b.	Practice question: Realize the 16-bit counter and perform the above observations.

Open Ended Experiments;

1. Synthesis of Serial Adder and perform the back-end flow.
2. Synthesis of 16X1 multiplier using two 8X1 multipliers and one 2X1 multiplexer and perform the backend flow.

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 Mc Graw 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.	Fundamentals of Ultra-Thin-Body MOSFETs and Fin FETs, Jerry G. Fossum, Vishal P. Trivedi, 1St Edition 2013, Cambridge University Press, ISBN-13:978-1107030411.

Course Outcomes: After completing the course, the students will be able to	
CO1	Analyze transistor circuits and its impact on VLSI design flow.
CO2	Apply & analyze the design parameters for speed, area & power optimization.
CO3	Evaluate the functionality of VLSI blocks using various architectures.
CO4	Analyze various fabrication processes for different logic families/designs.

RUBRICFOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
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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) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). 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. **THE FINAL MARKS WILL BE 50 MARKS**	**50**
	MAXIMUM MARKS FOR THE CIE	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
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	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						
EMBEDDED SYSTEM DESIGN (Theory) (Common to EC and EI)						
Course Code	**:**	**21EC54**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:1:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L+15T**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 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	**09 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, Cache replacement policies.	
Unit –III	**09 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	**09 Hrs**
Designing Embedded System Software-I: Application Software, System Software, Application debugging using ARM Cortex STM32F407, Board Support Library, Chip Support Library Analysis and Optimization: Execution Time, Energy & Power, Program Size; Floating point data representation. Introduction to tinyML and Programming using CMSIS library functions. Embedded System Coding Standards: MISRA C 2012.	
Unit –V	**09 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: After completing the course, the students will be able to	
CO1	Describe the architecture of embedded system, functional difference between general purpose system, operational & non-operational attributes of embedded system.
CO2	Interpret hardware & software of an 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, 2009, Tata McGraw Hill Education Private Limited, ISBN: 10: 0070678790
2	Embedded Systems – A contemporary Design Tool, James K Peckol, 2008, John Weily, ISBN: 0-444-51616-6
3	Real-Time Concepts for Embedded Systems, Qing Li and Carolyn Yao, 2003, CMP Books, ISBN:1578201241.
4	Reference Manuals: I2C, SPI, 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 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**) 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: V						
ANALOG INTEGRATED CIRCUITS DESIGN **Professional Core Elective-I** **(Theory)**						
Course Code	**:**	**21EC55B1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Current Sources and Current Mirrors: Basic current mirror, Cascode current mirror, active current mirror – analysis. **Differential Amplifiers:** MOS differential pair, Small signal operation - half circuit analysis, common mode response, differential amplifier with active load, common mode gain and CMRR.	
Unit – II	**09 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. Design of opamps from specifications.	
Unit –III	**09 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	**09 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	**09 Hrs**
DAC Architectures: Resistor String, R-2R Ladder networks, Current Steering **ADC Architectures:** Flash ADC, Successive Approximation ADC, First order Sigma Delta 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	Analyse 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 GrawHill 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

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 (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: V						
QUANTUM COMPUTING HARDWARE **Professional Core Elective-I** **(Theory)**						
Course Code	**:**	**21EC55B2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Fundamental Concepts of Quantum Computing-Part 1: 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	**09 Hrs**
Fundamental Concepts of Quantum Computing-Part 2: 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	**09 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	**09 Hrs**
Quantum Computing Hardware Basics: Quantum computing with trapped ion qubits, Quantum computing with superconducting qubits, Overview of the physics of superconductors and Josephson junctions, hybrid, Quantum computing with semiconductor spin qubits, An overview of spin physics, Semiconductor spin qubits: optical and electrical gating, other qubit technologies	
Unit –V	**09 Hrs**
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 center 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 MA, 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, July 2013.
4.	Exploring the Quantum: Atoms, Cavities, and Photons, Serge Haroche, Jean-Michel Raimond, 9780198509141, Oxford University Press, 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 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: V						
COMPUTER VISION **Professional Core Elective-I** **(Theory)**						
Course Code	**:**	**21EC55B3**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Introduction to Digital Image Fundamentals: The origin of Digital Image processing, Image acquisition, Image sensors, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Image Sampling and Quantization, Some Basic Relationships between Pixels. **Intensity Transformation and Spatial Filters:** Background, some basic Intensity Transformation Functions, Histogram Processing, Histogram Equalization, Mechanics of spatial filtering, spatial correlation and convolution, Smoothing spatial filters.	
Unit – II	**09 Hrs**
Early Vision: Just one image: Linear Filters, Linear Filters and Convolution, Shift Invariant Linear System, Discrete Convolution, Continuous Convolution., Edge Effects in Discrete Convolution, Spatial Frequency and Fourier Transformation, Fourier Transformation, Sampling and Aliasing, Filters as Templates, Technique: Normalized correlation and Finding Patterns, Technique: Scale and Image Pyramids **Image Segmentation:** Fundamentals, Point, Line Edge detection, Detection of Isolation points, Line detection, Edge Models, basic Edge detection, More Advanced Techniques for Edge Detection, Edge Linking and Boundary Detection. **Thresholding:** Foundation, Basic global thresholding, Region growing, Region splitting and Merging.	
Unit –III	**09 Hrs**
Image Segmentation by Clustering: Background subtraction, shot boundary detection, interactive segmentation, forming image regions. **Image segmentation by Clustering Pixels:** Basic clustering methods, watershed algorithm, K-means, Mean shift: Finding Local modes in Data, clustering and segmentation with Mean shift, terminology and facts for graphs, Agglomerative clustering with a graph, divisive clustering with a graph.	
Unit –IV	**09 Hrs**
Learning Phase to Classification: Classification, error and loss: using loss to determine decisions, training error, test error and overfitting, regularization, error rate and cross validation. Major classification strategies: Mahalanobis distance, class conditional histograms and Naive Bayes, classification using Nearest Neighbors, Linear Support vector Machine, Kernel machines, Boosting and Adaboost. Case study with deep neural networks, Baidu, Google Practical methods for Building classifiers: Manipulating training data to improve performance, Building multiclass classifiers out of Binary classifiers, solving for SVMS and Kernal machines.	
Unit –V	**09 Hrs**
Detecting Objects in Images: The sliding window method, Face detection, Detecting Humans, Detecting Boundaries, Detecting deformable objects **Topics in Object Recognition:** Object recognition current strategies of object recognition, categorization, Selection, improving current Image features, other kinds of Image Features, Geometrical, Semantic Questions, Attributes and unfamiliar, parts poselets and consistency, chunks of meanings	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explore and acquire knowledge on fundamentals of computer vision concepts.
CO2	Analyze the inherent difficulties encountered in computer vision and its interpretation.
CO3	Apply computer vision techniques to solve complex problems.
CO4	Investigate and draw inferences by processing image in real time applications.

Reference Books	
1.	Digital Image Processing, Rafael C. Gonzalez, Richard E. Woods, 3rd Edition, 2012, Pearson Education, ISBN- 9780131687288.
2.	Computer Vision: A Modern Approach, David Forsyth and Jean Ponce, 2nd Edition, 2015, Prentice Hall, ISBN- 978-81-203-5060-1.
3.	Image Processing-Principles and Applications, Tinku Acharya, Ajoy K. Ray, John Wiley & Sons, Inc., ISBN-13 978-0-471-71998-4, Aug 2005.
4.	Computer Vision: Algorithms and Applications, Richard Szeliski, Springer Verlag, 2013 Edition, ISBN-13: 978-1848829343

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 (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: V						
DATABASE MANAGEMENT SYSTESMS **Professional Core Elective-I** **(Theory)**						
Course Code	**:**	**21EC55B4**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Introduction: Evolution of Data Centric Systems, Need & Purpose of Database Systems. Transaction Management, Database user categories and Database architecture, Data Modelling- ER Diagrams. **Entity Relational Model:** Relational Model Concepts, Relational Model Constraints and Relational Database Schemas. Entity types, sets, Relationship, attribute. Integrity constraints, Referential constraints. Update Operations, Transactions and dealing with constraint violations. Concepts of Keys, Super Key, Primary, Candidate and Foreign Keys. Case Study discussions for ER Diagrams. Introduction to Mango DB.	
Unit – II	**09 Hrs**
Relational Algebra: Unary Relational Operations: SELECT and PROJECT, Relational Algebra Operations from Set Theory. Binary Relational operation: equi join, natural join, outer join and inner join. Additional relational operation **SQL:** SQL Data Definition and Data Types, Specifying basic constraints in SQL, Schema change statements in SQL, Basic queries in SQL, More complex SQL Queries. Insert, Delete and Update statements in SQL, Specifying constraints as Assertion and Trigger, Views (Virtual Tables) in SQL.	
Unit –III	**09 Hrs**
Postgre SQL: Data types, creating a database, create a table, drop the database, drop table, select table, insert a record, update record, delete a record, order by, group by, triggers, substring, database keys. Postgre SQL vs MySQL.	
Unit –IV	**09 Hrs**
Database Design – 1: Informal Design Guidelines for Relation Schemas, Functional Dependencies, Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form. **Database Design -2:** Properties of Relational Decompositions, Algorithms for Relational Database Schema Design, Multivalued Dependencies and Fourth Normal Form, Join Dependencies.	
Unit –V	**09 Hrs**
Transaction Management: The ACID Properties, Transactions and Schedules, Concurrent Execution of Transactions, Lock- Based Concurrency Control, Performance of locking, Transaction support in SQL, Introduction to crash recovery, 2PL, Serializability and Recoverability, Lock Management, Introduction to ARIES, The log, Other recovery-related structures, The write-ahead log protocol, Check pointing, Recovering from a System Crash, Media Recovery, Other approaches and interaction with concurrency control.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the fundamentals of Data Base management system, entity-relationship model, Relational Algebra, Database Design, Transaction Management.
CO2	Illustrate the working of data base & transactions by writing queries using SQL and Postgre SQL.
CO3	Analyze an information storage problem and derive an information model expressed in the form of an entity relation diagram and other optional analysis forms, such as a data dictionary.
CO4	Design a data model that satisfies relational theory and provides users with business Queries, business forms and business reports.

Reference Books	
1.	Fundamentals of Database Systems, Elmasri, Navathe, 5th Edition, Pearson Education, 2007, ISBN-13: 9780321369574.
2.	Database Management Systems, Raghu Ramakrishnan, Johannes Gehrke, 3rd Edition, McGraw, ISBN-10: 0072465638.
3.	The art of Postgre SQL, Dimitri Fontaine, 2nd Edition, O'Reilly Media, Inc., 2014, ISBN-9781788472296.
4.	Data base System Concepts, Silberschatz, Korth, Sudharshan, 6th Edition, Mc, ISBN-10: 9332901384.

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 (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
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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						
SIGNAL PROCESSING WITH AI **Professional Core Elective-I** **(Theory)**						
Course Code	**:**	**21EC55B5**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Introduction to Machine Learning: application of ML, regression model**,** Linear Regression, logistic regression, Capacity, Over fitting and Under fitting, Hyper parameters and Validation Sets, Estimators, Bias and Variance, Maximum Likelihood Estimation, Bayesian Linear Regression, Stochastic Gradient Descent, Back Propagation algorithm.	
Unit-II	**09 Hrs**
Supervised Machine Learning: Classification Model**,** Support vector machines., k-Nearest Neighbour, Decision tree, Random Forest model, Naïve Bayes classifier, **Unsupervised Machine Learning**: Application of Unsupervised Learning, K-means Clustering, Mixtures of Gaussians, Principal Component Analysis.	
Unit –III	**09 Hrs**
Introduction to Deep Learning: convolutional and recurrent networks**,** **Convolution Neural Network:** Introduction of Deep Neural Network, Various architecture of CNN, LeNet, AlexNet, ZF-Net, VGGNet, Object Detection: RCNN, Faster RCNN, YOLO **Recurrent Neural Network:** Truncated BPTT, Gated Recurrent Units (GRUs), Long Short-Term Memory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs, Generative Adversarial Networks (GANs).	
Unit –IV	**09 Hrs**
Introduction to Image and Video: Feature extraction and pre-processing, Applications of image processing, Image classification using CNNs, Image classification using machine learning Approaches	
Unit –V	**09 Hrs**
Introduction to Text and Speech: Feature extraction and pre-processing of signal. Analysis of audio signal using LSTM, GRU, GAN model, Application in the field of Natural language processing (Text to speech synthesis, Automatic speech recognition, Statistical modelling of automatic speech recognition.)	

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand the fundamentals of various neural network architecture and training methods.
CO2	Apply the techniques for regularization and optimization of the deep learning networks.
CO3	Appreciate the various models of deep learning networks and its applications
CO4	Engage in self-study to formulate, design, implement and analyze an application realized on relevant platform.

Reference Books	
1.	Deep Learning, Goodfellow, Bengio Y and Courville A., MIT Press, 2016.ISBN- 10: 0262035618.
2.	Learning Deep Architectures for AI: Foundations and Trends in Machine Learning, Yoshio Bengio, ISBN-978-3-642-24412-4.
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, ISBN978-0387848570.
5.	Digital Processing of Speech Signals, L R Rabiner and R W Schafer, Pearson Education 2004. ISBN: 0-13-213603-1.

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 (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
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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						
SUMMER INTERNSHIP – II (Practical)						
Course Code	**:**	**21ECI57**		**CIE**	**:**	**50 Marks**
Credits: L: T: P	**:**	**0:0:2**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**4 Weeks**		**SEE Duration**	**:**	**02 Hrs**
Students can opt the internship with the below options						**04 Weeks**

A. Within the respective department at RVCE (Inhouse) Departments may offer internship opportunities to the students through the available tools so that the students come out with the solutions to the relevant societal problems that could be completed within THREE WEEKS.

B. At RVCE Center of Excellence/Competence

RVCE hosts around 16 CENTER OF EXCELLENCE in various domains and around 05 CENTER OF COMPETENCE. The details of these could be obtained by visiting the website https:/ /rvce.edu.in / rvce-center- excellence. Each centre would be providing the students relevant training/internship that could be completed in three weeks.

C. At Intern Shala

Intern Shala is India's no.1 internship and training platform with 40000+ paid internships in Engineering. Studentscan opt any internship for the duration of three weeks by enrolling on to the platform through https: //internshala.com

D. At Engineering Colleges nearby their hometown

Students who are residing out of Bangalore, should take permission from the nearing Engineering College of theirhometown to do the internship. The nearby college should agree to give the certificate and the letter/email statingthe name of the student along with the title of the internship held with the duration of the internship in their officialletter head.

E. At Industry or Research Organizations

Students can opt for interning at the industry or research organizations like BEL, DRDO, ISRO, BHEL, etc.. through personal contacts. However, the institute/industry should provide the letter of acceptance through hard copy/email with clear mention of the title of the work assigned along with the duration and the name of the student.

Procedures for the Internship:

1. Request letter/Email from the office of respective departments should go to Places where internships are intended to be carried out with a clear mention of the duration of Three Weeks. Colleges/Industry/ CoEs/CoCs will confirm the training slots and the number of seats allotted for the internship via confirmation letter/ Email.
2. Students should submit a synopsis of the proposed work to be done during internship program. Internship synopsis should be assessed or evaluated by the concerned Colleges/Industry/CoEs/CoC. Students on joininginternship at the concerned Colleges/Industry/ CoEs/CoCs submit the Daily log of student's dairy from the joining date.
3. Students will submit the digital poster of the training module/project after completion of internship.
4. Training certificate to be obtained from industry.

Course Outcomes: After completing the course, the students will be able to	
CO1	Develop interpersonal, critical skills, work habits and attitudes necessary for employment.
CO2	Assess interests, abilities in their field of study, integrate theory and practice and explore career opportunities prior to graduation.
CO3	Explore and use state of art modern engineering tools to solve the societal problems with affinity towards environment and involve in ethical professional practice.

CO4	Compile, document and communicate effectively on the internship activities with the engineering community.

RUBRICS FOR THE CONTINUOUS INTERNAL EVALUATION		
#	**COMPONENTS**	**MARKS**
1.	**REVIEW I:** Explanation of the application of engineering knowledge in industries, abilityto comprehend the functioning of the organization/ departments, exhibiting professional and ethical practice, communication skills (oral and body language).	**20**
2.	**REVIEW II**: Presentation in the form digital poster, report writing, exhibiting ethics inreport writing, oral presentation.	**30**
MAXIMUM MARKS FOR THE CIE		**50**

RUBRICS FOR SEMESTER END EXAMINATION		
The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner.		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	**10**
2	Conduction of the Experiments	**20**
3	Viva	**20**
	TOTAL	**50**

Semester: VI						
PRINCIPLES OF MANAGEMENT & ECONOMICS (Theory)						
Course Code	**:**	**21HS61B**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 Hrs**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**06 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	**10 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	**10 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	**10 Hrs**
Introduction to Economics: Microeconomics and Macroeconomics, Circular flow model of economics, An Overview of Economic Systems. **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. **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.	
Unit –V	**09 Hrs**
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.	

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). 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**) 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; 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						
COMMUNICATION SYSTEMS (Theory and Practice)						
Course Code	**:**	**21EC62**		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100+50 Marks**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**03+03 Hrs**

Unit-I	**09 Hrs**
Digital Communication Transmitter: Geometric Representation of Signals in terms of a low pass basis set, Gram Schmidt procedure, conversion statement to bandpass basis set. Geometric representation of signals: Baseband modulated signals with examples Bandpass band limited signals - BPSK, QPSK, M-PSK, M- QAM. Transmitter Architectures and PSD, Power limited – FSK, DPSK, MSK and applications.	
Unit – II	**09 Hrs**
Communication through AWGN Channels: Detection: Centre point sampling, Matched Filter, and Correlation Receiver. Estimation Basics - MAP and MLI Estimation of Binary signals with AWGN, Probability of error for binary signaling, Probability of error for binary baseband pulses (Line codes). Coherent demodulation scheme – BPSK, QPSK, BFSK Receiver Architecture, Probability of symbol error. Coherent Demodulation scheme for multiple signals – M-PAM, M-PSK and M-QAM. Union Bounded Probability of error these signals, Lower and upper bounds. Non-Coherent demodulation of BFSK and DPSK – Symbol representation, Block diagrams treatment of Transmitter and Receiver, Probability of error (Without derivation).	
Unit –III	**09 Hrs**
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 (statement only), Sinc and Raised pulse shaping. Signal design for Band limited channel with controlled ISI – Correlative coding, DB and MDB, with and without Precoding.	
Unit –IV	**09 Hrs**
Principles of Spread Spectrum: 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 –V	**09 Hrs**
Capacity of Wireless channel: A Review of Differential Entropy. Shannon's Theorem, Capacity of a Linear time invariant Gaussian channel, Capacity of Colored Noise channels. Multicarrier Signalling: Single carrier vs Multicarrier, Multicarrier Concepts, Types of Multicarrier in AWGN channel, OFDM, DMT, Spectral Characteristics Multicarrier Channel: ISI and ICI, Power and bit allocation, Capacity, Peak to Average Power Ratio and Equalization.	

Practical's: Communication Systems-2 Lab

1. M-PSK transceiver Design using LabVIEW software
2. M-FSK transceiver Design using LabVIEW software
3. M-QAM transceiver Design using LabVIEW software
4. Performance of QAM with receiver impairments
5. MSK transceiver Design using LabVIEW software
6. Performance of modulations over AWGN channel:
   (a) MPSK, (b) MPAM, (c) MQAM, (d) coherently detected MFSK (e) noncoherently detected MFSK
7. a. Constellations of RC filtered waveforms of MSK and QPSK variants
   b. Compute and plot PSD estimates of BPSK, QPSK and MSK signals
8. Transmitter and Receiver Implementation of Direct Sequence Spread Spectrum
9. Transmitter and Receiver Implementation of Frequency Hopped Spread Spectrum
10. Performance of MPSK-CP-OFDM and MQAM-CP-OFDM on AWGN channel

Demo Experiment using software defined radio (NI-USRP 2920): Demonstration of Binary and M-ary modulation and demodulation techniques through wireless link (MPAM, MPSK, MQAM and MFSK) and Demonstration of FM demodulation technique through wireless link

Open ended experiments:

1. Analysis of M-QAM including ISI and AWGN channel- MATLAB
2. Analysis of G-MSK modulation scheme for GSM applications- MATLAB

Course Outcomes: After completing the course, the students will be able to	
CO1	Associate the concept of geometric basis to well specified baseband and bandpass symbols.
CO2	Analyze and compute performance of detected and estimated low pass and bandpass symbols under ideal and corrupted non band limited channels.
CO3	Test and validate symbol processing and performance parameters at the receiver under ideal and corrupted bandlimited channels.
CO4	Demonstrate by simulation and emulation bandpass signals subjected to convolution coding and symbol processed at transmitter and correspondingly demodulated and estimated at receiver after passing through a corrupted channel.

Reference Books	
1.	Digital Communication Systems, Simon Haykin ,1st Edition, 2013, John Wiley and sons, ISBN-978 81 265 2151 7.
2.	Fundamentals of Communication Systems, John G. Proakis, Masoud Salehi, 2nd Edition,2014, Pearson Educations, ISBN: 978-0-1333-5485-0
3.	Modern Digital and Analog communication Systems, B.P.Lathi and Zhi Ding, 4th Edition, 2010, Oxford University Press, , ISBN: 9780198073802.
4.	Digital Communications, Ian A. Glover, Peter M. Grant, 3rd Edition, 2010, Pearson Educations, ISBN:978-0-273-71830-7

RUBRICFOR 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 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) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). 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. **THE FINAL MARKS WILL BE 50 MARKS**	**50**
	MAXIMUM MARKS FOR THE CIE	**150**

RUBRIC FOR 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						
COMPUTER NETWORKS AND PROTOCOLS (Theory and Practice)						
Course Code	**:**	**21EC63**		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100+50 Marks**
Total Hours	**:**	**45L + 30P**		**SEE Duration**	**:**	**03+03 Hrs**

Unit-I	**09 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	**09 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.	
Unit –III	**09 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. Forwarding, Subnet addressing, Inter- and intra-domain routing, Datagram networks; virtual circuits. RIP, OSPF, BGP, Count to infinity.	
Unit –IV	**09 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. Leaky Bucket and token Bucket Algorithms. AES and DES Algorithms.	
Unit –V	**09 Hrs**
Multimedia Networking: Properties of Audio, Types of multimedia Network Applications, Streaming stored video,UDP Streaming, HTTP Streaming, 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, Different services, Per-connection Quality of service (QOS) Guarantees: Resource Reservation and Call admission.	

Practical's: Computer Networks and Protocols Lab

Part –I: Experiments Using C/C++ programming.

1. a) Implement Bit stuffing Algorithm
   b) Character stuffing algorithms and
   c) Cyclic Redundancy Check codes for error detection using C programs.
2. Implement Encryption and Decryption algorithms using C program.
3. Implement following Minimum Spanning Tree algorithms using C program
   i) Kruskal's Algorithm
   ii) Prim's Algorithms
4. Implement STOP and WAIT protocol using socket programming concept using C Program.
5. Implement RSA algorithm using C program.

Part-II: Experiments that may be carried out using QualNet/NS-3/Packet Tracer

1. Simulate &Analyze CSMA/CD and CSMA/CA Protocols.
2. Test and verify Network configurations using Packet Tracer.
3. Configure Inter VLAN network using Packet Tracer.
4. Configure and test a given network using Packet Tracer.

Part-III: Simulation of congestion control algorithms using NS-3.

Open ended Experiments:

1. Implement a four-node point to point network with links n_0-n_2, n_1-$n_2$and n_2-n_3. Apply TCP agent between n0-n3 and UDP between n_1-n_3. Apply relevant applications over TCP and UDP agents by changing the parameters and determine the number of packets sent by TCP/UDP.
2. Simulate and Compare following Routing Protocols using QualNet
   a) Open-Shortest Path First (OSPF) b) Routing Information Protocol (RIP)

Course Outcomes: 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. ISBN :978-0-13-212695-3
5.	Multimedia Networks: Protocols, Design and Application Hans W. Barz, Gregory A. Bassett, WILEY publication, ISBN: 978-1-119-09013-7

RUBRICFOR 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 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) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). 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. **THE FINAL MARKS WILL BE 50 MARKS**	**50**
	MAXIMUM MARKS FOR THE CIE	**150**

RUBRIC FOR 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						
OPTICAL FIBER COMMUNICATION AND NETWORKING **Professional Core Elective-III** **(Theory)**						
Course Code	**:**	**21EC64D1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Introduction: Overview of optical fiber communications, Basic principles of light propagation, Ray Model, Wave Model, Optical fiber modes, single and multi-mode fibers, single and multi-core fibers. **Transmission System Engineering:** System Model, Power penalty, Transmitter, Receiver, Different optical amplifiers - SOA, EDFA. **Introduction to Optical Components and Networks:** Optical Components - Couplers, Isolators, Circulators, Solitons, Multiplexes and Filters, Optical Amplifiers. Transmitters, Detectors, Switches, OADM and Wavelength Converters.	
Unit – II	**09 Hrs**
Optical Networks: Telecommunication networks, first generation optical networks, Multiplexing techniques, Second generation optical networks, System, and network evolution. **Optical Networks Architecture:** SONET/SDH, Computer interconnects, MANS, Layered architecture for SONET and second-generation networks. Broadcast and Select Networks: Topologies for Broadcast Networks, Media-Access Control Protocols, Operational principle of WDM, WDM network elements and Architectures, Introduction to DWDM.	
Unit –III	**09 Hrs**
Network Connections: Connection Management and Control: optical connections, logical connection, static networks: point to point and multipoint Connections, packet switching in optical layer: The MAC sublayer. **Wavelength Routed Networks:** Routing and channel assignments, static routing and channel assignments. Dynamic routing and channel assignments. Some basics routing and channel assignment algorithms.	
Unit –IV	**09 Hrs**
Wavelength Routed Switched Networks: Optical Circuit Switching, Optical Packet Switching, Optical Burst Switching, The passive optical networks, Energy Awareness in Optical Networking, Network Modelling Tools Network Design Guidelines. **Trends in Multiwavelength Optical Networks:** Metropolitan Area Networks, long Haul and Ultra long networks, New application and services.	
Unit –V	**09 Hrs**
Virtual Topology, Network Control and Management: Virtual topology design problem, Combines SONET/WDM network design, an ILP formulation, Regular virtual topologies, Control and management, Network management configuration management, Performance management, fault management. Network management functions, Optical safety.	

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Apply mathematical principles to various optical components and analyze their performance.
CO2	Explain the basic properties of light: Reflection, Refraction, Interference, Diffraction and Coherence.
CO3	Design circuits involving optical sources and detectors based on given design parameters.
CO4	Illustrate the networking aspect of optical fibre and describe various standards associated with it.

Reference Books	
1.	Optical Networks: A Practical Perspective, Kumar Sivarajan and Rajiv Ramaswamy, Morgan Kauffman, Elsevier Publication, Elsevier India Pvt. Ltd, 3rd Edition, 2010.
2.	Connection-Oriented Networks: SONET/SDH, ATM, MPLS and Optical Networks, Harry G. Perros, Wiley, ISBN: 9780470021644.
3.	Fiber Optic Communication Systems, G. Agrwal, John Wiley and Sons, 3rd Edition, New York, 2014.
4.	C. Siva Ram Moorthy and Mohan Gurusamy, WDM Optical Networks: Concept, Design and Algorithms, Prentice Hall of India, 1st Edition, 2002.

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 (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						
ANTENNAS FOR WIRELESS COMMUNICATION **Professional Core Elective-III** **(Theory)**						
Course Code	**:**	**21EC64D2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Electromagnetic Theorems: Introduction, Duality Theorem, Uniqueness Theorem, Image Theory: Vertical Electric Dipole, Horizontal Electric Dipole, Reciprocity Theorem, Reaction Theorem, Volume Equivalence Theorem, Surface Equivalence Theorem: Huygens's Principle, Induction Theorem (Induction Equivalent), Physical Equivalent and Physical Optics Equivalent	
Unit – II	**09 Hrs**
Fundamental Parameters of Antennas: Introduction, Radiation Pattern, Radiation Power Density, Radiation Intensity, Beamwidth, Directivity, Numerical Techniques, Antenna Efficiency, Gain, Beam Efficiency, Bandwidth, Polarization, Input Impedance, Antenna Radiation Efficiency, Antenna Vector Effective, Length and Equivalent Areas, Maximum Directivity and Maximum Effective Area, Friis Transmission, Equation and Radar Range Equation, Antenna Temperature	
Unit –III	**09 Hrs**
Linear Wire Antennas: Infinitesimal wire antenna: Radiated fields, Power Density, Radiation Resistance, Directivity, Gain, Finite length Dipole: Current Distribution, Radiated Fields: Element Factor, Space Factor, and Pattern Multiplication, Power Density, Radiation Intensity, and Radiation Resistance	
Unit –IV	**09 Hrs**
Antenna Array and Synthesis: Array Antenna Expression for electric fields from two, three and N element arrays-linear arrays: Broadside array and End-Fire array- Method of pattern multiplication- Binomial array. Array Synthesis: Continuous Sources, Schelkunoff Polynomial Method, Fourier Transform Method, Woodward-Lawson Method, Taylor Line-Source (Tschebyscheff-Error)	
Unit –V	**09 Hrs**
Antenna types and Measurements: Antenna Types: Folded Dipole, Log-Periodic Antennas, Horn Antennas, Microstrip Antennas, Reflector Antennas, Smart Antennas Introduction, Antenna Ranges, Radiation Pattern, Gain Measurements, Directivity Measurements, Radiation Efficiency, Impedance Measurements, Current Measurements, Polarization Measurements.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain and summarize the working of transmission line, Waveguides, Microwave Passive Devices and Antennas.
CO2	Analyze wave propagation in transmission line, Waveguides and characterize the passive microwave components and Antennas.
CO3	Design the transmission lines, passive microwave components and Antennas for given specification and match the impedance.
CO4	Evaluate S-Parameter, VSWR for transmission lines, Microwave components and radiation pattern for Antennas.

Reference Books	
1.	Advanced Engineering Electromagnetics, Constantine A. Balanis , Wiley India Pvt. Ltd, 2008, ISBN-13 978-8126518562.
2.	Antenna Theory and Design, C A Balanis, John Wiley & sons, Inc. Publication, 3rd Edition,2005, ISBN-13: 978-0471667827.

3.	Antennas, John D.Krauss, McGraw-Hill International Edition, 3rd Edition, 2006. ISBN-13: 978-0071232012
4.	Antenna Engineering Handbook, J.L. Volakis (ed.), McGraw-Hill; 4th Edition, 2007, ISBN-13: 978-0071475747.

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 (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						
LOW POWER VLSI DESIGN **Professional Core Elective-III** **(Theory)**						
Course Code	**:**	**21EC64D3**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Introduction: Need for Low Power VLSI Design, Sources of power dissipation, Power dissipation in CMOS circuits: Short Circuit dissipation, Dynamic dissipation, 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	**09 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	**09 Hrs**
Device and Technology Impact on Low Power Electronics: Introduction, Dynamic Dissipation in CMOS, Effects of V_{DD} and V_t on speed, Constraints on V_t Reduction, Transistor and Gate Sizing, Transistor Sizing and Optimal Gate Oxide Thickness (Quantitative analysis only) Impact of Technology Scaling. 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.	
Unit –IV	**09 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	**09 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 sew Vs tolerable skew, CMOS Floating Nodes, Low Power Bus, Delay Balancing, Energy recovery CMOS and Adiabatic computation.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Acquire the knowledge with regard to the physical principles, analysis and the characteristics of the low power designs.
CO2	Identify, formulate, and solve engineering problems in the area of low power VLSI designs.
CO3	Use the techniques and skills in system designing through modern engineering tools such as logic works SPICE and description languages such as VHDL and Verilog.
CO4	Design a digital system, components or process to meet desired needs of low power within realistic constraints.

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). 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						
DEEP LEARNING **Professional Core Elective-III** **(Theory)**						
Course Code	**:**	**21EC64D4**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**
Unit-I						**09 Hrs**
Introduction: History of Deep Learning, Deep Learning Success Stories Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Eigenvalues and eigenvectors, Eigenvalue Decomposition, Basis, Principal Component Analysis and its interpretations, Singular Value Decomposition						
Unit – II						**09 Hrs**
Autoencoders and relation to PCA, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders, Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout						
Unit –III						**09 Hrs**
Greedy Layerwise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization. Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Object Detection, RCNN, Fast RCNN, Faster RCNN, YOLO						
Unit –IV						**09 Hrs**
Recurrent Neural Networks, Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT						
Unit –V						**09 Hrs**
Gated Recurrent Units (GRUs), Long Short-Term Memory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs, Autoregressive Models: NADE, MADE, PixelRNN, Generative Adversarial Networks (GANs)						

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand the fundamentals of various neural network architecture and training methods
CO2	Apply the techniques for regularization and optimization of the deep learning networks
CO3	Appreciate the various models of deep learning networks and its applications
CO4	Engage in self-study to formulate, design, implement and analyze an application realized on relevant platform.

Reference Books	
1.	Deep Learning, Goodfellow, I., Bengio, Y., and Courville, A., MIT Press, 2016.ISBN- 10: 0262035618.
2.	Learning Deep Architectures for AI: Foundations and Trends in Machine Learning, Yoshio Bengio, ISBN- 978-3-642-24412-4.
3.	Pattern Recognition and Machine Learning, Bishop, C., Berlin: Springer-Verlag, 2006. ISBN- 978-0-387-31073-2.
4.	Artificial Neural Networks, B. Yegnanarayana Printice Hall India Learning Pvt. Ltd, 2009. ISBN- 13: 978-8120312531.

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 (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						
REAL TIME SYSTEMS **Professional Core Elective** **(Cluster Elective)**						
Course Code	**:**	**21EC65E1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Introduction: Overview, Real-Time Systems, Case Study: Radar System, Cross-Platform Development Process, Hardware Architecture, Build Target Images, Transfer Executable File Object to Target, Integrated Testing on Target, System Production, Interrupts Overview, Design patterns for ISR's, Interrupt Response time, System Bootloader, System Boot **I/O Resources: Memory:** Physical Hierarchy, Cache, Memory Planning, Memory shadowing	
Unit – II	**09 Hrs**
Real-Time UML: General Resource Modeling: Overview of UML, Architecture modelling in UML, Real-Time UML Profile, Resource Modeling, Time Modeling, Concurrency Modeling. **Real-Time UML: Model Analysis:** Elicitation of Timing Constraints, RT-UML Profile Schedulability, Modeling Subprofile	
Unit –III	**09 Hrs**
Software Architectures for Real-Time Embedded Systems: Real-Time Tasks, WCET, Intermediate FO, Execution Efficiency, Round-Robin Architecture, Round Robin with Interrupts, Queue-Based Architecture, Multitask Design, Multitask Resource Sharing, Addressing Resource Deadlocks, Addressing Priority Inversion.	
Unit –IV	**09 Hrs**
Real-Time Scheduling: Clock-Driven Approach, Rate-Monotonic approach, Sporadic Server approach, Resource sharing, IPC: Message Ques, Pipes, Signalling, Remote Procedure and Sockets, Real Time Memory Management: Process Stack Management, Dynamic Allocation, Hardware and software timing management.	
Unit –V	**09 Hrs**
Examples of Real Time OS: Vx-Works, RTX-ARM: Task Management, Scheduling, Primitive Kernel Services, Application Program development using APIs, QNX resource management, Case studies: Calculator, Device Drivers	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the fundamental concepts of real-time system and real-time operating system.
CO2	Analyze given requirements, design hardware & software for real time systems.
CO3	Apply modern engineering tools for real time firmware development & performance analysis
CO4	Verify the specifications of various real time operating systems used for meeting timing constraints of given problem

Reference Books	
1.	Real-Time Embedded Systems Design Principles and Engineering Practices by Xiaocong Fan, Newnes Publishers - an imprint of Elsevier, 2015, ISBN10: 0128015071
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.
5.	Rea1 Time Systems, Jane W. S. Liu, 2000, Prentice Hall, ISBN:0130996513

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 (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						
DIGITAL SYSTEM DESIGN WITH FPGA **Professional Core Elective** **(Cluster Elective)**						
Course Code	**:**	**21EC65E2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Introduction to Verilog and Design Methodology: Verilog IEEE standards, Verilog Data Types: Net, Register and Constant. Verilog Operators, Number representation and Verilog ports, Simulation and Synthesis, Test-benches. **Verilog Primitives**. **Logic Simulation, Design Verification, and Test Methodology:** Four-Value Logic and Signal Resolution in Verilog, Test Methodology Signal Generators for Test benches, Sized Numbers. **Introduction to Design Methodology:** Digital Systems and Embedded Systems, Real-world circuits. Design Methodology: Design Flow-Architecture, Functional design and verification, Synthesis, Physical design. Design Optimization-Area, Timing and Power, System representation.	
Unit – II	**09 Hrs**
Number Basics and Verilog Modelling Styles: **Number Basics:** Unsigned and Signed Integers, Fixed-point and Floating-point Numbers. Boolean Functions and Boolean Algebra, Verilog models for Boolean switching function, Binary Coding. **Behavioural Modelling**: Latches and Level-Sensitive Circuits in Verilog, Cyclic Behavioural Models of Flip-Flops and Latches, Behavioural Models of Multiplexers, Encoders, Decoders and Arithmetic circuits. **Dataflow Modelling**: Boolean Equation-Based Models of Combinational Logic, Propagation Delay and Continuous Assignments. Linear-Feedback Shift Register. Tasks & Functions. **Structural Modelling:** Design of Combinational Logic, Verilog Structural Models, Top-Down Design and Nested Modules. (Hands on using Xilinx Vivardo tool)	
Unit –III	**09 Hrs**
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. (Hand on using Xilinx Vivardo)	
Unit –IV	**09 Hrs**
System Implementation and Fabrics: CPLD vs FPGA Architecture - Programming Technologies-Chip I/O-Programmable Logic Blocks- Fabric and Architecture of FPGA. Xilinx Virtex VI Architecture – ALTERA Cyclone II Architecture - ALTERA Stratix IV Architecture, Hardcore and Softcore FPGA.	
Unit –V	**09 Hrs**
Processor Design and System Development: **Design of Processor Architectures:** Functional Units for Addition, Subtraction and Multiplication (overview). Design: Hierarchical Decomposition STG-Based Controller Design, Efficient STG-Based Sequential Binary Multiplier.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the digital system designs skills using VERILOG HDL based on IEEE-1364 standards and managed by Open Verilog International (OVI).
CO2	Demonstrate the skill on cost-effective system designs through proper selection of implementation fabrics for the desired application.

CO3	Analyze complete systems and build small scale applications using Interfacing concepts.
CO4	Design and implement complete digital systems using VERILOG HDL and demonstrate the innovation skills.

Reference Books	
1.	Advanced Digital Design with the Verilog HDL, Michael D. Ciletti, 2nd Edition, PHI, ISBN: 978–0–07–338054–4 2015.
2.	Digital Design: An Embedded Systems Approach Using VERILOG, Peter J. 1st Edition, Ashenden, Elsevier, ISBN: 978-0-12-369527-7, 2010.
3.	Digital Systems Design Using Verilog, 1st t Edition, Charles Roth, Lizy K. John, Byeong Kil Lee, Cengage Learning, ISBN-10: 1285051076, 2015.
4.	Fundamentals of Digital Logic with Verilog Design, Stephen Brown and Zvonko Vranesic, 6th Edition, McGraw Hill publication, ISBN: 978–0–07–338054–4, 2014.

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 (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						
SMART GRID TECHNOLOGY **Professional Core Elective** **(Cluster Elective)**						
Course Code	**:**	**21EE65E1**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Introduction to Smart Grid: Concept of Smart Grid, Conventional Grid Vs Smart Grid, Smart Grid Domains, Early Smart Grid Initiatives, Overview of the technologies required for the Smart Grid, Core Applications of Smart grid. **Modern Technologies in Transmission and Distribution for Smart Grid:** Present Challenges on Transmission Grids, Smart Transmission, Energy management systems, Wide Area applications, Substation automation, Distribution management systems, Applications for distribution network automation.	
Unit – II	**09 Hrs**
Measurement and Monitoring in Smart Grid: Intelligent Electronic devices, RTU, Evolution of Smart meters, Communication Infrastructure for smart Metering, WAMPAC, Multiagent System Technology. **Communication Technologies for Smart Grid:** Introduction, Communication Technologies, Smart Grid Network architecture. **Interoperability, Cyber Security and standards**: Interoperability, Information security for smart grid, Encryption and Decryption for security, Authentication, Digital signatures, Cyber security standards, Cyber security risks.	
Unit –III	**09 Hrs**
Communication technologies for Smart grid **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	**09 Hrs**
Renewable Energy Sources and Storage in Smart Grids: Sustainable energy options for smart grid, Penetration and variability issues associated with sustainable energy technology, Demand response issues, Energy Storage Technologies, Selection of storage technology, Case study of micro grid with renewable energy, Case study of renewable Energy Resources integration.	
Unit-V	**09 Hrs**
Power Quality Management in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit. **Indian Smart Grid Scenario:** Indian Power Sector, Renewable energy development in India, Smart grid Drivers for India, Smart grid Initiatives in India, Roadmap, Smart grid pilot projects, Case studies.	

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand the fundamental concepts of a smart grid and discuss the technologies needed for it.

CO2	Analyse the power quality and cyber risks of the smart grid and propose appropriate measures.
CO3	Select suitable energy storage devices for a given grid.
CO4	Design a WAM system for the grid, including the metering and communication infrastructure.

Reference Books	
1.	Smart Grid Applications, Communications, and Security, by Lars T. Berger and Krzysztof Iniewski, 1st Edition, Wiley, 2015, ISBN: 978-8126557363.
2.	Smart Grid: Technology And Applications, by Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, and Nick Jenkins, 1st Edition, John Wiley & Sons, 2012, ISBN: 978-0470974094.
3.	Smart Grid: Fundamentals of Design and Analysis, by James Momoh, 1st Edition, Wiley IEEE-Press, 2012, ISBN: 978-0470889398.
4.	Smart Grids – Fundamentals and Technologies in Electricity Networks, by Buchholz, Bernd M., Styczynski, Zbigniew, 2nd Edition, Springer, 2020, ISBN: 978-3662609293.
5.	Smart Grid: Infrastructure, Technology and Solutions, by Stuart Borlase, 1st Edition, CRC Press, 2012, ISBN: 978-1439829059.
6.	Fundamentals of Smart Grid Technology, by Bharat Modi, Anu Prakash, Yogesh Kumar, 1st Edition, S.K.Kataria & Sons, 2015 ISBN: 978-9350144855.

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 (20**) 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						
MODERN CONTROL THEORY **Professional Core Elective** **(Cluster Elective)**						
Course Code	**:**	**21EE65E2**		**CIE**	**:**	**100Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Introduction: State Variable Analysis of Dynamic systems, State Equations, SISO and MIMO Systems. State Model of Physical Systems: Signal flow graphs, Relation between Transfer function and State equation. **Eigen Values:** Characteristic equation, Eigen values, Eigen vectors, generalized Eigen vectors, Similarity transformation, transformation of a state model to diagonal/Jordan canonical form.	
Unit – II	**09 Hrs**
Solution of State Model: Solution of state equation, transition matrix and its properties, computation using Laplace transformation, power series method, similarity transformation, Cayley-Hamilton method. **Controllability & Observability:** Concept of controllability & observability, methods of determining the same, Relation between controllability, observability & pole zero cancellations.	
Unit –III	**09 Hrs**
Stability of Linear Systems: Lyapunov stability criteria, Lyapunov functions, direct method of Lyapunov for the linear systems. **Pole Placement Design Techniques:** Stability improvements by state feedback, necessary and sufficient conditions for arbitrary pole placement, state regulator design, and design of state observer.	
Unit –IV	**09 Hrs**
Non-Liner Systems: Introduction, behaviour of non-liner system, common physical non-linearity saturation, friction, backlash, dead zone, relay, multivariable non-linearity. Phase plane method, singular points, stability of nonlinear system, limit cycles, construction of phase trajectories. **Stability of Non-linear Systems:** Construction of Lyapunov functions for nonlinear system by Krasovskii's method	
Unit –V	**09 Hrs**
Nonlinear Control Design: Design and analysis of feedback control for nonlinear systems through linearization, feedback linearization and Lyapunov based methods, design and analysis of high gain feedback, e.g. sliding mode control, observers for nonlinear systems.	

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Explain the concepts of state space, eigen value and Eigen vectors, controllability and observability, pole placement, non-linear systems and Lyapunov stability.
CO2	Represent the systems in state space, Response of systems with and without state feedback controllers and observers, Analysis of stability of linear and nonlinear systems
CO3	Transform state models to canonical, observable and controllable forms. Asses the need of state feedback controllers and observers, Evaluate the stability of non-linear systems and Liapunov stability criterion.
CO4	Design state feedback controllers and observers.

Reference Books	
1.	Modern Control Engineering, Katsuhiko Ogata, 5th Edition, 2003, PHI, ISBN 81-7808-579-8.
2.	Automatic Control System, Benjamin C. Kuo and Farid Golnaraghi, 8th Edition, 2003, John Wiley and Sons, ISBN 0-471-13476-7.
3.	Analysis and Design of Nonlinear Feedback Control Systems, G. J. Thaler and M. P. Pastel McGraw-Hill, 1962.
4.	Analysis of Nonlinear Control Systems, D. Graham and D. McRuer, John Wiley
5.	Modern Control Principles and Applications, J. C. Hsu and A. V. Meyer, McGraw-Hill, 1968.
6.	Nonlinear Control Systems: Analysis and Design, H. J. Marquez, John Wiley Interscience, 2003.

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	**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						
ELECTRONICS EQUIPMENT INTEGRATION AND PROTOTYPE BUILDING **Professional Core Elective** **(Cluster Elective)**						
Course Code	**:**	**21EI65E1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Introduction to Electronic Products, Examples from Real Life: Parts to system, simulation of flat prismatic parts, flat parts enclosures, real life parts to scale on a graph. **Product Concepts and Prototyping:** First steps of prototyping, top down, outside to internals, using a print and fabrication video, details of keys and displays, improvement on marking and skills.	
Unit – II	**09 Hrs**
Integrating Sub Systems to Larger Systems: Mass production in sheet metal, prototyping of user interfaces for concepts, stacking of equipment to make a system, Recapitualising a subsystem, off the shelf enclosures and making a user interface.	
Unit –III	**09 Hrs**
Small Units: looking around for concepts and integration, representation on a paper, example features of solids and surfaces, simple and curved surfaces, describing inclined surfaces. **Drafting and Design:** Basics of engineering drawing, introduction to sizing and fits, practical mechanical assemblies, analogous mechanical to electronics detailing, solid modelling	
Unit IV	**09 Hrs**
Use of CAD Drawing for Detailing: Importance of dimensioning, ease of editing redesign, dimensioning of electronic components, 2D flat representation, Electronics to mechanical interfacing. **Practical Example Mock Up:** complexity of 3D assemblies with wiring, illustrative simple design, practical detailing, rendered onscreen.	
Unit V	**09 Hrs**
A Design Fully by Low Cost 2D 3D CAD: Fastenings and hardware, fastener representation and detailing, practical detailing, Recapitulation, context of course, Low cost is the key. **Case Studies:** physical simulation of small systems, building of prototype mock ups, Designs for production scale up, Design of front panel layout and graphics.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the concepts of protype building.
CO2	Apply the concepts for designing the layout a system, and developing drawings that can be used for fabrication in a workshop.
CO3	Analyze the build model.
CO4	Design a working prototype of electronic equipment.

Reference Books	
1.	Product Design and Development, Karl Ulrich, Steven D Eppinger, Tata Mc Graw Hill, 6th Edition, 2016, ISBN-13: 978-0-07-802906-6
2.	Electronic Prototype Construction, Stephan D. Kasten, September 1983, Sams Technical Publishing, ISBN-13: 978-0672218958

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 (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: IV						
VIRTUAL INSTRUMENTATION **Professional Core Elective** **(Cluster Elective)**						
Course Code	**:**	**21EI65E2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Virtual Instrumentation: Virtual instrument and traditional instrument, hardware and software in VI, graphical system design using LabVIEW. Introduction to LabVIEW: Advantages, software environment, creating and saving VI, front panel and block diagram tool bar, palettes, controls and indicators, block diagram, data types, data flow program.	
Unit – II	**09 Hrs**
Modular Programming: Build a VI front panel and block diagram, building a connector pane, displaying sub-VIs and express VIs, creating sub-VIs, Repetition and loops: For loops, while loops, structure tunnels, terminal inside or outside loops, shift registers, feedback nodes, control timing, communication among multiple loops, local and global variables. Structures: Case, sequence, customizing, timed structures, formula nodes, event structures.	
Unit –III	**09 Hrs**
Arrays & Clusters: Creating one dimensional, two dimensional, multi-dimensional arrays, array initialization, deleting, inserting, replacing elements within an array, array function, auto indexing. Clusters functions. **File and Strings**: Introduction to Files, File Formats, File I/O Functions, File operation, Introduction to String Functions, LabVIEW String Functions, Typical examples, Visual display types- graphs, charts, XY graph	
Unit IV	**09 Hrs**
Data Acquisition with LabVIEW: PC based data acquisition, Typical onboard DAQ card, Resolution and sampling frequency, Multiplexing of analog inputs-Single-ended and differential inputs, Concept of universal DAQ card, Use of timer- counter and analog outputs on the universal DAQ card, DAQ Assistants, Analysis Assistants. Real time application using DAQ Cards.	
Unit V	**09 Hrs**
Design Pattern: Producer-Consumer Model, Event Structure Model, Master-Slave Model, State Machine Model, and Synchronization using Semaphore. Signal Processing Application, Real time application using myRIO, configure myRIO for speed control of DC Motor using encoder.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Remember and understand the fundamentals of Virtual Instrumentation and data Acquisition.
CO2	Apply the theoretical concepts to realize practical systems.
CO3	Analyze and evaluate the performance of Virtual Instrumentation Systems.
CO4	Create a VI system to solve real time problems using data acquisition.

Reference Books	
1.	Jovitha Jerome, Virtual instrumentation Using LabVIEW,4th Edition, 2010, PHI Learning Pvt. Ltd, ISBN: 978-8120340305
2.	Sanjay Gupta & Joseph John, Virtual Instrumentation Using LabVIEW, 2nd Edition, 2017, Tata McGraw Hill Publisher Ltd, ISBN: 978-0070700284
3.	Lisa. K. Wills, LabVIEW for Everyone, 2nd Edition, 2008, Prentice Hall of India, ISBN: 978-013185672
4.	Garry Johnson, Richard Jennings, LabVIEW Graphical Programming, 4th Edition, 2017, McGraw Hill Professional, ISBN: 978-125900533

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 (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: IV						
SMART ANTENNAS **Professional Core Elective** **(Cluster Elective)**						
Course Code	**:**	**21ET65E1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Arrays: Introduction, Two-Element Array, N-Element Linear Array: Uniform Amplitude and Spacing, N-Element Linear Array: Directivity Design Procedure, N-Element Linear Array: Three-Dimensional Characteristics, Rectangular-to-Polar Graphical Solution, N-Element Linear Array: Uniform Spacing, Planar Array	
Unit – II	**09 Hrs**
Introduction to Smart Antennas: Need for Smart Antennas, Overview, Smart Antenna Configurations, Space Division Multiple Access, Architecture of Smart Antenna System, Benefits, Drawbacks, Basic Principles, Mutual Coupling Effects.	
Unit –III	**09 Hrs**
Beamforming: Fixed Weight Beamforming Basics - Maximum Signal-to-Interference Ratio, Minimum Mean-Square Error, Maximum Likelihood, Minimum Variance Adaptive Beamforming - Least Mean Squares, Sample Matrix Inversion, Recursive Least Squares Constant Modulus, Least Squares Constant Modulus, Conjugate Gradient Method, Spreading Sequence Array Weights, Description of the New SDMA Receiver	
Unit –IV	**09 Hrs**
Angle-of-Arrival Estimation: Array Correlation Matrix, AOA Estimation Methods -Bartlett AOA Estimate, Capon AOA Estimate, Linear Prediction AOA Estimate, Maximum Entropy AOA Estimate, Pisarenko Harmonic Decomposition AOA Estimate, Min-Norm AOA Estimate, MUSIC AOA Estimate, Root-MUSIC AOA Estimate, ESPRIT AOA Estimate.	
Unit –V	**09 Hrs**
Next generation Antennas: Metamaterial Antennas Metamaterial Antennas Based on NRI Concepts, High-Gain Antennas Utilizing EBG Defect Modes, Reconfigurable Antennas: Introduction, Analysis, Overview of Reconfiguration Mechanisms for Antennas, UWB planar antennas, Phased array antennas for 5G communications, MIMO antennas	

Course Outcomes: After completing the course, the students will be able to	
CO1	Elucidate parameters and principles of Adaptive Antennas, Application specific Antennas.
CO2	Apply signal processing concepts in analyzing beam forming techniques and Algorithms.
CO3	Analyze and compare various techniques employed in designing Adaptive Antennas with Beam forming algorithms.
CO4	Design and evaluate the industry specific Practical antennas.

Reference Books	
1.	Introduction to Smart Antennas. Synth. Lect. Antennas, Balanis, C.A., Ioannides, P.I.: 2(1), 1– 175,2007, 9781598291766.(Unit-2,Unit-3)
2.	Smart Antennas with Matlab: Principles and Applications in Wireless Communication, Frank B Gross,2015, McGraw-Hill Professional, New York, ISBN- 978-0-07-182494-1(Unit-1, Unit-4)

3.	Frontiers in Antennas: Next Generation Design & Engineering, Frank B gross, 2011, McGraw Hill Publications, ISBN: 9780071637930. (Unit-5)
4.	Smart antenna, Lal Chand Godara, 2004, CRC press, London, ISBN: 9780849312069.

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 (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						
SATELLITE COMMUNICATION **Professional Core Elective** **(Cluster Elective)**						
Course Code	**:**	**21ET65E2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hrs	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Orbital Mechanics: Orbital Mechanics, Look Angle Determination, Orbital Perturbations, Orbit Determination, Launches and Launch Vehicles, Orbital Effects in Communication systems	
Unit – II	**09 Hrs**
Satellite Sub-Systems: Altitude and orbit control system, TT&C Sub-System, Altitude control Sub-System, Power Systems, Communication Subsystems, Satellite antenna Equipment. **Satellite Link:** Basic transmission theory, system noise temperature and G/T ratio, Design of Uplinks and Downlink, C Band System Design Example.	
Unit –III	**09 Hrs**
Propagation effects: Introduction, Atmospheric Absorption, Cloud Attenuation, Tropospheric and Ionospheric Scintillation and Low angle fading, Rain Induced attenuation, rain induced cross polarization interference. **Multiple Access:** Frequency Division Multiple Access (FDMA), Intermodulation, Calculation of C/N. Time Division Multiple Access (TDMA), Frame structure, Burst structure, Satellite Switched TDMA On board processing, Demand Assignment Multiple Access (DAMA), CDMA Spread Spectrum Transmission and Reception	
Unit –IV	**09 Hrs**
Communication Satellites: Introduction, Related Applications, Frequency Bands, Payloads, Satellite Vs. Terrestrial Networks, Satellite Telephony, Satellite Television, Satellite radio, regional satellite Systems, National Satellite Systems.	
Unit –V	**09 Hrs**
Remote Sensing Satellites: Classification of remote sensing systems, orbits, Payloads, Types of images: Image Classification, Interpretation, Applications. Weather Forecasting Satellites: Fundamentals, Images, Orbits, Payloads, Applications. Navigation Satellites: Development of Satellite Navigation Systems, GPS system, Application.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the satellite orbits and its trajectories with the definitions of parameters associated with it.
CO2	Analyse the electronic hardware systems associated with the satellite subsystem and earth station.
CO3	Compute the satellite link parameters under various propagation conditions with the illustration of multiple access techniques.
CO4	Identify and analyse the working of the satellites used for applications in remote sensing, weather forecasting and Navigation.

Reference Books	
1.	Satellite Communications- Timothy Pratt, Charles Bostian and Jeremy Allnutt, WSE, Wiley Publications, 2nd Edition, 2003, John Wiley & Sons.
2.	Anil K. Maini, Varsha Agrawal, Satellite Communications, Wiley India Pvt Ltd, 2015, ISBN: 978-81-265-2071-8.
3.	K. N. Raja Rao, Satellite Communication: Concepts and Applications, PHI Learning Private India, 2013, ISBN-978-81-203-4725-0.

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 (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						
INDUSTRIAL SAFETY AND RISK MANAGEMENT **Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE6F1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 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, Hazard recognition.	
Unit – II	**09 Hrs**
Risk assessment and control: Individual and societal risks, Risk assessment, Risk perception, Acceptable risk, ALARP, Prevention through design. **Hazard Identification Methods:** Preliminary Hazard List (PHL): Overview, methodology, worksheets, case study. Preliminary Hazard Analysis (PHA), Fault tree and Event tree analyses.	
Unit –III	**09 Hrs**
Hazard analysis: Hazard and Operability Study (HAZOP): Definition, Process parameters, Guide words, HAZOP matrix, Procedure, Example. Failure Modes and Effects Analysis (FMEA): Introduction, system breakdown concept, methodology, example.	
Unit –IV	**09 Hrs**
Application of Hazard Identification Techniques: Case of pressure tank, heat exchanger, system breakdown structure, Accident paths, HAZOP application, risk adjusted discounted rate method, probability distribution, Hiller's model	
Unit-V	**09 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	Recall 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). 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						
RENEWABLE ENERGY SYSTEMS **Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE6F2**		**CIE**	**:**	**100Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Introduction: Energy systems model causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India. **Basics of Solar Energy:** Sun- earth Geometric Relationship, Layer of the Sun, Earth – Sun Angles and their Relationships, Solar Energy Reaching the Earth's Surface, Solar Thermal Energy Application. Block diagram of solar energy conversion.	
Unit – II	**09 Hrs**
Solar PV Systems: Basic Principle of SPV conversion – Types of PV Systems(Standalone, Grid connected, Hybrid system)- Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array ,PV Module I-V Characteristics, Array design (different methodologies),peak-power operation, system components.Efficiency & Quality of the Cell, series and parallel connections, maximum power point tracking, Applications..	
Unit –III	**09 Hrs**
Wind Power Systems: **Wind Speed and Energy:** Introduction, history of wind energy, scenario- world and India. Basic principle of Wind energy conversion system (WECS), Classifications of WECS, part of a WECS. Derivation of power in the wind, electrical power output and capacity of WECS, wind site selection consideration, advantages and disadvantages of WECS. Maximum energy capture, maximum power operation, , environmental aspects.	
Unit –IV	**09 Hrs**
Geothermal and Ocean Energy Systems: Geothermal well drilling, advantages and disadvantages, Comparison of flashed steam and total flow concept (T-S diagram). Associated Problems, environmental Effects. **Energy from Ocean:** OTEC power generation, OPEN and CLOSED cycle OTEC. Estimate of Energy and power in simple single basin tidal and double basin tidal system. Issues Faced in Exploiting Tidal Energy	
Unit –V	**09 Hrs**
Hydrogen Energy: Benefits of Hydrogen Energy, Hydrogen Production through block diagram, Use of Hydrogen Energy, Merits and Demerits, Problems Associated with Hydrogen Energy. **Biomass Energy:** Introduction-Biomass resources –Energy from Biomass: conversion processes-Biomass Cogeneration- Environmental Benefits. Biomass products – ethanol, biodiesel, biogas Electricity and heat production by biomass.	

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand the working principle and operation of various renewable energy sources and systems.
CO2	Analyze the performance and characteristics of renewable energy sources and systems.

CO3	Evaluate the parameters of wind and solar energy systems.
CO4	Design and demonstrate the applications of renewable energy sources in a typical system.

Reference Books	
1.	Non-conventional energy sources, by G.D Rai, Khanna publishes, 19th Edition, 2017, ISBN: 978-81-7409-073-8.
2.	Solar photo voltaic Technology and systems, by Chetan Singh Solanki, 3rd Edition, PHI, Learning private limited New Delhi, 2013, ISBN: 978-81-203-4711-3.
3.	Wind and solar power system design, Analysis and operation, Mukund R. Patel, 2nd Edition. CRC Group, Taylor and Francis group, New Delhi, ISBN 978-0-8493-1570-1.
4.	Renewable energy: Technology, Economics and Environment, Martin Kaltschmitt, Wolfgang Streicher Andreas Wiese, Springer Publication, 2007, ISBN 978-3-540-70947- 3

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 (20**) 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						
SYSTEMS ENGINEERING **Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE6F3**		**CIE**	**:**	**100Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**06 Hrs**
System Engineering and the World of Modem System: What is System Engineering? Origins of System Engineering, Examples of Systems Requiring Systems Engineering, System Engineering viewpoint, Systems Engineering as a Profession, The power of Systems Engineering, problems. **Structure of Complex Systems:** System building blocks and interfaces, Hierarchy of Complex systems, System building blocks, The system environment, Interfaces and Interactions. **The System Development Process:** Systems Engineering through the system Life Cycle, Evolutionary Characteristics of the development process, The system engineering method, Testing throughout system development, problems.	
Unit – II	**10 Hrs**
Systems Engineering Management: Managing systems development and risks, Work breakdown structure (WBS), System Engineering Management Plan (SEMP), Risk Management, Organization of Systems Engineering, Systems Engineering Capability Maturity Assessment, Systems Engineering standards, Problem. **Needs Analysis:** Originating a new system, Operations analysis, Functional analysis, Feasibility analysis, Feasibility definition, Needs validation, System operational requirements, problems. **Concept Exploration:** Developing the system requirements, Operational requirements analysis, Performance requirements formulation, Implementation concept exploration, Performance requirements validation, problems.	
Unit –III	**10 Hrs**
Concept Definition: Selecting the system concept, Performance requirements analysis, Functional analysis and formulation, Concept selection, Concept validation, System Development planning, System Functional Specifications, problems **Advanced Development:** Reducing program risks, Requirements analysis, Functional Analysis and Design, Prototype development, Development testing, Risk reduction, problems.	
Unit –IV	**10 Hrs**
Engineering Design: Implementing the System Building blocks, requirements analysis, Functional analysis and design, Component design, Design validation, Configuration Management, problems. **Integration and Evaluation:** Integrating, Testing and evaluating the total system, Test planning and preparation, System integration, Developmental system testing, Operational test and evaluation, problems.	
Unit –V	**09 Hrs**
Production: Systems Engineering in the factory, Engineering for production, Transition from development to production, Production operations, Acquiring a production knowledge base, problems. **Operations and support**: Installing, maintenance and upgrading the system, Installation and test, In-service support, Major system upgrades: Modernization, Operational factors in system development, problems.	

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand the Life Cycle of Systems.
CO2	Explain the role of Stake holders and their needs in organizational systems.
CO3	Develop and Document the knowledge base for effective systems engineering processes.
CO4	Apply available tools, methods and technologies to support complex high technology systems.

Reference Books	
1.	Systems Engineering – Principles and Practice, Alexander Kossoaikoff, William N Sweet, John Wiley & Sons, Inc, edition: 2012, ISBN: 978-81-265-2453-2
2.	Handbook of Systems Engineering and Management, Andrew P. Sage, William B. Rouse, John Wiley & Sons, Inc., edition:1999, ISBN 0-471-15405-9
3.	General System Theory: Foundation, Development, Applications, Ludwig von Bertalanffy, Penguin University Books, 1973, Revised, ISBN: 0140600043, 9780140600049.
4.	Systems Engineering and Analysis, Blanchard, B., and Fabrycky, W, Prentice Hall, 5th Edition, 2010.

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 (20**) 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						
MECHATRONICS **Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE66F4**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 Hrs**
Overview of Mechatronic Systems: Traditional and mechatronic design, automatic washing machine, automatic door, dishwasher, compact disc drive copy machine, camera, and temperature control. Principle and working of hall sensor, displacement sensor, absolute and incremental encoders, photoelectric sensors, inductive and capacitive proximity sensors, Relays and solenoids, Brushless DC, AC and servo motors, pulse width modulation by basic transistor circuit, H bridge circuit, Stepper motor: variable reluctance and permanent magnet, stepper motor control circuits, selection of motors.	
Unit – II	**10 Hrs**
Signal Conditioning: Operational Amplifiers - circuit diagrams and derivation - Numerical, filtering, multiplexers, 4:1 MUX, time division multiplexing -seven segment display, data acquisition, Analog and digital signals, analog to digital converters. Introduction to Digital signal processing – difference equation (Numericals). **Programmable Logic Controllers:** Components, principle of operation, modifying the operation, basic PLC instructions, and concepts of ladder diagram, latching, timer instructions, counter instructions.	
Unit –III	**10 Hrs**
Ladder Diagram for PLCs: Examples with ladder logic programs, simple programs using Boolean logic, word level logic instructions. Relay to ladder conversion examples., **Industrial Applications of PLCs:** Central heating system, valve sequencing, traffic light control in one direction, water level control, overhead garage door, sequential process, continuous filling operation, Fluid pumping with timers, parking garage counter, can counting in assembly line.	
Unit –IV	**08 Hrs**
Microcontrollers: Components of a full featured microcontroller, Memory, I/O Ports, Bus, Read & Write Cycle, Architecture of Intel 8051 microcontroller, Pin diagram, simple instructions for a microcontroller. – Data transfer, arithmetic functions, logical operations, Jump and branching operation. **Digital Circuits:** Digital representations, Combinational logic - Case studies: BCD to 7 segment decoder, calendar subsystem in a smartwatch., timing diagrams, Karnaugh maps – 3 variable and 4 variable, design of logic networks, flip-flops, Counters.	
Unit – V	**08 Hrs**
Dynamic Responses of Systems: Closed loop system, Terminology, transfer functions, step response of first order and second order systems, performance measures for first and second order systems, - Numerical **Mechanical Actuation Systems:** Four bar chain, slider crank mechanism, Cams and followers, gear trains – Numerical	

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Select appropriate sensors and transducers and devise an instrumentation system for collecting information about processes
CO2	Apply the electrical and logic concepts and inspect the functioning of mechatronic systems.
CO3	Evaluate a control system for effective functioning of Mechatronics systems using digital electronics, microprocessors, microcontrollers and programmable logic controllers
CO4	Develop conceptual design for Mechatronics products based on potential customer requirements

Reference Books	
1.	Mechatronics-Principles, Concepts & Applications, Nitaigour Premchand, TMH, 1st Edition, 2009, ISBN: 9780070483743
2.	Mechatronics-Electronic Control System in Mechanical and Electrical Engineering, Bolton W., Pearson Education, 4th Edition, 2012; ISBN:9788131732533
3.	Mechatronics, Tilak Thakur, Oxford University Press, 1st Edition, 2016, ISBN: 9780199459329
4.	Programmable logic controllers, Petruzella, Frank D, McGraw-Hill, 4th Edition, 2013, ISBN-13: 978-0-07-351088-0

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 (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: (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 **Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE6E5**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**09 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	**09 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	**09 Hrs**
Markov modelling: Mathematical foundations of Markov chain, applications of Markov modelling.	
Unit –IV	**09 Hrs**
Modelling through graphs: Graph theory concepts, modelling situations through different types of graphs.	
Unit –V	**09 Hrs**
Variational Problem and Dynamic Programming: Optimization principles and techniques, mathematical models of variational problem and dynamic programming and 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 of engineering.
CO2	Apply the knowledge and skills of discrete and continuous models.
CO3	Analyze the appropriate mathematical model to solve the real-world problem and 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 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 (05), Program specific requirements (05), Video based seminar/presentation/demonstration (10), MATLAB (20). **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						
INDUSTRY 4.0 - SMART MANUFACTURING FOR THE FUTURE **Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE66F6**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**42L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**07 Hrs**
Introduction: The Various Industrial Revolutions, Need – Reason for Adopting Industry 4.0, Definition, Goals and Design Principles – Interoperability, Virtualization, Decentralization, Real-time Capability, Service Orientation, Modularity. Individualization, Volatility, Energy and resource efficiency. Road to Industry 4.0 - Internet of Things (IoT), Architecture of IoT, Technologies for IoT & Industrial Internet of Things (IIoT), Internet of Services, Standardization, Cyber-Physical Systems, Smart Manufacturing, Network via Ethernet/ Wi-Fi for high-speed data transmission, Mobile technologies	
Unit – II	**10 Hrs**
Opportunities and Challenges: Lack of resources, Availability of skilled workers, Broadband infrastructure, Policies, Future of Works and Skills in the Industry 4.0 Era, Disruption as manufacturing's greatest modern challenge **Robotics in Industry 4.0:** Robotic Automation and Collaborative Robots, Human-Machine Interaction **Big Data:** Evolution**,** Essential of Big Data in Industry 4.0, Big Data Merits, Data transparency, Business Intelligence, Production planning, Quality, Acquisition of Automation Data, Digital Traceability, Radio-Frequency Identification (RFID), GPS, Data transformation, Big Data Characteristics, Data as a new resource for organizations, Data driven applications, Harnessing and sharing knowledge in organizations, Data analytics - Descriptive Analytics, Diagnostic analytics, Predictive Analytics, Prescriptive analytics	
Unit –III	**10 Hrs**
Cloud Computing: Fundamentals, Cloud/Edge Computing and Industry 4.0, The IT/OT convergence, Cyber Security **Horizontal and Vertical integration:** End-to-end engineering of the overall value chain, Digital integration platforms, Role of machine sensors, Sensing classification according to measuring variables, Machine-to-Machine communication **Artificial Intelligence/Machine Learning in Industry 4.0:** Fundamentals, Case Studies, Technology paradigms in production logistics - Intelligent conveyor system, Intelligent commissioning system, Intelligent production machine, Intelligent load carrier, Application-specific demand on Intelligent Objects (user-oriented functions), Technological realization of Intelligent Objects (product-oriented functions)	
Unit –IV	**08 Hrs**
Augmented Worker: Augmented and Virtual Reality, softwares, Industrial Applications – Maintenance, Assembly, Collaborative operations, Training **Digital-to-Physical:** Additive Manufacturing technologies, Advantages, impact on environment, Applications – Automotive, Aerospace, Electronics and Medical	

Unit –V	07 Hrs
Digital twin, Virtual factory, Total Productive Maintenance, Industry 4.0 case studies, Understanding I 4.0 in MSMEs, What's Next: Industry 5.0/Society 5.0	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Identify the basic components of Industry 4.0
CO2	Analyse the role of Big data for modern manufacturing
CO3	Create AR/VR models for industrial scenario
CO4	Create simple Additive manufactured parts

Reference Books	
1.	Industry 4.0: Managing the Digital Transformation, Alp Ustundag, Emre Cevikcan, 2017, Springer, ISBN: 978-3-319-57869-9, ISBN: 978-3-319-57870-5
2.	The Concept Industry 4.0 - An Empirical Analysis of Technologies and Applications in Production Logistics, Christoph Jan Bartodziej, 2017, Springer Gabler, ISBN 978-3-658-16501-7 ISBN 978-3-658-16502-4
3.	Industry 4.0 - The Industrial Internet of Things, Alasdair Gilchrist, 2016, APRESS, ISBN-13 978-1-4842-2046-7 ISBN-13: 978-1-4842-2047-4
4.	Digitizing the Industry – Internet of Things connecting the Physical, Digital and Virtual Worlds, Ovidiu Vermesan, 2016, River Publishers, ISBN 978-87-93379-81-7 ISBN 978-87-93379-82-4

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 (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						
INDUSTRIAL PSYCHOLOGY FOR ENGINEERS **Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE66F7**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

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	**10 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	**09 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	**09 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	**09 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 Counseling** - Need for Counseling, Types – Directed, Non- Directed, Participative Counseling.	

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, behavioral, 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). 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**) 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						
ELEMENTS OF FINANCIAL MANAGEMENT **Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE6F8**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

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. **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)**	
Unit – II	**10 Hrs**
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. **Risk and Return:** Risk and Return of single assets and portfolios, measurement of market risk, relationship between risk and return, implications **(Conceptual and Numerical treatment)**	
Unit –III	**10 Hrs**
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. **Cost of Capital:** Preliminaries Cost of debt and preference, cost of retained earnings, cost of external equity, determining the proportions, weighted average cost of capital, weighted marginal cost of capital schedule. **Capital structure and cost of capital:** Assumptions and concepts, net income approach, net operating income approach, traditional position, Modigliani and Miller Position, Taxation and Capital structure, Other imperfections and Capital structure **(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. **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)**	
Unit –V	**09 Hrs**

Contemporary Topics in Finance: Reasons and Mechanics of a merger, Takeovers, Divestures, Demergers, World monetary system, Foreign exchange markets, raising foreign currency finance, International capital budgeting, Options market, Futures market, Warrants, Venture capital financing framework, Indian venture capital scenario. (Conceptual treatment only)

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Explain the features of financial system and basic principles of financial management.
CO2	Describe the processes and techniques of capital budgeting and theories of capital structure.
CO3	Demonstrate an understanding of various sources of long term and working capital financing by organizations.
CO4	Analyze the trends in global financial scenarios.

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-Text, Problems and Cases, Khan M Y & Jain P K, 8th Edition, 2018, McGraw Hill Education (India) Pvt. Ltd, ISBN: 9353162181, 9789353162184

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 (20**) 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						
UNIVERSAL HUMAN VALUES - II **Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE6F9**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**42L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	**10 Hrs**
Introduction-Basic Human Aspiration, its fulfillment through All-encompassing Resolution. The basic human aspirations and their fulfillment 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 experience 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 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

#	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 (20**) 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; 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						
HUMAN MACHINE INTERFACE (HMI) **Institutional Elective** **Industry Assisted Elective-BOSCH**						
Course Code	**:**	**21IE6F10**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hrs**

Unit-I	09 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	09 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	09 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	09 Hrs

HMI User Interface: User-centered HMI development process, Basics of Web-Server. Web-based HMI: Basics of TwinCAT and HTML, CSS, JavaScript.
HMI on Mobile: Four Principles of Mobile UI Design, Benefits of Mobile HMIs, Mobile HMI Development Suites.

Unit –V	09 Hrs

HMI Control Systems: Introduction to Voice-Based HMI, Gesture-Based HMI, Sensor-Based UI controls.
Haptics in Automotive HMI: Kinesthetic Feedback Systems, Tactile Feedback Systems, Haptics in Multimodal HMI, Automotive Use-Cases
HMI Testing: Limitations of Traditional Test Solutions, Case - Study: Bosch's HMI validation tool - Graphics Test Systems (GTS).
UI analytics: Usage patterns, Debugging, Performance Profiling, Use Cases.

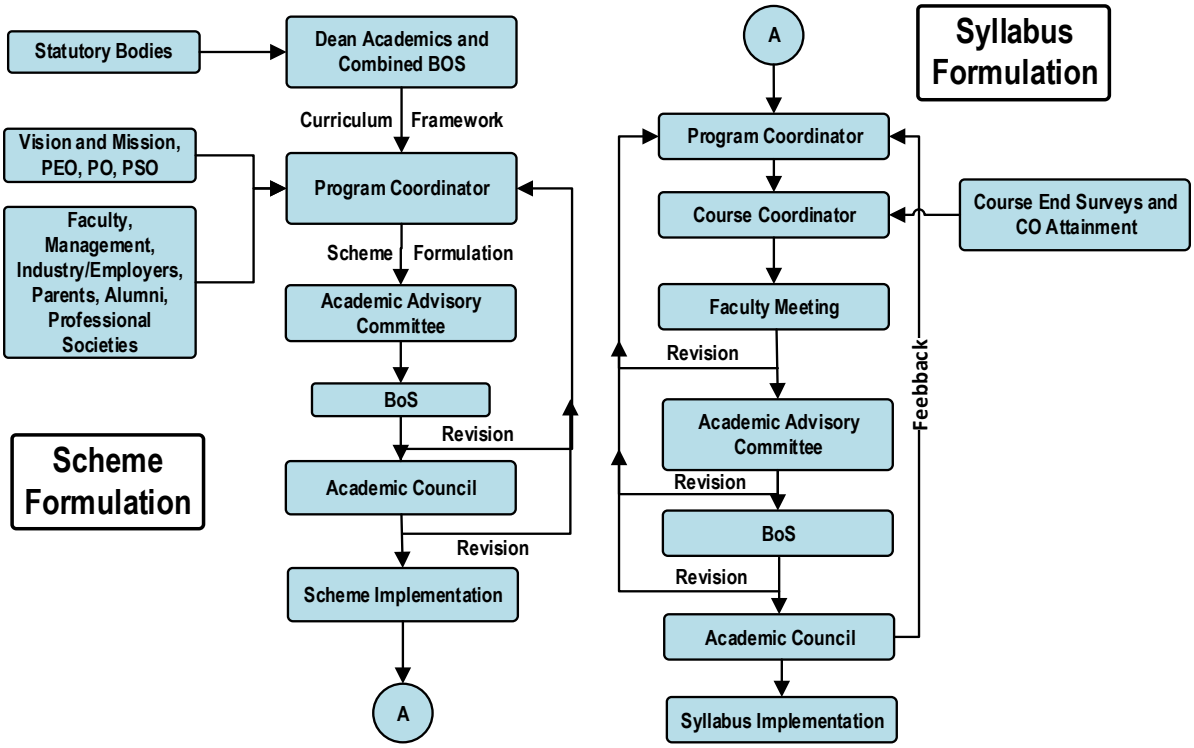
Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understanding the application of HMIs in various domain.
CO2	Comparison of various communication protocols used in HMI development.
CO3	Apply and analyse the car multimedia system free software and hardware evolution.
CO4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

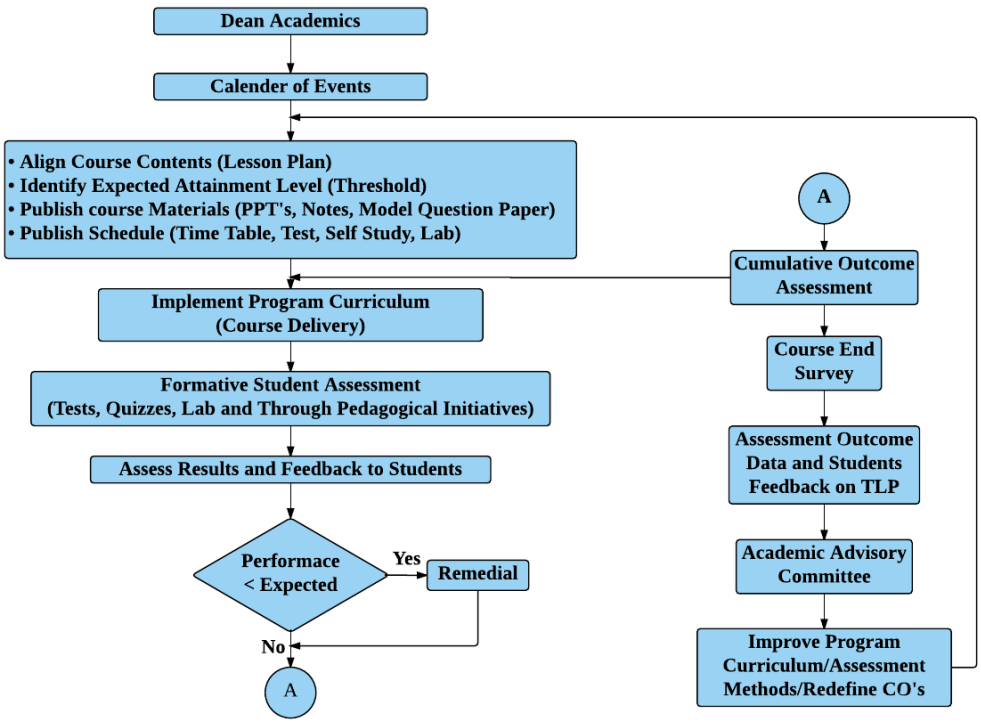
RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** 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 (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**

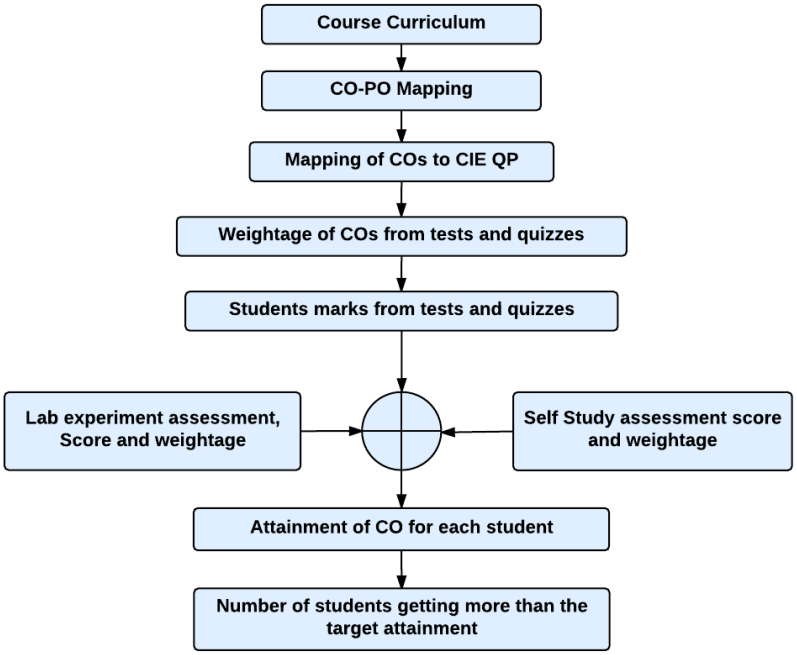
Curriculum Design Process



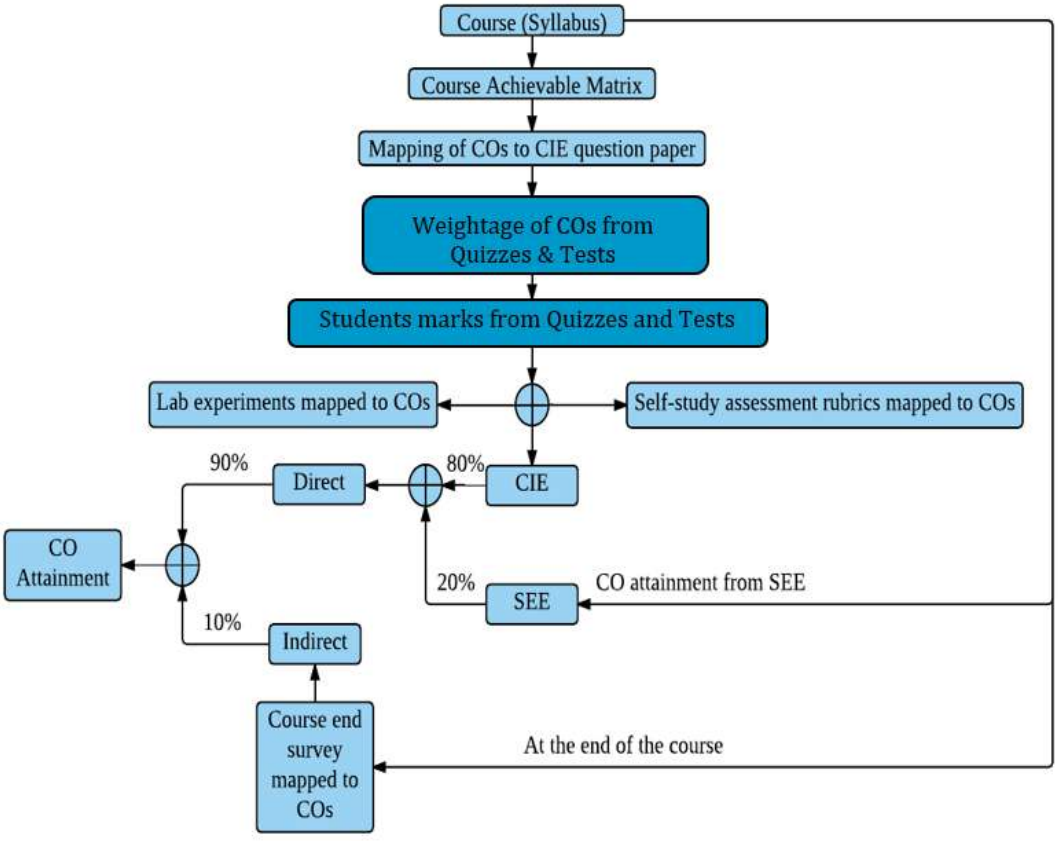
Academic Planning and Implementation



Process For Course Outcome Attainment



Final CO Attainment Process



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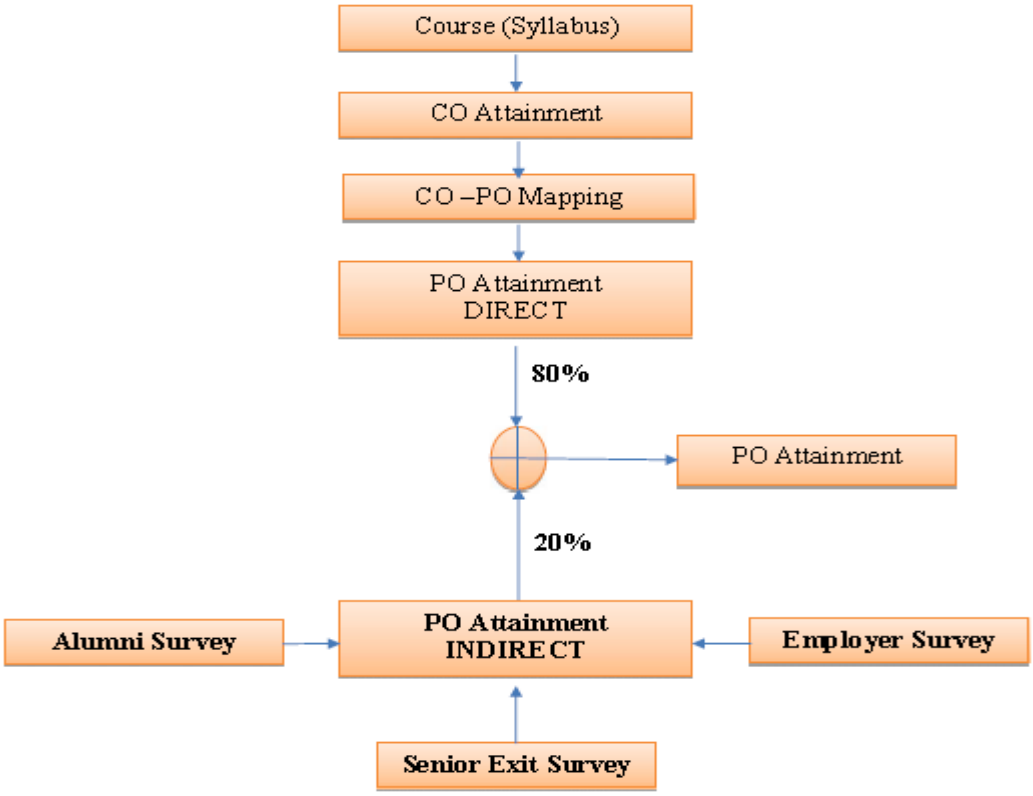
Approved by AICTE, New Delhi

Program Outcomes Attainment Process



RV Educational Institutions ®
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Approved by AICTE, New Delhi

PROGRAM OUTCOMES (POs)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.