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 & TELECOMMUNICATION ENGINEERING

ACADEMIC YEAR 2023-24

ELECTRONICS & TELECOMMUNICATION ENGINEERING

Department Vision

Imparting quality education in Electronics and Telecommunication Engineering through focus on fundamentals, research and innovation for sustainable development

Department Mission

- Provide comprehensive education that prepares students to contribute effectively to the profession and society in the field of Telecommunication.
- Create state-of-the–art infrastructure to integrate a culture of research with a focus on Telecommunication Engineering Education
- Encourage students to be innovators to meet local and global needs with ethical practice
- Create an environment for faculty to carry out research and contribute in their field of specialization, leading to Centre of Excellence with focus on affordable innovation.
- Establish a strong and wide base linkage with industries, R&D organization and academic Institutions.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO	Description
PEO1	Acquire appropriate knowledge of the fundamentals of basic sciences, mathematics, engineering sciences, Electronics & Telecommunication engineering so as to adapt to rapidly changing technology
PEO2	Think critically to analyze, evaluate, design and solve complex technical and managerial problems through research and innovation.
PEO3	Function and communicate effectively demonstrating team spirit, ethics, respectful and professional behavior.
PEO4	To face challenges through lifelong learning for global acceptance.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO	Description
PSO1	Analyze, design and implement emerging Telecommunications systems using devices, sub-systems,
PSO2	Exhibit Technical skills necessary to choose careers in the design, installation, testing, management and operation of Telecommunication systems.

Lead Society: Institute of Electrical and Electronics Engineers (IEEE)

ABBREVIATIONS

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

INDEX

Bachelor of Engineering in

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

V SEMESTER

Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Duration (H)	Max Marks CIE		SEE Duration (H)	Max Marks SEE	
			L	T	P	Total				Theory	Lab		Theory	Lab
1	21HS51A/61A	Intellectual Property Rights & Entrepreneurship	3	0	0	3	HSS	Theory	1.5	100	****	3	100	****
2	21ET52	Communication Engineering II	3	0	1	4	ET	Theory + Lab	1.5	100	50	3	100	50
3	21ET53	Signal Processing II	3	0	1	4	ET	Theory + Lab	1.5	100	50	3	100	50
4	21ET54	RF Circuits	3	1	0	4	ET	Theory	1.5	100	****	3	100	****
5	21ET55BX	Professional Core Elective-I (Group-B)	3	0	0	3	ET	Theory	1.5	100	****	3	100	****
6	21ET56CX	Professional Core Elective-II (Group C)	2	0	0	2	ET	NPTEL	1	100	****	3	100	****
7	21ETI57	Summer Internship- II	0	0	2	2	ET	Internship	1.5	50	50	3	50	50
						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	21ET55B1	Machine Learning
2	21ET55B2	Digital Telephony
3	21ET55B3	Multimedia Communication
4	21ET55B4	Digital VLSI circuits
5	21ET55B5	Operating Systems

GROUP-C-NPTEL		
SL. NO.	**COURSE CODE**	**COURSE TITLE**
1	21ET56C1	Basic Linear Algebra
2	21ET56C2	An Introduction to Information Theory
3	21EI56C3	Cloud Computing and Distributed systems.
4	21ET56C4	Electromagnetic Waves in Guided and Wireless Media
5	21EC56C5	VLSI Signal Processing
6	21ET56C6	Analog Circuits

Bachelor of Engineering in

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

VI SEMESTER

Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Duration (H)	Max Marks CIE		SEE Duration (H)	Max Marks SEE	
			L	T	P	Total				Theory	Lab		Theory	Lab
1	21HS51B/61B	Principles of Management & Economics	3	0	0	3	HSS	Theory	1.5	100	****	3	100	****
2	21ET62	Antenna Theory and Design	3	0	1	4	ET	Theory + Lab	1.5	100	50	2	100	50
3	21ET63	Data Communications and Networking	3	0	1	4	ET	Theory + Lab	1.5	100	50	3	100	50
4	21ET64DX	Professional Core Elective-III (Group – D)	3	0	0	3	ET	Theory	1.5	100	****	3	100	****
5	21XX65EX	Professional Core Elective (Cluster Elective) (Group- E) (TWO Courses under Each Program)	3	0	0	3	XX	Theory	1.5	100	****	3	100	****
6	21IE66FX	Institutional Electives – I (Group F)	3	0	0	3	XX	Theory	1.5	100	****	2	100	****
						20								

* Non-Circuit Programs: 21HS61A ; Circuit Programs: 21HS61B

GROUP-D: PROFESSIONAL ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	21ET64D1	Image Processing
2.	21ET64D2	VLSI physical design
3.	21ET64D3	WSN for IoT applications
4.	21ET64D4	Cryptography and Network Security
5.	21ET64D5	EMI, EMC and Signal Integrity

GROUP-E(Cluster Elective)		
Sl. No.	**Course Code**	**Course Title**
1	21ET65E1	Smart Antennas
2	21ET65E2	Satellite Communication
3	21EC65E1	Real Time Systems
4	21EC65E2	Digital System Design with FPGA
5	21EE65E1	Smart Grid Technology
6	21EE65E2	Modern Control Theory
7	21EI65E1	Electronics Equipment Integration and Prototype Building
8	21EI65E2	Virtual Instrumentation

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

Semester: V

INTELLECTUAL PROPERTY RIGHTS AND ENTREPRENEURSHIP

(Common to all Programs)

(Theory)

Course Code	**:**	**21HSI51A/61B**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**3 Hours**

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						
COMMUNICATION ENGINEERING II **Category: Professional Core Course** **Stream: Electronics and Telecommunication Engineering** **(Theory and Practice)**						
Course Code	**:**	**21ET52**		**CIE**	**:**	**100 +50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 +50 Marks**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3+3 Hours**

Unit-I	**9 Hrs**
Detection Concepts: Model of Digital communication System, Gram-Schmidt Orthogonalization procedure, Geometric Interpretation of Signals, Response of Bank correlators to Noisy Input, Detection of known signals in noise, Probability of Error, Correlation Receiver, Matched Filter Receiver.	
Unit – II	**9 Hrs**
Baseband Transmission: Digital Modulation Formats, ISI, Nyquist criterion for distortion less base-band binary transmission, eye pattern. **Bandpass Transmission:** MSK, M-ary Data Transmission systems (M-ary PSK, M-ary QAM,M-ary FSK), Bandwidth efficiency, OFDM.	
Unit –III	**9 Hrs**
Fundamental Limits on Performance of Sources and Channels: Uncertainty, Information, and Entropy, Source Coding Theorem, Huffman Coding, Discrete Memoryless Channels, Mutual Information, Channel Capacity, Channel Coding Theorem, Mutual Information, Channel Capacity theorem.	
Unit –IV	**9 Hrs**
Error-Control Coding: Rationale for Coding and Types of Codes, Discrete Memoryless Channels(coding Theorem)Linear Block Codes, Cyclic Codes, Convolution codes – Time domain and Transfer domain approaches, Viterbi decoding.	
Unit –V	**9 Hrs**
Spread Spectrum Modulation: Pseudo noise sequences, Notion of Spread Spectrum, PN sequences, DSSS Coherent Binary PSK, Signal-Space Dimensionality and Processing Gain, Probability of Error, Frequency-Hop spread spectrum, Applications.	
LABORATORY EXPERIMENTS	
Part A 1. Digital Modulation Scheme – DPSK, QPSK generation and detection 2. Quadrature Amplitude modulation – generation and detection. 3. Spread Spectrum systems – DSSS and FHSS. 4. Huffman Coding 5. Linear block code 6.Cyclic code 7.Convolution Coding **Part B** 1. Time Division Multiplexing. 2. Generation and Detection of DPSK signals. 3. Generation and Detection of QPSK 4. Spread Spectrum –FHSS generation and Detection 5. PN sequence generation	

Course Outcomes: After completing the course, the students will be able to: -	
CO 1	Explain basic principles of digital modulation techniques, Source coding and channel coding schemes and theorem.
CO 2	Analyze & design various modulation and demodulation circuits and wide band modulation techniques with and without noise.
CO 3	Apply Probability Theory, Random Variables, Random process knowledge in formulating and solving mathematical model for digital Communication system and Information Theory.
CO 4	Implement, Demonstrate and Evaluate the performance parameters of different digital communication circuits, Channel coder, Source Coder and wide band modulation techniques.

Reference Books	
1.	Digital communication, Simon Haykin, 1988, Reprint 2009, John Wiley, ISBN: 9788126508242.
2.	Communication Systems, Simon Haykin, 5 th Edition, 2006, John Wiley and Sons, ISBN: 9788126509041.
3.	Lab VIEW Digital Signal Processing and Digital Communications, Cory L.Cork, 2005, Tata McGraw Hill, ISBN: 007060141.
4.	Digital and Analog Communications, Sam Shanmugam, John Wiley, 2003.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION		
#	**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 upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **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 (20 Marks) and Innovative Experiment/ Concept Design and Implementation (10Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE(THEORY+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	20
3	Viva	20
	TOTAL	**50**

Semester: V						
SIGNAL PROCESSING– II **Category: Professional Core Course** **Stream: Electronics and Telecommunication Engineering** **(Theory and Practice)**						
Course Code	**:**	**21ET53**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L + 30P**		**SEE Duration**	**:**	**3 + 3 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.	
LABORATORY EXPERIMENTS: **Simulation-based experiments using MATLAB/SCILAB:** 1) Generation of step, ramp, sinewave and single/dual tone signals. 2) Computation of Linear and Circular Convolution, Deconvolution, Auto and Cross-Correlation in both time and frequency domains. 3) Impulse response of the LTI system. 4) Computation of DFT and inverse DFT. 5) Design of digital filters (IIR and FIR). 6) Demonstration of multirate operations. **Hardware experiments:** Implementation of various operations: Linear and Circular Convolution, DFT, and Correlation.	

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.

RUBRICFOR THE CONTINUOUS INTERNAL EVALUATION		
#	**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 upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **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 (20 Marks) and Innovative Experiment/ Concept Design and Implementation (10 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE (THEORY+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	20
3	Viva	20
	TOTAL	**50**

Semester: V						
RF CIRCUITS **Category: Professional Core Course** **Stream: Electronics and Telecommunication Engineering** **(Theory)**						
Course Code	**:**	**21ET54**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:1:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L + 30T**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Introduction to Microwaves: Properties, Frequency bands, Application of Microwaves Transmission Lines: Transmission lines equations, Input Impedance derivation Special Cases of Transmission lines, Reflection and transmission coefficients, standing waves and SWR, Quarter wave transforms, Microstriplines **High frequency lines**-Waveguides: Rectangular Waveguide-TE &TM modes, Cut-off frequency derivation, Excitation of waveguides (Only Qualitative Description)	
Unit – II	**09 Hrs**
S-Parameters: Review of S parameters and their properties and losses in microwave networks. (Only Qualitative description) **Basic Smith chart** – Construction, Basic Smith Chart Operations, Smith chart types-Impedance and Admittance Chart, Single Stub Tuning- Shunt Stubs, Series Stubs **Impedance Matching networks**: Goal of impedance matching, Components for matching, Concept of Matched Load, Matching network design using Lumped elements- RC, RL circuits	
Unit –III	**09 Hrs**
RF Passive Devices: Overview of Waveguide passive circuits, Circulators, Isolators, Properties of Power dividers, Wilkinson power dividers, Hybrid Couplers (Qualitative description with S-matrix), Digital Phase Shifters, Semiconductor Phase Shifter **RF Filter Design:** Basic filter configurations, Filter Transformation, Design of LPF and BPF using Insertion loss method	
Unit –IV	**09 Hrs**
High Power Microwave Sources: - Reflex Klystrons, Travelling Wave Tubes and Magnetron (only Qualitative description) **Active RF Components:** -Schottky Diodes- Detectors, PIN diodes: - as a switch and phase shifter. Gunn diode-Modes, RF Transistors- MESFET and HEMT Construction and V-I Characteristics, Microwave Integrated Circuits, HMIC, MMIC Features	
Unit –V	**09 Hrs**
Microwave Amplifiers-: Two port Power gains, Stability, Single stage Transistor Amplifier Design, Low Noise amplifier Design, Dynamic Range and Intermodulation Distortion, Power amplifier design	

Course Outcomes: After completing the course, the students will be able to	
CO1	Review and understand the Transmission Lines, S-parameters, Smith chart applications, Active RF semiconductor components.
CO2	Design and analyze the matching networks for the RF circuits using smith chart and EDA tools
CO3	Design RF Passive and Active circuits for given specifications
CO4	Evaluate the Performance of RF circuits through EDA tools.

Reference Books	
1	Microwave Engineering, David M Pozar, 3 rd Edition, 2011, John Wiley, ISBN-978-81-265-1049-8. 2
2	RF and Microwave Electronics Illustrated, Matthew M. Radmanesh, 1st edition, 2004, Pearson Education, ISBN-978-81-775-8401-1
3	RF Circuit Design Theory and Applications, Reinhold Ludwig, and Pavel Bretchko, 2004, Pearson Education edition, ISBN: 978-81-317-6218-9
4	Fundamentals of RF and Microwave Transistor Amplifiers, Inder J Bahl, 2009, John Wiley & Sons Inc, ISBN: 9780470391662

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						
MACHINE LEARNING **Category: Professional Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Theory)**						
Course Code	:	**21ET55B1**		**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 to Python Programming: Variables, Datatypes (string, list, tuple, dictionary, set), Conditional tests, Loops, Functions, Data Visualization: Matplotlib, plotting a simple line graph, downloading data and working with APIs. **Statistics for ML-I:** Inferential Statistics & Descriptive Statistics, Data Type, Population and Sample, Central Tendencies & Measures of Dispersion, Relationships in variables (covariance, ANOVA, Correlation, Kurtosis)	
Unit – II	**09 Hrs**
Statistics for ML-II: Normal Distribution, Poisson Distribution, Binomial Distribution, Hypothesis Testing, Central Limit Theorem, Degrees Of Freedom, Confidence Interval, P-value **Fundamentals of Machine Learning (ML):** What is ML? Why use ML? Types of ML systems, main challenges of ML, get the data, discover, and visualize the data to gain insights. **Prepare to model:** Exploring Structure of Data, Data Quality and Remediation, Data Pre-Processing.	
Unit –III	**09 Hrs**
Modelling and Evaluation: Introduction, Selecting a Model, Training a Model (for Supervised Learning), Model Representation and Interpretability, Evaluating Performance of a Model, Supervised learning – classification, Supervised learning – regression, Unsupervised learning – clustering, Improving Performance of a Model **Basics of Feature Engineering**: Introduction, Feature Transformation, Feature construction, Feature extraction, Feature Subset Selection, Issues in high-dimensional data, Key drivers of feature selection – feature relevance and redundancy, Measures of feature relevance and redundancy, Overall feature selection process, Feature Selection Approaches.	
Unit –IV	**09 Hrs**
Fundamentals of Machine Learning (ML) – Supervised ML Regression: Regression, Introduction, Example of Regression, Common Regression Algorithms, Simple linear regression, Multiple linear regression, Assumptions in Regression Analysis, Main Problems in Regression Analysis, Improving Accuracy of the Linear Regression Model, Polynomial Regression Model, Logistic Regression. **Supervised Learning: Classification:** KNN, Naive Bayes, SVM, decision trees, ensemble learning and random forest.	
Unit –V	**09 Hrs**
Unsupervised Learning: Introduction, Unsupervised vs Supervised Learning, Application of Unsupervised Learning, Clustering, Clustering as a machine learning task, Different types of clustering techniques, Partitioning methods, K-Medoids: a representative object-based technique, Hierarchical clustering, Density-based methods – DBSCAN, Finding Pattern using Association Rule, Definition of common terms, Association rule, The apriori algorithm for association rule learning, Build the apriori principle rules	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explore and apply the fundamentals of python programming and statistics in developing machine learning techniques.
CO2	Explore the fundamentals and analyse the different techniques of data pre-processing in ML techniques.
CO3	Analyse the strength and weakness of different machine learning models to solve real world problems
CO4	Implement and apply different supervised and unsupervised machine learning algorithms to solve real world problems.

Reference Books	
1	Eric Matthes, Python Crash Course: A Hands-On, Project-Based Introduction to Programming, 2nd Edition, May 2019, ISBN-13: 9781593279288.
2	Kothari C.R., Gaurav Garg, Research Methodology Methods and techniques, 4th edition, New Age International Publishers, 2020, ISBN: 978-93-86649-22-5.
3	Amit Kumar Das, SaikatDutt, Subramanian Chandramouli, Machine Learning, Pearson Education India, April 2018 ISBN: 9789389588132.
4	Introduction to Machine Learning, EthemAlpaydin, 2nd Edition,2010, PHI Publication, ISBN: 978-81-203-4160-9.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding 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						
DIGITAL TELEPHONY **Category: Professional Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Theory**						
Course Code	**:**	**21ET55B2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Background & Terminology: Telecommunications Standard Organizations, The Analog Network Hierarchy: Bell System Hierarch, Switching Systems, Transmission Systems, Pair-Gain Systems, FDM Multiplexing and Modulation, Wideband Transmission Media, Transmission Impairments, Power levels, Signaling, Analog Interfaces, The Intelligent Network, Dynamic Nonhierarchical Routing, Cellular Radio Telephone System, Voiceband Data Transmission, The Introduction of Digits.	
Unit – II	**09 Hrs**
Why Digital? Advantages of digital voice networks: Ease of Multiplexing, Ease of Signalling, Use of Modern Technology, Integration of Transmission and switching, Signal Regeneration, Digital Signal Processing, disadvantages of digital voice networks	
Unit –III	**09 Hrs**
Digital Switching: Switching Functions, Space Division Switching, Time Division Switching, Two-Dimensional Switching, Digital Cross-Connect Systems, Digital Switching in an Analog Environment	
Unit –IV	**09 Hrs**
Traffic Analysis: Traffic Characterization: Arrival Distributions, Holding Time Distributions, Loss Systems: Lost Calls Cleared, Lost Calls Returning, Lost Calls Held, Lost Calls Cleared-Finite Sources, Lost Calls Held-Finite Sources, Network Blocking probabilities, Delay Systems: Exponential Service Times, Constant Service Times, Finite Queues, Tandem queues.	
Unit –V	**09 Hrs**
Switching networks: Single-stage networks, Principle of gradings, Design of progressive grading, Types of grading, Traffic capacity of gradings, Applications of gradings, link systems. Grades of service of link systems, application of graph theory to link systems, stick-sense non-blocking networks, sectionalized switching networks	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain fundamental concepts of switching networks.
CO2	Analyse the various concepts related to Digital Switching
CO3	Analyse the performance of various functions related to call handling and call processing in Telecommunication Network.
CO4	Design Network models with respect to Grade of service and traffic capacity.

Reference Books	
1	Digital Telephony, John C.Bellamy, 3 rd Edition, 2002, Wiley series, ISBN: 9814126357.
2	Telecommunications, switching traffic and networks, J.E.Flood, 2005, Pearson education Ltd, ISBN: 1844860140.
3	Telecommunication switching systems and networks, Thiagarajan Viswanathan, 2004, Prentice Hall, ISBN: 1587202166.

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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9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
MULTIMEDIA COMMUNICATION **Category: Professional Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Theory)**						
Course Code	**:**	**21ET55B3**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**
UNIT-I						**09Hrs**
Introduction: Multimedia information representation, multimedia networks, multimedia applications. **QoS** -Network QoS and application QoS.						
UNIT-II						**09Hrs**
Multimedia Information Representation: Text formats–Unformatted, formatted and hypertext; Images- Graphics, Digitized documents& pictures, Audio-PCM speech, CD-quality audio, Synthesized audio and Video – Broadcast television, Digital video, PC video,						
UNIT-III						**09Hrs**
Text and image compression: Compression principles, Text compression- Huffman coding, Arithmetic Coding, LZ, LZW coding; Image compression- GIF, TIFF, Digitized documents and pictures, JPEG 2000: Development Process, Significant features, Architecture, Bit stream, Compressionefficiency comparisons.						
UNIT-IV						**09Hrs**
Audio and video compression: Audio compression - DPCM, Adaptive DPCM, Adaptive and Linearpredictive coding, CELP, MPEG and Dolby audio coders. **Video compression** -video compression principles; Standards - H.261, H.263, MPEG, MPEG-1,MPEG-2, MPEG-4.						
UNIT-V						**09 Hrs**
Multimedia Network Communications and Applications: Quality of Multimedia Data Transmission: QoS, QoS for IP protocols, Prioritized Delivery. **Multimedia over IP:** IP Multicast, RTP, RTCP, RSVP, RTSP, Internet Telephony. **Multimedia over ATM Networks:** Video Bitrates over ATM, ATM adaptation layer, MPEG – 2 Convergence to ATM, Multicast over ATM.						

Course Outcomes: After completing the course, the students will be able to:	
CO1	Understand and explain Multimedia information representation, networks, coding, imageprocessing and compression techniques.
CO2	Apply the knowledge learnt about the various coding, image processing and compression techniques.
CO3	Analyze and Justify the impact of multimedia communication on society through various applications like interpersonal communication, interactive applications over the internet
CO4	Design and Evaluate various coding, processing and compression techniques.

Reference Books	
1	Fred Halsall, "Multimedia Communications", Pearson Education, 2013, ISBN: 978-81-317-0994-8.
2	K.R. Rao, Zoran S.Bojkovic, D.A.Milovanovic, "Multimedia Communication Systems", PHI,2014.
3	Ze-NianLi and Marks S Drew, "Fundamentals of Multimedia", PHI, 2006.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) 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	
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7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
DIGITAL VLSI CIRCUITS **Category: Professional Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Theory)**						
Course Code	**:**	**21ET55B4**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Review of MOS transistor: MOSFET operation, MOSFET current-voltage characteristics. Geometrical effects: Channel length modulation, Substrate bias effect, Short-channel effects, Sub-threshold conduction, DIBL, Punch-through, Hot-carrier injection, Carrier-mobility degradation.	
Unit – II	**09 Hrs**
CMOS Circuits: CMOS Inverter operation with VTC, Design of CMOS Inverter, CMOS n-well process, CMOS Ring Oscillator Circuit, CMOS Logic Circuits, Pseudo-nMOS circuits, CMOS Transmission Gates, CMOS D-Latch and Flip-flop. VLSI Design Flow.	
Unit –III	**09 Hrs**
CMOS Circuits: Dynamic CMOS, Domino CMOS, TSPC Dynamic CMOS circuits. **Memories:** One-Transistor DRAM cell, Full CMOS SRAM cell, Nonvolatile Memory: 4-bit x 4-bit NOR and NAND-based ROM array, **Design Methodology:** Concepts of Hierarchy, Regularity, Modularity, and Locality.	
Unit –IV	**09 Hrs**
Synchronous Design: Timing Metrics for Sequential Circuits, Synchronous Timing Basics, Clock Skew, Clock Jitter, Impact of Skew and Jitter on Performance, Sources of Skew and Jitter. Composition of a phase-locked loop (PLL), Application of PLL for synchronization of communication between chips, On-chip Clock generation and Distribution.	
Unit –V	**09 Hrs**
Low-Power CMOS Logic Circuits: Need for low-power design, Supply voltage scaling, Overview of Power Consumption, Low-Power design through Voltage Scaling, Variable-Threshold CMOS (VTCMOS) Circuits, Multiple-Threshold CMOS (MTCMOS) Circuits, Pipelining Approach, Parallel Processing Approach, Introduction to adiabatic CMOS gates.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the fundamentals of semiconductor physics in MOS transistors and analyze the geometrical effects of MOS transistors and discuss design methodologies.
CO2	Analyze the synchronous timing metrics for sequential designs.
CO3	Justify the need for low power design and analyze various sources of power consumption and approaches to minimize them.
CO4	Design and realize combinational, sequential digital circuits and memory cells in CMOS logic.

Reference Books	
1	CMOS Digital Integrated Circuits: Analysis and Design, Sung-Mo Kang and Yusuf Leblebici, 3rd Edition, Tata McGraw-Hill, ISBN: 0070530777, 2003.
2	Digital Integrated Circuits: A Design Perspective, Jan M. Rabaey. Anantha Chandrakasan, and Borivoje Nikolic, 2nd Edition, Pearson Education India, ISBN: 9385152343.
3	Basic VLSI Design, Douglas A. Pucknell and Kamran Eshraghian, 3rd Edition, 2003, PHI, ISBN: 8120309863.
4	Deep-Submicron CMOS ICs, Harry Veendrick, 2nd Edition, 2000, Kluwer academic publishers, ISBN: 9044001116.

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
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7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
OPERATING SYSTEMS **Category: Professional Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Theory)**						
Course Code	**:**	**21ET55B5**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Overview of Operating Systems: Abstract Views of Operating Systems, Goals of an OS, Operation of an OS, Classes of OS –Batch Processing Systems, Multiprogramming Systems, Time Sharing Systems, Real-Time Operating Systems, Distributed Operating Systems.	
Unit-II	**09 Hrs**
Process Management: **Process Concept:** Process Concept, Process Scheduling, Operations on Processes, Inter-process Communication, IPC in Shared-Memory Systems, IPC in Message-Passing Systems. **Threads & Concurrency:** Overview, Multicore Programming, Multicore Programming, Implicit Threading: Thread pools, Fork-join, Implicit Threading. **CPU Scheduling:** Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Multi-Processor Scheduling	
Unit –III	**09 Hrs**
Process Synchronization: Synchronization Tools, Background, The Critical-Section Problem, Peterson's Solution, Hardware Support for Synchronization, Mutex Locks, Mutex Locks, Monitors. Deadlocks: System Model, Deadlock in Multithreaded Applications, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock	
Unit –IV	**09 Hrs**
Memory Management: **Main Memory:** Background, Contiguous Memory Allocation, Paging, Structure of the Page Table. **Virtual Memory:** Background, Demand Paging, Page Replacement: Basic Page Replacement, FIFO, LRU, Counting-Based Page Replacement, Allocation of Frames: Minimum Number of Frames, Allocation Algorithms, Global versus Local Allocation, Thrashing: Causes of Thrashing	
Unit –V	**09 Hrs**
File-System Interface: File Concept: File Attributes, File Operations, File Types, Access Methods Directory Structure **Linux System:** Process Management, Memory Management	

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the concepts of Operating Systems including functions, goals and classes of operating system.
CO2	Analyze the key concepts of Process, Threads and CPU Scheduling.
CO3	Evaluate the performance of various algorithms in Operating systems with respect to Process scheduling, Synchronization, Deadlocks and File management.
CO4	Apply the concepts of Process, Synchronization, Memory and filesystems in to understand any existing operating system.

Reference Books	
1	Operating System Concepts, Abraham Silberschatz, Peter B. Galvin and Greg Gagne, 10th Edition, Reprint 2018, Addison Wesley, ISBN: 978-1-118-06333-0
2	Operating Systems –A Concept Based Approach, D. M. Dhamdhere, 3rd Edition, Reprint 2017, McGraw Hill Education, ISBN: 978-0070611948
3	Operating Systems Internals and Design Principles, William Stallings, 9th Edition, 2018, Pearson Prentice Hall, ISBN: 978-9352866717.

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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	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: V						
BASIC LINEAR ALGEBRA **Category: Professional Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Theory)**						
Course Code	**:**	**21ET56C1**		**Duration**	**:**	**8 Weeks**
Credits: L:T:P	**:**	**2:0:0**				

Week 1 : Matrices and Matrix operations, REF
Week 2 : Linear systems, Gauss Elimination and Inverse of a matrix
Week 3 : Rn; subspaces, linear independence, rank of a matrix
Week 4 : Determinants, rank, inveribility
Week 5 : Linear transformations,rank-nullity
Week 6 : Inner product spaces, Gram-Schmidt process
Week 7 : Eigenvalues and Eigenvectors
Week 8 : Similarity, diagonalization and applications

Reference Books	
1	From Geometry to Algebra, an introduction to linear Algebra, Inder K Rana, Ane Books 2007.

Semester: V						
AN INTRODUCTION TO INFORMATION THEORY **Category: Professional Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Theory)**						
Course Code	**:**	**21ET56C2**		**Duration**	**:**	**8 Weeks**
Credits: L:T:P	**:**	**2:0:0**				

Week 1: Introduction: Entropy, Relative Entropy, Mutual Information; Information Inequalities;
Week 2: Block to variable length coding-I: Prefix-free code, Block to variable length coding-II: Bounds on optimal codelength; Block to variable length coding-III: Huffman coding.
Week 3: Variable to block length coding, The asymptotic equipartition property, Block to block coding of DMS
Week 4: Universal Source Coding-I: Lempel-Ziv Algorithm-LZ77, Universal source coding-II: Lempel-Ziv Welch Algorithm (LZW)
Week 5: Coding for sources with memory, Channel capacity of discrete memoryless channels.
Week 6: Joint typical sequences, Noisy channel coding theorem; Differential entropy;
Week 7: Gaussian Channel; Parallel Gaussian Channel.
Week 8: Rate Distortion Theory; Blahut-Arimoto Algorithm for computation of channel capacity and rate-distortion function.

Reference Books	
1	James L. Massey, Lecture notes on ``Applied Digital Information Theory I".
2	David J. C. MacKay, ``Information Theory, Inference, and Learning Algorithms", Cambridge University Press.
3	Thomas M. Cover, Joy A. Thomas, ``Elements of Information Theory", 2nd Edition, John Wiley & Sons, 2006.
4	Robert G. Gallager, ``Information Theory and Reliable Communications", John Wiley & Sons, 1968.
5	Raymond W. Yeung, ``Information Theory and Network Coding", Springer, 2008.
6	Robert Ash, ``Information Theory", Dover Publications, 1965.
7	Imre Csiszar and Jonos Korner, ``Information Theory", Second edition, Cambridge University Press, 2011

Semester: V						
CLOUD COMPUTING AND DISTRIBUTED SYSTEMS **Category: Professional Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Theory)**						
Course Code	**:**	**21EI56C3**		**Duration**	**:**	**8 Weeks**
Credits: L:T:P	**:**	**2:0:0**				

Week 1: Introduction to Clouds, Virtualization and Virtual Machine

1. Introduction to Cloud Computing: Why Clouds, What is a Cloud,Whats new in todays Clouds, Cloud computing vs. Distributed computing, Utility computing, Features of today's Clouds: Massive scale, AAS Classification: HaaS, IaaS, PaaS, SaaS, Data-intensive Computing, New Cloud Paradigms, Categories of Clouds: Private clouds, Public clouds
2. Virtualization: What's virtualization, Benefits of Virtualization, Virtualization Models: Bare metal, Hosted hypervisor
3. Types of Virtualization: Processor virtualization, Memory virtualization, Full virtualization, Para virtualization, Device virtualization
4. Hotspot Mitigation for Virtual Machine Migration: Enterprise Data Centers, Data Center Workloads, Provisioning methods, Sandipiper Architecture, Resource provisioning, Black-box approach, Gray-box approach, Live VM Migration Stages, Hotspot Mitigation

Week 2: **Network Virtualization and Geo-distributed Clouds**

1. Server Virtualization: Methods of virtualization: Using Docker,Using Linux containers, Approaches for Networking of VMs: Hardware approach: Single-root I/O virtualization (SR-IOV), Software approach: Open vSwitch, Mininet and its applications
2. Software Defined Network: Key ideas of SDN, Evolution of SDN,SDN challenges, Multi-tenant Data Centers: The challenges, Network virtualization, Case Study: VL2, NVP
3. Geo-distributed Cloud Data Centers: Inter-Data Center Networking, Data center interconnection techniques: MPLS, Google's B4 and Microsoft's Swan

Week 3: **Leader Election in Cloud, Distributed Systems and Industry Systems**

1. Leader Election in Rings (Classical Distributed Algorithms): LeLann-Chang-Roberts (LCR) algorithm, The Hirschberg and Sinclair (HS) algorithm
2. Leader Election (Ring LE & Bully LE Algorithm): Leader Election Problem, Ring based leader election, Bully based leader election, Leader Election in Industry Systems: Google's Chubby and Apache Zookeeper
3. Design of Zookeeper: Race condition, Deadlock, Coordination, Zookeeper design goals, Data model, Zookeeper architecture, Sessions, States, Usecases, Operations, Access Control List (ACL), Zookeeper applications: Katta, Yahoo! Message Broker

Week 4: **Classical Distributed Algorithms and the Industry Systems**

1. Time and Clock Synchronization in Cloud Data Centers: Synchronization in the cloud, Key challenges, Clock Skew, Clock Drift, External and Internal clock synchronization, Christians algorithm, Error bounds, Network time protocol (NTP), Berkley's algorithm, Datacenter time protocol (DTP), Logical (or Lamport) ordering, Lamport timestamps, Vector timestamps
2. Global State and Snapshot Recording Algorithms: Global state, Issues in Recording a Global State, Model of Communication, Snapshot algorithm: Chandy-Lamport Algorithm

3. Distributed Mutual Exclusion: Mutual Exclusion in Cloud, Central algorithm, Ring-based Mutual Exclusion, Lamport's algorithm, Ricart-Agrawala's algorithm, Quorum-based Mutual Exclusion, Maekawa's algorithm, Problem of Deadlocks, Handling Deadlocks, Industry Mutual Exclusion : Chubby

Week 5: **Consensus, Paxos and Recovery in Clouds**

1. Consensus in Cloud Computing and Paxos: Issues in consensus, Consensus in synchronous and asynchronous system, Paxos Algorithm
2. Byzantine Agreement: Agreement, Faults, Tolerance, Measuring Reliability and Performance, SLIs, SLOs, SLAs, TLAs, Byzantine failure, Byzantine Generals Problem, Lamport-Shostak-Pease Algorithm, Fischer-Lynch-Paterson (FLP) Impossibility
3. Failures & Recovery Approaches in Distributed Systems: Local checkpoint, Consistent states, Interaction with outside world, Messages, Domino effect, Problem of Livelock, Rollback recovery schemes, Checkpointing and Recovery Algorithms: Koo-Toueg Coordinated Checkpointing Algorithm

Week 6: **Cloud Storage: Key-value stores/NoSQL**

1. Design of Key-Value Stores: Key-value Abstraction, Key-value/NoSQL Data Model, Design of Apache Cassandra, Data Placement Strategies, Snitches, Writes, Bloom Filter, Compaction, Deletes, Read, Membership, CAP Theorem, Eventual Consistency, Consistency levels in Cassandra, Consistency Solutions
2. Design of HBase: What is HBase, HBase Architecture, Components, Data model, Storage Hierarchy, Cross-Datacenter Replication, Auto Sharding and Distribution, Bloom Filter, Fold, Store, and Shift

Week 7: **P2P Systems and their use in Industry Systems**

1. Peer to Peer Systems in Cloud Computing: Napster, Gnutella, FastTrack, BitTorrent, DHT, Chord, Pastry and Kelips.

Week 8: **Cloud Applications: MapReduce, Spark and Apache Kafka**

1. MapReduce: Paradigm, Programming Model, Applications, Scheduling, Fault-Tolerance, Implementation Overview, Examples
2. Introduction to Spark: Resilient Distributed Datasets (RDDs), RDD Operations, Spark applications: Page Rank Algorithm, GraphX, GraphX API, GraphX working

3.Introduction to Kafka: What is Kafka, Use cases for Kafka, Data model, Architecture, Types of messaging systems, Importance of brokers

Reference Books	
1	Distributed and Cloud Computing From Parallel Processing to the Internet of Things- Kai Hwang, Jack Dongarra, Geoffrey Fox.
2	Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wile, 2011
3	Distributed Computing: Principles, Algorithms, and Systems- Ajay D. Kshemkalyani and Mukesh Singhal
4	Distributed Computing: Fundamentals, Simulations and Advanced Topics-Hagit Attiya and Jennifer Welch

Semester: V						
ELECTROMAGNETIC WAVES IN GUIDED AND WIRELESS MEDIA **Category: Professional Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Theory)**						
Course Code	**:**	**21ET56C4**		**Duration**	**:**	**8 Weeks**
Credits: L:T:P	**:**	**2:0:0**				

Week 1 : Transmission lines
Week 2 : Applications of transmission lines
Week 3 : EM waves in free-space
Week 4 : Diffraction of EM waves
Week 5 : Guided waves in metallic waveguides
Week 6 : Guided waves in dielectric waveguides
Week 7 : Fundamentals of radiation
Week 8 : Wireless channel modeling

Reference Books	
1	Electromagnetic waves, D. H. Staelin et al, 1993.
2	Electromagnetic wave propagation, radiation and scattering, A. Ishimaru, 2017
3	Fields and waves in modern communication electronics, S. Ramo et. al., Wiley 1993
4	Digital communications with emphasis on data modems, R. W. Middlestead, 2017.

Semester: V						
VLSI SIGNAL PROCESSING **Category: Professional Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Theory)**						
Course Code	**:**	**21EC56C5**		**Duration**	**:**	**8 Weeks**
Credits: L:T:P	**:**	**2:0:0**				

Week 1: Graphical representation of DSP algorithms, signal flow graph (SFG), data flow graph (DFG) and dependence graph (DG), high level transformation, critical path.
Week 2 :Retiming of DFG, critical path minimization by retiming, loop retiming and iteration bound
Week 3 :Cutset retiming, design of pipelined DSP architectures, examples
Week 4 :Parallel realization of DSP algorithms, idea of unfolding, unfolding theorem, loop unfolding
Week 5: Polyphase decomposition of transfer functions, hardware efficient parallel realization of FIR filters, 2-parallel and 3-parallel filter architectures.
Week 6 :Hardware minimization by folding, folding formula, examples from biquad digital filters,
Week 7 :Delay optimization by folding, lifetime analysis, forward-backward data allocation, examples from digital filters
Week 8 :Pipelining digital filters, look ahead techniques, clustered and scattered look ahead, combining parallel processing with pipelining in digital filters

Reference Books	
1	."VLSI Digital Signal Processing Syustems", Keshab K. Parhi, Wiley Eastern
2	"Digital Signal Processing for Multimedia Systems", Keshab K. Parhi and Takao Nishitani, Marcel Dekker.
3	"Pipelined Lattice and Wave Digital Recursive Filters", J. G. Chung and Keshab K. Parhi, Kluwer.

Semester: V						
ANALOG CIRCUITS **Category: Professional Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Theory)**						
Course Code	**:**	**21ET56C6**		**Duration**	**:**	**8 Weeks**
Credits: L:T:P	**:**	**2:0:0**				

Week 1: Introduction, Poles and Zeros, Ideal Opamp, Applications of OPAMP – Inverting and Non Inverting Amplifier
Week 2: Applications of OPAMP (..Contd) – Summer Amplifier, Difference Amplifier, Integrator, Differentiator
Week 3: Non Idealities in an OPAMP – Finite Gain, Bandwidth, Slew Rate, Saturation, Offset Voltage, Bias Current
Week 4: Bode Plots, Frequency Response, Millers Theorem, Feedback, Effect of Feedback
Week 5: Stability, Nyquist Plot, Phase Margin, Gain margin, Frequency Compensation
Week 6: Filter Design, Butterworth and Chebyshev Filters Non Linear Applications of Filters – Limiters, Oscillators, Multivibrators
Week 7: Diodes, Basic BJT Circuits
Week 8: Basic BJT based circuits

Reference Books	
1	Microelectronic Circuits : Theory and Applications, by sedra and smith
2	Fundamentals of Electric Circuits by Alexander and Sadiku
3	Analog Integrated Circuit Design, by Johns and Martin,
4	.Analysis and Design of Analog Integrated Circuits, by Grey, Hurst and Mayer

Semester: V						
SUMMER INTERNSHIP - II (Practical)						
Course Code	:	**21ETI57**		**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. Studentscan opt any internship for the duration of three weeks by enrolling on to the platform through https: / /internshala.com

D. At Engineering Colleges nearby their hometown

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

E. At Industry or Research Organizations

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

Procedures for the Internship:

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

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

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

RUBRICS FOR THE CONTINUOUS INTERNAL EVALUATION		
#	**COMPONENTS**	**MARKS**
1.	**REVIEW I:** Explanation of the application of engineering knowledge in industries, ability to comprehend the functioning of the organization/ departments, exhibiting professional and ethical practice, communication skills (oral and body language).	**20**
2.	**REVIEW II**: Presentation in the form digital poster, report writing, exhibiting ethics inreport writing, oral presentation.	**30**
	MAXIMUM MARKS FOR THE CIE 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	**:**	**21HSM51A / 61B**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**06 Hrs**
Introduction to Management: Management Functions – POSDCORB – an overview, Management levels & Skills, Management History - **Classical Approach:** Scientific Management, Administrative Theory, **Quantitative Approach:** Operations Research, **Behavioral Approach:** Hawthorne Studies, **Contemporary Approach:** Systems Theory, Contingency Theory. **Caselets / Case studies**	
Unit – II	**10 Hrs**
Foundations of Planning: Types of Goals & Plans, Approaches to Setting Goals & Plans, Strategic Management Process, Corporate strategies – types of corporate strategies, BCG matrix, Competitive Strategies – Porters Five force Model, types of Competitive Strategies. **Caselets / Case studies** **Organizational Structure & Design:** Overview of Designing Organizational Structure - Work Specialization, Departmentalization, Chain of Command, Span of Control, Centralization & Decentralization, Formalization, Mechanistic & Organic Structures. **Caselets / Case studies**	
Unit –III	**10 Hrs**
Motivation: Early Theories of Motivation - Maslow's Hierarchy of Needs Theory, McGregor's Theory X & Theory Y, Herzberg's Two Factor Theory. Contemporary Theories of Motivation: Adam's Equity theory, Vroom's Expectancy Theory. **Caselets / Case studies** **Leadership:** Behavioral Theories: Blake & Mouton's Managerial Grid, Contingency Theories of Leadership: Hersey & Blanchard's Situational Leadership, Contemporary Views of Leadership: Transactional & Transformational Leadership. **Caselets / Case studies**	
Unit –IV	**10 Hrs**
Introduction to Economics: Microeconomics and Macroeconomics, Circular flow model of economics, An Overview of Economic Systems. **Macroeconomic models**- The classical growth theory, Keynesian cross model, IS-LM-model, The AS-AD model, The complete Keynesian model, The neo-classical synthesis. National Budgeting process in India. **Macroeconomic Indicators:** Prices and inflation, Consumer Price Index, Exchange rate, Labor Market, Money and banks, Interest rate. Gross Domestic product (GDP) - components of GDP, Measures of GDP: Outcome Method, Income method and Expenditure method, Numericals on GDP Calculations.	
Unit –V	**09 Hrs**
Essentials of Microeconomics: Demand, Supply, and Equilibrium in Markets for Goods and Services, Price Elasticity of Demand and Price Elasticity of Supply, Elasticity and Pricing, Numericals on determining price elasticity of demand and supply. Changes in Income and Prices Affecting Consumption Choices, Monopolistic Competition, Oligopoly.	

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

Reference Books:	
1.	Management, Stephen Robbins, Mary Coulter & 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: VI						
ANTENNA THEORY AND DESIGN **Category: Professional Core Course** **Stream: Electronics and Telecommunication Engineering** **(Theory and Practice)**						
Course Code	**:**	**21ET62**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L + 30P**		**SEE Duration**	**:**	**3 + 3 Hours**

Unit-I	**09 Hrs**
Antenna Basics: Basic antenna parameters, Radiation patterns, Radiation Intensity, Beam area, Beam Efficiency, Directivity and Gain, Antenna field zones, Radiation intensity, Power patterns, Electric dipole-fields of short dipole and Half wave dipole (Qualitative description), radiation resistance of short and half wave dipole. **Antenna Arrays** Introduction, pattern multiplication, Array of two isotropic point sources with various cases, Derivation of Array factor, Array factor N element linear array, Broadside, End fire array and Extended End Fire array	
Unit – II	**09 Hrs**
Antenna Types: Yagi-Uda array, Frequency Independent Antennas: log periodic antenna **RF Antennas**: Rectangular Horn antenna and its radiation characteristics, Parabolic antenna: Paraboloid reflector, Feed methods for parabolic reflectors. Helical antenna geometry and its modes, Microstrip Antennas: Introduction, Advantages and Limitations, Rectangular Microstrip antenna, feeding methods, Transmission line Model Analysis	
Unit –III	**09 Hrs**
Antennas for Special Applications: Ground Plane Antennas, Surface Wave and Leaky wave Antennas, Antennas for Terrestrial Mobile communications systems, Antennas for Ground Penetrating Radars, Embedded Antennas, Ultra-Wide band Antennas **Wave Propagation**: Wave Propagation – Categorizations and General Classifications, Different Modes of Wave Propagation, Ground Wave Propagation -Plane Earth Reflections, Space and Surface Waves, Wave Tilt, Space Wave Propagation-Field Strength of Space wave, Scattering Phenomena, Troposphere Propagation, Sky Wave Propagation- Structure of Ionosphere, MUF, Virtual height and Skip distance	
Unit –IV	**09 Hrs**
Practical Microstrip Antenna Design: - Antenna Design for Wireless Communication and Mobile Phones- Mobile Communication Standards, Mobile Phone Antennas, Multiband Antenna Design for Mobile Phones, Printed Antenna Arrays: Linear Microstrip Antenna Arrays, Planar Microstrip Antenna Arrays, Feed Techniques for Array Antenna, Reconfigurable Antennas **Phased Array Antennas**- Active Phased Arrays, Hybrid Phased Arrays, Phased Array Theory, Active Phased Array Antenna Design, Need for Smart Antennas, Smart Antenna Configurations, Architecture of Smart Antenna System	

Unit –V	09 Hrs
Antenna Measurements Antenna Ranges, Radiation Patterns, Gain Measurements, Directivity Measurements, Impedance Measurements, Polarization Measurements, Radiation Efficiency, Vector Network Analyzer and Spectrum Analyzer- block diagram and Measurements.	
LABORATORY EXPERIMENTS: **Students are expected to implement the following circuits on Microwave Benches** 1. Characterization of Gunn diode sources, Microstrip devices 2. Characterization of Directional Coupler, Tee junctions 3. Horn antenna, Parabolic Dish, Micro strip antennas **The students are expected to simulate the following Antennas using RF CAD tools** 1. Design of Matching circuits using ADS 2. Radiation characteristics of Dipole antenna, Microstrip Patch Antenna Using HFSS 3. Antenna array simulation Using MATLAB 4. Design of Passive circuits, Active circuits using ADS/AWR	

Course Outcomes: After completing the course, the students will be able to:	
CO1	Understand basic parameters of antenna, principles of Phased Array Antennas, physical phenomenon of wave propagation.
CO2	Analyze the characteristics of antennas and array structures for different applications
CO3	Design the antenna for a given application and evaluate its performance using RF CAD Tools
CO4	Characterize antennas using different measurement techniques.

Reference Books	
1	Antennas, John D. Kraus & Ronald J. Marhefka, 4th Edition, 2011, Mc Graw Hill, ISBN -0-07-060185-2
2	Antenna Theory, Constantine A Balanis, 2nd Edition, 2005, John Wiley & Sons, ISBN – 9971-51-233-5.
3	Anil Pandey, Practical Microstrip and Printed Antenna Design, ARTECH House,2019, ISBN-13: 978-1-63081-668-1
4	Introduction to Smart Antennas. Balanis, C.A., Ioannides, P.I.: 2(1), 1– 175,2007, 9781598291766

RUBRICFOR THE CONTINUOUS INTERNAL EVALUATION		
#	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 upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **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 (20 Marks) and Innovative Experiment/ Concept Design and Implementation (10 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE(THEORY+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	20
3	Viva	20
	TOTAL	**50**

Semester: VI						
DATA COMMUNICATIONS AND NETWORKING **Category: Professional Core Course** **Stream: Electronics and Telecommunication Engineering** **(Theory and Practice)**						
Course Code	**:**	**21ET63**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L + 30P**		**SEE Duration**	**:**	**3 + 3 Hours**

Unit-I	**09Hrs**
Introduction: Networks: Network Criteria, Physical Structures, Network types: Local Area Network, Wide Area Network, Switching, The Internet, Accessing the Internet. **Network Models:** TCP / IP protocol suite: Layered Architecture, Layers in the TCP/IP Protocol Suite, Description of Each Layer, Encapsulation and Decapsulation, Addressing, Multiplexing and Demultiplexing, The OSI Model: OSI versus TCP/IP, Lack of OSI Model's Success. **Introduction to Physical Layer**: Performance. **Switching:** Introduction : Three Methods of Switching , Switching and TCP/IP Layers, Circuit-Switched Networks : Three Phases , Efficiency , Delay , Packet Switching : Datagram Networks , Virtual-Circuit Networks. **Introduction to Data-Link Layer:** Introduction: Nodes and Links, Services, Two Categories of Links, Two Sublayers, Link-Layer Addressing: Three Types of addresses.	
Unit – II	**09 Hrs**
Link Layer: Data Link Control (DLC): DLC Services: Framing, Flow and Error Control, Connectionless and Connection-Oriented, High Level Data Link Control (HDLC) : Configurations and Transfer Modes , Framing, Point-to-Point Protocol (PPP): Services, Framing , Transition Phases , Multiplexing. **Media Access Control (MAC):** Random Access, Controlled Access. **Wired LANs**: Ethernet: Ethernet Protocol, Standard Ethernet: Characteristics, Addressing, Access Method, Efficiency of Standard Ethernet. **Wireless LANs**: Introduction: Architectural Comparison, Characteristics, Access Control, IEEE 802.11 Project: Architecture, MAC Sublayer, Addressing Mechanism.	
Unit –III	**09 Hrs**
Network Layer : Introduction to Network Layer: Network-Layer Services: Packetizing , Routing and Forwarding , Other Services , Network-Layer Performance, Ipv4 Addresses : Address Space , Classful Addressing, Classless Addressing , Dynamic Host Configuration Protocol (DHCP), Network Address Resolution (NAT), Forwarding Of IP Packets : Forwarding Based on Destination Address , Forwarding Based on Label , Routers as Packet Switches. **Network-Layer Protocols**: Internet Protocol (IP): Datagram Format, Fragmentation,Options, Security of IPv4 Datagrams, IPv6 Protocol: Packet Format.	
Unit –IV	**09 Hrs**
Network Layer: Unicast Routing: Routing Algorithms: Distance-Vector Routing, Link-State Routing, Path-Vector Routing, Unicast Routing Protocols: Internet Structure, Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Border Gateway Protocol	

Version 4 (BGP4). **Transport Layer: Introduction**: Transport-Layer Services, Connectionless and Connection-Oriented Protocols, Transport-Layer Protocols: Simple Protocol, Stop-and-Wait Protocol, Go-Back-*N* Protocol (GBN), Selective-Repeat Protocol, Bidirectional Protocols: Piggybacking.
Unit –V **09 Hrs**
Transport-Layer Protocols: Introduction: Services, Port Numbers. User Datagram Protocol: User Datagram, UDP Services, UDP Applications. Transmission Control Protocol: TCP Services, TCP Features, Segment A TCP Connection, Windows in TCP, Flow Control, Error Control, TCP Congestion Control,TCP Timers.
LABORATORY EXPERIMENTS: **Part- A** **Experiments Using Routers and Switches:** Configuration of Cisco router, IP static routing and RIP using Cisco router, and VLAN using Cisco switch. **Part- B** **Experiments Using Qualnet:** Experiments on PPP, IEEE 802.3 and IEEE 802.11, RIP and OSPF protocols for wired networks. **Part-C** **Programs based on implementation of various algorithm using C/C++.** 1. Program for error detecting code using CRC-CCITT (16-bits). 2. Shortest Path algorithm to find suitable path for transmission. 3. Spanning Tree algorithm to find loop less path. 4. Implement a client and server communication using sockets programming. 5. Message queues of FIFOs as IPC Channel. 6. Implement a simple multicast routing mechanism. 7. Computation of Linear Block code using C++ Program. 8. Implementation of congestion control algorithm.

Course Outcomes: After completing the course, the students will be able to:	
CO1	Explain the principles of computer network and layered model of networking.
CO2	Apply the algorithms/techniques of routing, congestion and Quality of Service to solve problems related to Computer Networks.
CO3	Design and Implement protocols and algorithms for TCP/IP model.
CO4	Evaluate and compare various algorithms/protocols available to address networking issues.

Reference Books	
1	Data Communications and Networking, Behrouz A Forouzan, 5th Edition, 2013, Tata McGraw-Hill, ISBN – 9781259064753.
2	Computer Networks, Andrew S Tanenbaum, 5th Edition, 2014, Pearson Education; ISBN – 978-81-7758-165-2.
3	Computer Networking, A Top-Down Approach, James Kurose and Keith Ross, 6th Edition, 2013, ISBN-13: 978-0-13-285620-1.
4	Data and Computer Communications, William Stallings, 8th Edition, 2009, Pearson Education, ISBN-13: 978-0131392052.

RUBRICFOR THE CONTINUOUS INTERNAL EVALUATION		
#	**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 upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **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 (20 Marks) and Innovative Experiment/ Concept Design and Implementation (10 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE (THEORY+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	20
3	Viva	20
	TOTAL	**50**

Semester: VI						
IMAGE PROCESSING **Category: Professional Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Theory)**						
Course Code	**:**	**21ET64D1**		**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: Introduction to Digital Image Processing, Origins of Digital Image Processing, Examples of fields that use DIP, Fundamental Steps in digital Image Processing, Components of an Image Processing System. **Digital Image Fundamentals:** Elements of Visual Perception, A Simple Image Formation Model,Basic Concepts in Sampling and Quantization, Representing Digital Images, Spatial and Gray-level Resolution, Zooming and Shrinking Digital Images, Some Basic Relationships Between Pixels,Linear and Nonlinear Operations.	
Unit – II	**09 Hrs**
Image Transforms: Two-dimensional &orthogonal unitary transforms, Properties of unitary transforms, two dimensional discrete Fourier transform, discrete cosine transform, sine transform, Hadamard transform, Haar transform, Slant transform, KL transform.	
Unit -III	**9 Hrs**
Image Enhancement in Spatial domain: Some Basic Gray Level Transformations, Histogram Processing, Enhancement using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters. **Image Enhancement in the Frequency Domain:** Smoothing Frequency-Domain Filters, Sharpening, Frequency Domain Filters, Homomorphic Filtering.	
Unit –IV	**9 Hrs**
Image Restoration: A Model of the Image Degradation/Restoration Process, Noise Models, Restoration in the Presence of Noise Only-Spatial Filtering, Periodic Noise reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering. Color Fundamentals, Color Models, Pseudo-color Image Processing, Basics of Full-Color Image Processing.	
Unit –V	**9 Hrs**
Morphological Image Processing: Preliminaries, Dilation and Erosion, Openingand Closing, The Hit-or-Miss Transformation, Some Basic Morphological Algorithms. **Segmentation:** Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-Based Segmentation.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand digital image processing fundamentals and its applications.
CO2	Apply image processing techniques in both spatial and frequency domains.
CO3	Analyze and apply different operations on an image for various applications.
CO4	Apply and justify the use of image processing in modern multimedia communication, society

Reference Books	
1	Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, Pearson Education, 2nd Edition, 2001, ISBN-13: 978-0131687288.
2	Fundamentals of Digital Image Processing, Anil K. Jain, Pearson Education / PHI, 2001, ISBN: 9780133361650.
3	Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, 2nd edition, Pearson Education, 2001.
4	Digital Image Processing, William K. Pratt, 3rd Edition John Wilely, 2004.

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						
VLSI PHYSICAL DESIGN **Category: Professional Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Theory)**						
Course Code	**:**	**21ET64D2**		**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 to ASICs: Full-custom, Standard-cell based, Gate-array based, and Programmable ASICs, ASIC Design flow, ASIC cell Libraries. **Datapath Logic Cells:** Data Path Elements, Adders: RCA, Carry save, Carry bypass, and Brent-Kung adder.	
Unit – II	**09 Hrs**
Datapath Logic Cells: Adders: Carry select and Conditional sum adder. Multiplier (Booth encoding). **ASIC Library Design:** Logical effort: Cell delay, Logical effort of Inverter, NAND and NOR gates, Predicting delay, Logical paths, Logical area and logical efficiency, Multi-stage cells, Optimum delay, Optimum number of stages.	
Unit -III	**9 Hrs**
Programmable ASIC Logic Cells: Actel ACT: ACT 1, ACT 2, and ACT 3 Logic Modules, Timing model and critical path for ACT 2 and ACT 3 Logic Modules. Xilinx LCA: XC3000 CLB, Altera: FLEX architecture, and MAX architecture. **Programmable ASIC I/O Cells:** Xilinx XC4000 IOB, Altera IOC, and Altera IOE. Schematic entry for ASICs, Hierarchical design with an example, Net-list screener.	
Unit –IV	**9 Hrs**
ASIC Construction-I: Physical Design, CAD Tools. **Partitioning:** Goals and objectives, Constructive Partitioning, Iterative Partitioning Improvement: KL, FM, and Look-ahead algorithms. **Floor planning:** Goals and objectives, Floor planning tools, Channel definition.	
Unit –V	**9 Hrs**
ASIC Construction-II: **Placement:** Goals and objectives, Min-cut Placement algorithm, Iterative Placement Improvement algorithms, Physical Design flow. **Global Routing:** Goals and objectives, Global Routing Methods, Back-annotation. **Detailed Routing:** Goals and objectives, Measurement of Channel Density, Left-Edge, and Area-Routing Algorithms, Final Routing Steps, Design checks.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the concepts of ASIC design methodology, data path elements, FPGA architectures and goals and objectives of Physical design.
CO2	Analyze the design of FPGAs and ASICs suitable for specific tasks, perform design entry and explain the physical design flow.
CO3	Design data path elements for ASIC cell libraries and compute optimum path delay.
CO4	Evaluate CAD algorithms for system partitioning, floorplan, placement and routing.

Reference Books	
1	Application Specific Integrated Circuits, Michael John Sebastian Smith, 1st Edition, 1997, Addison-Wesley Professional, ISBN: 0-201-50022-1.
2	CMOS VLSI Design: A Circuits and Systems Perspective, Neil H.E. Weste, David Harris, and Ayan Banerjee, 3rd Edition, 2006, Pearson education, ISBN: 108177585681.
3	VLSI Design: A Practical Guide for FPGA and ASIC Implementations, Vikram Arkalgud Chandrasetty, 2011, Springer, ISBN: 978-1-4614-1119-2.
4	Digital Integrated Circuits: A Design Perspective, Jan M. Rabaey. Anantha Chandrakasan, and Borivoje Nikolic, 2nd Edition, Pearson Education India, ISBN: 9385152343.

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						
WSN FOR IoT APPLICATIONS **Category: Professional Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Theory)**						
Course Code	**:**	**21ET64D3**		**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 and Overview and Applications of Wireless Sensor Networks: Introduction, Background of Sensor Network Technology, Basic overview of the Technology, Basic Sensor Network Architectural Elements. **Applications of Wireless Sensor Networks:** Introduction, Background, Range of Applications, Examples of Category 2 WSN Applications, Examples of Category 1 WSN Applications.	
Unit – II	**09 Hrs**
Basic Wireless Sensor Technology: Introduction, Sensor Node Technology, Sensor Taxonomy, WN Operating Environment, WN Trends. **MAC and Routing Protocols for Wireless Sensor Networks:** Introduction, Background, Fundamentals of MAC Protocols, MAC Protocols for WSNs,	
Unit -III	**9 Hrs**
Routing Protocols for Wireless Sensor Networks: Introduction, Background, Data Dissemination and Gathering, Routing Challenges and Design Issues in WSNs, Routing Strategies in WSNs.	
Unit –IV	**9 Hrs**
Transport Control Protocols for Wireless Sensor Networks : Traditional Transport Control Protocols, Transport Protocol Design Issues, Examples of Existing Transport Control Protocols, Performance of Transport Control Protocols.	
Unit –V	**9 Hrs**
Network Management Requirements for Wireless Sensor Networks: Introduction, Network Management Requirements, Traditional Network Management models , Network Management Design Issues, Example of Management Architecture : MANNA.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the Wireless sensor networks its architecture and its applications
CO2	Analyze the challenges in MAC layers and MAC protocols in WSN.
CO3	Analyze the routing challenges, routing protocols in WSN.
CO4	Analyze the transport and network management requirements in sensor networks.

Reference Books	
1	Wireless Sensor Networks: Technology, Protocols and Applications, Kazem Sohraby, Daniel Minoli, Taieb Znati, 2nd Edition (Indian), 2014, WILEY, ISBN 978-0-471-74300-2.
2	Wireless Sensor Networks, Ian F. Akyildiz, Mehmet Can Vuran,2010,Wiley, ISBN-13: 9780470036013.
3	Wireless Sensor Networks- An Information Processing Approach, Feng Zhao & Leonidas J. Guibas, 2007, Elsevier, ISBN-1558609148, 9781558609143.
4	Fundamentals of Wireless Sensor Networks Theory and Practice, Waltenegus Dargie and Christin Poellabauer, 1st EditionJohn Wiley 2010, ISBN 978-0-470- 99765-9.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding 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						
CRYPTOGRAPHY AND NETWORK SECURITY **Category: Professional Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Theory)**						
Course Code	**:**	**21ET64D4**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Computer and Network Security Concepts: Computer Security Concepts, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, Fundamental Security Design Principles, A Model for Network Security, Standards. **Classical Encryption Techniques**: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotor Machines, Steganography.	
Unit – II	**09 Hrs**
Block Ciphers and Data Encryption Standards (DES): Traditional Block Cipher Structure, The Data Encryption Standard, A DES Example, The Strength of DES, Block Cipher Design Principles. **Public-Key Cryptography and RSA**: Principles of Public-Key Cryptosystems, The RSA Algorithm, Diffie-Hellman key exchange, Elgamal Cryptographic System, Elliptic Curve Arithmetic, Elliptic Curve Cryptography.	
Unit -III	**09 Hrs**
Cryptographic Hash Functions: Applications of Cryptographic Hash Functions, Two Simple Hash Functions, Requirements and Security, Hash Functions Based on Cipher Block Chaining. **Message Authentication Codes**: Message Authentication Requirements, Message Authentication Functions, Requirements for Message Authentication Codes (MAC), Security of MACs, MACs Based on Hash Functions: HMAC. **Digital Signatures**: Digital Signatures, Elgamal Digital Signature Scheme, NIST Digital Signature Algorithm.	
Unit –IV	**09 Hrs**
Network Access Control and Cloud Security : Network Access Control, Extensible Authentication Protocol, IEEE 802.1X Port-Based Network Access Control, Cloud Computing, Cloud Security Risks and Countermeasures, Data Protection in the Cloud, Cloud Security as a Service, Addressing Cloud Computing Security Concerns. **Transport-Level Security**: Web Security Considerations, Transport Layer Security, HTTPS, Secure Shell (SSH).	
Unit –V	**09 Hrs**
Electronic Mail Security: Internet Mail Architecture, Email Formats, Email Threats and Comprehensive Email Security. **IP Security**: IP Security Overview, IP Security Policy, Encapsulating Security Payload, Combining Security Associations, Internet Key Exchange, Cryptographic Suites.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the fundamental concepts, issues and principles of cryptography for data transmission.
CO2	Apply cryptographic techniques and algorithms to provide security to the transmitted information.
CO3	Analyze the concepts of Authentication, Hash functions and Digital signature.
CO4	Understand and analyze System level security issues and protocols.

Reference Books	
1	Cryptography and Network Security, Williams Stallings, Seventh Edition, 2017, Pearson India Education Services, ISBN 978-0-13-444428-4.
2	Network Security, Perlman - Kaufman Spenciner, 2002, Pearson Education/PHI, ISBN: 9971–51–45–5.
3	Cryptography & Network Security, AtulKahate, 2003, TMH, ISBN-81-203-2186-3.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding 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						
EMI, EMC AND SIGNAL INTEGRITY **Category: Professional Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Theory)**						
Course Code	**:**	**21ET64D5**		**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 to Electromagnetic Compatibility: Aspects of EMC, Decibels and Common EMC Units. **EMC Requirements for Electronic Systems:** Governmental Requirements, Additional Product Requirements, Design Constraints for Products, Advantages of EMC Design	
Unit – II	**09 Hrs**
Transmission Lines and Signal Integrity: The Per-Unit-Length Parameters, High-Speed Digital Interconnects and Signal Integrity **Nonideal Behavior of Components:** Wires, Printed Circuit Board (PCB) Lands, Effect of Component Leads, Resistors, Capacitors, Inductors, Ferromagnetic Materials, Ferrite Beads, Common-Mode Chokes, Electromechanical Devices, Digital Circuit Devices, Effect of Component Variability	
Unit -III	**09 Hrs**
Conducted Emissions and Susceptibility: Measurement of Conducted Emissions, Power Supply Filters-Basic Properties of Filters, Power Supplies, Power Supply and Filter Placement, Conducted Susceptibility **Radiated Emissions and Susceptibility:** Simple Emission Models for Wires and PCB Lands, Simple Susceptibility Models for Wires and PCB Lands	
Unit –IV	**09 Hrs**
Crosstalk: Three-Conductor Transmission Lines and Crosstalk, Shielded Wires, Twisted Wires **Shielding:** Shielding Effectiveness.	
Unit –V	**09 Hrs**
System Design for EMC: Grounding, Safety Ground, Signal Ground, Single-Point Grounding, Multipoint Grounding, and Hybrid Grounding, Ground Loops and Subsystem Decoupling, Printed Circuit Board (PCB) Design, System Configuration and Design, Diagnostic Tools	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand and explain the concepts of EMI and EMC, standards and measurements
CO2	Apply EMI controlling techniques to reduce effect of interference on modern communication systems.
CO3	Analyze and measure the system for EMI and EMC to the standards defined
CO4	Design and develop a system and PCBs to control the effects of electromagnetic interference.

Reference Books	
1	C.R.Paul,"Introduction to Electromagnetic Compatibility", John Wiley and Sons, Inc, 2008.
2	V.P.Kodali, "Engineering EMC Principles, Measurements and Technologies", IEEE Press, Newyork, 2010.
3	Henry W.Ott.,"Electromagnetic Compatibility Engineering", A Wiley Inter Science Publications, John Wiley and Sons, Newyork, 2009

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						
SMART ANTENNAS **Category: Professional (Cluster) Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Common to EC,EE,EI& ET Programs)** **(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)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
SATELLITE COMMUNICATION **Category: Professional (Cluster) Elective Course** **Stream: Electronics and Telecommunication Engineering** **(Common to EC,EE,EI& ET Programs)** **(Theory)**						
Course Code	**:**	**21ET65E2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hrs	**:**	**45L**		**SEE Duration**	**:**	**3Hrs**

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 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**) 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						
REAL TIME SYSTEMS **Category: Professional (Cluster) Elective Course** **Stream: Electronics and Communication Engineering** **(Common to EC,EE,EI& ET Programs)** **(Theory)**						
Course Code	**:**	**21EC65E1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hrs	**:**	**45L**		**SEE Duration**	**:**	**3Hrs**

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 FO Resources: Memory: Physical Hierarchy, Cache, Memory Planning, Memory shadowing	
Unit – II	**09 Hrs**
Real-Time UML: General Resource Modeling: Overview of UML, Architecture modelling in UML, Real-Time UML Profile, Resource Modeling, Time Modeling, Concurrency Modeling. **Real-Time UML:** Model Analysis: Elicitation of Timing Constraints, RT-UML Profile Schedulability Modeling Subprofile	
Unit –III	**09 Hrs**
Software Architectures for Real-Time Embedded Systems: Real-Time Tasks, WCET, intermediate FO, Execution Efficiency, Round-Robin Architecture, Round Robin with Interrupts, Queue-Based Architecture, Multitask Design, Multitask Resource Sharing, Addressing Resource Deadlocks, Addressing Priori Inversion	
Unit –IV	**09 Hrs**
Real-Time Scheduling: Clock-Driven Approach, Rate-Monotonic approach, Sporadic Server approach, Resource sharing, IPC: Message Ques, Pipes, Signalling, Remote Procedure and Sockets, Real Time Memory Management: Process Stack Management, Dynamic Allocation, Hardware and software timing management.	
Unit –V	**09 Hrs**
Examples of Real Time OS: Vx-Works, RTX-ARM: Task Management, Scheduling, Primitive Kernel Services, Application Program development using APIs, QNX resource management, Case studies: Calculator, Device Drivers	

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

Reference Books	
1	Real-Time Embedded Systems Design Principles and Engineering Practices by Xiaocong Fan, Newnes Publishers an imprint of Elsevier 2015, ISBN10:)0128015071
2	Real-Time Embedded Systems and Components, Sam Siewert, 2007, Cengage Learning India Edition, ISBN: 9788131502532
3	Real-Time Embedded 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	Real Time Systems Jane W. S. Liu, 2000, Prentice Hall, ISBN:0130996513

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding 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						
DIGITAL SYSTEM DESIGN WITH FPGA **Category: Professional (Cluster) Elective Course** **Stream: Electronics and Communication Engineering** **(Common to EC,EE,EI& ET Programs)** **(Theory)**						
Course Code	**:**	**21EC65E2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hrs	**:**	**45L**		**SEE Duration**	**:**	**3Hrs**

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 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.

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	**40**

	seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	
	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 (Cluster) Elective Course** **Stream: Electrical and Electronics Engineering** **(Common to EC,EE,EI& ET Programs)** **(Theory)**						
Course Code	**:**	**21EE65E1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**2:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**3Hrs**

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 (Cluster) Elective Course** **Stream: Electrical and Electronics Engineering** **(Common to EC,EE,EI& ET Programs)** **(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: -	
CO1	Explain the concepts of state space, eigen value and Eigen vectors, controllability and observability, pole placement, non-linear systems and Lyapunov stability.
CO2	Represent the systems in state space, Response of systems with and without state feedback controllers and observers, Analysis of stability of linear and nonlinear systems

CO3	Transform state models to canonical, observable and controllable forms. Asses the need of state feedback controllers and observers, Evaluate the stability of non-linear systems and Liapunov stability criterion.
CO4	Design state feedback controllers and observers.

Reference Books	
1	Modern Control Engineering, Katsuhiko Ogata, 5th Edition, 2003, PHI ISBN 81-7808-579-8.
2	Automatic control system, Benjamin C. Kuo and Farid Golnaraghi, 8th Edition, 2003, John Wiley and Sons, ISBN 0-471-13476-7.
3	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**
	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: IV						
ELECTRONICS EQUIPMENT INTEGRATION AND PROTOTYPE BUILDING **Category: Professional (Cluster) Elective Course** **Stream: Electronics and Instrumentation Engineering** **(Common to EC,EE,EI& ET Programs)** **(Theory)**						
Course Code	**:**	**21EI65E1**		**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: 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 (Cluster) Elective Course** **Stream: Electronics and Instrumentation Engineering** **(Common to EC,EE,EI& ET Programs)** **(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	
1.	Jovitha Jerome, Virtual instrumentation Using LabVIEW,4th Edition, 2010, PHI Learning Pvt.Ltd , ISBN: 978-8120340305
2.	Sanjay Gupta & Joseph John, Virtual Instrumentation Using LabVIEW, 2nd Edition, 2017, Tata McGraw Hill Publisher Ltd, ISBN : 978-0070700284
3.	Lisa. K. Wills, LabVIEW for Everyone, 2nd Edition, 2008, Prentice Hall of India, , ISBN : 978-013185672
4.	Garry Johnson, Richard Jennings, LabVIEW Graphical Programming, , 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						
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	**:**	**45L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**09 Hrs**
Introduction Safety: Introduction to industrial safety engineering, major industrial accidents, safety and health issues, key concepts and terminologies, Hazard theory, Hazard triangle, Hazard actuation, Actuation transition, Causal factors, Hazard recognition.	
Unit – II	**09 Hrs**
Risk assessment and control: Individual and societal risks, Risk assessment, Risk perception, Acceptable risk, ALARP, Prevention through design. **Hazard Identification Methods:** Preliminary Hazard List (PHL): Overview, methodology, worksheets, case study. Preliminary Hazard Analysis (PHA), Fault tree and Event tree analyses.	
Unit –III	**09 Hrs**
Hazard analysis: Hazard and Operability Study (HAZOP): Definition, Process parameters, Guide words, HAZOP matrix, Procedure, Example. Failure Modes and Effects Analysis (FMEA): Introduction, system breakdown concept, methodology, example.	
Unit –IV	**09 Hrs**
Application of Hazard Identification Techniques: Case of pressure tank, heat exchanger, system breakdown structure, Accident paths, HAZOP application, risk adjusted discounted rate method, probability distribution, Hiller's model	
Unit –V	**09 Hrs**
Safety in process industries and case studies: Personnel Protection Equipment (PPE): Safety glasses, face shields, welding helmets, absorptive lenses, hard hats, types of hand PPE, types of foot PPE, types of body PPE. Bhopal gas tragedy, Chernobyl nuclear disaster, Chemical plant explosion and fire.	

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

Reference Books	
1	Functional Safety in the Process Industry: A Handbook of practical Guidance in the application of IEC61511 and ANSI/ISA-84, Kirkcaldy K.J.D Chauhan, 2012, North corolina,Lulu publication, ISBN:1291187235.
2.	Safety Instrumented Systems Verification Practical probabilistic calculations, Goble and William M., 2005, Pensulvania ISA publication, ISBN:155617909X.
3.	Industrial safety and risk Management, Laird Wilson and Doug Mc Cutche, 1st Edition, 2003,The University of alberta press,Canada, ISBN: 0888643942.
4.	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**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: VI						
RENEWABLE ENERGY SYSTEMS **Category: Institutional elective** **Stream: Electrical and Electronics Engineering** **(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: -	
CO1	Understand the working principle and operation of various renewable energy sources and systems.
CO2	Analyze the performance and characteristics of renewable energy sources and systems.
CO3	Evaluate the parameters of wind and solar energy systems.
CO4	Design and demonstrate the applications of renewable energy sources in a typical systems.

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

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding 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						
SYSTEMS ENGINEERING **Category: Institutional elective** **Stream: Industrial Engineering and Management** **(Theory)**						
Course Code	**:**	**21IE6F3**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 Hrs**		**SEE Duration**	**:**	**3 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:	
1.	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** **Stream: Mechanical Engineering** **(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 segmen 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	
1	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** **Stream: Mathematics** **(Theory)**						
Course Code	**:**	**21IE6F5**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3Hours**
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** **Stream: Mechanical Engineering** **(Theory)**						
Course Code	**:**	**21IE6F6**		**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: 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	**09Hrs**
Digital twin, Virtual factory, Total Productive Maintenance, Industry 4.0 case studies, Understanding I 4.0 in MSMEs, What's Next: Industry 5.0/Society 5.0	

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

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

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding 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 **Category: Institutional elective** **Stream: Humanities and Social Science** **(Theory)**						
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	
2.	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** **Stream: Industrial Engineering and Management** **(Theory)**						
Course Code	**:**	**21IE6F8**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 Hrs**		**SEE Duration**	**:**	**3 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:	
1	Fundamentals of Financial Management, Prasanna Chandra, 6th Edition, 2018, McGraw Hill Education(India) Pvt. Ltd, ISBN: 978-93-392-0313-9, 93-392-0313-5
2	Financial Management-Text, Problems and Cases, Khan M Y & Jain P K, 8th Edition,2018, McGraw Hill Education(India) Pvt. Ltd, ISBN: 9353162181 , 9789353162184

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding 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** **Stream: Humanities and Social Science** **(Theory)**						
Course Code	**:**	**21IE6F9**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**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	**09 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
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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**
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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)		
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	MAXIMUM MARKS FOR THE CIE THEORY	**100**

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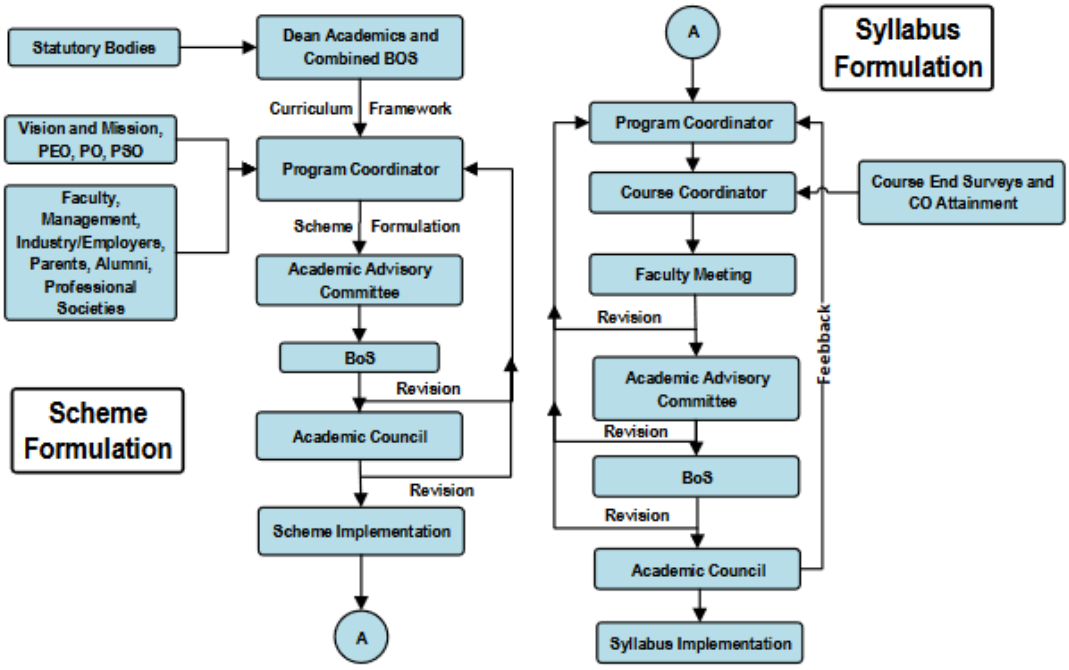
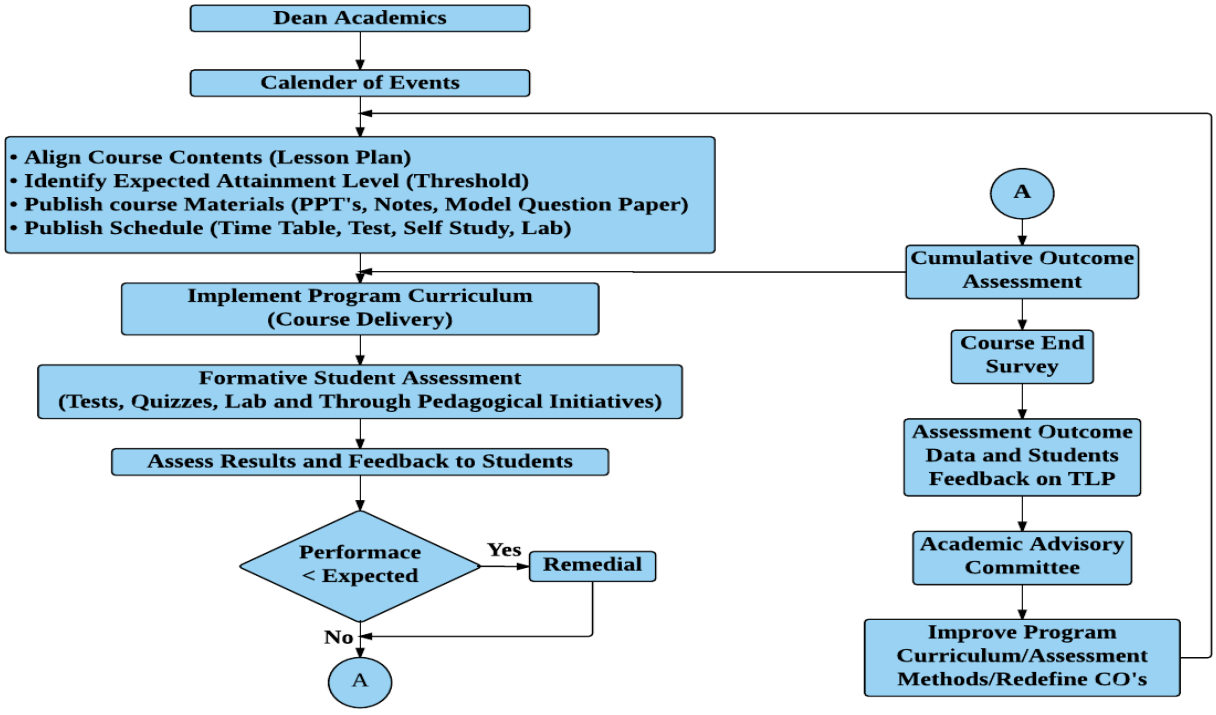
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

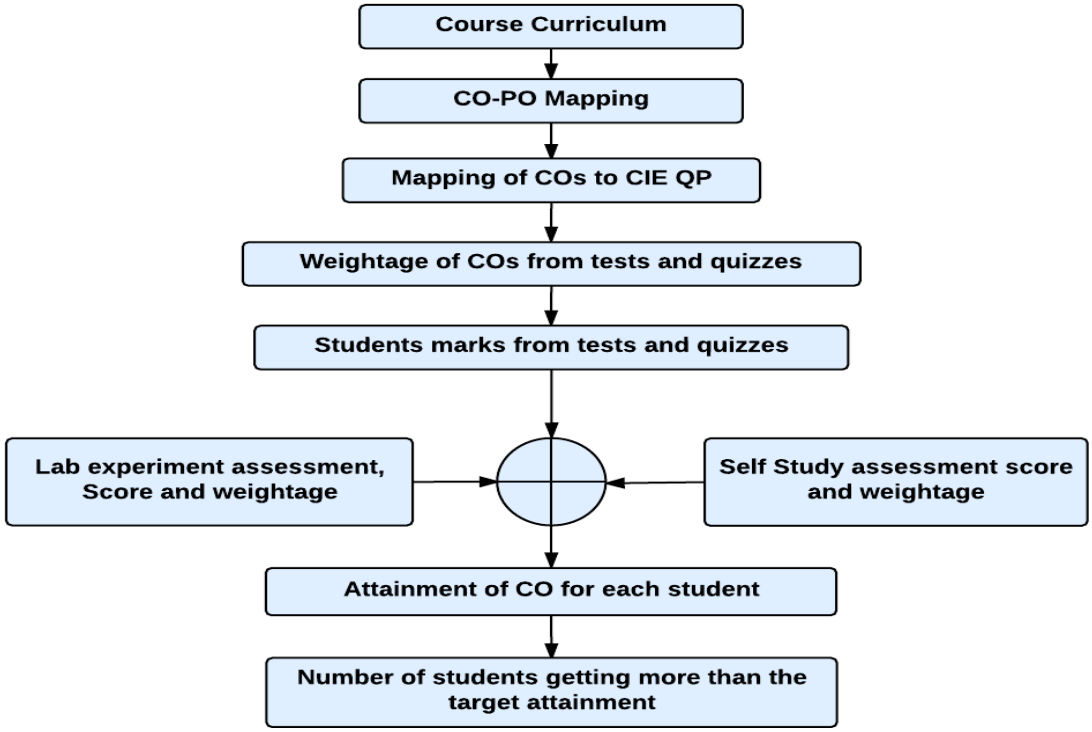
Curriculum Design Process



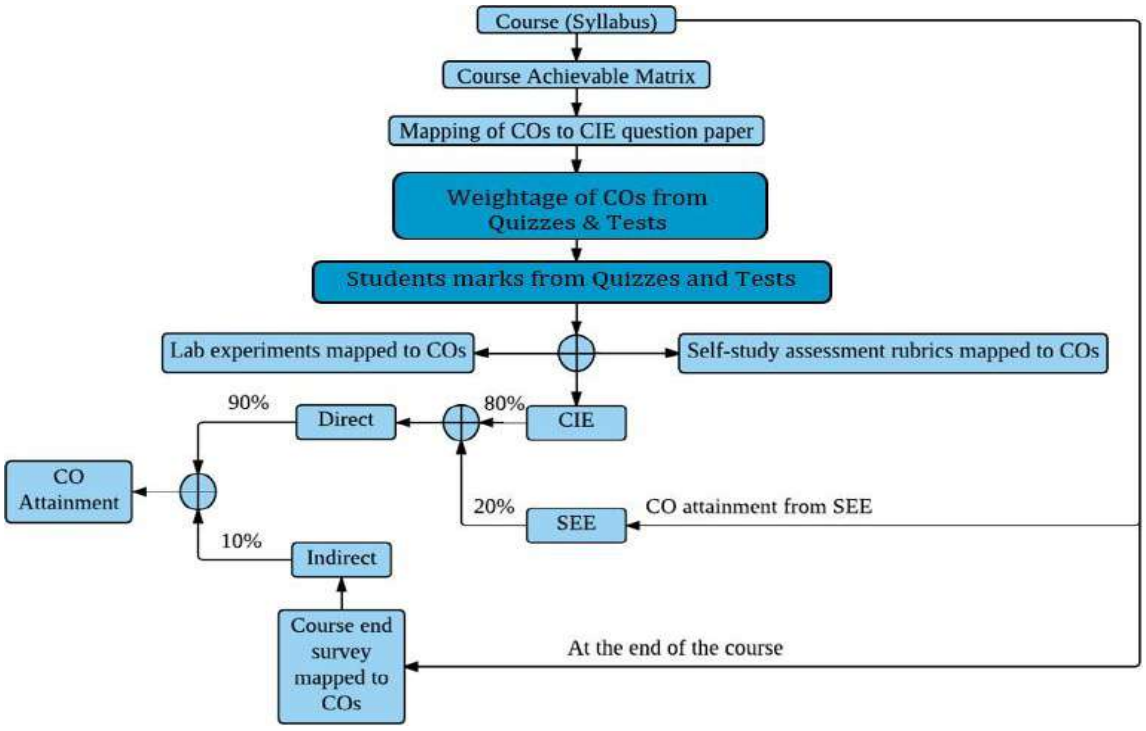
Academic Planning and Implementation



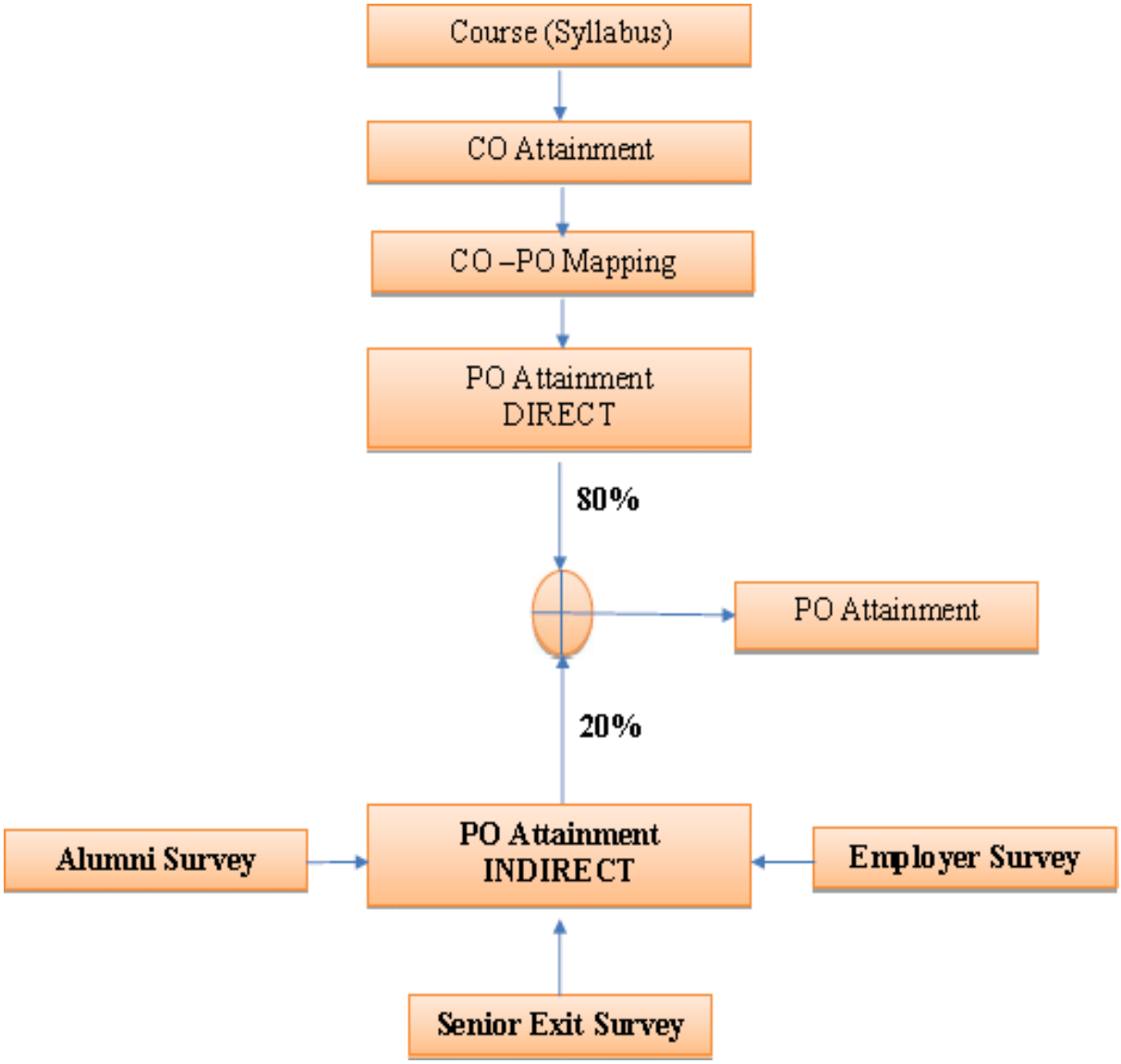
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcomes 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 anddesign 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 researchmethods including design of experiments, analysis and interpretation of data, and synthesis ofthe 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 assesssocietal, health, safety, legal, and cultural issues and the consequent responsibilities relevant tothe 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 needfor 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 leaderin diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member andleader 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.