RV Educational Institutions ®
RV College of Engineering ®

Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi

Approved by AICTE, New Delhi

Go, change the world

BACHELOR OF ENGINEERING (B.E.)
2021 SCHEME

SCHEME & SYLLABUS
THIRD YEAR B.E. PROGRAMS

ELECTRONICS & INSTRUMENTATION ENGINEERING

ACADEMIC YEAR 2023-24

DEPARTMENT VISION

Achieving academic excellence in Instrumentation Technology by adopting interdisciplinary research with a focus on sustainable and inclusive technologies.

DEPARTMENT MISSION

M1: To create an environment for students to excel in domain areas and get motivated to involve in interdisciplinary research by utilizing state of the art infrastructure.

M2: To impart technical knowledge, encourage experiential learning and develop future professional leaders.

M3: To establish industry-academia networking and develop industry-ready students and future entrepreneurs, to meet societal & industrial challenges.

M4: To motivate lifelong learning and research in sustainable technologies to find improved solutions for the betterment of society.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Apply Instrumentation, Electronics, Controls and Automation concepts to develop technical solutions for industrial problems.

PEO2: Exhibit competency in adapting to various industrial challenges and work in inter-disciplinary projects with team spirit and professional ethics for achieving organizational goals.

PEO3: Pursue higher education in technology or management and achieve professional excellence by imbibing leadership qualities and communication skills.

PEO4: Become entrepreneurs with a focus on sustainable technologies and develop innovative solutions to meet industrial and societal needs.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Design, analyze and practice the instrumentation, controls and automation concepts and techniques required for industrial and/or research pursuits resulting in product development, publications or patents.

PSO2: Demonstrate the knowledge of basic science, mathematics, electronic system design and programming for real-time applications, towards developing industrial solutions and become technology leaders of future.

LEAD SOCIETY

Lead Society: International Society of Automation (ISA)

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
24.	AEC	Ability Enhancement Courses

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2.	21EI56C2	Fuzzy Logic and Neural Network
3.	21EI56C3	Cloud Computing and Distributed Systems
4.	21EI56C4	Mechatronics
5.	21EC56C5	VLSI Signal Processing
6.	21EI56C6	Health Research and Fundamentals

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V SEMESTER

Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	Max Marks CIE		SEE Duration (H)	Max Marks SEE	
			L	T	P	Total			Theory	Lab		Theory	Lab
1	21HS51A	Intellectual Property Rights & Entrepreneurship	3	0	0	3	HSS	Theory	100	****	3	100	****
2	21EI52	Automatic Process Control and Virtual Instrumentation (Theory and Practice)	3	0	1	4	EI	Theory + Lab	100	50	3	100	50
3	21EC53	Digital VLSI Design (common to EC & EI) (Theory and Practice)	3	0	1	4	EC	Theory + Lab	100	50	3	100	50
4	21EC54	Embedded System Design (Common to EC & EI)	3	1	0	4	EC	Theory	100	****	3	100	****
5	21EI55BX	Professional Core Elective-I (Group-B)	3	0	0	3	EI	Theory	100	****	3	100	****
6	21EI56CX	Professional Core Elective-II (Group C)	2	0	0	2	EI	NPTEL	50	****	2	50	****
7	21EII57	Summer Internship- II	0	0	2	2	EI	Internship	****	50	2	****	50
		Total				22							

Note: Summer Internship-II will be undertaken between IV & V semester for a period of 06 Weeks (this will have both CIE & SEE)
Circuit Programs: 21HS51A - Non-Circuit Programs: 21HS51B

GROUP-B		
Sl. No.	**Course Code**	**Course Title**
1	21EI55B1	MEMS & Applications
2	21EI55B2	Advance Control Systems
3	21EI55B3	Data Communication for Instrumentation
4	21EI55B4	Bio Potentials & Medical devices
GROUP-C (NPTEL)		
Sl. No.	**Course Code**	**Course Title**
1	21EI56C1	User-centric Computing for Human-Computer Interaction
2	21EI56C2	Fuzzy Logic and Neural Network
3	21EI56C3	Cloud Computing and Distributed Systems
4	21EI56C4	Mechatronics
5	21EC56C5	VLSI Signal Processing
6	21EI56C6	Health Research and Fundamentals

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VI SEMESTER

Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	Max Marks CIE		SEE Duration (H)	Max Marks SEE	
			L	T	P	Total			Theory	Lab		Theory	Lab
1	21HS61B	Principles of Management & Economics	3	0	0	3	HSS	Theory	100	****	3	100	****
2	21EI62	PLC and SCADA Systems (Theory and Practice)	3	0	1	4	EI	Theory + Lab	100	50	3	100	50
3	21EI63	Digital Signal Processing (Theory and Practice)	3	0	1	4	EI	Theory + Lab	100	50	3	100	50
4	21EI64DX	Professional Core Elective (Group – D)	3	0	0	3	EI	Theory	100	****	3	100	****
5	21EI65EX	Professional Core Elective (Cluster Elective) (Group- E) (TWO Courses under Each Program)	3	0	0	3	EI	Theory	100	****	3	100	****
6	21IE66FX	Institutional Electives – I (Group-F)	3	0	0	3	XX	Theory	100	****	3	100	****
		Total				**20**							

GROUP-D		
Sl. No.	**Course Code**	**Course Title**
1	21EI64D1	Automation in Industry 4.0
2	21EI64D2	An Introduction to the Internet of Things
3	21EI64D3	Virtual & Augmented Reality
4	21EI64D4	Application-Specific Integrated Circuit (ASIC) Design
GROUP-E		
Sl. No.	**Course Code**	**Course Title**
1	21EI65E1	Electronics Equipment Integration and Prototype Building
2	21EI65E2	Virtual Instrumentation
3	21EE65E1	Smart Grid Technology
4	21EE65E2	Modern Control Theory
5	21EC65E1	Real Time Systems
6	21EC65E2	Digital System Design with FPGA
7	21ET65E1	Smart Antennas
8	21ET65E2	Satellite Communication

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

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	**:**	40L		**SEE Duration**	**:**	**3Hours**

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.	Poornima M. Charantimath "Entrepreneurship Development and Small Business Enterprise", 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 upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)* (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						
AUTOMATIC PROCESS CONTROL & VIRTUAL INSTRUMENTATION **Category: Professional Core Course** **(Theory & Practice)**						
Course Code	**:**	**21EI52**		**CIE**	**:**	**100 Marks**
Credits: L:T: P	**:**	**3:0:1**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L + 30P**		**SEE Duration**	**:**	**03 + 03 Hours**

Unit-I	**09 Hrs**
Introduction to Process control: Introduction, Process control systems, Process-Control Block Diagram, control system evaluation, Stability, Steady State & Transient Regulation. **Analog & Digital Processing:** Data representation, On/Off Control, Analog Control, Digital Control, Supervisory Control, Direct Digital control, Smart Sensor, Networked Control Systems, PLC for On/Off Control application, Process Control Drawings, Problems.	
Unit – II	**09 Hrs**
Controller principles: Introduction, Process Characteristics, Process Equation, Process Load, Process Lag, Process Regulation, Control System Parameters. **Controller Modes:** Mathematical Analysis of Two-Position Controller Mode, Direct & Reverse Action, **Mathematical Analysis** of Single-Mode, 2-Mode & 3-Mode Composite Controllers, Applications & Problems.	
Unit –III	**09 Hrs**
Analog controller Design: Introduction, Electronic controllers, Error Detector, Design of an Electronic 2-position Controller, Design of Single-Mode, 2-Mode and 3-Mode Continuous Controller Modes, Design exercises. **Alarms:** Single and multi-variable alarms, Design examples.	
Unit –IV	**09 Hrs**
Digital controllers: Introduction, Digital Electronic Methods, Computers in Process Controls, DAS, Controller Software, Computer Controller Modes, P, I, D, and PID Digital Controller Algorithms, Computer Controllers- Examples. **Control loop characteristics:** Introduction, Control system configurations, Cascade Control, Multi-Variable Control systems, Analog Control, Supervisory & Direct Digital Control.	
Unit –V	**09 Hrs**
Process loop tuning methods: Open-Loop Transient Response Method and Ziegler-Nichols Closed- Loop Method for P, PI, & PID control Modes, Frequency Response Methods for P, I, & D Modes. **P&ID Symbols,** Introduction, Connecting Lines, General Instruments or Functions, Actuators & Process Elements, P&ID for a Chemical Process, ISA Flow Diagrams, - Drill Problems.	

Course Outcomes: After completing the course, the students will be able to:	
CO1:	Understand the basic concepts, develop schematics & block diagrams for Industrial process control systems, using ISA Flow Diagrams, P&ID Symbols, and ISA Standards.
CO2:	Analyze & Design electronic analog P, I, D, PI, PD, PID controllers and write the algorithms for their digital implementation.
CO3:	Apply the techniques of control loop tuning for accurate control of Processes.
CO4:	Understand and apply the programming techniques of VI to simulate & interface, using myDAQ & myRIO.

Reference Books	
2.	Process Control Instrumentation Technology, Curtis D. Johnson, 7th Edition, 2012, PHI, ISBN: 81-7758-410-3
2.	Process Control – Concepts, Dynamics and Applications, S. K Singh, 2009, PHI, ISBN: 978-81-203-3678-0
3.	Instrument Engineers Handbook, Process Measurement, Bela G. Liptak , Volume 1, Process control volume 2, 3rd Edition, 2010, Chilton book Company, ISBN 81-7956-540-8
4.	Instrumentation, Kirk and Rimboi ,2nd Edition, 2010, PHI, ISBN: 81-7758-410-5.
5.	Virtual Instrumentation Using LabVIEW, Jovitha Jerome, 2021, PHI, ISBN-978-81-203-4030-5.
6.	Virtual instrumentation using LabVIEW principles and practices of graphical programming, Sanjay Gupta & Joseph John, 2020, Tata McGraw-Hill, 2nd Edition, ISBN (13): 978-0-07-070028-4.

PRACTICALS:	
VIRTUAL INSTRUMENTATION Experiments:	
DAQ EXPERIMENTS	
1	Determine warning VI using DAQ.
2	Acquisition of Temperature using DAQ.
3	Counter operation using DAQ.
4	Build Inverter circuit using myDAQ.
myRIO EXPERIMENTS	
5	Configuring on-board Sensors in myRIO.
6	Speed and direction control of DC motor.
7	LCD Character Display using myRIO (URT)
SIMULATION EXPERIMENTS	
8	Create a VI to find **nCr** and **nPr** of a given number using a For Loop, while loop, and **sub-VI**.
9	Build a VI to find the roots of a quadratic equation. Input the coefficients of x^2, x and constant as **a, b** and **c**, respectively. Display the roots and the message if the roots are real or imaginary.
10	To develop a VI to match the inputs and generate a Sine wave. Use a Tab control to give different inputs. Match the inputs; if the inputs match, generate a Sine wave, else generate a DC wave.
11	The random number data is written a text file and then transferring the same data to another file.
12	Create a 1-D numeric array which consists of ten elements and rotate it ten times. For each rotation, display the equivalent binary number of the first array element in the form of a Boolean array. Also, display the reversed Boolean array. Provide delay to view the rotation.
13	To create a table which consists of usernames and passwords, input a username and a password. Check whether the username and password match the contents of the table. If they are matched, glow the "ACCESS GIVEN" LED, otherwise glow "ACCESS DENIED" LED. Also display the username.
14	Build a **VI** to compute the following equations and plot the results on a waveform graph. $y_1 = (x^3 + x^2 - 5)$; $y_2 = (x^2 + 4)$; Where x varies from 0 to 10, in steps of 0.2.
Automatic ON/OFF, P, PI, PID, Controller Tuning Experiments:	
15	Tuning and Testing the Performance of PI & PID **Flow** control loop.
16	Tuning and Testing the Performance of PD & PID **Temperature** control loop.
17	Tuning and Testing the Performance of P & PI **Level** control loop.
18	Tuning and Testing the Performance of ON/OFF & PID **Pressure** control loop.

Innovative Experiments: -

Advanced process control experiments (Cascade F/F and Ratio control system) using **Universal Process Control Trainer** set-up.

1. Ratio, FF, and Cascade controls, using **Multi-process Trainer.**
2. Producer Consumer design pattern.
3. State machine operation.
4. Master Slave operation - Notifier

RUBRICFOR THE CONTINUOUS INTERNAL EVALUATION (THEORY and PRACTICE)		
#	**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 **50Marks**, 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 (THEORY and PRACTICE)	**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**

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

Semester: V						
DIGITAL VLSI DESIGN **Category: Professional Core Course** **(Theory & Practice)** **(Common to EC & EI)**						
Course Code	:	21EC53		**CIE**	:	100+50Marks
Credits: L:T:P	:	3:0:1		**SEE**	:	100+50Marks
Total Hours	:	45L+30P		**SEE Duration**	:	03+03Hours

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.

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.

Reference Books	
3.	CMOS VLSI Design, Neil H.E. Weste, David Harris, Ayan Banerjee, 3rdEdition, 2006, Pearson Education, ISBN: 0321149017.
2.	CMOS Digital Integrated Circuits, Sung MO Kang, YousfLeblebici, 3rd Edition, Tata McGrawHill, 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 FinFETs, Jerry G. Fossum, Vishal P. Trivedi, 1StEdition 2013, Cambridge University Press, ISBN-13:978-1107030411.

RUBRICS FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY and PRACTICE)		
#	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 **50Marks**, 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 (THEORY and PRACTICE)	**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**

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

Semester: V						
EMBEDDED SYSTEM DESIGN **Category: Professional Core Course** **(Theory)** **(Common to EC & EI)**						
Course Code	**:**	21EC54		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:1:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L+15T		**SEE Duration**	**:**	**3Hours**

Unit-I	**08 Hrs**
Introduction to Embedded System Design: Introduction, Characteristics of Embedding Computing Applications, Concept of Real time Systems, Challenges in Embedded System Design, Design Process: Requirements, Specifications, Hardware Software Partitioning, Architecture Design. **Embedded System Architecture:** Co-Processor & Hardware Accelerators, Processor performance Enhancement: Pipelining, Superscalar Execution, Multi Core CPUs..	
Unit – II	**08 Hrs**
Designing Embedded System Hardware –I: Memory systems: Memory organization, Error detecting and correcting memories, memory Access times, SRAM, DRAM, Flash, Interfacing program and data memory, Cache, Unified versus Harvard caches, Cache coherency, Cache, Cache replacement policies.	
Unit –III	**08 Hrs**
Designing Embedded System Hardware –II: I/O Devices: Watchdog Timers, Interrupt Controllers, Interfacing Protocols:I2C,I3C, CAN: Frame Formats, Interconnect Topology, Reset Circuits, Interfacing RTC, SATA, PCI,PCB design **Practice:** Wiring and connection of I2C, CAN on STM32F2407VG	
Unit –IV	**08 Hrs**
Designing Embedded System Software-I: Application Software, System Software, Application debugging using ARM Cortex STM32F7,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	**08 Hrs**
Designing Embedded System Software –II: OS based Design, Real Time Kernel, Process& Thread, Inter Process Communications, Synchronization, Kernel services, ISR, Software Timers, Case Study: RTX-ARM/FreeRTOS, **Practice:** Application code development on STM32F407VG with Kernel	

Course Outcomes: 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 upto 100 Marks **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)* (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						
MEMS & APPLICATIONS **Category: Professional Core Elective -I (Group B)** **(Theory)**						
Course Code	**:**	21EI55B1		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L		**SEE Duration**	**:**	**3Hours**

Unit-I	**09 Hrs**
Overview of MEMS & Microsystems: MEMS and Microsystems, Typical MEMS and micro system products, Evolution of micro fabrication, Microsystems and microelectronics, Multidisciplinary nature of Microsystems, Design and manufacture, Applications of Microsystems in automotive, healthcare, aerospace and other industries. Working Principle of Microsystems: Biomedical and biosensors. Micro sensors: Acoustic, Chemical, Optical, Pressure, Thermal.	
Unit – II	**09 Hrs**
Micro actuation: Using thermal forces, shape memory alloys, Piezoelectric crystals, and electrostatic forces. MEMS with micro actuators: Microgrippers, micromotors, microvalves and micropumps, micro accelerometers, microfluidics. Introduction to Scaling: Scaling in Geometry, Scaling in Rigid body dynamics, Scaling in Electrostatic forces, scaling in electromagnetic forces and scaling in fluid mechanics.	
Unit –III	**08 Hrs**
Materials for MEMS and Microsystems: Substrates and wafers, Active substrate materials, Silicon as substrate material, Silicon Compounds, Si-Piezoresistors, GaAs, Quartz, Piezoelectric Crystals, Polymers, and packaging materials. Three level of Microsystem packaging, Die level packaging, Device level packaging, System level packaging. Interfaces in microsystem packaging. Essential packaging technologies: die preparation, Surface bonding, Wire bonding, Sealing, 3D packaging	
Unit –IV	**09 Hrs**
Microsystem Fabrication Process: Introduction to microsystems, Photolithography, Ion Implantation, Diffusion, Oxidation, CVD, PVD-Sputtering, Deposition by Epitaxy, Etching, LIGA process: General description, Materials for substrates and photoresists, Electroplating and SLIGA process.	
Unit –V	**09 Hrs**
Micro Sensors, Actuators, Systems and Smart Materials: An Overview Silicon Capacitive Accelerometer, Piezo resistive Pressure sensor, Fibre-optic sensors, Conductometric Gas Sensor, Electrostatic Comb drive, Magnetic Micro relay, Portable blood analyser, Piezo electric Inkjet Print head, Micromirror array for Video projection, Micro-PCR Systems, Smart materials and systems.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the operation of micro devices, micro systems and their applications.
CO2	Apply the principle of material science to sensor design.
CO3	Analyze the materials used for sensor designs.
CO4	Conceptualize and design micro devices, micro systems.

Reference Books	
4.	MEMS & Microsystems Design and Manufacture, Tai-Ran Hsu, 2nd Edition, 2002, Tata McGraw Hill Education, New Delhi, ISBN-13:978-0-07-048709-3.
2.	Micro and Smart Systems, G.K. Anantha Suresh, K.J .Vinoy, K.N. Bhat, V.K. Aatre, 2015, Wiley Publications, ISBN-:978-81-265-2715-1.
3.	Foundations of MEMS, Chang Liu, 2012, Pearson Education Inc., ISBN-13:978-0-13-249736-7.
4.	Smart Material Systems and MEMS, Vijay K Varadan, K. J. Vinoy, S. Gopalakrishnan, 2006, Wiley-INDIA, ISBN-978-81-265-3170-7

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester: V						
ADVANCED CONTROL SYSTEMS **Category: Professional Core Elective -I (Group B)** **(Theory)**						
Course Code	**:**	21EI55B2		**CIE**	**:**	**100 Marks**
Credits: L: T: P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L		**SEE Duration**	**:**	**3Hours**

Unit-I	**09 Hrs**
Nonlinear Systems: Introduction, properties of nonlinear systems. **Classification of nonlinear systems:** Incidental nonlinearity, Intentional nonlinearity. **Describing Function:** Introduction, basics of describing function analysis, Types of relays, Derivation of describing function for relays, Stability criteria in terms of describing function	
Unit – II	**09 Hrs**
State Space Analysis: Introduction, Concept of state, state space model from transfer function, Determination of transfer function from state equation, Phase variable Form or Controllable Canonical Model Decomposition of transfer function: Series decomposition, parallel decomposition-simple poles, repeated poles.	
Unit –III	**09 Hrs**
Characteristic Equations, Eigen values and Eigenvectors: Introduction, Derivation of characteristic Equation from Differential Equation, Derivation of characteristic Equation from Transfer Function, Derivation of characteristic Equation from State Equation. State Space Representations of Transfer Function Systems. Eigen values and Eigen vectors, Generalized Eigenvectors. Similarity Transformations: Invariance Properties of Similarity Transformation, Controllable Canonical Form.	
Unit –IV	**09 Hrs**
Solution of State Equations: Introduction, classical power series method, State Transition Matrix, Properties of state transition matrix, Caley Hamilton theorem, Sylvester interpolation formula. Solution of Non-Homogeneous state equation with input: classical solution of differential equation, Concept of controllability and observability.	
Unit –V	**09 Hrs**
Pole Placement Technique: Introduction, Necessary and sufficient conditions for arbitrary pole placement, Determination matrix k, concept of state observer, full order state observer, dual problem, necessary and sufficient condition for state observation, and determination of state observer gain matrix. Advanced Applications of Control Systems- A Modular and Scalable wheeled mobile ROBOT, The MARS Sojouner ROVER, Deep Space1, and Experimental unmanned Vehicle (XUV).	

Course Outcomes: After completing the course, the students will be able to	
CO1	Have a good understanding of linear, nonlinear, continuous & discrete control systems, dynamic system modelling and analysis
CO2	Apply the concepts of dynamic modelling, stability, pole-placement of control systems.
CO3	Analyze and evaluate dynamic control systems
CO4	Develop/Create solutions for control systems problems.

Reference Books	
5.	Advanced control systems, B.N. Sarkar, 1 st Edition, 2013, PHI, ISBN: 9788120347106.
2.	Advanced control systems, Dr. K. M. Soni, P.M. Tiwari, Ayushi Sharma, 4th Edition 2013, S.K.Kataria & Sons, ISBN: 978-81-907386-0-6.
3.	Advanced control Theory, Nagoor Kani, 2nd Edition, 2014, RBA Publications, ISBN: 4567146603.
4.	Design and Analysis of Control Systems, Arthur G.O. Mutambara, 2nd Edition,2017, CRC Press Book, ISBN: 9781315140940.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester: V						
DATA COMMUNICATION FOR INSTRUMENTATION **Category: Professional Core Elective -I (Group B)** **(Theory)**						
Course Code	:	21EI55B3		**CIE**	:	**100 Marks**
Credits: L: T: P	:	3:0:0		**SEE**	:	**100 Marks**
Total Hours	:	45L		**SEE Duration**	:	**3 Hours**

Unit-I	**09 Hrs**
Introduction: Data Communication, Components, Data flow, Data Representation, Networks. **Network Models:** Layered Tasks, The OSI Model, Layers in the OSI Model, TCP/IP Protocol Suite, Addressing.	
Unit – II	**09 Hrs**
Data and Signals: Transmission Impairment, Data Rate Limits, Performance, **Multiplexing:** FDM, WDM, TDM **Transmission Media:** Guided Media. **The Data Link Layer:** Data link layer design issues, Error detecting Codes, Sliding window protocols.	
Unit –III	**09 Hrs**
The medium access control sublayer: The channel allocation problem, multiple access protocols. Ethernet: Classic Ethernet Physical Layer, Classic Ethernet MAC sublayer protocol, Ethernet Performance, Switched Ethernet.	
Unit –IV	**09 Hrs**
Routing Algorithms: The optimality principle, shortest path algorithm, flooding, Distance vector routing, Link state vector routing, Hierarchical Routing. **The network layer in the internet:** IP version 4, IP address, IP version 6.	
Unit –V	**09 Hrs**
Network Security: Introduction to Cryptography, substitution Ciphers, transposition Ciphers, Symmetric Key algorithm: DES, AES, RSA algorithm, Firewall.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Acquire a solid foundation in the principles of computer communication networks and the many strategies used in these networks.
CO2	Utilise the numerous networking protocols and methods appropriate for the networking circumstance at hand.
CO3	Conduct research into the various networking principles and algorithms, as well as the applications of each.
CO4	Create simulation models for computer network infrastructure.

Reference Books	
6.	Data Communications and Networking, Behrouz A Forouzan, 5th Edition, 2012, McGraw-Hill, ISBN: 9781259064753.
2.	Computer Networks, Andrews S. Tanenbaum, 5th Edition, 2014, Pearson Publication, ISBN: 978-93-325-1874-2.
3.	Data and Computer Communications, W. Stallings, 10th Edition, 2014, Pearson Education, ISBN: 978-0024542526.
4.	Introduction to Data Communications and Networking, Wayne Tomasi, 1st Edition, 2011, Pearson Education, ISBN: 978-81- 31709306.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester: V						
Bio-Potentials and Medical Devices **Category: Professional Core Elective -I (Group B)** **Theory**						
Course Code	:	21EI55B4		**CIE**	:	**100 Marks**
Credits: L: T: P	:	3:0:0		**SEE**	:	**100 Marks**
Total Hours	:	45L		**SEE Duration**	:	**3 Hours**

Unit-I	**09 Hrs**
Sources of Biomedical Signals & device development: Introduction to sources of Biomedical signals. Basic Medical instrumentation System with block diagram Constraints in design of Biomedical Systems. Reliability of Medical devices: Basics, Effects of Medical devices, Causes of Failure, Safety and Risk Management. The feasibility phase: Device classification, Overview of FDA and the approval process in India. Important medical device standards.	
Unit – II	**09 Hrs**
Electrodes for Bio-electric signal Acquisition Electrodes for ECG; Limb electrode, Floating Electrodes, Pre-gelled Disposable electrodes and paste less electrodes The electrode skin interface and motion artifact. Electrodes for EEG Sleep EEG and EMG. Micro electrodes, Needle Electrodes	
Unit –III	**09 Hrs**
Cardiac Devices: Functioning of Heart, Electrical Conductivity of Heart Basic Principles of ECG Cardiac Pacemakers-Need, types and functional characteristics Cardiac defibrillators, disadvantages, DC defibrillator, types Instantaneous, Synchronized.	
Unit –IV	**09 Hrs**
Respiratory Aids: Basics of Respiratory System, Mechanics of Respiration, Pulmonary Function tests Ventilator- Need, Types, Intermittent positive pressure, breathing apparatus operating sequence, electronic IPPB unit with monitoring for all respiratory parameter, Humidifier, Nebulizer, Aspirator.	
Unit –V	**09 Hrs**
Central Nervous system & BCI; Basics of CNS, Neuron, Propagation of impulses, EEG, Brain Computer Interface. Brain Computer Interface Types, Types of BCI Signals, Monitoring Brain Activity Using EEG, EcoG BCI System, Brain Computer Interface Applications, BCI Trends.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Identify the source of Bio-Electric potentials.
CO2	Identify the various types of electrodes for acquisition of Bio-electric potentials.
CO3	Understand how bioelectric potentials can be used for disease diagnosis.
CO4	Understand the integration of Biopotentials of major organ systems in development of devices.

Reference Books	
7.	Handbook of Biomedical Instrumentation, Khandpur, R.S, 3rd Edition 2014 McGraw Hill Education ISBN: 9789339205430.
2.	Introduction to Biomedical Equipment Technology, Joseph .J.Carr and John .M.Brown, 4th Edition 2000 Pearson **ISBN**-978-0130104922**.**
3.	Therapeutic medical devices, application and design, Albert M.Cook and Webster.J.G, Prentice Hall Inc., New Jersey, 1982 ISBN;0139147969 9780139147968
4.	Medical Instrumentation Application and Design, John G.Webster ,4th Edition ISBN 13; 978-0471-67600-3
5	Essentials of Medical Physiology, Prema Sembulingam, K Sembulingam, 8th Edition 2019 JAYPEE BROTHERS MEDICAL PUBLISHER. ISBN-978-9352706921
6	Brain Computer Interfaces-Applying Your Minds to Human-Computer Interaction, Desney S.Tan, Anton Nijholt,ISBN: 978-1-84996-271-1, DOI: 10.1007/978-1-84996-272-8

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester: V						
SUMMER INTERNSHIP - II (Practical)						
Course Code	:	21XXI57		**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						4 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 OP EXCELLENCE in various domains and around 05 CENTER OP 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 InternShala

Intern Shala is India's no.1 internship and training platform with 40000+ paid internships in Engineering. Students can 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 their hometown to do the internship. The nearby college should agree to give the certificate and the letter/email stating the name of the student along with the title of the internship held with the duration of the internship in their official letter 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/CoCswill 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 joining internship 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 in report writing, oral presentation.	**30**
MAXIMUM MARKS FOR THE CIE THEORY		**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	**:**	45Hrs		**SEE Duration**	**:**	**3Hours**

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	
8.	Management, Stephen Robbins, Mary Coulter & NeharikaVohra, 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 upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester:						
PLC and SCADA Systems **Category: Professional Core Course** **(Theory and Practice)**						
Course Code	**:**	21EI62		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:1		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L + 30P		**SEE Duration**	**:**	**3Hours**

Unit-I	**09 Hrs**

Introduction:
Introduction to Industrial Automation, Historical background, Principles of Operations, PLC Versus Other types of Controls, PLC Product Application Ranges, why to use PLC, Introduction to Fixed and Modular I/O Hardware PLC Operation: Binary Data representation,
Input and output status files for modular PLC, Input and output status files for Fixed PLC Addressing concept.

Unit – II	**09 Hrs**

PLC Hardware:
Input modules: Discrete and Analog input modules
Output Modules: Discrete output module switching, solid state output module switching, TTL and Relay output modules.

Unit –III	**09 Hrs**

Basics of PLC Programming:
Processor memory organization, Program scan, PLC programming languages, Basic Relay Instruction, Bit or relay instructions, NO, NC, One Shot, Output latching software, negated Output and Internal Bit Type instructions, mode of operations

Special programming Instructions:
Timer instructions: On and Off delay, retentive timer instructions, with an example, cascading timer.
Counter Instructions: PLC Counter up and Counter down instructions, combining counters and timers

Program Control Instructions, Comparison &Data manipulation Instructions
Jump, Subroutine Instructions, EQU, NEQ, LES, LEQ, GRT, GEQ,MOVE, MOVM, FRD TOD, COPY, Mathematical Instructions, Logical Instructions: AND, OR, XOR, NOT, Looping Instructions

Unit –IV	**09 Hrs**

SCADA , DCS and HMI systems
Building Block of SCADA System, Hardware structure of Remote Terminal Unit, Block diagram of Distributive Control System.

Creating SCADA Applications
Creating database tags, Creating and editing graphical display with animations, Object movements with blinking and visibility, Trends in real-time and hysteresis, Commissioning and networking

Unit –V	**09 Hrs**

Industrial and Data Communications:
Serial Communication, Interface, Ethernet -IP, MODBUS, Field bus, Profibus network, HART,CAN, OPC Protocol communication

Practicles:

1. Write a Ladder diagram for simulating Valve Movement A+B+A-B-using Automation Studio software.
2. Write a LD for manual operation on simple piston extraction.
3. Write a LD for sequencing of a Piston using. Piston, where the piston will extract and retract after a delay of 10s. The simulation should stop after a count of 5 piston movements.
4. Write a Ladder diagram for three motors operating in Sequence using Delay Timers.
5. Write a Ladder diagram for 2 Way Traffic Light to using HMI and timers.
6. Write a LD forPneumatic AND &OR Operation using Automation Studio pneumatic Libraries.
7. Write a ladder program for designing a 24 Hr clock using timer and counters.
8. Write a LD for analyzing a latch and implementation of logic gates in a single ladder diagram.
9. Write a Ladder diagram for simulating the Elevator System using ABB PLC.
10. Write a Ladder diagramforsimulating Bottle-filling process using ABB PLC.
11. Write a Ladder diagramusing automation studio for the implementing Bottle-filling system.
12. Write a Ladder diagramusing automation studio for Robotic Arm application using OPC Server and I/O Kit.
13. Write a Ladder diagram for simulating Automatic Material Sorting by Conveyor using ABB PLC.
14. Simulating a PLC program to drive AC motor (Speed Control) using variable Frequency Drive in ABB Hand /Auto Macro mode.
15. Write a Ladder diagram to drive Servo motor (Speed Control/ Direction) using AB PLC
16. Write a Ladder diagram to drive Stepper motor (Speed Control/ Direction) using AB PLC.

Innovative Experiments:

1. HMI Programming for speed control of Servo Stepper motors.
9. SCADA Programming for ON OFF Control,
10. Data acquisition using Communication Protocols like HART, MODBUS, PROFIBUS
11. Interfacing and Communication with multiple process control loops using DCS

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the basic concepts of PLC's and SCADA techniques.
CO2	Apply the programming concepts to interface peripheral.
CO3	Analyze and evaluate the automation techniques for industrial applications.
CO4	Develop a system for automation application.

Reference Books	
12.	Introduction to Programmable Logic Controllers, Garry Dunning, CENGAGE Learning, 3rd Edition, 2007, ISBN: 978-8131503027
2.	Industrial Control and Instrumentation, Bolton W, Universities Press, 6th Edition, 2006. ISBN 978-0128029299
3.	Computer Based Industrial control, Krishna Kant, PHI Publishers, 2nd Edition, 2010. ISBN 978-8120339880.
4.	Programmable-Controllers-Theory-Implementation, Bryan, Library of Congress Cataloging-in-Publication Data, 2nd Edition, 2010, 978-0826913005
5	Data and Computer Communication , Stallings Williams, Fourth Edition, PHI Learning, New Delhi,2006, ISBN-10 : 1425982026

RUBRICS FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY and PRACTICE)		
#	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 **50Marks**, 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 (THEORY and PRACTICE)	**150**

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**

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

Semester: VI						
Digital Signal Processing **Category: Professional Core Course** **(Theory and Practice)**						
Course Code	**:**	**21EI63**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L + 30P**		**SEE Duration**	**:**	**03 + 03 Hours**

Unit-I	**09 Hrs**
Digital Signal Processor: Features of fixed point and floating point processors. **TMS320C67x Processor**: Introduction, Features, Internal architecture, CPU, General purpose Register files, Functional units and operations, Data paths, control Register file. **Applications of DSP:** Digital Crossover Audio system, Speech Coding and Compression, Interference Cancellation in Electrocardiography, Compact-Disc Recording System, and DTMF Generation and Detection.	
Unit – II	**09 Hrs**
Design of IIR Filters: **Analog Filters:** Characteristics of commonly used Analog Filters–Butterworth and Chebyshev Type-1 filters,Design of analog filters, Frequency Transformation in the Analog Domain. **Digital Filters:** Analog to Digital Transformations: Impulse Invariance Technique, Bilinear Transformation. Design of Digital IIR Filters using Impulse Invariance and Bilinear Transformation.	
Unit –III	**09 Hrs**
Design of FIR Filters: Symmetric and anti-symmetric FIR Filters, Window functions: Rectangular, Bartlett, Hanning, Hamming, Blackman, and Kaiser. Design of Linear-phase FIR Filters using Windows, Design of Linear-phase FIR filters by Frequency-sampling method, Design of FIR Differentiators.	
Unit –IV	**09 Hrs**
Structures of IIR Systems: Direct-form, Signal flow graphs and Transposed, Cascade-form and Parallel-form Structures. **Structures of FIR Systems:** Direct-form, Cascade form, Linear-phase form, Lattice and Polyphase structures.	
Unit –V	**09 Hrs**
Multirate Digital Signal Processing: Up sampling, Down sampling, Interpolation and Decimation. Changing Sampling rate by a non-integer factor, Applications: CD Audio player, Multistage Decimation, Poly-phase filter structures and Implementation, DSP Applications.	

LABORATORY EXPERIMENTS:

LIST OF EXPERIMENTS USING MATLAB/Sci LAB

1. Write a MATLAB/Sci LAB code to verify the Low pass and High Pass FIR linear phase filter design using Hamming and Hanning windows (with inbuilt and without using inbuilt commands). Plot the magnitude and phase response. Also, Provide the inference on the basis of results obtained for the set of specifications. (To design should be verified by convolving the input signal with the designed filter coefficients)
2. Write a MATLAB/Sci LAB code to verify the Band pass and Band reject FIR linear phase filter design using Hamming and Hanning windows (with inbuilt and without using inbuilt commands). Plot the magnitude and phase response. Also, Provide the inference on the basis of results obtained for the set of specifications.
3. Write a MATLAB/Sci LAB code to verify the Low pass Butterworth IIR filter design using bilinear transformation (BLT) method and Impulse Invariant Technique (IIT) method.
4. Write a MATLAB/Sci LAB code to implement the Low pass Chebyshev (Type 1) IIR filter design using bilinear transformation (BLT) method and Impulse Invariant Technique (IIT) method.
5. Write a MATLAB/Sci LAB code to illustrate the effect of Decimation and Interpolation by an integer factor. Plot the magnitude spectrum. Design the necessary filter to overcome aliasing and image frequencies after decimating and interpolating the signal respectively.
6. Write a MATLAB/Sci LAB code to illustrate the effect of sampling rate conversion by a non-integer factor. Plot the magnitude spectrum. Design the necessary filter to overcome aliasing and image frequencies.
7. Write a MATLAB/Sci LAB code to illustrate the Nyquist sampling theorem. The program should illustrate the effects the sampling the signal
    - At exactly the folding frequency.
    - Frequency less than the folding frequency
    - Frequency greater than the folding frequency
    - Plot the magnitude spectrum for all the above said cases

LIST OF EXPERIMENTS USING DSP PROCESSOR

1. Realization of an FIR filter (any type) to meet given specifications .The input can be a signal from function generator / speech signal.
2. Audio applications such as to plot time and frequency (Spectrum) display of Microphone output plus a cosine using DSP. Read a wav file and match with their respective spectrogram.
3. Implementation of LP FIR Filter for Given Sequence & Implementation of HP FIR Filter for Given Sequence
4. Implementation of LP IIR Filter for Given Sequence & Implementation of HP IIR Filter for Given Sequence
5. Generation of Sinusoidal Signal through Filtering.
6. Implementation of Decimation Process
7. Implementation of Interpolation Process

Noise: Add noise above 3kHz and then remove; Interference suppression using 400 Hz tone.

Course Outcomes: After completing the course, the students will be able to:	
CO1	Explain the various signal processing operations, features of filters and processors.
CO2	Analyze various signal processing applications and multirate operations.
CO3	Design, and implement analog and digital filters for required specifications.
CO4	Evaluate the digital signal processing systems using simulation tool and DSP processors.

Reference Books	
1	Digital Signal Processing, John G. Proakis and Dimitris G. Manolakis, Pearson Education, 4th Edition, 2014. ISBN: 81-317-1000-9
2	Digital Signal Processing – Fundamentals and Applications, Li Tan, 2008, Elsevier Inc., ISBN: 978-0-12-374090-8
3	Digital Signal Processors: Architecture, Programming and Applications, B. Venkataramani and M. Bhaskar,2nd Edition, 2012, McGraw Hill, ISBN:978-0-07-070256-1.
4	V. Udayashankara, Modern Digital Signal Processing, 2nd Edition, 2012, PHI, ISBN: 978-81-203-4567-6.

RUBRICS FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY and PRACTICE)		
#	**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 **50Marks**, 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 (THEORY and PRACTICE)	**150**

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**

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

Semester: VI						
AUTOMATION IN INDUSTRY 4.0 **Category: Professional Core Elective (Group – D)** **(Theory)**						
Course Code	**:**	21EI64D1		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L		**SEE Duration**	**:**	**3Hours**

Unit-I	**09Hrs**
Introduction to Industry 4.0- The Various Industrial Revolutions, Digitalisation and the Networked Economy, Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0, Comparison of Industry 4.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation	
Unit – II	**09 Hrs**
Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services, Smart Manufacturing, Smart Devices and Products, Smart Logistics, Smart Cities, Predictive Analytics	
Unit –III	**09 Hrs**
Technologies for enabling Industry 4.0 - Cyber Physical Systems, Robotic Automation and Collaborative Robots, Support System for Industry 4.0, Mobile Computing, Cyber Security	
Unit –IV	**09 Hrs**
3D printing technologies, selection of material and equipment, develop a product using 3D printing in Industry 4.0 environment	
Unit –V	**09 Hrs**
IIoT case studies, Industry 4.0 in healthcare services, Strategies for competing in an Industry 4.0 world	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the drivers and enablers of Industry 4.0
CO2	Appreciate the smartness in Smart Factories, Smart cities, smart products and smart services
CO3	Outline the various systems used in a manufacturing plant and their role in an Industry 4.0 world
CO4	Outlines a strategic framework to exploit new technologies to enable Healthcare 4.0

Reference Books	
13.	Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, Apress, 2016.
2.	Lan Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
3.	Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing”, Hanser Publisher, 2011.
4.	J. Chanchaichujit, A.Tan, Meng, F., Eaimkhong, S. “Healthcare 4.0 Next Generation Processes with the Latest Technologies”, Palgrave Pivot, 2019.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester: VI						
Internet of Things **Category: Professional Core Elective (Group – D)** **(Theory)**						
Course Code	**:**	21EI64D2		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L		**SEE Duration**	**:**	**3Hours**

Unit-I	**07 Hrs**
FUNDAMENTALS OF IoT: Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects.	
Unit – II	**07 Hrs**
IoT PROTOCOLS: IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT.	
Unit –III	**07 Hrs**
DESIGN AND DEVELOPMENT: Design Methodology – Embedded computing logic – Microcontroller, System on Chips – IoT system building blocks – Arduino – Board details, IDE programming – Raspberry Pi – Interfaces and Raspberry Pi with Python Programming.	
Unit –IV	**07 Hrs**
DATA ANALYTICS AND SUPPORTING SERVICES:Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG.	
Unit –V	**07 Hrs**
CASE STUDIES/INDUSTRIAL APPLICATIONS:Cisco IoT system – IBM Watson IoT platform – Manufacturing – Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – GridBlocks Reference Model – Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand and Explore Internet of Things (IoT) with New Computing Paradigms like 5G, Fog, Edge, and Clouds
CO2	Analyze, Prototype and demonstrate resource management concepts in New Computing Paradigms
CO3	Apply optimal wireless technology to implement Internet of Things and edge computing Applications
CO4	Propose IoT-enabled applications for building smart spaces and services with security features, resource management and edge computing

Reference Books	
14.	IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, 1st Edition, Perason Education, 2017, ISBN: 9386873745, 978-9386873743.
2.	Internet of Things – A hands-on approach,Arshdeep Bahga, Vijay Madisetti, 1st Edition, 2014, Universities Press, ISBN:0996025510, 978-0996025515
3.	The Internet of Things – Key applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi, 2nd Edition, 2020, Wiley,ISBN:938899101X, 978-9388991018 .
4.	Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), 2011th, 2011, Springer,ISBN:3642426980, 978-3642426988.
5	Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2MCommunications, Daniel Minoli, 1st Edition, 2013, Willy Publications ,ISBN: 978-1-118-47347-4.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester: VI						
VIRTUAL & AUGMENTED REALITY **Category: Professional Core Elective (Group – D)** **(Theory)**						
Course Code	**:**	21EI64D3		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L		**SEE Duration**	**:**	**3Hours**

Unit-I	**09 Hrs**
Introduction of Virtual Reality: Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality. Multiple Models of Input and Output Interface in Virtual Reality: Input - Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner etc. Output - Visual /Auditory / Haptic Devices.	
Unit – II	**09 Hrs**
Visual Computation in Virtual Reality: Fundamentals of Computer Graphics. Software and Hardware Technology on Stereoscopic Display. Advanced Techniques in CG: Management of Large-Scale Environments & Real Time Rendering. Interactive Techniques in Virtual Reality: Body Track, Hand Gesture, 3D Menus, Object Grasp.	
Unit –III	**09 Hrs**
Development Tools and Frameworks in Virtual Reality: Frameworks of Software Development Tools in VR. X3D Standard; Vega, MultiGen, Virtools. Application of VR in Digital Entertainment: VR Technology in Film & TV Production. VR Technology in Physical Exercises and Games. Demonstration of Digital Entertainment by VR.	
Unit –IV	**09 Hrs**
Augmented and Mixed Reality, Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality. Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.	
Unit –V	**09 Hrs**
Applications: Medical, robotics, Advanced Real time Tracking, games, movies, simulations, therapy. Frontiers: Touch, haptics, taste, smell, robotic interfaces, telepresence, brain-machine interfaces.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the perspective on the VR/AR landscape; past, present, and future
CO2	Apply the fundamental computer vision, computer graphics and human-computer interaction techniques related to VR/AR
CO3	Demonstrate insights to key application areas for VR/AR
CO4	Design and implement VR/AR experiences.

Reference Books	
15.	Augmented Reality: Principles and Practice, D. Schmalstieg and T. Höllerer Addison-Wesley, Boston, 2016, ISBN-13 978-0-32-188357.
2.	Virtual Reality. Steven M. LaVallCambridge University Press, 2017, http://vr.cs.uiuc.edu/ (Links to an external site.) (Available online for free)
3.	Hand-written VR lecture notes from UIUC course in Spring 2015, on which the book was based
4.	Steve LaValle's recorded VR lectures from NPTEL at IIT Madras, July 2015.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester: VI						
APPLICATION SPECIFIC INTEGRATED CIRCUIT (ASIC) DESIGN **Category: Professional Core Elective (Group – D)** **(Theory)**						
Course Code	**:**	21EI64D4		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L		**SEE Duration**	**:**	**3Hours**

Unit-I	**Hrs**
Introduction: Full Custom with ASIC, Semicustom ASICS, Standard Cell based ASIC, Gate array based ASIC, Channelled gate array, Channelless gate array, structured get array, Programmable logic device, FPGA design flow, ASIC cell libraries	
Unit – II	**08 Hrs**
ASIC Library Design: Logical effort: practicing delay, logical area and logical efficiency logical paths, multi stage cells, optimum delay, optimum number of stages, library cell design.	
Unit –III	**08 Hrs**
Low-level Design Entry: Schematic Entry: Hierarchical design. The cell library, Names, Schematic Icons &Symbols, Nets, schematic entry for ASIC'S, vectored instances and buses, edit in place attributes, Net list, screener, Back annotation connections.	
Unit –IV	**08 Hrs**
ASIC Construction Floor Planning and placement: Physical Design, CAD Tools, System Partitioning, Estimating ASIC size, partitioning methods. Floor planning tools, I/O and power planning, clock planning, placement algorithms, iterative placement improvement, Time has driven placement methods	
Unit –V	**08 Hrs**
Physical Design: Global Routing, Local Routing, Detail Routing, Special Routing, Circuit Extraction and DRC	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the full custom and semicustom design flow
CO2	Apply the concept to design standard cell library.
CO3	Analyse and evaluate the different design techniques and physical design algorithms to achieve effective power, area and timing
CO4	Design a complex system using different design flow.

Reference Books	
16.	Michael John Sebastin Smith, Application Specific Integrated Circuits, Pearson Education, 2008, ISBN, 0201500221
2.	Malcolm R. Haskard, Lan.C.May, Analog VLSI Design-NMOS and CMOS, 1998, Prentice Hall, ISBN-10: 0130326402
3.	Andrew Brown,VLSI Circuits and Systems in Silicon,2001, McGraw Hill, ISBN-10: 0077072219.
4.	Norman G. Einspruch and Norman Einspruch, Application Specific Integrated Circuit (ASIC) Technology - Academic Press, 2012, ISBN: 978-0124315211

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). Two tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester: VI						
Electronics Equipment Integration and Prototype Building **Category: Professional Core Elective (Cluster Elective) (Group- E)** **Theory**						
Course Code	**:**	21EI65E1		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L		**SEE Duration**	**:**	**03 Hours**

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 th e 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:-	
CO 1	Understand the concepts of protype building
CO 2	Apply the concepts for designing the layout a system, and developing drawings that can be used for fabrication in a workshop
CO 3	Analyze the build model
CO 4	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 upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester: VI						
VIRTUAL INSTRUMENTATION **Category:Professional Core Elective (Cluster Elective) (Group- E)** **(Theory)**						
Course Code	**:**	**21EI65E2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**03 Hours**

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	
17.	Virtual instrumentation Using LabVIEW, Jovitha Jerome, 4th Edition, 2010, PHI Learning Pvt.Ltd , ISBN: 978-8120340305
2.	Virtual Instrumentation Using LabVIEW, Sanjay Gupta & Joseph John, 2nd Edition, 2017, Tata McGraw Hill Publisher Ltd, ISBN : 978-0070700284
3.	LabVIEW for Everyone, Lisa. K. Wills, 2nd Edition, 2008, Prentice Hall of India, , ISBN : 978-013185672
4.	LabVIEW Graphical Programming, Garry Johnson, Richard Jennings, 4thEdition , 2017, McGraw Hill Professional, ISBN: 978-1259005336

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester: VI						
SMART GRID TECHNOLOGY **Category: Professional Core Elective (Cluster Elective) (Group- E)** **(Theory)**						
Course Code	**:**	21EE65E1		**CIE**	**:**	50 Marks
Credits: L:T:P	**:**	2:0:0		**SEE**	**:**	50 Marks
Total Hours	**:**	45 L		**SEE Duration**	**:**	3 Hours

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: -	
CO 1	Understand the fundamental concepts of a smart grid and discuss the technologies needed for it.
CO 2	Analyse the power quality and cyber risks of the smart grid and propose appropriate measures.
CO 3	Select suitable energy storage devices for a given grid.
CO 4	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.

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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of 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 **Category: Professional Core Elective (Cluster Elective) (Group- E)** **(Theory)**						
Course Code	**:**	21EE65E2		**CIE**	**:**	100Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	45 L		**SEE Duration**	**:**	3 Hours

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 non linear systems.	

Course Outcomes: After completing the course, the students will be able to: -	
CO 1	Explain the concepts of state space, eigen value and Eigen vectors, controllability and observability, pole placement, non-linear systems and Lyapunov stability.
CO 2	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
CO 3	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.
CO 4	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.	G. J. Thaler and M. P. Pastel Analysis and Design of Nonlinear Feedback Control Systems, McGraw-Hill, 1962.
4.	D. Graham and D. McRuer Analysis Of Nonlinear Control Systems, John Wiley 1961 (also Dover edition 1971).

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. **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**
4.		
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of 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 **Category: Professional Core Elective (Cluster Elective) (Group- E)** **(Cluster Elective)**						
Course Code	**:**	21EC65E1		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L		**SEE Duration**	**:**	**3Hours**

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, Memoryshadowing	
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	Analyse 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	
18.	Real-Time Embedded Systems Design Principles and Engineering Practices by Xiaocong Fan, Newnes Publishers - an imprint of Elsevier, 2015, ISBN10: 0128015071
19.	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

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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of 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 **Category: Professional Core Elective (Cluster Elective) (Group- E)**						
Course Code	:	21EC65E2		**CIE**	:	100 Marks
Credits: L:T:P	:	3:0:0		**SEE**	:	100 Marks
Total Hours	:	45L		**SEE Duration**	:	3 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 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.

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. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR THE SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of 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 ANTENNAS **Category: Professional Core Elective (Cluster Elective) (Group- E) (Theory)**						
Course Code	**:**	**21ET65E1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

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 beamforming 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 upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester: VI						
SATELLITE COMMUNICATION **Category: Professional Core Elective (Cluster Elective) (Group- E)** **(Theory)**						
Course Code	**:**	**21ET65E2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hrs	**:**	**45L**		**SEE Duration**	**:**	**3.00 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 Onboard 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 Communication 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 upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
CONTENTS	**MARKS**	
PART A		
Objective type questions covering entire syllabus	20	
PART B (Maximum of TWO Sub-divisions only)		
Unit 1 : (Compulsory)	16	
Unit 2 : Question 3 or 4	16	
Unit 3 : Question 5 or 6	16	
Unit 4 : Question 7 or 8	16	
Unit 5: Question 9 or 10	16	
	TOTAL	**100**

Semester: VI						
INDUSTRIAL SAFETY AND RISK MANAGEMENT **Category: Institutional elective** **Stream: Chemical Engineering** **(Theory)**						
Course Code	**:**	**21IE6F1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**08 Hrs**
Introduction Safety: Introduction to industrial safety engineering, major industrial accidents, safety and health issues, key concepts and terminologies, Hazard theory, Hazard triangle, Hazard actuation, Actuation transition, Causal factors, Hazard recognition.	
Unit – II	**08 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	**08 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	**08 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	**08 Hrs**
Safety in process industries and case studies: Personnel Protection Equipment (PPE): Safety glasses, face shields, welding helmets, absorptive lenses, hard hats, types of hand PPE, types of foot PPE, types of body PPE. Bhopal gas tragedy, Chernobyl nuclear disaster, Chemical plant explosion and fire.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	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	
20.	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.	ndustrial 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 upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
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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 **Category: Institutional Elective** **(Theory)**						
Course Code	**:**	21IE6F2		**CIE**	**:**	100Marks
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40L		**SEE Duration**	**:**	3 Hours

Unit-I	**08 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	**08 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	**08 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	**08 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	**08 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: -	
CO 1	Understand the working principle and operation of various renewable energy sources and systems.
CO 2	Analyze the performance and characteristics of renewable energy sources and systems.
CO 3	Evaluate the parameters of wind and solar energy systems.
CO 4	Design and demonstrate the applications of renewable energy sources in a typical systems.

Reference Books	
5.	Non conventional energy sources, by G.D Rai, Khanna publishes, 19th Edition, 2017, ISBN: 978-81-7409-073-8
6.	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.
7.	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.
8.	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**
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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 (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
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3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
SYSTEMS ENGINEERING **Category: Institutional elective** **(Theory)**						
Course Code	**:**	**21IE6F3**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45 Hrs		**SEE Duration**	**:**	**3.00 Hours**

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:	
21.	Alexander Kossoaikoff, William N Sweet, "Systems Engineering – Principles and Practice" John Wiley & Sons, Inc, edition: 2012, ISBN: 978-81-265-2453-2
2.	Andrew P. Sage, William B. Rouse, "Handbook of Systems Engineering And Management" John Wiley & Sons, Inc., edition:1999, ISBN 0-471-15405-9
3.	Ludwig von Bertalanffy, "General System Theory: Foundation, Development, Applications", Penguin University Books, 1973, Revised, ISBN: 0140600043, 9780140600049.
4.	Blanchard, B., and Fabrycky, W. Systems Engineering and Analysis, Saddle River, NJ, USA: 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 upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester: VI

MECHATRONICS Category: Institutional Elective (Theory)						
Course Code	**:**	21IE6F4		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45 Hrs		**SEE Duration**	**:**	**3 Hours**

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, Karnough 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	
22.	Nitaigour Premchand, 'Mechatronics-Principles, Concepts & Applications', TMH 1st Edition, 2009, ISBN: 9780070483743
2.	Bolton W., 'Mechatronics-Electronic Control System in Mechanical and Electrical Engineering', Pearson Education, 4th Edition, 2012; ISBN:9788131732533
3.	Tilak Thakur 'Mechatronics', Oxford University Press, I Edition, 2016, ISBN: 9780199459329
4.	Petruzella, Frank D, Programmable logic controllers, 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 upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester: VI						
MATHEMATICAL MODELLING **Category: Institutional elective** **(Theory)**						
Course Code	**:**	21IE6E5		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L		**SEE Duration**	**:**	**3.00 Hours**

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 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 (05), Program specific requirements (05), Video based seminar/presentation/demonstration (10), MATLAB (20). **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester: VI						
INDUSTRY 4.0 - SMART MANUFACTURING FOR THE FUTURE **Category: Institutional Elective** **(Theory)**						
Course Code	**:**	21IE66F6		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	42 Hrs		**SEE Duration**	**:**	**3 Hours**

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	
23.	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 upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: (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						
Industrial Psychology for Engineers (Theory - Institutional Electives – I))						
Course Code	**:**	21IE6F7		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45 Hrs		**SEE Duration**	**:**	**3 Hours**

Unit-I	**08 Hrs**
Introduction to Psychology: Definition and goals of Psychology: Role of a Psychologist in the Society: Today's Perspectives (Branches of psychology- Clinical, Industrial). Psychodynamic, Behavioristic, Cognitive, Humanistic, Psychological Research and Methods to study Human Behavior: Experimental, Observation, Questionnaire and Clinical Method.	
Unit – II	**08 Hrs**
Intelligence and Aptitude: Concept and definition of Intelligence and Aptitude, Nature of Intelligence. Theories of Intelligence – Spearman, Thurston, Guilford Vernon. Characteristics of Intelligence tests, Types of tests. Measurement of Intelligence and Aptitude, Concept of IQ, Measurement of Multiple Intelligence – Fluid and Crystallized Intelligence.	
Unit –III	**10 Hrs**
Personality: Concept and definition of personality, Approaches of personality- psychoanalytical, Socio-Cultural, Interpersonal and developmental, Humanistic, Behaviorist, Trait and type approaches. Assessment of Personality: Self- report measures of Personality, Questionnaires, Rating Scales and Projective techniques, its Characteristics, advantages & limitations, examples. Behavioral Assessment.	
Unit –IV	**10 Hrs**
Learning: Definition, Conditioning – Classical Conditioning, Basics of Classical Conditioning (Pavlov), the process of Extinction, Discrimination and Generalization. Operant Conditioning (Skinner expt). The basics of operant conditioning, Schedules of reinforcement. Cognitive – Social approaches to learning – Latent Learning, Observational Learning, Trial and Error Method, Insightful Learning.	
Unit –V	**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	
24.	Understanding Psychology Feldman R. S, IV edition, (1996) McGraw Hill India
2.	Psychology Robert A. Baron, III 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, IV 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 upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester: VI						
ELEMENTS OF FINANCIAL MANAGEMENT **Category: Institutional Elective** **(Theory)**						
Course Code	**:**	**21IE6F8**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45 Hrs		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**06 Hrs**
Financial Management-An overview: Financial Decisions in a firm, Goals of a firm, Fundamental principle of finance, Organization of finance function and its relation to other functions, Regulatory framework. **The financial System:** Functions, Assets, Markets, Market returns, Intermediaries, regulatory framework, Growth and trends in Indian financial system. **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:	
25.	Fundamentals of Financial Management, Prasanna Chandra, 6th Edition, 2018, McGraw Hill
2.	Education(India) Pvt. Ltd, ISBN: 978-93-392-0313-9, 93-392-0313-5
3.	Financial Management-Text, Problems and Cases, Khan M Y & Jain P K, 8th Edition, 2018,
4.	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 upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester: VI						
Universal Human Values - II **Category: Institutional Elective**						
Course Code	**:**	**21IE6F9**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**42L**		**SEE Duration**	**:**	**3.00 Hours**

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

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

CO4	Understand human conduct and the holistic way of living leading to human tradition

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

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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

Semester: VI						
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**	:	3Hours

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

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
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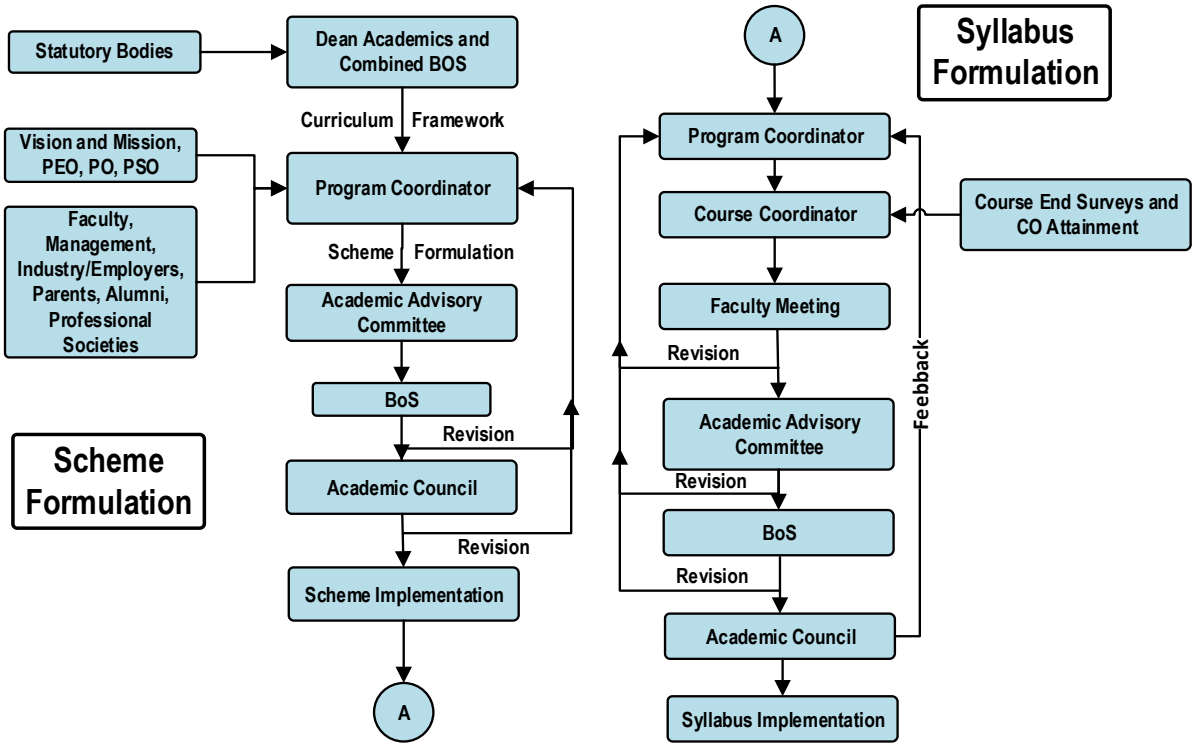
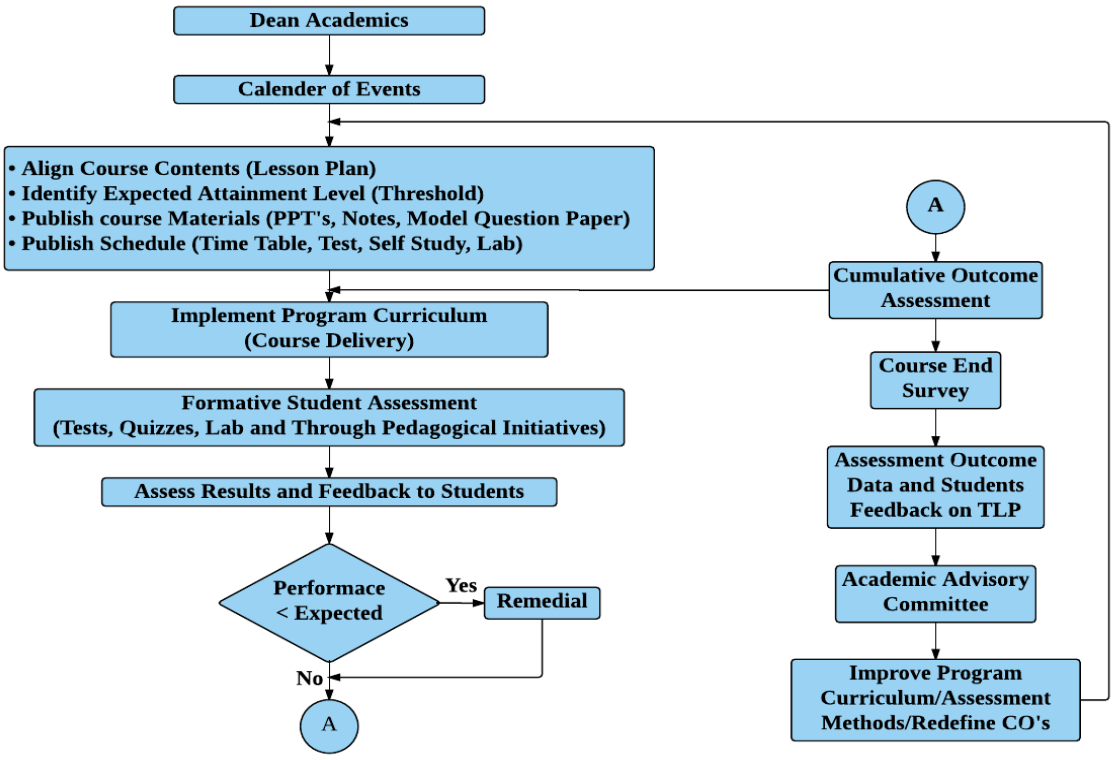
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

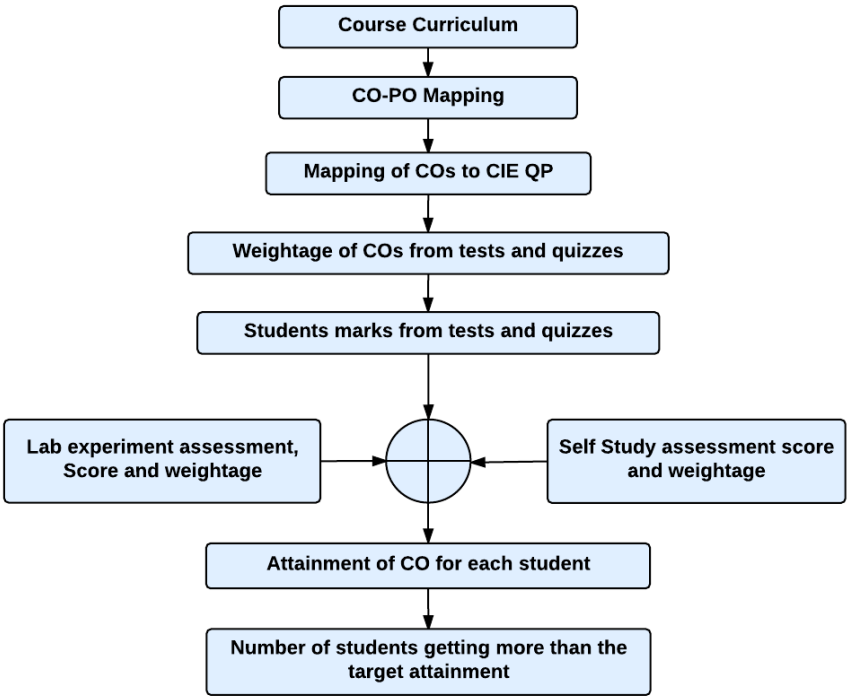
Curriculum Design Process



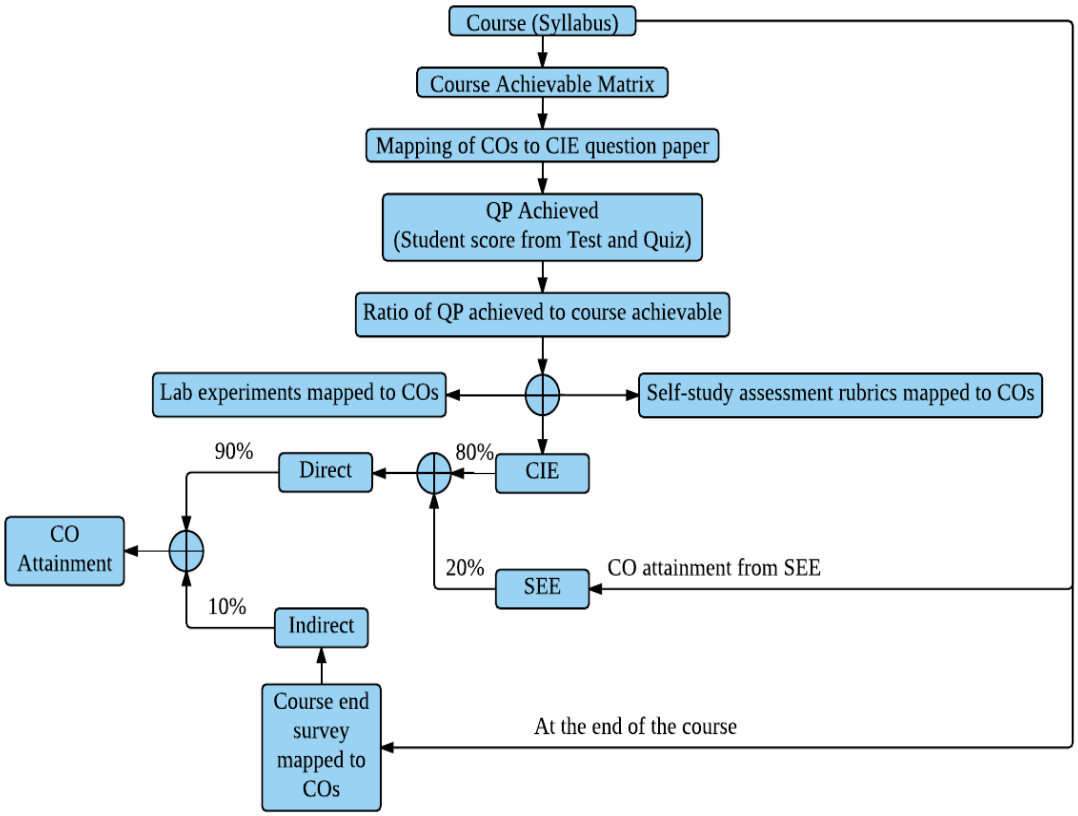
Academic Planning and Implementation



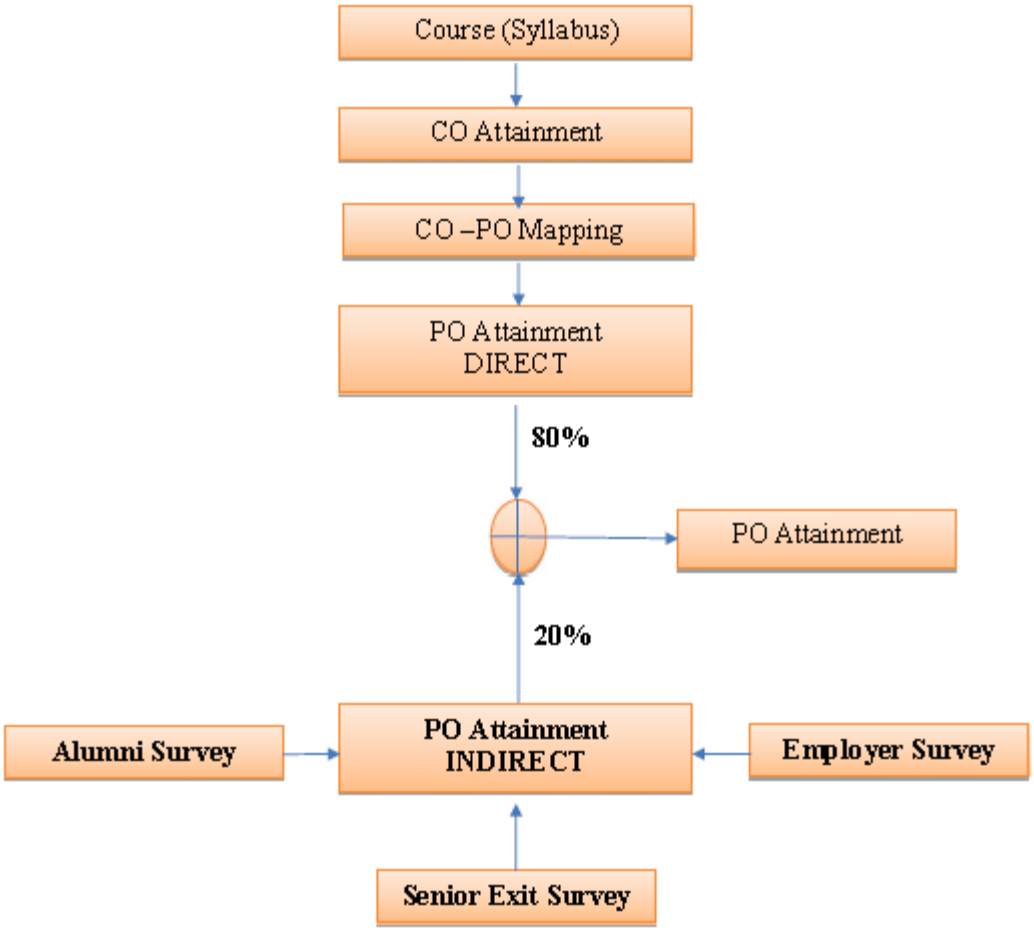
Process for Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



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 th e 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.