RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)

R.V. Vidyaniketan Post, Mysore Road

Bengaluru – 560 059

Bachelor of Engineering (B.E.)
Scheme and Syllabus of V& VI Semesters

2018 SCHEME

TELECOMMUNICATION ENGINEERING

VISION

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

MISSION

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

QUALITY POLICY

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

CORE VALUES

Professionalism, Commitment, Integrity, Team Work, Innovation

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Bachelor of Engineering (B.E.)
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2018 SCHEME

DEPARTMENT OF
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, propagation models, networking of Wireless and Wire line communication 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.	PE	Professional 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

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RV COLLEGE OF ENGINEERING®, BENGALURU- 560059

(Autonomous Institution Affiliated to VTU, Belagavi)
TELECOMMUNICATION ENGINEERING

FIFTH SEMESTER CREDIT SCHEME							
Sl. No	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			**Total Credits**
				L	**T**	**P**	
1.	18HSI51	Intellectual Property Rights and Entrepreneurship	HSS	3	0	0	**3**
2.	18TE52	Digital Modulation & Coding (Theory & Practice)	TE	3	1	1	**5**
3.	18TE53	Digital Signal Processing (Common to TE, EE, EI) (Theory & Practice)	TE	3	0	1	**4**
4.	18TE54	Microwave Engineering	TE	3	0	0	**3**
5.	18TE55	Telecommunication Switching Systems	TE	3	0	0	**3**
6.	18TE5AX	Group A: Professional Electives (MOOC Courses)	TE	3	0	0	**3**
7.	18G5BXX	Group B: Global Electives	Respective BoS	3	0	0	**3**
Total Number of Credits				**21**	**1**	**2**	**24**
Total number of Hours/Week				**21**	**2**	**5**	**28**

GROUP A: PROFESSIONAL ELECTIVES (MOOC COURSES)			
Sl. No.	**Course Code**	**Course Title**	**Duration**
1.	18TE5A1	Introduction to Embedded System Design	12 Weeks
2.	18TE5A2	Semiconductor Devices and Circuits	12 Weeks
3.	18TE5A3	Control systems	12 Weeks
4.	18TE5A4	Computer architecture and organization	12 Weeks
5.	18CS5A5	The Joy of Computing using Python	12 Weeks

RV COLLEGE OF ENGINEERING®, BENGALURU- 560059

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TELECOMMUNICATION ENGINEERING

SIXTH SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			**Total Credits**
				L	**T**	**P**	
1.	18HEM61	Introduction to Management and Economics	HSS	3	0	0	**3**
2.	18TE62	Antenna & Propagation (Theory & Practice)	TE	4	0	1	**5**
3.	18TE63	Computer Communication Networks (Theory & Practice)	TE	3	0	1	**4**
4.	18TE64	Minor Project	TE	0	0	2	**2**
5.	18TE6CX	Group C (PE)	TE	3	0	0	**3**
6.	18TE6DX	Group D (PE)	TE	3	0	0	**3**
7.	18G6EXX	Group E (GE)	Respective BoS	3	0	0	**3**
8.	18HS68	Professional Practice-II Employability Skills and Professional Development of Engineers	HSS	0	0	1	**1**
Total Number of Credits				**19**	**0**	**5**	**24**
Total number of Hours/Week				**19**	**0**	**10+1**	**29+1**

GROUP C: PROFESSIONAL ELECTIVES			
Sl. No.	**Course Code**	**Course Title**	**Credits**
1.	18CS6C1	Internet of Things (Common to all Branches)	03 Credits
2.	18TE6C2	Image Processing & Computer Vision	03 Credits
3.	18TE6C3	DSP Applications	03 Credits
4.	18TE6C4	Operating Systems	03 Credits

GROUP D: PROFESSIONAL ELECTIVES			
Sl. No.	**Course Code**	**Course Title**	**Credits**
1.	18CS6D1	Machine Learning (Common to AE, BT, CH, CV, EE, EI, TE, IM, ME)	03 Credits
2.	18TE6D2	CMOS Digital Integrated circuits	03 Credits
3.	18EC6D3	Data Structures and Algorithms (Common to EC & TE)	03 Credits
4.	18TE6D4	JAVA	03 Credits

V Semester				
GROUP B: GLOBAL ELECTIVES				
Sl. No.	Dept	Course Code	Course Title	Credits
1	AS	18G5B01	Fundamentals of Aerospace Engineering	03
2	BT	18G5B02	Nanotechnology	03
3	CH	18G5B03	Fuel Cell Technology	03
4	CS	18G5B04	Intelligent Systems	03
5	CV	18G5B05	Remote Sensing and Geographic Information	03
6	EC	18G5B06	Automotive Electronics	03
7	EE	18G5B07	E-Mobility	03
8	EI	18G5B08	Smart Sensors & Instrumentation	03
9	IM	18G5B09	Operations Research	03
10	IS	18G5B10	Management Information Systems	03
11	ME	18G5B11	Automotive Mechatronics	03
12	TE	18G5B12	Telecommunication Systems	03
Courses offered by Science Department & HSS board				
13	PY	18G5B13	Quantum Mechanics of Hetero/Nano Structures	03
14	PY	18G5B14	Thin Films and Nanotechnology	03
15	CY	18G5B15	Advances in Corrosion Science and Technology	03
16	MA	18G5B16	Computational Advanced Numerical Methods	03
17	MA	18G5B17	Mathematics for Machine learning	03
18	HSS	18G5B18	Engineering Economy	03

VI Semester				
GROUP E: GLOBAL ELECTIVES				
Sl. No.	**Dept**	**Course Code**	**Course Title**	**Credits**
1	AS	18G6E01	Aircraft Systems	03
2	BT	18G6E02	Bioinspired Engineering	03
3	CH	18G6E03	Sustainable Technology	03
4	CS	18G6E04	Graph Theory	03
5	CV	18G6E05	Disaster Management	03
6	EC	18G6E06	Wearable Electronics	03
7	EE	18G6E07	Energy Auditing and Management	03
8	EI	18G6E08	Virtual Instrumentation & Applications	03
9	IM	18G6E09	Systems Engineering	03
10	IS	18G6E10	Introduction to Mobile Application Development	03
11	ME	18G6E11	Industrial Automation	03
12	TE	18G6E12	Mobile Network System & Standards	03
Courses offered by Science Department & HSS board				
13	PY	18G6E13	Thin film nanodevice fabrication technology	03
14	CY	18G6E14	Chemistry of advanced energy storage devices for	03
15	MA	18G6E15	Advanced Stastical Methods	03
16	MA	18G6E16	Mathematical Modelling	03
17	HSS	18G6E17	Foundation Course in Entrepreneurship	03

Semester						
INTELLECTUAL PROPERTY RIGHTS AND ENTREPRENEURSHIP (Theory)						
Course Code	**:**	**18HSI51**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hrs**

Course Learning Objectives: 1 The students will be able to

1	To build awareness on the various forms of IPR and to build the perspectives on the concepts and to develop the linkages in technology innovation and IPR.
2	To encourage innovation, invention and investment and disclosure of new Technology and to recognize and reward innovativeness
3	To motivate towards entrepreneurial careers and build strong foundations skills to enable starting, building and growing a viable as well as sustainable venture.
4	Develop an entrepreneurial outlook and mind set along with critical skills and knowledge to manage risks associated with entrepreneurs.

Unit-I	**08 Hrs**
Introduction: Types of Intellectual Property, WIPO. **Patents:** Introduction, Scope and salient features of patent; patentable and non-patentable inventions, Patent Procedure - Overview, Transfer of Patent Rights; Biotechnology patents, protection of traditional knowledge, Infringement of patents and remedy, Case studies. **Trade Secrets:** Definition, Significance, Tools to protect Trade secrets in India.	
Unit – II	**08 Hrs**
Trade Marks: Concept, function and different kinds and forms of Trade marks, Registrable and non-registrable marks. Registration of Trade Mark; Deceptive similarity; Transfer of Trade Mark, ECO Label, Passing off, Infringement of Trade Mark with Case studies and Remedies.	
Unit –III	**09 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. **Intellectual property and cyberspace:** Emergence of cyber-crime; Meaning and different types of cybercrime. Overview of Information Technology Act 2000 and IT Amendment Act 2008.	
Unit –IV	**07 Hrs**
Introduction to Entrepreneurship – Learn how entrepreneurship has changed the world. Identify six entrepreneurial myths and uncover the true facts. Explore E-cells on Campus. **Listen to Some Success Stories: -** Global legends Understand how ordinary people become successful global entrepreneurs, their journeys, their challenges, and their success stories. Understand how ordinary people from their own countries have become successful entrepreneurs. **Characteristics of a Successful Entrepreneur** Understand the entrepreneurial journey and learn the concept of different entrepreneurial styles. Identify your own entrepreneurship style based on your personality traits, strengths, and weaknesses. Learn about the 5M Model, each of the five entrepreneurial styles in the model, and how they differ from each other. **Communicate Effectively:** Learn how incorrect assumptions and limiting our opinions about people can negatively impact our communication. Identify the barriers which cause communication breakdown, such as miscommunication and poor listening, and learn how to overcome them. **Communication Best Practices.** Understand the importance of listening in communication and learn to listen actively. Learn a few body language cues such as eye contact and handshakes to strengthen communication. (Practical Application).	
Unit –V	**07Hrs**
Design Thinking for Customer Delight: - Understand Design Thinking as a problem-solving process. Describe the principles of Design Thinking. Describe the Design Thinking process. **Sales Skills to Become an Effective Entrepreneur: -** Understand what customer focus is and how all selling effort should be customer-centric. Use the skills/techniques of personal selling, Show and Tell,	

and Elevator Pitch to sell effectively. **Managing Risks and Learning from Failures: -** Identify risk-taking and resilience traits. Understand that risk-taking is a positive trait. Learn to cultivate risk-taking traits. (Practical Application) Appreciate the role of failure on the road to success, and understand when to give up. Learn about some entrepreneurs/risk-takers. (Practical Application). **Are You Ready to be an Entrepreneur: -** Let's ask "WHY" Give participants a real picture of the benefits and challenges of being an entrepreneur. Identify the reasons why people want to become entrepreneurs. Help participants identify why they would want to become entrepreneurs.

Reference Books	
1.	Law Relating to Intellectual Property, Wadehra B L,5th Edition, 2012, Universal Law Pub Co. Ltd.-Delhi, ISBN: 9789350350300
2.	Intellectual Property Rights: Unleashing Knowledge Economy, Prabuddha Ganguly, 1st Edition, 2001, Tata McGraw Hill Publishing Company Ltd., New Delhi, ISBN: 0074638602.
3.	Intellectual Property and the Internet, Rodney Ryder, 2002, Lexis Nexis U.K., ISBN: 8180380025, 9788180380020.
4.	Entrepreneurship, Rajeev Roy, 1st Edition, 2012, Oxford University Press, New Delhi, ISBN: 9780198072638.

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.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20. **50% weightage should be given to case studies. Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level. **50% weightage should be given to case studies.**

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**1**	**2**	**2**	**-**	**1**
CO2	**1**	**1**	**-**	**-**	**-**	**3**	**2**	**3**	**1**	**2**	**-**	**1**
CO3	**-**	**1**	**-**	**-**	**-**	**2**	**1**	**3**	**3**	**3**	**3**	**3**
CO4	**-**	**1**	**2**	**2**	**3**	**-**	**-**	**-**	**1**	**-**	**2**	**1**

High-3 : Medium-2 : Low-1

Semester: V						
DIGITAL MODULATION & CODING (Theory & Practice)						
Course Code	**:**	**18TE52**		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P	**:**	**3:1:1**		**SEE**	**:**	**100+50 Marks**
Total Hours	**:**	**40L+26T+33P**		**SEE**	**:**	**3.00+3.00 Hrs**

Course Learning Objectives: The students will be able to

1	Explain the principles of detection concepts in digital communication systems.
2	Compare different modulation techniques and its application.
3	Explain the various performance measures of Sources and Channels.
4	Implement different channel coding and decoding schemes.
5	Analyze various spread spectrum concepts and their applications.
6	Formulate simple communication systems with hardware/software and test the system.

UNIT-I **8 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, Numerical problems.

UNIT-II **10 Hrs**

Digital Modulation Techniques: Digital Modulation Formats, Coherent Binary Modulation Techniques, Coherent Quadrature-Modulation Techniques, Non-coherent Binary Modulation Techniques, Comparison of various modulation techniques, QAM techniques, Applications-Digital radio and voice grade modem, ISI, Nyquist criterion for distortion less base-band binary transmission, eye pattern, Numerical problems.

UNIT-III **10 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, Differential Entropy and Mutual Information, Channel Capacity theorem.

UNIT-IV **6 Hrs**

Error-Control Coding: Rationale for Coding and Types of Codes, Discrete Memoryless Channels, Linear Block Codes, Cyclic Codes, Convolution codes – Time domain and Transfer domain approaches.

UNIT-V **6 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 **The students are expected to simulate the following circuits/systems using LabVIEW or MATLAB tool.** 1. Digital Modulation Scheme – BPSK & QPSK generation and detection. 2. Quadrature Amplitude modulation – generation and detection. 3. Spread Spectrum systems – DSSS and FHSS. 4. Huffman Coding 5. Convolution Coding 6. Linear block code 7. To generate ASK/ FSK using Lab view / Matlab Simulink. **Part B** **The students are expected to implement the following circuits on hardware**. 1. Time Division Multiplexing. 2. Generation and Detection of ASK, FSK and BPSK signals. 3. Generation and Detection of Quadrature Phase Shift Keying & Differential Phase shift keying 4. Spread Spectrum –FHSS generation and Detection

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain basic principles of digital modulation techniques, Source coding and channel coding schemes and theorem.
CO2	Analyze & design various modulation and demodulation circuits and wide band modulation techniques with and without noise.
CO3	Apply Probability Theory, Random Variables, Random process knowledge in formulating and solving mathematical model for digital Communication system and Information Theory.
CO4	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, 4th Edition, 2006, John Wiley and Sons, ISBN: 9788126509041.
3	Sam Shanmugam, Digital and Analog Communications, John Wiley, 2003.
4	Lab VIEW Digital Signal Processing and Digital Communications, Cory L.Cork, 2005, Tata McGraw Hill, ISBN: 007060141.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.
Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks

SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	2	---	---	---	---	---	---	2	---	---
CO2	2	3	3	2	3	---	---	---	---	2	---	3
CO3	2	3	3	2	3	---	---	---	1	---	---	3
CO4	---	3	3	3	---	---	---	---	---	---	---	3

High-3: Medium-2: Low

Semester: V						
DIGITAL SIGNAL PROCESSING **(Theory & Practice)** **(Common to TE, EE & EI)**						
Course Code	**:**	**18TE53**		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100+50 Marks**
Total Hours	**:**	**40L+33P**		**SEE**	**:**	**3.00+3.00Hrs**

Course Learning Objectives: The students will be able to	
1	Explain signal processing operations, features of signal processors and applications of DSP.
2	Analyze the characteristics and representations of systems.
3	Design & implement analog and digital filters.
4	Realize various structures for discrete-time systems.

UNIT-I	**8 Hrs**

LTI Systems and Z Transforms: LTI Systems: Transfer Function, Causality and Stability, Inverse Systems and System Identification.
Realization of IIR systems: Direct form structures, Transposed structures, Cascade form and Parallel-Form Structures.

UNIT-II	**10 Hrs**

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	**8 Hrs**

FIR Filters: Characteristics of practical Frequency Selective Filters, Symmetric and anti-symmetric FIR Filters, Window functions: Rectangular, Hann, Hamming, Blackmann and Kaiser. Design of FIR Filters using Windows, Design of Linear phase FIR filters by frequency sampling method. **Realization of FIR filters**: Direct form, Linear Phase form, Cascade form and lattice form structures. Quantization of coefficients in FIR filters, Round-off effects in digital filters: Scaling to prevent overflow.

UNIT-IV	**7 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 Audio system, Speech Coding and Compression, Compact-Disc recording system, Interference cancellation in electrocardiography, DTMF generation and detection.

UNIT-V	**7 Hrs**

Multirate Digital Signal Processing: Introduction, Up sampling, Down sampling, Interpolation and Decimation. Sampling rate conversion (Reduction, Increase), Sampling rate change by non-integer factor, Multistage Decimation, Poly phase structures and implementation.

Laboratory Experiments
Part – A Simulation using MATLAB/SCILAB tool: 1) Computation of Circular, Linear Convolution, Correlation. 2) Study of multi rate operations. 3) Computation of DFT, IDFT. 4) Computation of Response of discrete-time systems. 5) Design of digital filters and study of response in time domain and frequency domain. **Part – B** Simulation using DSP hardware: 1) Implementation of various operations: DFT, Convolution and Correlation. 2) Design and implementation of various digital filters.

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 signals and systems; and perform various signal processing operations.
CO3	Design, implement and present analog & digital filters for required specifications.
CO4	Evaluate the digital signal processing systems using simulation tool and DSP processors.

Reference Books	
1	Digital Signal Processing, Proakis G, Dimitris G. Manolakis, 4th Edition, 2007, PHI, ISBN: 81-317-1000-9.
2	Digital Signal Processing – Fundamentals and Applications, Li Tan,2008, Elsevier, 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.

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks

SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	---	3	2	---	--	---	---	---	---	1
CO2	3	2	1	--	3	---	--	---	---	---	---	1
CO3	3	3	2	2	3	---	--	---	---	---	---	2
CO4	3	3	3	2	3	---	--	---	2	---	---	2

High-3: Medium-2: Low-1

Semester: V						
MICROWAVE ENGINEERING (Theory)						
Course Code	**:**	**18TE54**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**3.00 Hrs**

Course Learning Objectives: The students will be able to

1	Use the concept of Electromagnetic field theory and network analysis to analyze microwave transmission line and Waveguides.
2	Design an impedance matching circuit at microwave frequency using transmission lines.
3	Analyze the characteristics of Microwave passive devices, active devices and vacuum
4	Measure various network parameters used to analyze microwave networks.

Unit-I	**10 Hrs**

Introduction to Microwaves: Properties, Frequency bands, Application of Microwaves in Domestic, Industrial and Medical fields, Microwave Hazards.

Transmission lines: The Lumped- Element Circuit Model for a Transmission Line, Terminated Lossless Transmission Line, Slotted Line, Quarter Wave Transformer – The Impedance Viewpoint, Conjugate Matching, Low Loss Line, Distortionless Line, Terminated Lossy Line.

Planar transmission lines: Stripline, Microstripline, Coplanar waveguides line.

Unit – II	**8 Hrs**

S-Parameters: Review of S parameters and their properties and losses in microwave networks.

Basic Smith chart &Impedance Matching Smith Chart – Construction , Basic Smith Chart Operations ,Smith chart types-Impedance and Admittance Chart ,Single Stub Tuning- Shunt Stubs, Series Stubs (only smith chart solution) Matching – using Absorption and Resonance method(only Analytical solution).

Unit –III	**8Hrs**

High frequency lines-Waveguides: Rectangular Waveguide-TE &TM modes, Cut-off frequency derivation, Excitation of waveguides.

Microwave Vacuum Tube Devices: Working principle of Reflex Klystrons, Travelling Wave Tubes and Cylindrical Magnetron Construction, Operation (only Qualitative Discussion) and microwave performance.

Unit –IV	**7Hrs**

Microwave Passive Devices: Passive Devices: Waveguides- Attenuators, Magic Tee junctions, Ferrite Isolators, Ferrite Phase shifters, Circulators, Matched Load, two-hole directional couplers Basic Properties of Power dividers, Wilkinson power dividers, Hybrid couplers-Qualitative description with S-matrix.

Filters: Low pass filter design by Insertion loss method, Filter Transformations-Bandpass filter

Unit –V	**7 Hrs**

Active RF Components:Microwave Diode characteristics: SchottkyDiodes and Detectors, PIN diodes:- as a switch and phaseshifter.Gunn diode-Modes, construction and V-I Characteristics.

RF Transistor construction and characteristics: Bipolar junction transistors –BJT, HBT, Field effect transistors-MOSFET,MESFET,HEMT with their constructions and V-I characteristics, Introduction to Microwave Integrated Circuits-HMIC,MMIC.

Course Outcomes: After completing the course, the students will be able to

CO1	Define the circuit parameters for design of microwave subsystems using active and passive devices.
CO2	Identify and design the transmission line for a given application.
CO3	Apply Smith Chart for microwave network/circuit analysis
CO4	Compute microwave network/circuit parameters and Evaluate their performances.

Reference Books

1	Microwave Engineering, David M Pozar, 3rd Edition, 2011, John Wiley, ISBN-978-81-265-1049-8.
2	Microwave Engineering, Annapurna Das, Sisir K das, 2nd Edition reprint, 2011, Tata McGraw-Hill, ISBN -13:978-0-07-066738-9, ISBN – 10: -0-07-066738-1.
3	Microwave devices and circuits,SamuelYLiao, 3rd Edition, 2000, PHI, ISBN-81-203-0699-6.
4	Radio Frequency and Microwave Electronics, Mathew M. Radmanesh, 2001, Pearson Education Asia,ISBN-9780130279583.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.
Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	-	-	-	-	-	-	-	-	-	-	2
CO2	3	3	3	2	-	-	-	-	-	-	-	3
CO3	3	3	2	2	2	-	-	-	-	-	1	3
CO4	3	3	3	2	2	-	-	-	-	-	1	3

High-3: Medium-2: Low-1

Semester: V						
TELECOMMUNICATION SWITCHING SYSTEMS (Theory)						
Course Code	**:**	**18TE55**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40L**		**SEE**	**:**	**3.00 Hrs**

Course Learning Objectives: The students will be able to	
1	Understand the concept of switching over wired and wireless channels.
2	Explain switching, signaling, traffic and standards in telecommunication networks.
3	Analyze how a telecommunication network handles traffic.
4	Apply the concept of Grade of Service, Traffic and Grading in designing a multi-stage network.
5	Analyze the steps in call handling and call processing

UNIT-I	**7Hrs**
Introduction: The development of telecommunications, Network Structures, Network Services, Terminology, Regulation, Standards, ISO reference model for open systems interconnection **Evolution of Switching Systems:** Introduction, message switching, circuit switching, register-translator, senders and distribution frames.	
UNIT-II	**10Hrs**
Cross bar systems, need of trunking, electronic switching, reed-electronic systems, digital systems. **Telecommunication traffic:** Introduction, the unit of traffic, congestion, traffic measurement, a mathematical model, Lost-call systems, queuing systems, Numericals.	
UNIT-III	**10Hrs**
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.	
UNIT-IV	**7 Hrs**
Time- division switching: Introduction, Space and time switching, Time-division switching networks, Grades of service of time-division switching networks, Non-blocking networks,	
UNIT-V	**6Hrs**
Control of Switching Systems: Introduction, Call-processing functions, Common control, Reliability, availability and security, Stored-program control.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain fundamental concepts of switching for wired and wireless networks.
CO2	Analyze various functions related to call handling and call processing in Telecommunication Network.
CO3	Design Network models with respect to Grade of service and traffic capacity.
CO4	Evaluate the performance of various types of grading and link systems.

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

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.
Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	-	-	1	-	-	-	-		-	1
CO2	3	1	1	1	1	-	-	-	-		-	1
CO3	3	3	2	1	1	-	-	-	-		-	1
CO4	3	3	2	1	1	-	-	-	-		-	1

High-3: Medium-2: Low-1

Semester: V						
INTRODUCTION TO EMBEDDED SYSTEM DESIGN (GROUP-A: PROFESSIONAL ELECTIVES, MOOC COURSE)						
Course Code	**:**	**18TE5A1**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**Online Exam**

Course Learning Objectives: The students will be able to

1.	Describe the concepts and system components of embedded system.
2.	Interpret embedded system, general computing systems and the issues that arise in designing real-time systems.
3.	Illustrate the Design and Development of the Program model.
4.	Analyze the concepts of hardware debugging
5.	Evaluate and apply the concepts of RTOS, IPC's and Semaphores in real time embedded system

Unit – I	**7 Hrs**
Introduction to Embedded Systems and Computer Systems Terminology. Modular approach to Embedded System Design using Six-Box model: Input devices, output devices, embedded computer, communication block, host and storage elements and power supply. Microcontroller Based Embedded System Design. Salient Features of Modern Microcontrollers. Elements of Microcontroller Ecosystem and their significance.	
Unit – II	**9 Hrs**
Design of Power Supply for Embedded Systems. Linear Regulator Topologies. Switching Power Supply Topologies. Power Supply Design Considerations for Embedded Systems. Introduction to MSP430 Microcontroller. MSP430 CPU Architecture. Programming Methods for MSP430. Introduction to Lunchbox Platform. Fundamentals of Physical Interfacing. Connecting Input Devices:Switches, Keyboard and Output devices: LEDs, Seven Segment Displays(SSD). Assignment: MCQ/MSQ	
Unit – III	**9 Hrs**
Advanced Physical Interfacing: Driving load - high side, low side and H-bridge. Multiplexing displays including Charlieplexing. Shaft encoder. Programming the MSP430. Basics of version control system - Git. Installing and using Code Composer Studio(CCS). Introduction to Embedded C. Interfacing LEDs and Switches with MSP430 using Digital Input and Output. MSP430 Clock and Reset System. MSP430 Clock sources and distribution. Types of Reset sources. Handling Interrupts in MSP430. Writing efficient Interrupt	
Unit – IV	**7 Hrs**
Interfacing Seven Segment Displays and Liquid Crystal Displays with MSP430. Low Power Modes in MSP430. Introduction to MSP430 Timer Module and it's Modes of Operation. Generating Pulse Width Modulation (PWM) using Timer Capture Mode. ADC operation in MSP430. Interfacing analog inputs. Generating random numbers using LFSR and other methods. Adding DAC to MSP430. Custom Waveform generation using MSP430.	
Unit – V	**8 Hrs**
Timer Capture Modes. Measuring frequency and time period of external signals and events. Serial Communication Protocols: UART, SPI, I2C. Interfacing Universal Serial Communication Interface (USCI) Module of the MSP430 for UART Communication. Advanced Coding Exercises based on Interrupt driven Programming. Building an Electronics Project. Circuit Prototyping techniques. Designing Single Purpose Computers using Finite State Machine with Datapath (FSMD) approach. MSP430 Based Project Design and Implementation. Recap of Course Coverage.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify the concepts of system components to assemble small embedded systems.
CO2	Analyze the synchronization of system components in embedded systems.
CO3	Apply firmware Design and development tools for designing Embedded System.
CO4	Apply the key concepts of Real-Time Operating Systems in Embedded system design.

Reference Books	
1	Designing Embedded Hardware, John Catsoulis. 2nd edition, Shroff Publishers and Distributors. ISBN-10: 9788184042597.
2	Embedded System Design: A Unified Hardware / Software Introduction, Tony Givargis and Frank Vahid, Wiley. ISBN-10: 812650837X.
3	Operating Systems Internals and Design Principles, William Stallings, 7th Edition, 2012, Pearson, Prentice Hall, ISBN: 978-0132309981.
4	MSP430 Microcontroller Basics, John H. Davies, Elsevier, ISBN-10: 9789380501857.
5	Programming Embedded Systems in C and C++, Micheal Barr, Shroff Publishers and Distributors. ISBN-10: 817366076X

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	---	---	---	---	---	---	1	---	---	---
CO2	3	1	---	---	---	---	---	---	1	---	---	---
CO3	3	3	3	2	2	---	---	---	2	---	---	2
CO4	3	3	3	2	2	---	---	---	2	---	---	2

High-3: Medium-2: Low-1

Semester: V						
SEMICONDUCTOR DEVICES AND CIRCUITS (GROUP-A: PROFESSIONAL ELECTIVE, MOOC COURSE)						
Course Code	**:**	**18TE5A2**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**Online Exam**

Course Learning Objectives: The students will be able to

1	Design and characterize differential amplifiers using BJT and MOSFET.
2	Define the structure of MOS transistors and explain geometrical effects of a MOSFET.
3	Analyze design steps involved in digital design and explain the need for low power in IC design.
4	Analyze the design issues of VLSI-ICs.

Unit – I	**7 Hrs**
Excursion in Quantum Mechanics, Excursion in Solid State Physics.	
Unit – II	**9 Hrs**
Density of States, Fermi Function and Doping, Recombination-Generation, Charge Transport and Continuity Equation, Metal-Semiconductor (MS) Junctions.	
Unit – III	**9 Hrs**
PN Junctions, Bipolar Junction Transistors (BJT), Metal Oxide Semiconductor Capacitors (MOSCAP) and CV Characteristics.	
Unit – IV	**8 Hrs**
Metal Oxide Semiconductor Field Effect Transistors (MOSFET), MOSFET Continued.	
Unit – V	**7 Hrs**
Connections: Circuit Design to Device Physics, Thin Film Transistors.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the fundamentals of semiconductor physics in MOS transistors
CO2	Analyze the characteristics of MOS transistors.
CO3	Evaluate the performance of various MOS transistors in the IC design.
CO4	Design various VLSI sub systems.

Reference Books	
1	Prof. Manish Jain, Physics, IISc Solid State Physics and Quantum Mechanics) Prof. Navakant Bhat, CENSE, IISc (Device Physics) Optional Reviewers Dr.Kaushik Mazumdar, ECE, IISc Prof. Venkatraman, Physics, IISc.
2	Solid State Electronic Devices, Ben Streetman and Sanjay Banerjee, Prentice Hall.
3	Introduction to Semiconductor Materials and Devices, M. S. Tyagi, Wiley Publications.
4	Robert L Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, Prentice Hall India publication, 10th Edition, 2009, ISBN: 978-317-2700-3.
5	D P Kothari,I J Nagrath, Basic Electronics, MCGraw Higher Ed, 2nd Edition, ISBN: 9789352606467.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	1	---	---	---	---	1	---	2	---	1
CO2	2	2	2	---	---	---	---	1	---	2	---	1
CO3	3	3	3	---	---	---	---	1	---	2	---	2
CO4	3	3	3	---	---	---	---	1	---	2	---	3

High-3: Medium-2: Low-1

Semester: V						
CONTROL SYSTEMS (GROUP-A: PROFESSIONAL ELECTIVE, MOOC COURSE)						
Course Code	**:**	**18TE5A3**		**CIE Marks**	**:**	**100**
Credits: L:T:P	:	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	:	**40L**		**SEE Duration**	**:**	**Online Exam**

Course Learning Objectives: The students will be able to

1.	Learn the fundamental concepts of Control Systems.
2.	Analyze the Time Response and Frequency response of control systems using conventional approach.
3.	Perform stability analysis of control systems
4.	Design a Stabilized Control system using Classical Methods.

Unit – I	**8 Hrs**
Introduction to Control, Classification of Dynamic Systems, Closed Loop Control System with Feedback, Mathematical Preliminaries – Complex Variables, Laplace Transform, Standard Inputs, Free and Forced Response, Transfer Function, Poles and Zeros.	
Unit – II	**8 Hrs**
Response to various Inputs, Effect of Poles, Notion of Bounded Input Bounded Output (BIBO) stability, Effect of Zeros, Closed Loop Transfer Function, Dynamic Performance Specification, First Order.	
Unit – III	**8 Hrs**
Second Order Systems, Unit Step Response of Underdamped Second Order Systems, Concepts of Rise Time, Peak Time, Maximum Peak Overshoot and Settling Time. Controllers – Proportional (P), Integral (I) and Derivative (D) Blocks, Examples of PID controller.	
Unit – IV	**8 Hrs**
Routh's Stability Criterion, Use in Control Design, Incorporation of Performance Specifications in Controller Design, Analysis of Steady State Errors. Root Locus and its Application in Control Design, Frequency Response, Bode Plots, Nyquist Plots.	
Unit – V	**8 Hrs**
Nyquist Stability Criterion, Relative Stability – Gain and Phase Margins. Control System Design via Frequency Response – Lead, Lag and Lag-Lead Compensation, Case Studies.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Model the Feedback Control Systems in Integro-Differential Equations and generalize using Block Diagram and Signal flow graph methods.
CO2	Analyze the first and second order system for stability due to various input test signals.
CO3	Describe the stability of the control systems by Classical Methods.
CO4	Evaluate the Dynamic Behavior of Control System using State Space Models.

References	
1	Modern Control Engineering, Katsuhiko Ogata, Prentice Hall.
2	Feedback Control of Dynamic Systems, Gene Franklin,J.D. Powell,and Abbas Emami-Naeini Prentice Hall.
3	Automatic Control Systems, Benjamin C. Kuo, Prentice Hall.
4	System Dynamics and Control, Eronini I. Umez-Eronini, Thomson Engineering.
5	MATLAB Tutorials.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	---	1	2	---	---	---	---	---	---	---	---
CO2	3	---	1	2	---	---	---	---	---	---	---	---
CO3	3	2	2	1	2	---	---	---	---	---	---	---
CO4	3	2	3	2	2	---	---	---	---	---	---	---

High-3: Medium-2: Low-1

Semester: V						
COMPUTER ARCHITECTURE AND ORGANIZATION (GROUP-A: PROFESSIONAL ELECTIVE, MOOC COURSE)						
Course Code	**:**	**18TE5A4**		**CIE Marks**	**:**	**100**
Credits: L:T:P	:	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	:	**40L**		**SEE Duration**	**:**	**Online Exam**
Course Learning Objectives: The students will be able to						
1	Understand the functions of major components and their organization in a computer.					
2	Analyze the various processors, Memory and bus architectures.					
3	Analyze the algorithms for computational units.					
4	Choose an architecture and associated components for a given application.					

Unit – I	**8 Hrs**
Evolution of Computer Systems, Instruction Set Architecture.	
Unit – II	**8 Hrs**
Quantitative Principles of Computer Design, Control Unit Design, Memory System Design.	
Unit – III	**8 Hrs**
Design of Cache Memory Systems, Design of Arithmetic Unit, Design of Arithmetic Unit (contd.)	
Unit – IV	**8 Hrs**
Input-Output System Design, Input-Output System Design (contd.)	
Unit – V	**8 Hrs**
Instruction Set Pipelining, Parallel Processing Architectures	

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the basic architecture and operational concepts involved in computer system design.
CO2	Identify the memory and bus structure requirements for a given system design.
CO3	Design Memory of a computer & ALU by applying fast computation algorithms.
CO4	Choose the appropriate processor for a particular application.

Reference Books	
1.	Computer Architecture: A Quantitative Approach, D.A. Patterson and J.L. Hennessy, 5/E", Morgan Koffman, 2011.
2.	Computer Organization and Design: The Hardware/Software Interface, D.A. Patterson and J.L. Hennessy, 5/E", Elsevier India, 2016.
3.	Computer Organization and Architecture: Designing for Performance, W. Stallings, Pearson, 2015.
4	Computer Organization, C. Hamacher, Z. Vranesic and S. Zaky, 5/E", McGraw Hill, 2011.
5	Computer Architecture and Organization, J.P. Hayes, 3/E", McGraw Hill, 1998.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	1	---	---	---	---	1	---	2	---	1
CO2	2	2	2	---	---	---	---	1	---	2	---	1
CO3	3	3	3	---	---	---	---	1	---	2	---	2
CO4	3	3	3	---	---	---	---	1	---	2	---	3

High-3: Medium-2: Low-1

Semester: V						
THE JOY OF COMPUTING USING PYTHON (GROUP-A: PROFESSIONAL ELECTIVE, MOOC COURSE)						
Course Code	**:**	**18CS5A5**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**Online Exam**

Course Learning Objectives: The students will be able to

1	Understand why Python is a useful scripting language for developers.
2	Learn how to use lists, tuples, and dictionaries in Python programs.
3	Define the structure and components of a Python program.
4	Develop cost-effective robust applications using the latest Python trends and technologies

Unit – I	**8 Hrs**
Motivation for Computing, Welcome to Programming!!,Variables and Expressions : Design your own calculator, Loops and Conditionals : Hopscotch once again. Lists, Tuples and Conditionals : Let's go on a trip, Abstraction Everywhere : Apps in your phone.	
Unit – II	**8 Hrs**
Counting Candies : Crowd to the rescue, Birthday Paradox : Find your twin, Google Translate : Speak in any Language, Currency Converter : Count your foreign trip expenses.	
Unit – III	**8 Hrs**
Monte Hall : 3 doors and a twist, Sorting : Arrange the books, Searching : Find in seconds, Substitution Cipher : What's the secret !!,Sentiment Analysis : Analyse your Facebook dataPermutations : Jumbled Words,Spot the similarities : Dobble game.	
Unit – IV	**8 Hrs**
Count the words : Hundreds, Thousands or Millions, Rock, Paper and Scissor : Cheating not allowed !!, Lie detector : No lies, only TRUTH , Calculation of the Area : Don't measure, Six degrees of separation, Image Processing : Fun with images.	
Unit – V	**7 Hrs**
Tic tac toe : Let's play, Snakes and Ladders : Down the memory lane, Recursion : Tower of Hanoi, Page Rank : How Google Works !!.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explore and apply the concept of python to solve real world problems.
CO2	Design Classes and establish relationships among Classes for various applications from problem definition.
CO3	Develop applications using google translator and gaming application.
CO4	Implement real time application such as browser automation, NLP, Image processing etc using python

Reference Books:	
1.	Head First Python, Paul Barry,10th Edition,2016, O'Reilly , ISBN 978-9352134823.
2.	Python Cookbook: Recipes for Mastering Python 3,David Beazley, Brian K. Jones, 9th Edition, 2017, O'Reilly, ISBN 978-1449340377.
3.	Python: The Complete Reference,Martin C Brown,7th Edition,2018,McGraw Hill Education, ISBN 978-9387572942.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	1	1	-	-	1	-	-	-	2
CO2	3	3	2	1	1	-	-	1	-	-	-	2
CO3	3	3	3	2	1	-	-	2	-	-	-	2
CO4	3	3	3	2	1	-	-	2	-	-	-	2

High-3: Medium-2: Low-1

Semester: V						
FUNDAMENTALS OF AEROSPACE ENGINEERING **(GROUP B: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G5B01**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:

1	Understand the history and basic principles of aviation
2	Demonstrate and explain foundation of flight, aircraft structures, material, aircraft propulsion
3	Comprehend the importance of all the systems and subsystems incorporated on an air vehicle
4	Appraise the significance of all the subsystems in achieving a successful flight

Unit-I	**08 Hrs**
Introduction to Aircraft: History of aviation, International Standard atmosphere, Atmosphere and its properties, Temperature, pressure and altitude relationships, Classification of aircrafts, Anatomy of an aircraft & Helicopters, Basic components and their functions, Simple Problems on Standard Atmospheric Properties.	
Unit – II	**08 Hrs**
Basics of Aerodynamics: Bernoulli's theorem, Centre of pressure, Lift and drag, Types of drag, Aerodynamic Coefficients, Aerodynamic centre, Wing Planform Geometry, Airfoil nomenclature, Basic Aerodynamic characteristics of airfoil, NACA nomenclature, Simple problems on lift and drag.	
Unit -III	**07 Hrs**
Aircraft Propulsion: Introduction, Classification of power plants, Gas Turbine Engine: Brayton Cycle, Principle of operation of turbojet, turboprop, turbofan engines, ramjet and scramjet engines, Comparative merits and demerits of different types Engines.	
Unit -IV	**09 Hrs**
Introduction to Space Flight: The upper atmosphere, Introduction to basic orbital mechanics, Kepler's Laws of planetary motion, Orbit equation, and Space vehicle trajectories**.** **Rocket Propulsion:** Principles of operation of rocket engines, Rocket Equation, Types of rockets: Solid, Liquid and Hybrid Propellant Rockets, Rocket Performance parameters: Thrust, Specific Impulse, Exhaust Velocity, Simple Problems on rocket performance.	
Unit -V	**07 Hrs**
Aerospace Structures and Materials: Introduction, General types of construction, Monocoque, Semi-Monocoque and Geodesic structures, Structure of Wing and Fuselage and its basic construction.	

Course Outcomes: At the end of this course the student will be able to:

CO1:	Appreciate and apply the basic principles of aviation
CO2:	Apply the concepts of fundaments of flight, basics of aircraft structures, aircraft propulsion and aircraft materials during the development of an aircraft
CO3:	Comprehend the complexities involved during development of flight vehicles.
CO4:	Evaluate and criticize the design strategy involved in the development of airplanes

Reference Books

1	Introduction to Flight, John D. Anderson, 7th Edition, 2011, McGraw-Hill Education, ISBN 9780071086059.
2	Rocket Propulsion Elements, Sutton G.P., 8th Edition, 2011, John Wiley, New York, ISBN: 1118174208, 9781118174203.

3	Fundamentals of Compressible Flow, Yahya, S.M, 5th Edition, 2016, New Age International, ISBN: 8122440223
4	Aircraft structural Analysis, T.H.G Megson, 2010, Butterworth-Heinemann Publications, ISBN: 978-1-85617-932-4

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	3	2	2	-	-	-	1
CO2	2	2	2	3	2	1	1	1	-	-	-	1
CO3	1	-	3	3	-	-	-	-	-	-	-	1
CO4	2	2	3	3	-	2	2	2	-	-	-	1

High-3: Medium-2: Low-1

Semester: V						
NANOTECHNOLOGY **(GROUP B: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G5B02**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the basic knowledge of nanomaterials and the process to synthesize and characterize the nanoparticles.
2	Learn about Nano sensors and their applications in mechanical, electrical, electronic, magnetic, chemical fields.
3	Apply the concept of nanotechnology in sensing, transducing and actuating mechanism.
4	Design the nanoscale products used in multidisciplinary fields.

Unit-I	**08 Hrs**
Introduction to Nanomaterials: History of Nanotechnology, structures and properties of carbon based, metal based, bio-nanomaterails and hybrids: Bucky Ball, Nanotubes, Diamond like carbon(DLC), Quantum Dots, Nano Shells, Dendrimers, Nanocarriers, Nanocrystals, hybrid biological/inorganic, protein & DNA based nanostructures. Nanosafety Issues: Toxicology health effects caused by nanoparticles.	
Unit – II	**09 Hrs**
Nano Synthesis and Fabrication: Introduction & overview of Nanofabrication: Bottom up and Top down approaches using processes like Ball milling, Sol-gel Process, and Chemical Vapour deposition (CVD), electrodeposition and various lithography techniques (Hard & Soft lithography). **Characterization of Nanostructures:** Spectroscopy - UV-Visible spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR), Raman Spectroscopy, X-ray spectroscopy. Electron Microscopy - Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM). Scanning Probe Microscopy - Atomic Force microscopy (AFM), Scanning Tunnel Microscopy (STM).	
Unit –III	**08 Hrs**
Nanosensors: Overview of nanosensors, prospects and market. Types of Nanosensors and their applications. Electromagnetic nanosensors: Electronic nose and electronic tongue, Magnetic nanosensors. Mechanical nanosensors: Cantilever Nanosensors, Mechanics of CNTs, Biosensors: Biosensors in modern medicine.	
Unit –IV	**07 Hrs**
Micro & Nano-Electromechanical systems and Microfluidics: MEMS/NEMS: Magnetic, Chemical and Mechanical Transducers –Sensing and Actuators. Microfluidics: Laminar flow, Hagen-Peouiselle equation, basic fluid ideas, Special considerations of flow in small channels, mixing, microvalves & micropumps.	
Unit –V	**07 Hrs**
Applications of Nanotechnology: Molecular electronics, molecular switches, mechanical cutting tools, machine components, magnets, DLC coated grinding wheels. Electrical, electronic, solar cells, Batteries, fuel cells, Nanofilters. Medical nanotechnology: in Diagnostics, Therapeutics, Drug delivery and Nanosurgery. Nano in Agriculture- nanopesticides, nanofertilizers etc.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the structures of nano materials and their properties.
CO2:	Apply the various synthesis and fabrication methods and interpret the characterization results.
CO3:	Analyze the working mechanism of nanosensors and transducers and Apply its knowledge in various fields.
CO4:	Create and evaluate nano Design, Devices and Systems in various disciplines.

Reference Books	
1	B.S. Murty., P. Shankar., B.Raj, B..B. Rath, and J. Murday, Textbook of Nanosciences and Nanotechnology, Springer, Co-publication with University Press (India) Pvt. Ltd. VCH, XII.1st Edition, 2013, ISBN- 978-3-642-28030-6.
2	V. K. Khanna, Nanosensors: Physical, Chemical and Biological, CRC press, 1st Edition, 2013, ISBN 9781439827123 (Unit III).
3	C. C. Kock., Nanostructured materials, Nanostructured materials, William Andrew Publishing, 2nd Edition, 2007, ISBN 0-8155-1534-0.
4	M. Wilson., K. Kannangara., G.Smith., M.Simmons., B. Raguse., Nanotechnology, , overseas Press (India) Private Ltd.,1st Edition, 2005,ISBN 81-88689-20-3.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.
Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	3	2	3	3	-	-	1	2	-
CO2	3	3	3	2	3	3	2	-	2	-	-	-
CO3	3	2	2	2	2	1	1	-	-	-	1	-
CO4	1	2	3	3	3	2	1	-	-	2	-	-

High-3: Medium-2: Low-1

Semester: V						
FUEL CELL TECHNOLOGY **(GROUP B: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G5B03**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Recall the concept of fuel cells
2	Distinguish various types of fuel cells and their functionalities
3	Know the applications of fuel cells in various domains
4	Understand the characterization of fuel cells

Unit-I	**07 Hrs**
Introduction – I: Fuel cell definition, historical developments, working principle of fuel cell, components of fuel cell, EMF of the cell, Fuel Cell Reactions, fuels for cells and their properties	
Unit – II	**07 Hrs**
Types of fuel cells – II: Classification of fuel cells, alkaline fuel cell, polymer electrolyte fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, advantages and disadvantages of each	
Unit –III	**07 Hrs**
Efficiencies, losses and kinetics– III: Intrinsic maximum efficiency, voltaic efficiency, faradaic efficiency, overall efficiency, activation losses, fuel crossover and internal current, ohmic losses, mass transport/concentration losses, and activation/electrode/reaction kinetics	
Unit –IV	**08 Hrs**
Fuel Cell Characteristics – IV: In-situ characterization: I-V curve, current – voltage measurement, current interrupt measurement, cyclic voltammetry, electrochemical impedance spectroscopy Ex-situ characterization techniques: Proton conductivity, flexural strength, electrical conductivity, electrochemical surface area and electrochemical activity	
Unit –V	**10 Hrs**
Applications of fuel cells – V: Applications of fuel cells in air, road and rail transport, hydrogen storage, handling and safety issues. Production and storage of hydrogen	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the fundamentals and characteristics of fuel cells
CO2:	Apply chemical engineering principles to distinguish fuel cells from conventional energy systems
CO3:	Analyze the performance of fuel cells using different characterization techniques
CO4:	Evaluate the possibility of integrating fuel cell systems with conventional energy systems

Reference Books	
1	Fuel Cells – Principles and Applications, Viswanathan and M Aulice Scibioh, 1st Edition, 2009, Universities Press, ISBN – 13: 978 1420 060287
2	Fuel Cell Systems Explained, James Larminie and Andrew Dicks, 2nd Edition, 2003, John Wiley & Sons, ISBN – 978 0470 848579

3	Fuel Cell Fundamentals, O 'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, 1st Edition, 2006, Wiley, New York, ISBN – 978 0470 258439
4	Recent Trends in Fuel Cell Science and Technology, Basu. S, 1st Edition, 2007, Springer, ISBN – 978 0387 688152

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	-	-	-	-	-	1	-	1	-	-	-
CO2	2	-	2	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	3	-	2	-	-	-
CO4	-	2	2	-	-	-	2	-	3	-	-	2

High-3: Medium-2: Low-1

Semester: V						
INTELLIGENT SYSTEMS **(GROUP B: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G5B04**		**CIE Marks**	**:**	**100 Marks**
Credits: L:T:P	:	**3:0:0**		**SEE Marks**	**:**	**100 Marks**
Total Hours	:	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1.	Understand fundamental AI concepts and current issues.
2.	Understand and apply a range of AI techniques including search, logic-based reasoning, neural networks and reasoning with uncertain information.
3.	Recognize computational problems suited to an intelligent system solution.
4.	Identify and list the basic issues of knowledge representation, blind and heuristic search.

Unit – I	**07 Hrs**
Introduction: The Foundations of Artificial Intelligence, History of Artificial Intelligence, The State of the Art, **Intelligent Agent:** Introduction, How Agents Should Act, Structure of Intelligent Agents, **Problem-solving**: Solving Problems by Searching Search Strategies, Avoiding Repeated States, Avoiding Repeated States	
Unit – II	**08 Hrs**
Informed Search Methods: Best-First Search, Heuristic Functions, Memory Bounded Search, Iterative Improvement Algorithms **Game Playing:** Introduction: Games as Search Problems, Perfect Decisions in Two-Person, Games Imperfect Decisions, Alpha-Beta Pruning, Games That Include an Element of Chance	
Unit – III	**08 Hrs**
Knowledge Inference Knowledge representation -Production based system, Frame based system. Inference - Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning - Certainty factors, Bayes Rule, Uncertainty Principles, Bayesian Theory-Bayesian Network-Dempster - Shafer theory.	
Unit – IV	**08 Hrs**
Learning from Observations: A General Model of Learning Agents, Inductive Learning, Learning Decision Trees, Using Information Theory, Learning General Logical Descriptions, Why Learning Works: Computational Learning Theory **Reinforcement Learning:** Passive Learning in a Known Environment, Passive Learning in an Unknown Environment, Active Learning in an Unknown Environment	
Unit – V	**08 Hrs**
Expert Systems, Components, Production rules, Statistical reasoning, certainty factors, measure of belief and disbelief, Meta level knowledge, Introspection. Expert systems - Architecture of expert systems, Roles of expert systems - Knowledge Acquisition –Meta knowledge, Heuristics. Typical expert systems - MYCIN, DART, XOON, Expert systems shells.	

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Understand and explore the basic concepts and challenges of Artificial Intelligence.
CO 2:	Analyze and explain basic intelligent system algorithms to solve problems.
CO 3:	Apply Artificial Intelligence and various logic-based techniques in real world problems.
CO 4:	Assess their applicability by comparing different Intelligent System techniques

Reference Books:	
1.	AI – A Modern Approach, Stuart Russel, Peter Norvig, 3rd Edition, 2010, Pearson Education, ISBN-13: 978-0-13-604259-4
2.	Artificial Intelligence (SIE), Kevin Night, Elaine Rich, Nair B., 3rd Edition, 2008, McGraw Hill, ISBN: 9780070087705
3.	Introduction to AI and ES, Dan W. Patterson, Pearson Education, 3rd Edition, 2007, ISBN-13: 978-0134771007
4.	Introduction to Expert Systems, Peter Jackson, 4th Edition, Pearson Education, 2007, ISBN-13: 978-8131709337

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	2	2	1	2	-	2	2
CO2	3	3	3	3	3	2	2	1	2	-	2	2
CO3	3	3	3	3	3	2	1	1	2	-	2	2
CO4	3	3	3	3	3	1	2	1	1	1	2	2

High-3: Medium-2: Low-1

Semester: V						
REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM **(GROUP B: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G5B05**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand concept of using photographic data to determine relative positions of points.
2	Study the methods of collection of land data using Terrestrial and Aerial camera.
3	Analyze the data gathered from various sensors and interpret for various applications.
4	Apply the principles of RS, GIS and GPS in various scopes of Civil Engineering.

Unit-I	**07 Hrs**
Remote Sensing- Definition, types of remote sensing, components of remote sensing, electromagnetic spectrum, Black body, Atmospheric windows, energy interaction with earth surface features. Spectral reflectance curve. Platforms and sensors. Sensor resolutions. Types of satellites- Indian and other remote sensing satellites (IRS, IKONS and Landsat). Principle of visual interpretation - key elements.	
Unit – II	**08 Hrs**
Photogrammetry: Introduction types of Photogrammetry, Advantages Photogrammetry, Introduction to digital Photogrammetry. **Aerial Photogrammetry:** Advantages over ground survey methods- geometry of vertical photographs, scales of vertical photograph. Ground coordination- relief displacement, scale ground coordinates – flight planning.	
Unit –III	**08 Hrs**
Geographic Information System- Introduction, Functions and advantages, sources of data for GIS. Database – Types, advantages and disadvantages. Data Analysis.-overlay operations, network analysis, spatial analysis. Outputs and map generation. **GPS**- components and working principles.	
Unit –IV	**08 Hrs**
Applications of GIS, Remote Sensing and GPS: Water Resources engineering and management (prioritization of river basins, water perspective zones and its mapping), Highway and transportation (highway alignment, Optimization of routes, accident analysis), Environmental Engineering (Geo-statistical analysis of water quality, rainfall).	
Unit –V	**08 Hrs**
Applications of GIS, Remote Sensing and GPS: Urban Planning & Management, urban sprawl, Change detection studies, forests and urban area, agriculture, Disaster Management. Layouts: Dead end, Radial, Grid iron, Circular system.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand and remember the principle of Remote Sensing (RS) and Geographical Information Systems (GIS) data acquisition and its applications.
CO2:	Apply RS and GIS technologies in various fields of engineering and social needs

CO3:	Analyze and evaluate the information obtained by applying RS and GIS technologies.
CO4:	Create a feasible solution in the different fields of application of RS and GIS

Reference Books	
1	Geographic Information System-An Introduction, Tor Bernharadsen, 2009, 3rd Edition, Wiley India Pvt. Ltd. New Delhi, ISBN - 9788126511389.
2	Principles of Remote sensing and Image Interpretation, Lillesand and Kiefer, 2011, 6th Edition, John Wiley Publishers, New Delhi, ISBN – 8126532238.
3	Higher Surveying, Chandra A.M, 2015, 3rd Edition, New age international (P) Ltd, ISBN: 8122438121
4	Remote Sensing, Robert A. Schowengerdt, 2009, 3rd Edition, Elsevier India Pvt Ltd, New Delhi.
5	Remote Sensing and GIS, Bhatta B, 2011, Oxford University Press, New Delhi, ISBN - 0198072392

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	-	-	-	-	1	-	-	-	-	-	-
CO2	2	1	-	-	1	1	-	-	-	-	-	-
CO3	2	2	1	-	2	1	1	-	-	-	-	1
CO4	2	2	1	-	3	2	2	-	-	-	1	1

High-3: Medium-2: Low-1

Semester: V						
AUTOMOTIVE ELECTRONICS (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B06**		**CIE Marks**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100 Marks**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Acquire the knowledge of automotive domain fundamentals, need of Electronics and communication interfaces in Automotive systems.
2	Apply various types of sensors, actuators and Motion Control techniques in Automotive systems
3	Understand digital engine control systems and Embedded Software's and ECU's used in automotive systems.
4	Analyse the concepts of Diagnostics, safety and advances in Automotive electronic Systems.

UNIT-I	**08 Hrs**

Fundamentals of Automotive: Evolution and Use of Electronics in Automotive, Automotive Systems, The Engine, Engine Control, Internal Combustion Engines, Spark Ignition Engines and Alternative Engines. Ignition System, Ignition Timing, Drivetrain, Suspensions, Brakes and Steering Systems.

Basics of electronic engine control: Motivation for Electronic Engine Control, Concept of an Electronic Engine control system, Definition of General terms, Definition of Engine performance terms, Engine mapping, Effect of Air/Fuel ratio, spark timing and EGR on performance, Control Strategy, Electronic Fuel control system, Analysis of intake manifold pressure, Electronic Ignition.

UNIT-II	**07 Hrs**

Automotive Sensors and Actuators:

Automotive Control System Applications of Sensors and Actuators,

Sensors: Air Flow Sensor, Engine Crankshaft Angular Position Sensor, Throttle Angle Sensor, Temperature Sensor, Sensors for Feedback Control, Sensors for Driver Assistance System: Radar, Lidar, Video Technology.

Actuators: Solenoids, Piezo Electric Force Generators, Fluid mechanical Actuators**,** Electric Motors and Switches.

UNIT-III	**08 Hrs**

Digital Engine Control Systems: Digital Engine control features, Control modes for fuel Control (Seven Modes), EGR Control, Electronic Ignition Control - Closed Loop Ignition timing, Spark Advance Correction Scheme, Integrated Engine Control System.

Vehicle Motion Control: Typical Cruise Control System, Digital Cruise Control System, Digital Speed Sensor, Throttle Actuator, Digital Cruise Control configuration, Cruise Control Electronics (Digital only), Antilock Brake System (ABS), Electronic Suspension System, Electronic Steering Control.

UNIT-IV	**08 Hrs**

Automotive Communication Systems:

Automotive networking: Bus systems, Technical principles, network topology. Buses in motor vehicles: CAN, Flex Ray, LIN, Ethernet, IP, PSI5, MOST, D2B and DSI.

Automotive Embedded Software Development

Fundamentals of Software and software development lifecycles. Overview of AUTOSAR methodology and principles of AUTOSAR Architecture.

UNIT-V	08 Hrs
Diagnostics and Safety in Automotive: Timing Light, Engine Analyzer, Electronic Control System Diagnostics: Onboard diagnostics, Off-board diagnostics, Expert Systems, Occupant Protection Systems – Accelerometer based Air Bag systems, Case study on ON-BOARD, OFF-BOARD diagnostics. **Advances in Automotive Electronic Systems:** Alternative Fuel Engines, Electric and Hybrid vehicles, Fuel cell powered cars, Collision Avoidance Radar warning Systems, Navigation: Navigation Sensors, Radio Navigation, dead reckoning navigation, Video based driver assistance systems, Night vision Systems.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Acquire the knowledge of automotive domain fundamentals, need of Electronics and communication interfaces in Automotive systems.
CO2:	Apply various types of sensors, actuators and Motion Control techniques in Automotive systems
CO3:	Analyze digital engine control systems and Embedded Software's and ECU's used in automotive systems.
CO4:	Illustrate the concepts of Diagnostics, safety and advances in Automotive electronic Systems.

Reference Books	
1.	Understanding Automotive Electronics, Williams. B. Ribbens, 6th Edition, 2003, Elsevier science, Newness publication, ISBN-9780080481494.
2.	Automotive Electronics Handbook, Robert Bosch, 2004, John Wiley and Sons, ISBN-0471288357
3.	Automobile Electrical and Electronic Systems, Tom Denton, 3rd Edition, Elsevier Butterworth-Heinemann. ISBN 0-7506-62190.
4.	Advanced Automotive Fault Diagnosis, Tom Denton, 2nd Edition, Elsevier Butterworth-Heinemann. ISBN 0-75-066991-8.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**1**	**2**	**1**	**-**	**1**
CO2	**3**	**2**	**1**	**1**	**1**	**-**	**1**	**1**	**1**	**1**	**-**	**1**
CO3	**3**	**2**	**2**	**2**	**1**	**-**	**1**	**1**	**2**	**1**	**-**	**1**
CO4	**3**	**2**	**2**	**2**	**-**	**1**	**2**	**1**	**1**	**1**	**-**	**1**

High-3: Medium-2 : Low-1

Semester: V						
e- MOBILITY **(GROUP B: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G5B07**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the basics of electric and hybrid electric vehicles, their architecture and modelling.
2	Explain different energy storage technologies used for electric vehicles and their management system.
3	Describe various electric drives and its integration with Power electronic circuits suitable for electric vehicles.
4	Design EV Simulator through performance evaluation and system optimization techniques and need for the charging infrastructure.

Unit-I	**06 Hrs**
Electromobility and the Environment: A Brief History of the Electric Powertrain, Energy Sources for Propulsion and Emissions, The Advent of Regulations, Drive Cycles, BEV Fuel Consumption, Range, and mpge, Carbon Emissions for Conventional and Electric Powertrains, An Overview of Conventional, Battery, Hybrid, and Fuel Cell Electric Systems, A Comparison of Automotive and Other Transportation Technologies. **Vehicle Dynamics:** Vehicle Load Forces, Vehicle Acceleration, Simple Drive Cycle for Vehicle Comparisons	
Unit – II	**09 Hrs**
Batteries: Batteries Types and Battery Pack, Lifetime and Sizing Considerations, Battery Charging, Protection, and Management Systems, Battery Models, Determining the Cell/Pack Voltage for a Given Output\Input Power, Cell Energy and Discharge Rate. **Battery Charging:** Basic Requirements for Charging System, Charger Architectures, Grid Voltages, Frequencies, and Wiring, Charging Standards and Technologies, SAE J1772, Wireless Charging, The Boost Converter for Power Factor Correction.	
Unit -III	**10 Hrs**
Battery Management System: BMS Definition, Li-Ion Cells, Li-Ion BMSs, Li-Ion Batteries, BMS Options: Functionality, CCCV Chargers, Regulators, Balancers, Protectors, Functionality Comparison, Technology, Topology. **BMS Functions:** Measurement: Voltage, Temperature, Current, Management: Protection, Thermal Management, Balancing, Distributed Charging, Evaluation, External Communication: Dedicated analog and digital wires.	
Unit –IV	**07 Hrs**
Electric Drivetrain: Overview of Electric Machines, classification of electric machines used in automobile drivetrains, modelling of electric machines, Power Electronics, controlling electric machines, electric machine and power electronics integration Constraints.	
Unit –V	**07 Hrs**
EV Simulation: system level simulation, EV simulator, simulator modules, performance evaluation, system optimization. **EV Infrastructure:** Domestic charging infrastructure, Public charging infrastructure, Standardization and regulations, Impacts on power system.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and modelling.
CO2:	Discuss and implement different energy storage technologies used for electric vehicles and their management system.
CO3:	Analyze various electric drives and its integration techniques with Power electronic circuits suitable for electric vehicles.
CO4:	Design EV Simulator for performance evaluation and system optimization and understand the requirement for suitable EV infrastructure.

Reference Books	
1	Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, 1st Edition, 2018, Wiley, *ISBN* 9781119063667.
2	Battery Management system for large Lithium Battery Packs, Davide Andrea, 1st Edition, 2010, ARTECH HOUSE, ISBN-13 978-1-60807-104-3
3	Hybrid Vehicles from Components to System, F. BADIN, Ed, 1st Edition, 2013, Editions Technip, Paris, *ISBN 978-2-7108-0994-4.*
4	Modern Electric Vehicle Technology C.C. Chan and K.T. Chau, 1st Edition, 2001, Oxford university press, ISBN 0 19 850416 0.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	2	2	2	3	-	2	-	-	1
CO2	3	3	3	3	3	3	3	-	2	2	1	-
CO3	2	3	3	3	3	2	3	-	2	1	1	-
CO4	3	3	3	3	3	2	3	2	2	-	1	-

High-3: Medium-2: Low-1

Semester: V						
SMART SENSORS & INSTRUMENTATION (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B08**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the fundamentals of transducers and sensors.
2	Demonstrate the working principles of different transducers and sensors.
3	Apply the principles of different type of sensors and transducers on state of art problems.
4	Create a system using appropriate transducers and sensors for a particular application.

Unit-I	**07 Hrs**
Introduction: Definition of a transducer, Block Diagram, Classification of Transducers, Advantages of Electrical transducers. **Resistive Transducers:** **Potentiometers:** Characteristics, Loading effect, and problems. **Strain gauge:** Theory, Types, applications and problems. **Thermistor, RTD:** Theory, applications and problems.	
Unit – II	**09 Hrs**
Thermocouple: Measurement of thermocouple output, compensating circuits, lead compensation, advantages and disadvantages of thermocouple. **LVDT:** Principle, Characteristics, Practical applications and problems. **Capacitive Transducers:** Capacitive transducers using change in area of plates, distance between plates and change of dielectric constants, Applications of Capacitive Transducers and problems	
Unit –III	**09 Hrs**
Piezo-electric Transducers: Principles of operation, expression for output voltage, Piezo-electric materials, equivalent circuit, loading effect, Frequency response and Problems. **Special Transducers:** Hall effect transducers, Thin film sensors, and smart transducers: Principles and applications, Introduction to MEMS Sensors and Nano Sensors, Schematic of the design of sensor, applications.	
Unit –IV	**07 Hrs**
Chemical sensors: pH value sensor, dissolved oxygen sensor, oxidation-reduction potential sensor, Zirconium probe Sensors, Chem FET sensors. **Photo sensors**: Photo resistor, Photodiode, Phototransistor, Photo-FET, Charge coupled device. **Tactile sensors:** Construction and operation, types.	
Unit –V	**07 Hrs**
Humidity Sensors and Moisture Sensors: Concept of humidity, Electrical Conductivity Sensors, Thermal Conductivity Sensors, Optical Hygrometer, Oscillating Hygrometer. **IR Sensors:** Golay cells, Thermopile, pyroelectric sensor, bolometers, Active Far-Infrared Sensors, Gas flame detectors	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the basic principles of different transducers and sensors.
CO2:	Apply the knowledge of transducers and sensors to comprehend digital instrumentation systems.
CO3:	Analyze and evaluate the performance of different transducers and sensors for various applications.
CO4:	Create a system using appropriate transducers and sensors for a particular application.

Reference Books	
1	Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, 4th Edition 2008, PHI Publication, ISBN: 978-1-4419-6465-6.
2	Clarence W.de Silva, Sensors and Actuators: Control systems Instrumentation, 2013 Edition, CRC Press, ISBN: 978-1-4200-4483-6.
3	A.K. Sawhney, Electrical and Electronic Measurements and Instrumentation, 18th Edition, 2008, Dhanpat Rai and Sons, ISBN: 81-7700-016-0.
4	Transducers and Instrumentation, D.V.S. Murthy, 2nd Edition 2008, PHI Publication, ISBN: 978-81-203-3569-1.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.
Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks are executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	2	2	-	-	-	-	-	-
CO3	1	2	2	-	1	1	-	-	-	-	-	2
CO4	-	-	-	-	1	1	-	-	-	3	-	1

High-3: Medium-2: Low-1

Semester: V						
OPERATIONS RESEARCH (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B09**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Develop the skills in the application of operations research models for complex decision-making situations.
2	Implement the methodology and tools of operations research to assist decision-making.

UNIT-I	**07 Hrs**
Introduction: OR methodology, Definition of OR, Application of OR to Engineering and Managerial problems, Features of OR models, Limitations of OR. **Linear Programming:**Definition, Mathematical Formulation, Standard Form, Solution Space, Types of solution - Basic Feasible, Degenerate, Solution through Graphical Method. Usage of software tools to demonstrate LPP (demonstrations and assignments only)	
UNIT-II	**10Hrs**
Simplex Method & Sensitivity Analysis: Simplex methods, Artificial Stating Solution - M Method & Two phase method, Sensitivity Analysis - Graphical sensitivity analysis, Algebraic sensitivity analysis. Interpretation of graphical output from software packages such as MS Excel	
UNIT-III	**10 Hrs**
Transportation Problem: Formulation of transportation model, Basic feasible solution using different methods, Optimality Methods, Unbalanced transportation problem, Degeneracy in transportation problems, Variants in Transportation Problems, Applications of Transportation problems. **Assignment Problem:** Formulation of the Assignment problem, Solution method of assignment problem-Hungarian Method, Solution method of assignment problem-Hungarian Method, Variants in assignment problem, Traveling Salesman Problem. Usage of software tools to demonstrate Transportation and Assignment problems	
UNIT-IV	**06 Hrs**
Project Management Using Network Analysis: Network construction, Determination of critical path and duration, floats, CPM - Elements of crashing, Usage of software tools to demonstrate N/W flow problems	
UNIT-V	**06 Hrs**
Game Theory: Introduction, Two person Zero Sum game, Pure strategies – Games with saddle point, Graphical Method, The rules of dominance, solution method of games without saddle point, Arithmetic method.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the basic concepts of different models of operations research and their applications.
CO2:	Build and solve Transportation Models and Assignment Models.
CO3:	Design new simple models, like: CPM, MSPT to improve decision –making and develop critical thinking and objective analysis of decision problems.
CO4:	

Reference Books	
1	Operation Research an Introduction, Taha H A, 8th Edition, 2004, PHI, ISBN:0130488089.
2	Operations Research: Principles and Practice, Ravindran, Phillips, Solberg, 2nd Edition, 2007, John Wiley & Sons, ISBN: 8126512563
3	Introduction to Operation Research, Hiller and Liberman, 8th Edition, 2004, Tata McGraw Hill, ISBN: 0073017795.
4	Operations Research Theory and Application, J K Sharma,2nd Edition, 2003, Pearson Education Pvt Ltd, ISBN: 0333-92394-4.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	-	3	2	2	-	-	-	1	-	-	1
CO2	-	2	-	-	-	-	-	-	-	1	-	1
CO3	2	-	-	2	2	-	-	1	-	-	-	-
CO4												

High-3: Medium-2: Low-1

Semester: V						
MANAGEMENT INFORMATION SYSTEMS (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B10**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	To understand the basic principles and working of information technology.
2	Describe the role of information technology and information systems in business.
3	To contrast and compare how internet and other information technologies support business processes.
4	To give an overall perspective of the importance of application of internet technologies in business administration.

Unit-I	**08 Hrs**
Information systems in Global Business Today: The role of information systems in business today, Perspectives on information systems, Contemporary approaches to information systems, Hands-on MIS projects. **Global E-Business and Collaboration**: Business process and information systems, Types of business information systems, Systems for collaboration and team work, The information systems function in business. A Case study on E business.	
Unit – II	**08 Hrs**
Information Systems, Organizations and Strategy: Organizations and information systems, How information systems impact organization and business firms, Using information systems to gain competitive advantage, management issues, **Ethical and Social issues in Information Systems**: Understanding ethical and Social issues related to Information Systems, Ethics in an information society, The moral dimensions of information society. A Case study on business planning.	
Unit –III	**08 Hrs**
IT Infrastructure and Emerging Technologies: IT infrastructure, Infrastructure components, Contemporary hardware platform trends, Contemporary software platform trends, Management issues**. Securing Information Systems**: System vulnerability and abuse, Business value of security and control, Establishing framework for security and control, Technology and tools for protecting information resources. A case study on cybercrime.	
Unit –IV	**08 Hrs**
Achieving Operational Excellence and Customer Intimacy: Enterprise systems, Supply chain management (SCM) systems, Customer relationship management (CRM) systems, Enterprise application. **E-commerce: Digital Markets Digital Goods**: E-commerce and the internet, E-commerce-business and technology, The mobile digital platform and mobile E-commerce, Building and E-commerce web site. A Case study on ERP.	
Unit –V	**07 Hrs**
Managing Knowledge: The knowledge management landscape, Enterprise-wide knowledge management system, Knowledge work systems, Intelligent techniques. **Enhancing Decision Making**: Decision making and information systems, Business intelligence in the enterprise. Business intelligence constituencies. **Building Information Systems**: Systems as planned organizational change, Overview of systems development.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand and apply the fundamental concepts of information systems.
CO2:	Develop the knowledge about management of information systems.
CO3:	Interpret and recommend the use information technology to solve business problems.
CO4:	Apply a framework and process for aligning organization's IT objectives with business strategy.

Reference Books	
1	Kenneth C. Laudon and Jane P. Laudon: Management Information System, Managing the Digital Firm, Pearson Education, 14th Global edition, 2016, ISBN:9781292094007.
2	James A. O' Brien, George M. Marakas: Management Information Systems, Global McGraw Hill, 10th Edition, 2011, ISBN: 978-0072823110.
3	Steven Alter: Information Systems, The Foundation of E-Business, Pearson Education, 4th Edition, 2002, ISBN:978-0130617736.
4	W.S. Jawadekar: Management Information Systems, Tata McGraw Hill, 2006, ISBN: 9780070616349.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	1	-	1
CO2	3	3	-	-	-	-	-	-	-	1	-	1
CO3	3	3	1	-	2	-	-	-	-	1	-	1
CO4	3	3	2	1	2	-	-	-	-	1	-	1

High-3: Medium-2: Low-1

V Semester						
AUTOMOTIVE MECHATRONICS (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B11**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Identify various Mechatronics systems of a modern automobile
2	Describe how the proper quantity/grade of fuel affects engine performance.
3	Understand Bharat-VI / EURO-VI emission norms
4	Apply the knowledge of engineering and science to analyse the performance of Mechatronics system
5	Analyse vehicle sub-systems comprising of sensors and actuators

Unit-I	**06 Hrs**
Automobile Engines Classifications of Internal Combustion Engines**.** Engine nomenclature and mechanics. Mixture formation and direct fuel injection – homogeneous and stratified injection. Thermodynamic principles of Otto and Diesel cycle. Operation, characteristics and energy yield in a 4-stroke engine. Fuels: Gasoline, Diesel, LPG and Natural Gas for automotive applications. Fuel properties- Octane number and Cetane number.	
Unit-II	**10 Hrs**
Engine Auxiliary Systems: Air Intake and Exhaust System (Bharat Stage –VI norms) **-** Intake manifold, Turbocharger, Intercooler, Exhaust manifold, 3-way and oxidation catalytic convertor, Exhaust Gas Recirculation system. **Common Rail Fuel Injection system**- Low pressure and high-pressure fuel systems, Return line, Quantity control valve, Injectors – solenoid and piezo injectors.	
Unit-III	**10 Hrs**
Vehicular Auxiliary Systems: Vehicle frame and body classification- Hatchback, Sedan, SUV, Coupe, Roadster. Adaptive Brakes - Disc and drum brakes, Antilock Braking Systems, ESP, TCS. Wheels and Tyres- Toe-In, Toe-Out, Caster and Camber angle. Classification of tyres, Radial, Tubeless. **Supplemental Restraint System**: Active and passive safety, Vehicle structure, Gas generator and air bags, Belt Tensioner, Acceleration sensor, Rollover sensor, Seat occupancy recognition.	
Unit-IV	**07 Hrs**
Principles of motor vehicle electronics – Basic structure of control units, Functions of control units and On-Board Diagnostic kit. **Telematics in vehicles** – Radio Transmission, Interference and signal processing. Lubrication and cooling system- Components, working principle, Properties, Viscosity.	
Unit-V	**06 Hrs**
Sensors: Oxygen sensors, Crankshaft Angular Position Sensor, Manifold Absolute Pressure Sensor, Coolant Temperature Sensor, Hot Film Mass Air flow Sensor, Throttle Position Sensor.	

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

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

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Experiential Learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30 (Q) + 50 (T) + 20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	2	1	2	1	-	-	1	2	3	-	-
CO2	2	1	2	1	3	-	-	2	2	3	-	-
CO3	1	2	2	1	2	-	-	2	2	3	-	-
CO4	1	2	2	1	2	-	-	2	2	1	-	1

High-3: Medium-2: Low-1

Semester: V						
TELECOMMUNICATION SYSTEMS (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B12**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Represent schematic of communication system and identify its components.
2	Classify satellite orbits and sub-systems for communication.
3	Analyze different telecommunication services, systems and principles.
4	Explain the role of optical communication system and its components.
5	Describe the features of wireless technologies and standards

UNIT-I	**06 Hrs**
Introduction to Electronic Communication: The Significance of Human Communication, Communication Systems, Types of Electronic Communication, Modulation and Multiplexing, Electromagnetic Spectrum, Bandwidth, A Survey of Communication Applications. **The Fundamentals of Electronics:** Gain, Attenuation, and Decibels. **Radio Receivers:** Super heterodyne receiver.	
UNIT-II	**10 Hrs**
Modulation Schemes: Analog Modulation: AM, FM and PM- brief review. **Digital Modulation:** PCM, Line Codes, ASK, FSK, PSK. **Wideband Modulation:** Spread spectrum, FHSS, DSSS. **Multiple Access**: FDMA, TDMA, CDMA.	
UNIT-III	**09 Hrs**
Satellite Communication: Satellite Orbits, Satellite Communication Systems, Satellite Subsystems, Ground Stations, Satellite Applications, Global Positioning System.	
UNIT-IV	**07 Hrs**
Optical Communication: Optical Principles, Optical Communication Systems, Fiber-Optic Cables, Optical Transmitters and Receivers, Wavelength-Division Multiplexing, Passive Optical Networks.	
UNIT-V	**07 Hrs**
Cell Phone Technologies: Cellular concepts, Frequency allocation, Frequency reuse, Internet Telephony, The Advanced Mobile Phone System [AMPS]. **Wireless Technologies:** Wireless LAN, PANs and Bluetooth, ZigBee and Mesh Wireless Networks.	

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

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

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	-	1	1	-	-	-	1	-	-	-
CO2	2	1	-	1	1	-	-	-	1	-	-	-
CO3	2	1	-	1	1	-	-	-	2	-	-	-
CO4	1	1	-	1	1	1	-	-	1	-	-	-

High-3: Medium-2: Low-1

Semester: V						
QUANTUM MECHANICS OF HETERO/NANO STRUCTURES (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B13**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the role of Quantum mechanics in physical processes as we reduce dimensions.
2	Explain the design and performance of low dimensional semiconductors and their modelling.
3	Understand the differences observed in transport properties of low dimensional materials.
4	Apply the role of heterostructures in devices
5	Acquire the knowledge to design and develop smart devices and sensors that runs on the quantum technology.

Unit-I	**08 Hrs**
Review of Quantum Mechanics and Solid state Physics: Wave particle duality, Heisenberg's Uncertainty Principle, group velocity, Time independent and dependent Schrodinger Equation and its application, Perturbation theory, Fermi's Golden Rule. Free electron and Fermi gas model of solids, Density of states and its dependence on dimensionality, Bloch theorem in periodic structures, Dynamics of electrons and holes in bands, Effective mass, distinct regimes of conduction and the important parameters characterising it.	
Unit – II	**08 Hrs**
Basics of semiconductors and lower dimensions: Intrinsic and extrinsic semiconductors, electron and hole concentration. Mobility, Energy Diffusion, Continuity equations. Carrier life-times and Diffusion length. Degenerate semiconductors. Optical processes of semi-conductors, inter-band and intra-band process. Quantum wells of nanostructures of different geometries-Square, Parabolic, Triangular and their solutions, Quantum Dots, wires and wells (From 0-Dim to 3 Dim). Strained Layers and its effect on bands. Band structure/energy levels in Quantum Wells and Excitonic effects in them.	
Unit –III	**08 Hrs**
Quantum Nano structures and Quantum Transport: Architecture and working of n-channel MOSFET, metal – semiconductor contact(interface) in details, Homo-junction, Hetero-junction, Hetero-structures. Modulation and strain doped Quantum Wells. Super Lattice: Kronig Penney Model of a super-lattice, Tight Binding Approximation of a super lattice. The genesis of Quantum Transport: Parallel transport : scattering mechanism, experimental data(focus will be on GaAs), hot electrons. Perpendicular transport: Resonant tunneling. Electric field effect in super lattices: Stark effect.	
Unit –IV	**08 Hrs**
Transport in Nano-structures in electric and magnetic fields: Quantized conductance: Landauer Buttiker transmission formalism, Application of formalism to explain quantized conductance of devices like quantum point contacts. Aharonov-Bohm effect in gold rings and other systems. Violation of Kirchhoff's circuit laws for quantum conductors. Coulomb Blockade. Density of States of a 2D system in a magnetic field. Landau quantization of electrons in a magnetic field. Shubnikov-de Haas effect. Quantum Hall Effect-integer and quantum.	
Unit –V	**07 Hrs**
Applications in Opto-electronics and Spintronics: Lasers and photodetectors on quantum wells and quantum dots, High-mobility transistors, Ballistic-	

transport devices, Single-electron transistors**,** Optical properties of Quantum Wells and Superlattices, Quantum Dots and Nano crystals. Quantum confined Stark effect, Stark ladders, Bloch oscillations. Spintronics, transport of spin, spin valve, Giant Maneto-resistance, Spin Injection (Johnson-Silsbee experiments).

Course Outcomes: After completing the course, the students will be able to	
CO1:	After successful completion of the course the student will be able to identify the different domains of application of the concepts of Quantum mechanics in Nano structures, super-lattices and Photonics.
CO2:	The student will gain knowledge to understand the crucial physics layers and principles that are at the core of nano and meso technology.
CO3:	The student will be able to apply the concepts to solve problems (quantitative and qualitative)
CO4:	The student can apply the concepts in an interdisciplinary manner and can create new ideas and products related to appliances and sensors, that use the said concepts.

Reference Books	
1	The Physics of Low Dimensional Semiconductors an introduction, John H Davies, xxx Edition, 1998, Cambridge University Press, ISBN: 0-521-48491-X (pbk).
2	Introduction to Quantum Mechanics, David J Griffiths & Darrell F. Schroeter, 3rd Edition, 2018, Cambridge University Press, ISBN: 978-1107189638
3	Nanotechnology for Microelectronics and Optoelectronics, J.M. Martinez-Duert, R.J. Martin Palma and F. Agullo-Rueda, 1st Edition, 2006, Elsevier Press, ISBN: 9780080456959
4	Electronic Transport in Mesoscopic Systems, Supriyo Datta, 1st Edition,1997, Cambridge University Press ISBN: 9780521599436
5	Semiconductor Optoelectronic devices, Pallab Bhattacharya, 2nd Edition, 1996, Prentice Hall of India, ISBN: 978-0134956565
6	Semiconductor Devices, Physics and Technology, S. M. Sze, 2nd Edition, 2008, Wiley Student Edition, ISBN: 978-8126516810

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Experiential Learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	2	1	3	2	2	-	-	-	1
CO2	3	3	3	2	1	2	1	1	-	-	-	1
CO3	3	3	3	2	1	1	1	1	-	-	-	1
CO4	1	2	1	2	1	2	2	1	2	2	-	1

High-3: Medium-2: Low-1

Semester: V						
THIN FILMS AND NANOTECHNOLOGY (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B14**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the basics of thin films structure and property.
2	Acquire the knowledge of thin film preparation by various techniques and their characterization methods.
3	Apply the knowledge to select the most potential methods to produce thin films for wanted applications.
4	Asses typical thin film applications.

Unit-I	**08 Hrs**

Nanostructures and Nanomaterials:

Types of nanostructures and properties of nanomaterials: Introduction, Three dimensional, Two dimensional, One dimensional, Zero-dimensional nano-structured materials. Carbon Nano Tubes (CNT), Quantum Dots, shell structures, Multilayer thin films and super lattice clusters. Synthesis through Sol gel and Spray Pyrolysis. Mechanical-physical-chemical properties. Current trends and challenges of nanoscience and nanotechnology.

Unit – II	**08 Hrs**

Thin Film Preparation Methods:

Vacuum technology- Basics of Vacuum pumps and vacuum measurements, **Physical Vapour Deposition (PVD) Techniques:** Evaporation - Thermal evaporation, Electron beam evaporation, and Cathode arc deposition. **Sputtering:** DC sputtering, RF Sputtering, Magnetron sputtering, and Ion beam sputtering.

Unit –III	**08 Hrs**

Surface Preparation and Growth of Thin Films:

Nucleation – theoretical and experimental aspects. Surface preparation & Engineering for Thin film growth: Cleaning, Modification, Masking & Patterning, Base Coats and Top Coats. Thin Film growth: Sequence of thin film growth, Defects and impurities, Effect of Deposition Parameters on film growth. Properties of Thin Films: Adhesion, Thickness, Surface, Physical, Chemical and Mechanical.

Unit –IV	**08 Hrs**

Characterization of Thin Film Properties:

Film thickness measurement: Quartz crystal thickness monitor and Stylus Profiler methods. Surface morphology and topography by SEM, AFM. Film composition by X-ray Photoelectron Spectroscopy; Electrical characterization by Hall effect measurement, Four probe analyzer. Optical characterization – Ellipsometry, Raman Spectroscopy. Dielectric and Mechanical properties characterization.

Unit –V	**07 Hrs**

Thin Film Applications:

Band gap Engineering through thin films for electrical and optical applications. Thin Film for energy applications - coating on solar cells, fuel cells, batteries and super capacitors. Thin film thermo electric materials for thermal sensor applications. Thin film coating as protective coating for optical surfaces and as anti-reflection. Thin Film drug delivery and antibacterial surfaces - opportunities and challenges

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the basic mechanism of surface modification and thin film growth.
CO2:	Attain strong hold on thin film preparation by various techniques and their characterization methods.
CO3:	Apply the knowledge to select the most potential methods to produce thin films for wanted applications.
CO4:	Detailed knowledge of thin film selection for various applications.

Reference Books	
1	Thin Film Phenomenon, K.L.Chopra, 1st edition, 1969, McGraw-Hill ISBN-13**:** 978-0070107991.
2	Materials Science of Thin Films, Milton Ohring, 2nd Edition, Academic Press, 2002, ISBN 978-0-12-524975-1
3	Thin-Film Deposition: Principles and Practice, Donald Smith, 1st edition, 1994, McGraw-Hill College, ISBN-13: 978-0071139137.
4	Handbook of Thin-Film Technology, Hartmut Frey, Hamid R Khan Editors, 1st edition, 2015, Springer, ISBN 978-3-642-05429-7.
5	Nanostructures and Thin Films for Multifunctional Applications Technology, Properties and Devices, Ion Tiginyanu, Pavel Topala, Veaceslav Ursaki, 1st edition, 2016, Springer, ISBN 978-3-319-30197-6.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Experiential Learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	1	-	-	-	-	-	-	-	-	2
CO2	3	2	2	2	-	-	-	-	-	-	-	2
CO3	2	3	3	2	-	1	1	1	-	-	-	2
CO4	2	3	3	2	1	2	2	2	2	2	-	2

High-3: Medium-2: Low-1

Semester: V						
ADVANCES IN CORROSION SCIENCE AND TECHNOLOGY (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B15**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the fundamental & socio, economic aspects of corrosion.
2	Identify practices for the prevention and remediation of corrosion.
3	Analyzing methodologies for predicting corrosion tendencies.
4	Evaluate various corrosion situations and implement suitable corrosion control measures.

Unit-I	**08 Hrs**

Introduction to corrosion and its effect

Introduction: The direct and indirect effects of corrosion, economic losses, Indirect losses -Shutdown, contamination, loss of product, loss of efficiency, environmental damage, Importance of corrosion prevention in various industries, corrosion auditing in industries, corrosion map of India.

Corrosion issues in specific industries-power generation, chemical processing industries, oil and gas Industries, pulp and paper plants, corrosion effect in electronic industry.

Unit – II	**08 Hrs**

Types of Electrochemical corrosion

Introduction: Galvanic series, Pilling-Bedworth ratio, Types: Galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, erosion corrosion, stress corrosion, season cracking, hydrogen embrittlement, high temperature corrosion, bacterial corrosion, corrosion in polymer (plastic) materials.

Crevice corrosion-mechanism of differential aeration corrosion, mixed potential theory for understanding common corrosion of metals and alloys.

Unit –III	**07 Hrs**

Corrosion in different engineering materials

Concrete structures, duplex, super duplex stainless steels, ceramics, composites.

Corrosion in Specific Materials: Corrosion of Iron, Nickel, Aluminium, Titanium and Super alloys.

Thermodynamics of Corrosion: Pourbaix diagram and its importance in metal corrosion and its calculation for Al, Cu, Ni and Fe.

Unit –IV	**07 Hrs**

Advances in Corrosion Control

Principles of corrosion prevention, material selection, design considerations, control of environment-decrease in velocity, passivity, removal oxidizer, Inhibitors and passivators, coatings- organic, electroplating of Copper, Nickel and Chromium, physical vapor deposition-sputtering, Electroless plating of Nickel.

Unit –V	**09 Hrs**

Corrosion Testing

Physio-chemical methods: Specimens, environment, evaluation of corrosion damage, Accelerated laboratory tests-salts spray, service tests.

Electrochemical methods: Electrode potential measurements, polarization measurements. Stern-Geary equation, Impedance measurements, Accelerated tests. Advantages and limitations of corrosion testing methods.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the causes and mechanism of various types of corrosion
CO2:	Identify, analyze and interpret corrosion with respect to practical situations.
CO3:	Apply the knowledge of chemistry in solving issues related to corrosion.
CO4:	Develop practical solutions for problems related to corrosion.

Reference Books	
1	Corrosion Engineering, M.G, Fontana, 3rd Edition, 2005, Tata McGraw Hill, ISBN: 978-0070214637.
2	Principles and Prevention of Corrosion, D. A Jones, 2nd Edition, 1996, Prentice Hall, ISBN: 978-0133599930.
3	Design and corrosion prevention, Pludek, 1978, McMillan, ISBN: 978-1349027897
4	Introduction to metal corrosion, Raj Narain, 1983, Oxford &IBH, ISBN: 8120402995.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	1	-	1
CO2	3	2	2	1	-	-	-	-	-	1	-	1
CO3	3	3	2	2	2	-	-	-	-	1	-	1
CO4	3	3	3	3	2	-	-	-	-	1	-	1

High-3: Medium-2: Low-1

Semester: V						
COMPUTATIONAL ADVANCED NUMERICAL METHODS (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B16**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Gain adequate exposure to learn alternative methods to solve algebraic and transcendental equations using suitable numerical techniques.
2	Use the concepts of interpolation techniques arising in various fields.
3	Solve initial value and boundary value problems which have great significance in engineering practice.
4	Apply the concepts of eigen value and eigen vector to obtain the critical values of various physical phenomena.
5	Demonstrate elementary programming language, implementation of algorithms and computer programs to solve mathematical problems.

Unit-I	**07 Hrs**
Algebraic and Transcendental Equations: Roots of equations in engineering practice - Fixed point iterative method, Aitken process, Muller method, Chebyshev method. Simulation using MATLAB.	
Unit – II	**07 Hrs**
Interpolation: Introduction to finite differences, Finite differences of a polynomial, Divided differences, Newton's divided difference interpolation formula, Hermite interpolation, Spline interpolation - linear, quadratic and cubic spline interpolation. Simulation using MATLAB.	
Unit –III	**08 Hrs**
Differential Equations I: Runge-Kutta and Runge-Kutta-Felhberg methods to solve differential equations, Boundary value problems (BVPs) - Rayleigh-Ritz method, Shooting method, Differential transform method to solve differential equations. Simulation using MATLAB.	
Unit –IV	**08 Hrs**
Differential Equations II: Solution of second order initial value problems - Runge-Kutta method, Milne method, Cubic spline method, Finite difference method for ordinary linear, Nonlinear differential equations, Simulation using MATLAB.	
Unit –V	**09 Hrs**
Eigen Value Problems: Eigen values and Eigen vectors, Power method, Inverse Power method, Bounds on Eigen values, Gershgorin circle theorem, Jacobi method for symmetric matrices, Given's method. Simulation using MATLAB.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Identify and interpret the fundamental aspects of different Mathematical concepts and corresponding computational techniques.
CO2:	Apply the knowledge and skills of computational techniques to solve different types of application problems.
CO3:	Analyze the physical problem and use appropriate method to solve numerically using computational techniques.
CO4:	Distinguish the overall mathematical knowledge gained to demonstrate and analyze the problems arising in engineering practice.

Reference Books	
1	Numerical methods for scientific and engineering computation, M. K. Jain, S. R. K. Iyengar and R. K. Jain, 6th Edition, 2012, New Age International Publishers, ISBN-13: 978-81-224-2001-2.
2	Numerical Analysis, Richard L. Burden and J. Douglas Faires, 9th Edition, 2012, Cengage Learning, ISBN-13: 978-81-315-1654-6.
3	Introductory Methods of Numerical Analysis, S. S. Sastry, 4th Edition, 2011, PHI Learning Private Ltd., ISBN: 978-81-203-2761-0.
4	Numerical Methods for Engineers, Steven C. Chapra, Raymond P. Canale, 5th Edition, 2011, Tata Mcgraw Hill, ISBN-10: 0-07-063416-5.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	1	-	-	-	-	-	-	-	2
CO2	3	2	1	-	-	-	-	-	-	-	-	2
CO3	2	3	2	2	-	-	-	-	-	-	-	1
CO4	3	3	1	2	1	-	-	-	-	-	-	3

High-3: Medium-2: Low-1

Semester: V						
MATHEMATICS FOR MACHINE LEARNING (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G5B17**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the basic knowledge on the fundamental concepts of linear algebra that form the foundation of machine intelligence.
2	Acquire practical knowledge of vector calculus and optimization to understand the machine learning algorithms or techniques.
3	Use the concepts of probability and distributions to analyze possible applications of machine learning.
4	Apply the concepts of regression and estimation to solve problems of machine learning.
5	Analyze the appropriate mathematical techniques for classification and optimization of decision problems.

Unit-I	**07 Hrs**
Linear Algebra: Review of Vector Spaces-Linear Independence, Basis, Rank and Linear Mappings. Affine Spaces, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Inner Product of Functions, Orthogonal Projections, Rotations, Singular Value Decomposition.	
Unit – II	**07 Hrs**
Vector Calculus and Continuous Optimization: Gradients of Vector-Valued Functions, Gradients of Matrices, Identities for Computing Gradients, Backpropagation and Automatic Differentiation, Linearization and Multivariate Taylor Series, Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers and Convex Optimization.	
Unit –III	**08 Hrs**
Probability and Distributions: Construction of a Probability Space, Discrete and Continuous Probabilities, Sum Rule, Product Rule and Bayes' Theorem, Gaussian Distribution, Conjugacy and the Exponential Family, Change of Variables - Inverse Transform.	
Unit –IV	**08 Hrs**
Linear Regression: Problem Formulation, Parameter Estimation, Bayesian Linear Regression, Maximum Likelihood as Orthogonal Projection. **Density Estimation with Gaussian Mixture Models:** Gaussian Mixture Model, Parameter Learning via Maximum Likelihood, EM Algorithm, Latent-Variable Perspective.	
Unit –V	**09 Hrs**
Dimensionality Reduction with Principal Component Analysis (PCA): Problem Setting, Maximum Variance Perspective, Projection Perspective, Eigenvector Computation and Low-Rank Approximations, PCA in High Dimensions, Key Steps of PCA in Practice, Latent Variable Perspective. **Classification with Support Vector Machines:** Separating Hyperplanes, Primal Support Vector Machine, Dual Support Vector Machine, Kernels, Numerical Solution.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explore the fundamental concepts of mathematics involved in machine learning techniques.
CO2:	Orient the basic concepts of mathematics towards machine learning approach.
CO3:	Apply the linear algebra and probability concepts to understand the development of different machine learning techniques.
CO4:	Analyze the mathematics concepts to develop different machine learning models to solve practical problems.

Reference Books	
1	Mathematics for Machine Learning, M. P. Deisenroth, A. A. Faisal and C. S. Ong, 1st Edition, 2020, Cambridge University Press.
2	Linear Algebra and Learning from Data, Gilbert Strang, 1st Edition, 2019, Wellesley Cambridge Press, ISBN: 0692196382, 9780692196380.
3	Introduction to Machine Learning, Ethem Alpaydin, 2nd Edition, 2010, PHI Publication, ISBN-978-81-203-4160-9.
4	The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani and Jerome Friedman, 2nd Edition, 2009, Springer, ISBN: 978-0-387-84857-0, 978-0-387-84858-7.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	1	-	-	-	-	-	-	-	2
CO2	3	2	1	-	-	-	-	-	-	-	-	2
CO3	2	3	2	2	-	-	-	-	-	-	-	1
CO4	3	3	1	2	1	-	-	-	-	-	-	3

High-3: Medium-2: Low-1

V Semester						
ENGINEERING ECONOMY (GROUP B: GLOBAL ELECTIVE) (Theory)						
Course Code	:	**18G5B18**		**CIE**	:	**100 Marks**
Course Code	:	**18G5B02**		**SEE**	:	**100 Marks**
Total Hours	:	**39L**		**SEE Duration**	:	**03 Hours**

Course Learning Objectives: Students are expected to

1.	To inculcate an understanding of concept of money and its importance in the evaluation of projects.
2.	Analyze the present worth of an asset.
3.	Evaluate the alternatives based on the Equivalent Annual Worth.
4.	Illustrate concept of money and its importance in evaluating the projects.

Unit – I	**07 Hrs**
Introduction: Principles of Engineering Economy, Engineering Decision- Makers, Engineering and Economics, Problem solving and Decision making, Intuition and Analysis, Tactics and Strategy. Interest and Interest Factors: Interest rate, Simple interest, Compound interest, Cash- flow diagrams, Exercises and Discussion.	
Unit – II	**07 Hrs**
Present worth comparison : Conditions for present worth comparisons, Basic Present worth comparisons, Present worth equivalence, Net Present worth, Assets with unequal lives, infinite lives, Future worth comparison, Pay – back comparison, Exercises, Discussions and problems.	
Unit – III	**07 Hrs**
Equivalent annual worth comparisons: Equivalent Annual Worth Comparison methods, Situations for Equivalent Annual Worth Comparison Consideration of asset life, Comparison of assets with equal and unequal lives, Use of sinking fund method, Exercises, Problems. Rate of return calculations: Rate of return, Minimum acceptable rate of return, IRR, IRR misconceptions, Problems.	
Unit – IV	**06 Hrs**
Replacement Analysis: Replacement studies, replacement due to deterioration, obsolescence, inadequacy, economic life for cyclic replacements, Exercises, Problems. Break- Even Analysis: Basic concepts, Linear Break- Even analysis, Exercises, Problems.	
Unit – V	**06 Hrs**
Depreciation: Causes of Depreciation, Basic methods of computing depreciation charges, Exercises, Problems. Effects of inflation: Causes, consequences and control of inflation, inflation in economic analysis.	

Course Outcomes: After going through this course the student will be able to	
CO 1:	Explain the time value of money, and how to sketch the cash flow diagram
CO 2:	Compare the alternatives using different compound interest factors, Select a feasible alternative based on the analysis.
CO 3:	Formulate a given problem for decision making

CO 4:	Evaluate alternatives and develop capital budget for different scenarios

Reference Books:	
1.	Engineering Economy, Riggs J.L., 5th Edition, Tata McGraw Hill, ISBN 0-07-058670-5
2.	Engineering Economics, R Panneerselvam, Eastern Economy Edition 2001, PHI, ISBN – 81-203-1743-2.
3.	Cost Accounting, Khan M Y, 2nd Edition, 2000, Tata McGraw-Hill, ISBN 0070402248
4.	Mechanical Estimating & Costing, T.R.Banga, S.C.Sharma, 16th Edition, 2011, Khanna Publishers, ISBN 8174091009

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20. **Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	1	1	-	-	-	-	-	-	-	-	1
CO2	2	1	1	-	-	-	-	-	-	-	-	-
CO3	1	1	1	-	1	-	-	-	-	-	-	-
CO4	-	1	2	-	1	1	-	-	-	-	1	-

High-3: Medium-2: Low-1

VI Semester						
INTRODUCTION TO MANAGEMENT & ECONOMICS (Theory)						
Course Code	**:**	**18HEM61**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hrs**

Course Learning Objectives: The students will be able to

1	Understand the evolution of management thought.
2	Acquire knowledge of the functions of Management.
3	Gain basic knowledge of essentials of Micro economics and Macroeconomics.
4	Understand the concepts of macroeconomics relevant to different organizational contexts.

Unit-I	**07 Hrs**
Introduction to Management: Management Functions, Roles & Skills, Management History – Classical Approach: Scientific Management & Administrative Theory, Quantitative Approach: Operations Research, Behavioral Approach: Hawthorne Studies, Contemporary Approach: Systems & Contingency Theory. Case studies.	
Unit – II	**09 Hrs**
Foundations of Planning: Types of Goals & Plans, Approaches to Setting Goals & Plans, Strategic Management Process, Corporate & Competitive Strategies. **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. **Case studies.**	
Unit –III	**09 Hrs**
Motivating Employees: 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 & Vroom's Expectancy Theory. **Case studies.** **Managers as Leaders:** Behavioral Theories: Ohio State & University of Michigan Studies, Blake & Mouton's Managerial Grid, Contingency Theories of Leadership: Hersey & Blanchard's Situational Leadership, Contemporary Views of Leadership: Transactional & Transformational Leadership. **Case studies.**	
Unit –IV	**07 Hrs**
Introduction to Economics: Importance of Economics, Microeconomics and Macroeconomics, Theories and Models to Understand Economic Issues, An Overview of Economic Systems. Demand, Supply, and Equilibrium in Markets for Goods and Services, Price Elasticity of Demand and Price Elasticity of Supply, Elasticity and Pricing, Changes in Income and Prices Affecting Consumption Choices, Monopolistic Competition, Oligopoly.	
Unit –V	**07Hrs**
Essentials of Macroeconomics: Prices and inflation, Exchange rate, Gross domestic product(GDP), components of GDP, the Labor Market, Money and banks, Interest rate, Macroeconomic models- an overview, Growth theory, The classical model, Keynesian cross model, IS-LM-model, The AS-AD-model, The complete Keynesian model, The neo-classical synthesis, Exchange rate determination and the Mundell-Fleming model	

Reference Books	
1	Stephen Robbins, Mary Coulter &NeharikaVohra, Management, Pearson Education Publications, 10th Edition, ISBN: 978-81-317-2720-1.
2	James Stoner, Edward Freeman & Daniel Gilbert Jr, Management, PHI, 6th Edition, ISBN: 81-203-0981-2.
3	Steven A. Greenlaw ,David Shapiro,Principles of Microeconomics,2nd Edition,ISBN:978-1-947172-34-0
4	Dwivedi.D.N, Macroeconomics: Theory and Policy,McGraw Hill Education; 3rd

	Edition,2010,ISBN-13: 978-0070091450.
5	Peter Jochumzen, Essentials of Macroeconomics, e-book(www.bookboon.com), 1st Edition., 2010, ISBN:978-87-7681-558-5.

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain 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	Select & Implement the right leadership practices in organizations that would enable systems orientation.
CO4	Understand the basic concepts and principles of Micro economics and Macroeconomics.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.
50% weightage should be given to case studies. Total CIE is 30(Q) + 50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level. **50% weightage should be given to case studies.**

CO-PO Mapping												
CO/ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	---	1	---	----	3	----	3	3	3	3	3
CO2	3	2		---	---	---	----	1	2	3	2	2
CO3	---	---	1	---	---	2	---	2	2	3	3	3
CO4	2	---	2	---	----	3	1	3	2	2	3	3

High-3 : Medium-2 : Low-1

Semester: VI						
ANTENNA AND PROPAGATION (Theory & Practice)						
Course Code	**:**	**18TE62**		**CIE Marks**	**:**	**100+50=150**
Credit: L:T:P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50=150**
Total Hours	**:**	**52L+33P**		**SEE Duration**	**:**	**3.00+3.00 Hrs**

Course Learning Objectives: The students will be able to	
1	Understand various parameters of Antenna and Basic Antenna theory.
2	Analyze and Design the antenna and antenna arrays for various applications.
3	Learn the fundamentals of Smart Antennas design.
4	Measure Antenna Parameters and learn the physical effects in wave propagation.

UNIT-I	**10 Hrs**
Antenna Basics: Basic antenna parameters, Radiation patterns, Radiation Intensity, Beam area, Beam Efficiency, Directivity and Gain, Aperture antennas, Antenna field zones, Shape-impedance, Power theorem & its applications, Radiation intensity, Power patterns, Examples of Power patterns. Electric dipole-fields of short dipole, radiation resistance of short and half wave dipole.	
UNIT-II	**10 Hrs**
Antenna arrays: Field patterns, Phase patterns of Point sources, Arrays of two isotropic point sources, Arrays of Non-isotropic sources, Pattern multiplication and synthesis, Array of n-isotropic point sources with equal amplitude and spacing, Broadside, End fire arrays & Extended end-fire arrays, dipole arrays with parasitic elements, Yagi-Uda array, Phased Array Antennas.	
UNIT-III	**10 Hrs**
Types of Antennas: Microwave antennas: Rectangular Horn antenna and its radiation characteristics, Parabolic antenna: General properties, Paraboloid reflector, Feed methods for parabolic reflectors. **Broadband antennas:** Helical antenna geometryand its modes, Practical considerations for the monofilar Axial-mode Helical antenna. **Microstrip Antennas:** Introduction, Advantages and Limitations, Rectangular Microstrip antenna, feeding methods. Antennas for Terrestrial Mobile communication systems.	
UNIT-IV	**10 Hrs**
Introduction to Smart Antennas: Smart Antenna Configurations, Switch Beam Antennas, Adaptive Antenna Approach, Space Division multiple access, Architectures of smart antennas, Benefits and drawbacks, Basic Principles, Mutual Coupling Effects. Direction of Arrival and Beamforming Concepts.	
UNIT-V	**12 Hrs**
Wave Propagation: Introduction, Definitions, Characterizations and general classifications, different modes of wave propagation, Ray/Mode concepts, Ground wave propagation (Qualitative treatment) - Introduction, Plane earth reflections, Space and surface waves, wave tilt, curved earth reflections, Space wave propagation - Introduction, field strength variation with distance and height, effect of earth's curvature, absorption, scattering phenomena, tropospheric propagation, fading and path loss calculations, Summary of Wave Characteristics in different frequency ranges. **Antenna Measurements:** Anechoic Chamber, Gain, Polarization, Radiation Pattern and Impedance mismatch measurement of an Antenna.	

Laboratory Experiments
Students are expected to implement the following circuits on Microwave Benches 1. Characterization of Reflex Klystron, Gunn diode sources 2. Characterization of Directional Coupler, Tee junctions, Circulator and Isolator, 3. Horn antenna, Parabolic Dish, Micro strip antennas, 4. Microstrip Passive components **The students are expected to simulate the following Antennas using RF CAD tools** 1. Radiation characteristics of Dipole antenna, 2. N- isotropic point source array 3. Rectangular Microstrip patch antenna

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand basic principles of antennas, antenna and physical phenomenon of wave propagation.
CO2	Analyze the characteristics of narrowband and Broadband antennas.
CO3	Design the antenna for a given application and evaluate its performance.
CO4	Characterize antennasusing 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	Introduction to Smart Antennas, Constantine A Balanis , Bannides , 2007, ISBN: 1598291769.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.
Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.
Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks

SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	---	1	1	---	---	---	1	---	---	---
CO2	2	1	---	1	1	---	---	---	1	---	---	---
CO3	2	1	---	1	1	---	---	---	2	---	---	---
CO4	1	1	---	1	1	1	---	---	1	---	---	---

High-3: Medium-2: Low-1

Semester: VI						
COMPUTER COMMUNICATION NETWORKS (Theory & Practice)						
Course Code	**:**	**18TE63**		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100+50 Marks**
Total Hours	**:**	**40L+33P**		**SEE Duration**	**:**	**3.00+3.00 Hrs**

Course Learning Objectives: The students will be able to :

1	Understand the functionalities of various elements of the network.
2	Understand the design aspects in computer networks.
3	Gain the knowledge of routing, internetworking and congestion control.
4	Explore networks layer, transport layer and application layer protocols.

UNIT-I	**08 Hrs**

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	**08 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	**09Hrs**

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	**08 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	**07 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.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.
Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.
Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.
Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks

SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	2	2	-	-	-	-	-	1	-	2
CO2	3	2	2	1	2	-	-	-	-	1	-	2
CO3	2	2	2	2	2	-	-	-	-	1	-	2
CO4	3	3	3	3	2	-	-	-	-	1	-	2

High-3: Medium-2: Low-1

Semester: VI						
Minor Project						
Course Code	**:**	**18TE64**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**0:0:2**		**SEE**	**:**	**50 Marks**
Hours	**:**	**26P**		**SEE Duration**	**:**	**02 Hours**
Course Learning Objectives: To enable the students to:						
1	***Knowledge Application:*** Acquire the ability to make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.					
2	***Communication:*** Acquire the skills to communicate effectively and to present ideas clearly and coherently to a specific audience in both the written and oral forms.					
3	***Collaboration:*** Acquire collaborative skills through working in a team to achieve common goals.					
4	***Independent Learning:*** Learn on their own, reflect on their learning and take appropriate action to improve it.					

Guidelines for Minor Project

1. The minor project is to be carried out individually or by a team of two-three students.
2. Each student in a team must contribute equally in the tasks mentioned below.
3. Each group has to select a current topic that will use the technical knowledge of their program of study after intensive literature survey.
4. The project should result in system/module which can be demonstrated, using the available resources in the college.
5. The CIE evaluation will be done by the committee constituted by the department. The committee shall consist of respective guide & two senior faculty members as examiners. The evaluation will be done for each student separately.
6. The final copy of the report should be submitted after incorporation of any modifications suggested by the evaluation committee.

The minor-project tasks would involve:

1. Carry out the Literature Survey of the topic chosen.
2. Understand the requirements specification of the minor-project.
3. Detail the design concepts as applicable through appropriate functional block diagrams.
4. Commence implementation of the methodology after approval by the faculty.
5. Conduct thorough testing of all the modules developed and carry out integrated testing.
6. Demonstrate the functioning of the minor project along with presentations of the same.
7. Prepare a project report covering all the above phases with proper inference to the results obtained.
8. Conclusion and Future Enhancements must also be included in the report.

The students are required to submit the report in the prescribed format provided by the department.

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Interpreting and implementing the project in the chosen domain by applying the concepts learnt.
CO 2:	The course will facilitate effective participation by the student in team work and development of communication and presentation skills essential for being part of any of the domains in his / her future career.
CO 3:	Appling project life cycle effectively to develop an efficient product.
CO 4:	Produce students who would be equipped to pursue higher studies in a specialized area or carry out research work in an industrial environment.

Scheme of Evaluation for CIE Marks:

Evaluation will be carried out in three phases:

Phase	**Activity**	**Weightage**
I	Synopsis submission, approval of the selected topic, Problem definition, Literature review, formulation of objectives, methodology	10M
II	Mid-term evaluation to review the progress of implementation, design, testing and result analysis along with documentation	15M
III	Submission of report, Final presentation and demonstration	25M
	Total	**50M**

Scheme of Evaluation for SEE Marks:

Sl. No.	**Evaluation Component**	**Marks**
1.	Written presentation of synopsis: Write up	5M
2.	Presentation/Demonstration of the project	15M
3.	Demonstration of the project	20M
4.	Viva	05M
5.	Report	05M
	Total	**50M**

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	2	2	1	2	2	2	2	2
CO2	3	3	3	3	2	2	1	2	2	2	2	2
CO3	3	3	3	3	2	2	1	2	2	2	2	2
CO4	1	1	1	1	1	1	1	2	1	2	1	1

High-3: Medium-2: Low-1

Semester: VI						
INTERNET OF THINGS **(ELECTIVE C: PROFESSIONAL ELECTIVE)** **(Common to All Branches)**						
Course Code	**:**	**18CS6C1**		**CIE Marks**	**:**	**100**
Credits: L:T:P	:	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	:	**39L**		**SEE Duration**	**:**	**3.00 Hrs**

Course Learning Objectives: The students will be able to

1.	Understand design principles in Iot ,edge ,fog computing and its challenges
2.	Identify the Internet Connectivity, security issues and its protocols
3.	Explore and implement Internet of Things (IoT) and New Computing Paradigms
4.	Apply and analyze the Orchestration and resource management inioT, 5G, Fog, Edge, and Clouds

Unit – I	**8 Hrs**
Internet of Things Strategic Research and Innovation Agenda: Internet of Things Vision ,IoT Strategic Research and Innovation Directions , IoT Applications , Internet of Things and Related Future Internet Technologies , Infrastructure , Networks and Communication , Processes , Data Management , Security, Privacy & Trust , Device Level Energy Issues.	
Unit – II	**8 Hrs**
Internet of Things Standardisation: Status, Requirements, Initiatives and Organisations - Introduction , M2M Service Layer Standardisation , OGC Sensor Web for IoT , IEEE and IETF , ITU-T . Simpler IoT Word(s) of Tomorrow, More Interoperability Challenges to Cope Today-Physical vs Virtual , Solve the Basic First — The Physical Word , The Data Interoperability , The Semantic Interoperability , The Organizational Interoperability , The Eternal Interoperability , The Importance of Standardisation — The Beginning of Everything.	
Unit – III	**8 Hrs**
Internet of Things Privacy, Security and Governance: Introduction, Overview of Activity Chain — Governance, Privacy and Security Issues, Contribution From FP7 Project, Security and Privacy Challenge in Data Aggregation for the IoT in Smart Cities-Security, Privacy and Trust in Iot-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach.	
Unit – IV	**8 Hrs**
Internet of Things (IoT) and New Computing Paradigms: Fog and Edge Computing Completing the Cloud ,Advantages of FEC: SCALE , How FEC AchievesThese Advantages: SCANC 9,Hierarchy of Fog and Edge Computing , Business Models , **Addressing the Challenges in Federating Edge Resources,** The Networking Challenge, The Management Challenge , **Integrating IoT + Fog + Cloud.**	
Unit – V	**7 Hrs**
Management and Orchestration of Network Slices in 5G, Fog, Edge, and Clouds: Introduction ,Background, Network Slicing in 5G, Network Slicing in Software-Defined Clouds, Network Slicing Management in Edge and Fog.	

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

Reference Books:	
1.	Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers, 2013ISBN: 978-87-92982-73-5(Print) ISBN: 978-87-92982-96-4(E-Book).
2.	Fog and Edge Computing: Principles and Paradigms, Rajkumar Buyya , Satish Narayana Srirama, 2019, Wiley series on parallel and distributed computing, ISBN: 978-1-119-52498-4.
3.	Internet of Things: Architecture and Design Principles, Raj Kamal, 2017, TMH Publications, ISBN:9789352605224.
4.	Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, Daniel Minoli, 1st Edition, 2013, Willy Publications ,ISBN: 978-1-118-47347-4.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.
Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	1	1	-	2	2	-	-	1	-	2
CO2	2	2	1	1	-	2	2	-	1	1	-	3
CO3	1	2	1	1	-	2	2	-	1	1	-	2
CO4	1	2	2	2	-	3	3	1	2	2	-	3

High-3: Medium-2: Low-1

Semester: VI						
IMAGE PROCESSING & COMPUTER VISION (GROUP C: PROFESSIONAL ELECTIVE) (Theory)						
Course Code	**:**	**18TE6C2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**3.00 Hrs**

Course Learning Objectives:	
1	List and understand various processes and steps employed in image processing.
2	Illustrate different transforms used in image operations.
3	Analyze image enhancement and restoration processes and techniques.
4	Apply image processing in real time applications.

Unit-I	**8 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	**8 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	**8 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	**8 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	**8 Hrs**
Morphological Image Processing: Preliminaries, Dilation and Erosion, Opening and Closing, The Hit-or-Miss Transformation, Some Basic Morphological Algorithms. **Image Segmentation:** Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-Based Segmentation.	

Course outcomes: On completion of the course, the student should have acquired the ability 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 and Technology.

3	Digital Signal Processing – Fundamentals and Applications, Li Tan, 2008, Elsevier.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.
Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	---	3	---	3	---	---	---	1	---	---	2
CO2	3	---	3	---	3	---	---	---	1	2	---	2
CO3	3	3	---	3	2	1	---	---	---	---	---	2
CO4	2	2	1	2	---	2	1	---	2	2	--	3

High-3: Medium-2: Low-1

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.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	1	1	1	---	---	---	1	---	---	---
CO2	3	2	2	1	1	---	---	---	1	---	---	---
CO3	3	2	2	1	1	---	---	---	1	---	---	---
CO4	3	3	2	2	1	---	---	---	1	---	---	---

High-3: Medium-2 : Low-1

Semester: VI						
DSP APPLICATIONS (GROUP C: PROFESSIONAL ELECTIVE) (Theory)						
Course Code	**:**	**18TE6C3**		**CIE Marks**	**:**	**100**
L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**3.00 Hrs**

Course Learning Objectives: The students will be able to

1	Explain the process of up sampling and down sampling of signals.
2	Design the filter banks and M-channel QMF bank.
3	Design an adaptive filter based on LMS/RLS algorithm for different applications
4	Explain the various concepts of Image Processing such as filtering, histogram, compression etc.
5	Describe various applications such as audio, CD, mobile telephony and set top box.

UNIT-I	**08 Hrs**

Multi-rate DSP: Introduction, Concepts of sampling rate conversion; Noble Identities, Poly phase structures for sampling rate conversion. Applications: Design of Phase shifters, Interfacing of Digital Systems with different sampling rates, Narrow band filters, Sub band Coding of Speech signals.

UNIT-II	**08 Hrs**

Digital Filter Banks: Concepts, Polyphase structures of uniform filter banks, Transmultiplexers – TDM to FDM conversion, FDM to TDM conversion.

Two-channel QMF Bank: Elimination of Aliasing, Perfect Reconstruction, Polyphase form of QMF bank, Linear phase FIR QMF bank, IIR QMF bank, Perfect Reconstruction Two-channel FIR QMF Bank, QMF banks in sub band Coding.

M-channel QMF Bank: Alias-free and Perfect reconstruction condition, Polyphase form of the M-channel QMF Bank.

UNIT-III	**08 Hrs**

Adaptive Filters: Use of adaptive filters, Concepts of adaptive filtering, Weiner filter theory, Basic LMS adaptive algorithm, Recursive least squares algorithm, Applications – Noise cancellation, System modelling, adaptive telephone echo cancellation, multi-path effect cancellation, Jammer suppression, adaptive signal enhancement.

UNIT-IV	**08 Hrs**

Image Processing Basics: Notation and Data formats; Histogram and Equalization, Image level adjustment and contrast, Image filtering enhancement, Pseudo-color generation and detection, Image spectra, Image compression.

UNIT-V	**08 Hrs**

Applications: Audio applications – digital audio mixing, speech synthesis and recognition, CD digital audio system, High quality ADC for digital audio, DAC for hi-fi systems, multirate narrow band digital filtering, high resolution narrow band spectral analysis. CD recording system, Telecommunication applications – digital cellular mobile telephony, set-top box for digital TV.

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the importance and functions of Decimator, Interpolator, Adaptive filters and its applications.
CO2	Apply different DSP operations for various data.
CO3	Design and Analyze filter banks and Adaptive filters.
CO4	Develop signal processing algorithms for various applications

Reference Books	
1	Digital Signal Processing, Proakis and Monolakias, 4th Edition, 2013, Pearson/PHI, ISBN: 81-317-1000-9.
2	Digital Signal Processing – A Practical approach,E.C.Ifeachor and B.W.Jervis, 2nd Edition, 2002, Pearson Education.

SEMESTER: VI						
OPERATING SYSTEMS **(GROUP C: PROFESSIONAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18TE6C4**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Define fundamental principles of operating system design and kernel implementation.
2	Explain the classes of Operating system and their significance.
3	Analyse the various aspect of Process, Threads and CPU Scheduling.
4	Analyse the different approaches to Process Synchronization and Deadlocks.
5	Explain the key concepts of Memory Management and File Management.

UNIT-I	**07 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	**10 Hrs**
Processes: Process concept, Process Scheduling, Operations on processes, cooperating process, Inter process communication, Multithreading Models, Threading Issues. **CPU Scheduling:** Basic concepts, Scheduling Criteria, Scheduling Algorithms, Multi-processor scheduling, Thread scheduling.	
UNIT-III	**10 Hrs**
Process Synchronization: The critical selection problem, Peterson's solutions, Synchronization Hardware, Semaphores. **Deadlocks:** System models, Deadlocks Characterization, Methods for handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock.	
UNIT-IV	**07 Hrs**
Memory management: Swapping, Contiguous Memory Allocation, Paging, Structure of the Page Table, Segmentation. **Virtual Memory:** Demand Paging, Copy-on-write, Page Replacement, Allocation of Frames, Thrashing.	
UNIT-V	**06 Hrs**
File Systems: File concept, Access methods, Protection, File-system structure, File-system Implementation, Directory Implementation and Allocation Methods.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify and interpret various functions, goals and classes of operating system.
CO2	Describe the key concepts of Process, Threads and CPU Scheduling.
CO3	Evaluate the performance of various algorithms in Operating systems with respect to Process Synchronization and Deadlocks.
CO4	Analyse the key aspects in Memory and File management.

Reference Books	
1.	Operating System Concepts, A Sliberschatz and P B Galvin, 7th Edition, 2011,Addison Wesley, Reprint 2011, ISBN:978-81-265-0962-1.
2.	Operating Systems -A Concept Based Approach,D. M. Dhamdhere, 2nd, Edition,2006, TMHISBN NO: 0-07-061194-7.
3.	Operating Systems Internals and Design Principles, William Stallings, 7th Edition, 2012,Pearson, Prentice Hall, ISBN:978-0132309981.

4.	Operating Systems, Design and Implementation, Andrew S. Tanenbaum, 2006, Pearson Education, ISBN:978-0131429383.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	2	---	1	---	---	---	---	---	1	---
CO2	2	3	2	---	2	---	---	---	---	---	1	---
CO3	3	3	---	1	2	---	---	---	---	---	1	---
CO4	1	2	---	2	2	---	---	---	-	---	1	---

High-3: Medium-2: Low-1

Machine Learning **(GROUP D: PROFESSIONAL ELECTIVE)** **(Common to AE, BT, CH, CV, EE, EI, TE, IM, ME)**						
Course Code	**:**	**18CS6D1**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hrs**
Course Learning Objectives: The students will be able to						
1	Understand the concepts of supervised and unsupervised learning.					
2	Analyze models such as support vector machines, kernel SVM, naive Bayes, decision tree classifier, random forest classifier, logistic regression, K-means clustering and more in Python					
3	Implement and work with state-of-art tools in machine learning					

Unit – I	**08 Hrs**
Introduction to Machine Learning: Introduction, What is Human Learning?**,**Types of Human Learning**,** What is Machine Learning?Types of Machine Learning - Supervised learning**,** Unsupervised learning**,** Reinforcement learning**,** Comparison – supervised, unsupervised, and reinforcement learning**,** Problems Not To Be Solved Using Machine Learning, Applications of Machine Learning, State-of-The-Art Languages/Tools In Machine Learning**,** Issues in Machine Learning. **Preparing to Model:** Introduction**,** Machine Learning Activities**,** Basic Types of Data in Machine Learning**,** Exploring Structure of Data**,** Data Quality and Remediation**,** Data Pre-Processing	
Unit – II	**08 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 – III	**08 Hrs**
Bayesian Concept Learning: Introduction, Why Bayesian Methods are Important?, Bayes' Theorem, Bayes' Theorem and Concept Learning, Brute-force Bayesian algorithm, Concept of consistent learners, Bayes optimal classifier, Naïve Bayes classifier, Applications of Naïve Bayes classifier, Handling Continuous Numeric Features in Naïve Bayes Classifier, Bayesian Belief Network, Independence and conditional independence, Use of the Bayesian Belief network in machine learning.	
Unit – IV	**08 Hrs**
Supervised Learning: Classification Introduction**,** Example of Supervised Learning**,** Classification Model**,** Classification Learning Steps**,** Common Classification Algorithms**,** k-Nearest Neighbour (KNN)**,** Decision tree**,** Random forest model**,** Support vector machines. **Super vised Learning: 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, Maximum Likelihood Estimation.	
Unit – V	**07 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 machine learning techniques.
CO2	Understand different techniques of data pre processing.
CO3	Analyze 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.

Reference Books	
1.	Machine Learning, Amit Kumar Das, SaikatDutt, Subramanian Chandramouli, Pearson Education India, April 2018 ISBN: 9789389588132.
2.	Introduction to Machine Learning, EthemAlpaydin, 2nd Edition,2010, PHI Publication, ISBN-978-81-203-4160-9.
3.	Practical data science with R, Zumel, N., & Mount J, Manning Publications, 2014, ISBN 9781617291562
4.	Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms, Nikhil Buduma, O'Reilly Publications, 2016 Edition, ISBN-13: 978-1491925614.
5.	Pattern Recognition and Machine Learning, Christopher M Bishop, Springer, February 2006, ISBN-10: 0-387-31073-8, ISBN-13: 978-0387-31073-2.
6.	The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani, and Jerome Friedman, Springer, Second Edition, April 2017, ISBN 978-0-387-84858-7

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

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CO1	3	3	3	2	1	-	-	-	-	-	-	1
CO2	2	2	2	2	1	-	-	-	-	-	-	1
CO3	3	3	3	3	2	-	-	-	-	-	-	1
CO4	3	3	3	3	2	2	-	-	-	-	-	2

High-3: Medium-2: Low-1

Semester: VI						
CMOS DIGITAL INTEGRATED CIRCUITS (GROUP D: PROFESSIONAL ELECTIVE) (Theory)						
Course Code	**:**	**18TE6D2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hrs**

Course Learning Objectives: The students will be able to	
1	Define the structure of MOS transistors and explain second-order effects of a MOSFET.
2	Explain the various sources of power in CMOS circuits and ways to minimize.
3	Realize digital circuits in variants of CMOS logic.
4	Draw stick diagram for a given CMOS digital circuit.

Unit-I	**08 Hrs**
Review of MOS transistor: MOSFET operation, MOSFET current-voltage characteristics. **Geometrical effects:** Channel length modulation, Substrate bias effect, Short-channel effects, Narrow-channel effects, Sub threshold conduction, DIBL, punch-through, Hot-carrier injection.	
Unit – II	**08 Hrs**
Review of different forms of pull-up. CMOS inverter operation with VTC, Design of CMOS inverter, Supply voltage scaling, CMOS ring oscillator circuit, Switching Power Dissipation of CMOS Inverters, CMOS logic circuits, Pseudo-nMOS logic.	
Unit –III	**08 Hrs**
CMOS transmission gates, CPL logic, CMOS D-latch and Flip-flop. **Fabrication Process Flow:** Basic Steps, Fabrication of the nMOS Transistor, CMOS nWell Process, Stick diagram for CMOS logic circuits. Dynamic CMOS logic, Domino logic, TSPC Dynamic CMOS circuits.	
Unit –IV	**08 Hrs**
Low-Power CMOS Logic Circuits: Need for low-power design, Overview of Power Consumption, Low-Power design through Voltage Scaling, Variable-Threshold CMOS (VTCMOS) Circuits, Multiple-Threshold CMOS (MTCMOS) Circuits, Pipelining Approach, and Parallel Processing Approach, Introduction to adiabatic CMOS gates.	
Unit –V	**07 Hrs**
Memories: 4-bit x 4-bit NOR and NAND based ROM array, Full CMOS SRAM cell, One-Transistor DRAM Cell.On-Chip Clock Generation and Distribution, Concepts of Hierarchy, Regularity, Modularity and Locality, Design quality.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the fundamentals of semiconductor physics in MOS transistors and analyze geometrical effects of MOS transistors.
CO2	Analyze the working of CMOS inverter and to realize the Boolean functions in variants of CMOS logic and draw stick diagrams for CMOS circuits.
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: Analysisand Design, Sung-Mo Kang and Yusuf Leblebici, 3rd Edition, Tata McGraw-Hill, ISBN: 0070530777, 2003.
2	Basic VLSI Design, Douglas A. Pucknell and Kamran Eshraghian, 3rd Edition, 2003, PHI, ISBN: 8120309863.

3	Deep-Submicron CMOS ICs, Harry Veendrick, 2nd Edition, 2000, Kluwer academic publishers, ISBN: 9044001116.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	1	1	3	---	---	---	---	---	---	1
CO2	2	2	2	1	3	---	---	---	---	---	---	1
CO3	2	2	1	2	3	---	---	---	---	---	---	1
CO4	1	2	2	2	3	---	---	---	---	---	---	1

High-3: Medium-2: Low-1

Semester: VI						
DATA STRUCTURES AND ALGORITHMS (GROUP D: PROFESSIONAL ELECTIVE) (Common to EC and TE)						
Course Code	**:**	**18EC6D3**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Formulate and apply object-oriented programming, using C++/Java, as a modern tool to solve engineering problems.
2	Demonstrate an understanding of basic data structures (such as an array-based list, linked list, stack, queue, binary search tree) and algorithms.
3	Demonstrate the ability to analyze, design, apply and use data structures and algorithms to solve engineering problems and evaluate their solutions.
4	Demonstrate an understanding of analysis of algorithms. Study an algorithm or program code segment that contains iterative constructs and analyze the asymptotic time complexity of the algorithm or code segment.

Unit-I	**08Hrs**
Introduction to data structures: Introduction to oops concepts. Introduction to data representation, Linear Lists, Linked Representation **Algorithm Analysis:** Mathematical Background, Model, What to Analyze, Running Time Calculations.	
Unit – II	**08 Hrs**
Stack and queue: Stack and queue implementation using linear list and linked list. Stack application-Parenthesis matching, Queue application-railroad car rearrangement. **Hashing:** Hash table representation- ideal hashing, hashing with linear open addressing, hash tables with chains.	
Unit –III	**07 Hrs**
Binary and other Trees: Trees, Binary Trees, Properties and Representation of Binary Trees-Formula Based Representation, Linked Representation, Common Binary Tree Operations. **Binary Search Tree (BST).** Organizing data in a BST. Inserting and deleting items in a BST.	
Unit –IV	**08 Hrs**
Priority Queues (Heaps): Model, Simple Implementations, Binary Heap, Leftist Heaps. **Graph Algorithms:** Definitions, Properties of graphs, Representation of Graphs, Shortest-Path Algorithms, Network Flow Problems, Minimum Spanning Tree, Depth-First Search, Breadth-First Search ,Introduction to NP-Completeness.	
Unit –V	**08 Hrs**
Searching and Sorting Techniques: Sorting Techniques: Bubble sort, Merge sort, Selection sort', Heap sort, Insertion Sort. Searching Techniques: Sequential Searching, Binary Searching, Search Trees. **Algorithm Design Techniques:** Greedy Algorithms, Divide and Conquer, Dynamic Programming, Randomized Algorithms, Backtracking Algorithms.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Acquire the knowledge of importance of data structures in computer programs.
CO2	Represent and solve data analytics problems using graph algorithms.
CO3	Implement classic data structures: array lists, linked lists, stacks, queues, heaps, binary trees, hash tables.
CO4	Evaluate the performance of various algorithms built using different data structures.

Reference Books	
1	Data Structures and Algorithm Analysis in C++ (3rd edition), by M. A. Weiss. Addison-Wesley, ISBN-10: 032144146X & ISBN-13: 9780321441461.
2	Sartaj Sahani; "Data structures, Algorithms and applications in c++"; McGraw Hill; 2000;1st Edition; *ISBN*: 10:007236226X.
3	Data Structures Using C++, D.S. Malik, 2nd Edition, 2009, Cengage Learning, ISBN- 13: 978-0-324-78201-1.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.
Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	3	-	-	-	-	-	-		-	-
CO2	3	2	2	3	-	-	-	2	2		-	-
CO3	2	2	3	3	-	-	-	2	2		-	-
CO4	3	3	3	3	2	3	2	3	3	3	2	3

High-3: Medium-2: Low-1

Semester: VI						
JAVA **(GROUP D: PROFESSIONAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18TE6D4**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**3.00 Hrs**

Course Learning Objectives:	
1	Map the concepts learnt in object oriented programming by considering suitable use-cases and implement same using the programming constructs specified in Java.
2	Build awareness of basic programming constructs and methods in Java and implement simple programs on it.
3	Introduce utilities and advanced programming concepts in Java to cater the demand of full-fledged application.
4	Develop a project that will apply concepts in to workable code.

Unit-I	**08 Hrs**
Java Programming Fundamentals: Java Language introduction, Java features, why Java is important to internet, Hello World (simple java programs), Lexical Issues, Java class Libraries, Variables, Data Types- the primitive Types, Type conversion and Casting, Arrays. Operators, Flow Control-Branching, Looping.	
Unit – II	**08 Hrs**
Introducing classes: Class fundamentals, declaring objects**,** Classes-Object References, Instance Variables, The new operator, The Dot (.) Operator, introducing methods, Method Declaration, Method Calling, Constructors, Method Overloading. **Inheritance:** Inheritance basics, Method Overriding, uses of super, Dynamic Method Dispatch, Abstract classes, Enumerations, Type wrappers.	
Unit -III	**08 Hrs**
Packages and Interfaces: Packages, Access protection, Importing packages and Interfaces. **Exception handling:** Excepton types, uncaught exceptions, java's built-in exceptions. **Multithreaded programming:** The java thread model, Thread life cycle, main thread, creation of threads using implementing runnable and extending thread, creating multiple threads, Thread priorities, synchronization, Inter thread communication, suspending, resuming, and stopping threads.	
Unit –IV	**08 Hrs**
Introduction to Java GUI: Applets: Applet Basics, Architecture, Applet Lifecycle, repaint (), update, HTML APPLET Tags, passing parameters to Applets. **AWT:** AWT classes, Window fundamentals. **Swings:** Introduction to Swings, JApplet, JFrame and JComponent, Icons & labels, Handling Threading issues, Text Fields, Buttons.	
Unit –V	**08 Hrs**
Servlets: Servlet Lifecycle, The Concept of JDBC; JDBC Driver Types; JDBC Packages;Database Connection; Associating the JDBC/ODBC Bridge with the Database. J2ME basics, J2ME overview and J2ME Architecture.	

Course outcomes: On completion of the course, the student should have acquired the ability to	
CO1	Understand the fundamentals concepts and its applications of JAVA such as Exceptions, Applets, AWT, Swings, JDBC, JSP.
CO2	Apply the concepts of classes, instances & Inner classes in Java, inheritance, exceptions and threading concepts in programming.
CO3	Create applications using the concepts of Applets, Swings, and Servlets.
CO4	Design and implement applications using Java allied technologies.

Reference Books	
1	The Complete Reference–Java, Herbert Schildt, 7th Edition,TMH Publications, ISBN-10: 0071808558.
2	The Complete Reference - J2EE, JimKeogh, TMHpublications, ISBN: 10, 0070529124.
3	The Complete Reference J2ME, Jim Keogh, 2006, Tata McGraw Hill, ISBN: 9780070534155.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.
Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	2	1	---	---	1	---	---	---	1
CO2	3	3	3	2	2	---	---	1	---	---	---	1
CO3	3	3	3	1	1	---	---	1	---	---	---	1
CO4	3	3	3	2	1	---	---	1	---	---	---	1

High-3 : Medium-2 : Low-1

Semester: VI						
AIRCRAFT SYSTEMS **(GROUP E: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G6E01**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:

1	List the various systems involved in the design of an aircraft
2	Demonstrate the technical attributes of all the subsystems of an aircraft
3	Explain the significance of each systems and its subsystems for developing an airplane
4	Demonstrate the integration of the systems with the airplane

Unit-I	**07Hrs**
Flight Control Systems: Primary and secondary flight controls, Flight control linkage system, Conventional Systems, Power assisted and fully powered flight controls.	
Unit – II	**10Hrs**
Aircraft Hydraulic & Pneumatic Systems: Components of a typical Hydraulic system, Working or hydraulic system, Power packs, Hydraulic actuators. Pneumatic system and components, Use of bleed air, Landing gear and braking, Shock absorbers-Retraction mechanism.	
Unit -III	**08Hrs**
Aircraft Fuel Systems: Characteristics of aircraft fuel system, Fuel system and its components, Gravity feed and pressure feed fuel systems, Fuel pumps-classification, Fuel control unit.	
Unit -IV	**07Hrs**
Environmental Control Systems: Air-conditioning system, vapour cycle system, de-icing and anti-icing system, Fire detection- warning and suppression. Crew escape aids. **Engine Systems: Engine** starting sequence, Starting and Ignition systems, Engine oils and a typical lubricating system.	
Unit -V	**07Hrs**
Aircraft Instruments : Instruments displays, panels & layouts, Instrumentation grouping, Navigation instruments, Radio instruments, Hydraulic and Engine instruments. **Air Data Instruments :** Basic air data system and probes, Mach meter, Air speed indicator, Vertical speed indicator, Barometric pressure sensing, Altimeter, Air data alerting system- angle of attack sensing, stall warning, Mach warning, altitude alerting system.	

Course Outcomes:

At the end of this course the student will be able to :

CO1:	Categorise the various systems required for designing a complete airplane
CO2:	Comprehend the complexities involved during development of flight vehicles.
CO3:	Explain the role and importance of each systems for designing a safe and efficient flight vehicle
CO4:	Demonstrate the different integration techniques involved in the design of an air vehicle

Reference Books

1	Introduction to Flight, John D. Anderson, 7th Edition, 2011, McGraw-Hill Education, ISBN 9780071086059.
2	Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, Moir, I. and Seabridge, A.,3rd Edition, 2008, Wiley Publications, ISBN- 978-0470059968

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	3	2	2	-	-	-	1
CO2	2	3	3	3	1	1	1	1	-	-	-	1
CO3	2	2	3	3	1	-	-	-	-	-	-	2
CO4	3	3	3	3	1	2	1	2	-	-	-	1

High-3: Medium-2: Low-1

Semester: VI						
BIO INSPIRED ENGINEERING **(GROUP E: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G6E02**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	To familiarize engineering students with basic biological concepts
2	Utilize the similarities noted in nature for a particular problem to bring inspiration to the designer.
3	Explain applications such as smart structures, self-healing materials, and robotics relative to their biological analogs
4	To gain an understanding that the design principles from nature can be translated into novel devices and structures.

Unit-I	**08 Hrs**
Introduction to biological systems: General and Special biomolecules, Plant, animal and microbial cell types, Somatic and Sensory system. Plant process - Photosynthesis. Neural networks, Neuron models–Signal encoding architecture, Synaptic plasticity–Supervised, unsupervised and reinforcement learning, Evolution of artificial neural networks–Hybrid neural systems with case study Harvesting Desert Fog.	
Unit – II	**08 Hrs**
Introduction to Biomimetics: Introduction to micro architectural aspects. Structures and physical functions of biological composites of engineering – related case study: Camera from eyes, clothing designs and hooks from Velcro Criteria for future materials design and processing. Computation Cellular systems: Cellular automata – modelling with cellular systems with cellular systems – artificial life – analysis and synthesis of cellular systems: Nature's Water Filter.	
Unit –III	**08 Hrs**
Engineering of synthetic organs: Growth, development and principle of artificial skins, hearing aids, artificial limbs, artificial lungs and artificial lever. Implants-working principle of pacemaker, Breast Implants, Artificial Eye Lenses, Blood sugar monitoring, artificial heart. Application of Spine Screws, Rods and Artificial Discs, Metal Screws, Pins, Plates and Rods	
Unit –IV	**07 Hrs**
Biosimilars: Introduction, characteristics and bioequivalence. Criteria for Bioequivalence, Development of Biosimilars, Statistical Methods for Assessing Biosimilarity, Issues on Immunogenicity Studies, Regulatory Requirements, Stability Analysis of Biosimilar Products, Challenges involved in Biosimilars.	
Unit –V	**08 Hrs**
Biomechatronics: Introduction to MEMS based devices, Evolution of behavioural systems, learning in behavioural systems – co evolution of body and control. Behaviour in cognitive science and artificial intelligence. Biological inspiration for robots, Robots as biological models and robotics behaviour, Application of sleek scale of shark skin.	

Course Outcomes: After completing the course, the students will be able to

CO1:	Remember and explain the concepts of biological and physiological processes
CO2:	Elucidate the basic principles for design and development of biological systems.
CO3:	Differentiate biological phenomena to support inspiration for visual and conceptual design problems

CO4:	Develop technical solutions to customer needs by utilizing a variety of bio-inspiration techniques.

Reference Books	
1	Yoseph Bar-Cohen. Biomimetics: Biologically Inspired Technologies D. Floreano and C. Mattiussi, "Bio-Inspired Artificial Intelligence", CRC Press, 2018. ISBN: 1420037714, 9781420037715.
2	Bououdina, Mohamed. Emerging Research on Bioinspired Materials Engineering. IGI Global, 2016. ISBN: 1466698128, 9781466698123.
3	Christopher H. M. Jenkins. Bio-Inspired Engineering. Momentum Press, 2011. ISBN: 1606502255, 9781606502259.
4	Göran Pohl, Werner Nachtigall. Biomimetics for Architecture & Design: Nature - Analogies – Technology. Springer, 2019. ISBN: 3319191209, 978331919120

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover the entire unit having the same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	-	-	1	3	2	-	1	1	1	-
CO2	3	3	2	3	2	-	1	2	-	1	2	-
CO3	2	2	2	3	3	3	2	2	-	1	2	2
CO4	2	2	3	3	2	-	1	2	1	-	-	-

High-3: Medium-2: Low-1

Semester: VI						
SUSTAINABLE TECHNOLOGY (GROUP E: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G6E03**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the fundamental concepts related to interaction of industrial and ecological systems.
2	Understand the basic concepts of life cycle assessment.
3	Demonstrate life cycle assessment methodology using appropriate case studies.
4	Use concepts of systems-based, trans-disciplinary approach to sustainability.

Unit-I	**08 Hrs**
Introduction to sustainability: Introduction to Sustainability Concepts and Life Cycle Analysis, Material flow and waste management, Chemicals and Health Effects, Character of Environmental Problems	
Unit – II	**07 Hrs**
Environmental Data Collection and LCA Methodology: Environmental Data Collection Issues, Statistical Analysis of Environmental Data, Common Analytical Instruments, Overview of LCA Methodology. – Goal, Definition.	
Unit –III	**08 Hrs**
Life Cycle Assessment: Life Cycle Impact Assessment, Life Cycle Interpretation, LCA Benefits and Drawbacks. **Wet Biomass Gasifiers:** Introduction, Classification of feedstock for biogas generation, Biomass conversion technologies: Photosynthesis, Biogas generation, Factors affecting bio-digestion, Classification of biogas plants, Floating drum plant and fixed dome plant their advantages and disadvantages.	
Unit –IV	**08 Hrs**
Design for Sustainability: Green Sustainable Materials, Environmental Design for Sustainability. **Dry Biomass Gasifiers:** Biomass energy conversion routes, Thermal gasification of biomass, Classification of gasifiers, Fixed bed systems:	
Unit –V	**08 Hrs**
Case Studies: Odor Removal for Organics Treatment Plant, Bio-methanation, Bioethanol production. Bio fuel from water hyacinth.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the sustainability challenges facing the current generation, and systems-based approaches required to create sustainable solutions for society.
CO2:	Identify problems in sustainability and formulate appropriate solutions based on scientific research, applied science, social and economic issues.
CO3:	Apply scientific method to a systems-based, trans-disciplinary approach to sustainability
CO4:	Formulate appropriate solutions based on scientific research, applied science, social and economic issues.

Reference Books	
1	Sustainable Engineering Principles and Practice, Bavik R Bhakshi, 2019, Cambridge University Press, ISBN - 9781108333726.

2	Environmental Life Cycle Assessment, Olivier Jolliet, Myriam Saade-Sbeih, Shanna Shaked, Alexandre Jolliet, Pierre Crettaz , 1st Edition, CRC Press, ISBN: 9781439887660 .
3	Sustainable Engineering: Drivers, Metrics, Tools, and Applications, Krishna R. Reddy, Claudio Cameselle, Jeffrey A. Adams, 2019, John Wiley & Sons, ISBN-9781119493938

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	1	-	1
CO2	3	2	2	1	-	-	-	-	-	1	-	1
CO3	3	3	2	2	-	-	-	-	-	1	-	1
CO4	3	3	3	3	-	-	-	-	-	1	-	1

High-3: Medium-2: Low-1

Semester: VI						
GRAPH THEORY **(GROUP E: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G6E04**		**CIE Marks**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand the basics of graph theory and their various properties.
2	Model problems using graphs and to solve these problems algorithmically.
3	Apply graph theory concepts to solve real world applications like routing, TSP/traffic control, etc.
4	Optimize the solutions to real problems like transport problems etc.,

UNIT-I	**07 Hrs**
Introduction to graph theory Introduction, Mathematical preliminaries, definitions and examples of graphs, degrees and regular graphs, sub graphs, directed graphs, in degrees and out degrees in digraphs. **Basic concepts in graph theory** Paths and cycles, connectivity, homomorphism and isomorphism of graphs, connectivity in digraphs.	
UNIT-II	**09 Hrs**
Graph representations, Trees, Forests Adjacency matrix of a graph, Incidence matrix of a graph, Adjacency lists, Trees and properties of trees, Characterization of trees, Centers of trees, Rooted trees, Binary threes, Spanning trees and forests, Spanning trees of complete graphs, An application to electrical networks, Minimum cost spanning trees.	
UNIT-III	**09 Hrs**
Fundamental properties of graphs and digraphs Bipartite graphs, Eulerian graphs, Hamiltonian graphs, Hamiltonian cycles in weighted graphs, Eulerian digraphs. **Planar graphs, Connectivity and Flows** Embedding in surfaces, Euler's formula, Characterization of planar graphs, Kuratowski's theorem, Dual of a planar graphs.	
UNIT-IV	**07 Hrs**
Matchings and Factors Min-Max theorem, Independent sets and covers, Dominating sets, maximum bipartite matching. **Coloring of graphs** The chromatic number of a graph, Results for general graphs, The chromatic polynomial of a graph, Basic properties of chromatic polynomial, chordal graphs, powers of graphs, Edge coloring of graphs	
UNIT-V	**07Hrs**
Graph algorithms Graph connectivity algorithms, Breadth first search and Depth first search, Shortest path algorithms, Dijikstra's shortest path algorithm, Minimum cost spanning tree algorithms, Algorithm of Kruskal's and Prim's.	

Course Outcomes: After completing the course, the students will be able to	
CO1.	Understand and explore the basics of graph theory.
CO2.	Analyse the significance of graph theory in different engineering disciplines
CO3.	Demonstrate algorithms used in interdisciplinary engineering domains.
CO4.	Evaluate or synthesize any real world applications using graph theory.

Reference Books	
1.	Introduction to graph theory, Douglas B. West, 2nd Edition, 2001, PHI, ISBN- 9780130144003, ISBN-0130144002.
2.	Graph Theory, Modeling, Applications and Algorithms, Geir Agnarsson, Raymond Greenlaw, Pearson Education, 1st Edition, 2008, ISBN- 978-81-317-1728-8.
3.	Introduction to Algorithms, Cormen T.H., Leiserson C. E, Rivest R.L., Stein C., 3rd Edition, 2010, PHI, ISBN:9780262033848

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	-	-	-	-	-	-	1	1	-	-
CO2	2	3	2	1	-	-	-	-	2	2	-	1
CO3	2	2	3	2	-	-	-	-	2	2	-	1
CO4	2	2	3	2	-	1	-	-	2	2	-	1

High-3: Medium-2: Low-1

Semester: VI						
DISASTER MANAGEMENT **(GROUP E: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G6E05**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Study the environmental impact of natural and manmade calamities
2	Learn to analyze and assess risk involved due to disasters.
3	Understand the role of public participation.
4	Learn the management tools and mitigation techniques.

Unit-I	**08 Hrs**
Natural disasters and Disaster management Introduction to natural and Industrial Hazards- floods, landslides, earthquakes, volcanoes, avalanche, cyclones, drought, fire, release of effluents, harmful gases, Blast etc. Prediction and perception. Environmental risk due to project activities. Preparation of on-site and off-site disaster management plans - Pre disaster, actual disaster, Post disaster plans. Relief camp organization. Role of voluntary organization and armed forces during disasters.	
Unit – II	**07 Hrs**
Risk analysis and assessment Basic concept. Purpose of risk analysis. Analytical techniques and tools of risk assessment. Toxicology. Significance of risk. Risk characterization. Risk communication and Management, AI in emergency responses.	
Unit –III	**08 Hrs**
Environmental Impact Assessment (EIA) Definition, Basic concepts and principles of EIA. Regulatory framework in India. Environmental inventory. Base line studies. Over view of EIA studies.	
Unit –IV	**08 Hrs**
Assessment and Methodologies Physical, Biological, Natural resources, Socio economic and cultural environmental assessment. EIA methodologies- Adhoc, Matrix, Checklist approaches. Economic evaluation of impacts- cost benefits of EIA. Public participation in environmental decision making. Procedures for reviewing EIA analysis and statement. Decision methods for evaluation of alternatives.	
Unit –V	**08 Hrs**
Disaster Mitigation and Management Introduction, types, modes of disaster management, tools and techniques, primary and secondary data. Natural disasters its causes and remedies-Earthquake hazards-Causes and remedies, Flood and Drought assessment, causes and remedies, Landslides-causes and remedies. Fire hazards in buildings, Fire hazard management, Traffic management, Cyclones and hurricanes, inter department cooperation. Regional and global disaster mitigation.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explain the different types of disasters and manage the pre and post disaster situation.
CO2:	Estimate and communicate the risk by conducting the risk assessment and Environmental Impact Assessment
CO3:	Identify the methods of disaster mitigation based on the basis of the risk assessment.

CO4:	Analyze and evaluated the impact of measures adopted to mitigate the impacts.

Reference Books	
1	Environmental Impact Analysis Hand Book, John G Rau and David C Wooten, Edition: 2013, ISBN: 978-0070512177.
2	Introduction to environmental Impact assessment, John Glasson, RikiTherivel, Andrew Chadwick, Edition: 2012, Research Press, ISBN:000-0415664705.2005, Reliance Publishing House, New Delhi.
3	Natural Disaster Reduction, Girish K Mishrta, G C Mathew (eds), Edition, 2005, Reliance Publishing House, New Delhi,
4	Remote Sensing and Image Interpretation, Thomas M. Lillisand and R.W. Keifer, 6th Edition, 2002, John Wiley, ISBN:9780470052457.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) + 30 (Q) + 20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	1	1	-	-	1	1	-	-	-	-	-
CO2	-	2	1	-	-	2	1	1	-	-	-	-
CO3	-	2	1	-	-	2	1	3	-	-	-	-
CO4	-	1	1	-	-	3	2	1	-	-	-	-

High-3: Medium-2: Low-1

Semester: VI						
WEARABLE ELECTRONICS **(GROUP E: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G6E06**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Explain the types and application of wearable sensor.
2	Describe the working of sensitivity, conductivity and energy generation in wearable devices.
3	Explain the various facets of wearable application, advantage & challenges.
4	Understand different testing and calibration in wearable devices.

Unit-I	**08 Hrs**
Introduction: world of wearable (WOW), Role of wearable, The Emerging Concept of Big Data, The Ecosystem Enabling Digital Life, Smart Mobile Communication Devices, Attributes of Wearables, Taxonomy for Wearables, Advancements in Wearables, Textiles and Clothing, Applications of Wearables. [Ref 1: Chapter 1.1]	
Unit – II	**08 Hrs**
Wearable Bio and Chemical Sensors: Introduction, System Design, Microneedle Technology, Sampling Gases, Types of Sensors, Challenges in Chemical Biochemical Sensing, Sensor Stability, Interface with the Body, Textile Integration, Power Requirements, Applications: Personal Health, Sports Performance, Safety and Security, Case studies. [Ref 1: Chapter 2.1]	
Unit –III	**07 Hrs**
Smart Textile: Conductive fibres for electronic textiles: an overview, Types of conductive fibre, Applications of conductive fibres, Bulk conductive polymer yarn, Bulk conductive polymer yarn, Techniques for processing CPYs, Wet-spinning technique, Electrospinning technique, case studies, Hands on project in wearable textile: Solar Backpack, LED Matrix wallet. [Ref 2: Chapter 1,2] &. [Ref 3: Chapter 6,9]	
Unit –IV	**08 Hrs**
Energy Harvesting Systems: Introduction, Energy Harvesting from Temperature Gradient, Thermoelectric Generators, Dc-Dc Converter Topologies, Dc-Dc Converter Design for Ultra-Low Input Voltages, Energy Harvesting from Foot Motion, Ac-Dc Converters, Wireless Energy Transmission, Energy Harvesting from Light, Case studies. [Ref 1: Chapter 4.1]	
Unit –V	**08 Hrs**
Wearable antennas for communication systems: Introduction, Background of textile antennas, Design rules for embroidered antennas, Integration of embroidered textile surfaces onto polymer substrates, Characterizations of embroidered conductive, textiles at radio frequencies, RF performance of embroidered textile antennas, Applications of embroidered antennas. [Ref 2: Chapter 10]	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Describe the different types and wearable sensors, textile, energy harvesting systems and antenna
CO2:	Analysis measurable quantity and working of wearable electronic devices.
CO3:	Determine & interpret the outcome of the wearable devices and solve the design challenges
CO4:	Analyse and Evaluate the wearable device output parameter in real time scenario or given problem statement.

Reference Books	
1	Wearable Sensors: Fundamentals, Implementation and Applications, Edward Sazonov, Michael R. Neuman Academic Press, 1st Edition, 2014, ISBN-13: 978-0124186620.
2	Electronic Textiles: Smart Fabrics and Wearable Technology, Tilak Dias, Woodhead Publishing; 1st Edition, ISBN-13: 978-0081002018.
3	Make It, Wear It: Wearable Electronics for Makers, Crafters, and Cosplayers, McGraw-Hill Education, 1st Edition, ISBN-13: 978-1260116151.
4	Flexible and Wearable Electronics for Smart Clothing: Aimed to Smart Clothing, Gang Wang, Chengyi Hou, Hongzhi Wang, Wiley, 1st Edition, ISBN-13: 978-3527345342
5	Printed Batteries: Materials, Technologies and Applications, Senentxu Lanceros-Méndez, Carlos Miguel Costa, Wiley, 1st Edition, ISBN-13: 978-1119287421

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	3	-	-	-	-	-	-		-	-
CO2	3	2	2	3	-	-	-	2	2		-	-
CO3	2	2	3	3	-	-	-	2	2		-	-
CO4	3	3	3	3	2	3	2	3	3	3	2	3

High-3: Medium-2: Low-1

Semester: VI						
ENERGY AUDITING AND MANAGEMENT **(GROUP E: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G6E07**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**
Course Learning Objectives: The students will be able to						
1	Understand the need for energy audit, energy management and the concepts of both.					
2	Explain Processes for energy audit of electrical systems.					
3	Design and develop processes for energy audit of mechanical systems.					
4	Prepare the format for energy audit of buildings and lighting systems.					

Unit-I	**06 Hrs**
Types of Energy Audit and Energy-Audit Methodology: Definition of Energy Audit, Place of Audit, Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, Energy Monitoring and Training. **Survey Instrumentation**: Electrical Measurement, Thermal Measurement, Light Measurement, Speed Measurement, Data Logger and Data Acquisition System, **Energy Audit of a Power Plant**: Indian Power Plant Scenario, Benefit of Audit, Types of Power Plants, Energy Audit of Power Plant.	
Unit – II	**10 Hrs**
Electrical-Load Management: Electrical Basics, Electrical Load Management, Variable-Frequency Drives, Harmonics and its Effects, Electricity Tariff, Power Factor, Transmission and Distribution Losses. **Energy Audit of Motors:** Classification of Motors, Parameters related to Motors, Efficiency of a Motor, Energy Conservation in Motors, BEE Star Rating and Labelling. **Energy Audit of Pumps, Blowers and Cooling Towers:** Pumps, Fans and Blowers, Cooling Towers	
Unit -III	**10 Hrs**
Energy Audit of Boilers: Classification of Boilers, Parts of Boiler, Efficiency of a Boiler, Role of excess Air in Boiler Efficiency, Energy Saving Methods. **Energy Audit of Furnaces:** Parts of a Furnace, classification of Furnaces, Energy saving Measures in Furnaces, Furnace Efficiency **Energy Audit of Steam-Distribution Systems** :S team as Heating Fluid, Steam Basics, Requirement of Steam, Pressure, Piping, Losses in Steam Distribution Systems, Energy Conservation Methods	
Unit –IV	**07 Hrs**
Compressed Air System: Classification of Compressors, Types of Compressors, Compressed Air – System Layout, Energy – Saving Potential in a Compressed – Air System. **Energy Audit of HVAC Systems:** Introduction to HVAC, Components of Air – Conditioning System, Types of Air – Conditioning Systems, Human Comfort Zone and Psychrometry, Vapour – Compression Refrigeration Cycle, Energy Use Indices, Impact of Refrigerants on Environment and Global Warming, Energy – Saving Measures in HVAC, Star Rating and Labelling by BEE.	
Unit –V	**06 Hrs**
Energy Audit of Lighting Systems: Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures (Luminaries), Reflectors, Lenses and Louvres, Lighting Control Systems, Lighting System Audit, Energy Saving Opportunities.	

Energy Audit Applied to Buildings: Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings.

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

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

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	2	2	1	2	3	2	1	1	1	2
CO2	3	3	2	2	2	2	3	2	1	1	2	2
CO3	3	3	2	2	2	2	3	2	1	1	2	2
CO4	3	3	2	2	2	2	3	3	1	1	2	2

High-3: Medium-2: Low-1

Semester: VI						
VIRTUAL INSTRUMENTATION & APPLICATIONS (GROUP E: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G6E08**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understanding the difference between conventional and graphical programming
2	Differentiating the real time and virtual instrument.
3	Analyzing the basics of data acquisition and learning the concepts of data acquisition with LabVIEW
4	Developing a real time application using myRIO and myDAQ programming concepts.

Unit-I	**07 Hrs**
Basic of Virtual Instrumentation, Introduction to Lab VIEW, Components of LabVIEW and Labels., Controller, Indicators data types, wiring tool, debugging tools, Creating Sub-Vis, Boolean, - Mechanical action- switch, and latch actions, Enum, Text, Ring, Type Def, Strict Type Def.	
Unit – II	**09 Hrs**
For Loop, While Loop , Shift registers, stack shift register , feedback node, and tunnel , elapsed time, wait function, Case structures, formula node, Sequence structures, Local and Global variables.	
Unit –III	**09 Hrs**
Arrays and clusters, Visual display types- graphs, charts, XY graph, Introduction to String Functions, LabVIEW String Functions, Typical examples, File Formats, File I/O Functions, File operation	
Unit –IV	**07 Hrs**
Design Pattern- Producer-Consumer Model, Event Structure Model, Master-Slave Model, State Machine Model, Synchronization using Semaphore, Introduction to DAQ System, Measurement and Automation Explorer, DAQ Assistants, Analysis Assistants, Instrument Assistant, Real time application using myDAQ Configured it as Virtual labs, Counters, Low level Lab-VIEW Program,	
Unit –V	**07 Hrs**
Signal Processing Application- Fourier transforms, Power spectrum, Correlation methods, windowing & flittering , Real time application using myRIO, Communication protocol (SPI, I2C, UART) for Embedded Applications, Configure myRIO for speed control of DC Motor using encoder, Keypad application, LCD, IR Sensor, , and onboard sensors. Development of control system, Image acquisition and processing	

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

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks are executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	1	-	-	-	-	-	1	1	-	1
CO2	1	3	2	1	2	-	-	-	1	1	-	1
CO3	2	2	3	3	3	-	-	-	1	1	-	2
CO4	1	2	2	3	3	1	0	2	3	2	1	2

High-3: Medium-2: Low-1

Semester: VI						
SYSTEMS ENGINEERING (GROUP E: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G6E09**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives:

1.	Understand the Life Cycle of Systems.
2.	Explain the role of Stake holders and their needs in organizational systems.
3.	Develop and Document the knowledge base for effective systems engineering processes.
4.	Apply available tools, methods and technologies to support complex high technology systems.
5.	Create the frameworks for quality processes to ensure high reliability of systems.

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	**07 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	**06 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.
CO5:	Create the frameworks for quality processes to ensure high reliability of systems.

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

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part A and Part B. Part A consists of objective type questions for 20 marks covering the complete syllabus. Part B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	-	-	-	-	1	-	-	-	-	-	1
CO2	-	2	3	-	1	-	-	1	-	-	2	-
CO3	-	3	-	-	-	2	2	1	-	3	2	-
CO4	-	-	2	1	-	-	-	-	-	-	-	-
CO5	1	1	-	2	-	1	2	-	3	-	-	-

High-3: Medium-2: Low-1

Semester: VI						
INTRODUCTION TO MOBILE APPLICATION DEVELOPMENT **(GROUP E: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G6E10**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Comprehend the knowledge on essentials of android application development.
2	Demonstrate the basic and advanced features of android technology.
3	Develop the skills in designing and building mobile applications using android platform.
4	Create. debug and publish innovative mobile applications using android Platform.
5	Comprehend the knowledge on essentials of android application development.

Unit-I	**08 Hrs**
Introduction: Smart phone operating systems and smart phones applications. Introduction to Android, Installing Android Studio, creating an Android app project, deploying the app to the emulator and a device. UI Design: Building a layout with UI elements, Layouts, Views and Resources, Text and Scrolling Views. Activities and Intents, The Activity Lifecycle, Managing State, Activities and Implicit Intents, Testing, debugging, and using support libraries, The Android Studio Debugger, Testing android app, The Android Support Library.	
Unit – II	**08 Hrs**
User experience: User interaction, User Input Controls, Menus, Screen Navigation, Recycler View, Delightful user experience, Drawables, Styles, and Themes, Material Design, Providing Resources for Adaptive Layouts, Testing app UI, Testing the User Interface	
Unit –III	**08 Hrs**
Working in the background: Background Tasks, AsyncTask and Async Task Loader, Connect to the Internet, Broadcast Receivers, and Services. Triggering, scheduling and optimizing background tasks – Notifications, Scheduling Alarms, and Transferring Data Efficiently	
Unit –IV	**08 Hrs**
All about data: Preferences and Settings, Storing Data, Shared Preferences, App Settings. Storing data using SQLite - SQLite Primer, SQLite Database. Sharing data with content providers. Loading data using loaders. Using Selection Widgets and Debugging, Displaying and Fetching Information, Using Dialogs and Fragments, Advanced Android Programming: Internet, Entertainment, and Services, Implementing drawing and animations. Displaying web pages and maps, communicating with SMS and emails. Creating and consuming services - Location based services, Sensors.	
Unit –V	**07 Hrs**
Hardware Support & devices: Permissions and Libraries, Performance and Security. Firebase and AdMob, Publish and Polish, Multiple Form Factors, Using Google Services.	

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

Reference Books	
1	Android Programming, Phillips, Stewart, Hardy and Marsicano, Big Nerd Ranch Guide, 2nd Edition, 2015, ISBN-13 978-0134171494
2	Android Studio Development Essentials - Android 6, Neil Smyth, 2015, Createspace Independent Publishing Platform, ISBN: 9781519722089
3	Android Programming – Pushing the limits, Eric Hellman, 2013, Wiley, ISBN-13: 978-1118717370
4	Professional Android 2 Application Development, Reto Meier, Wiley India Pvt.Ltd 1st Edition, 2012, ISBN-13: 9788126525898
5	Beginning Android 3, Mark Murphy, Apress Springer India Pvt Ltd, 1st Edition, 2011, ISBN-13: 978-1-4302-3297-1
6	Android Developer Training - https://developers.google.com/training/android/ Android Testing Support Library - https://google.github.io/android-testing-support-library/

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Self-Study(S). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Self-study is 20. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	-	-	-	3	-	-	-	-	-	-	2
CO2	3	-	-	-	3	-	-	-	-	-	1	2
CO3	-	3	3	-	3	-	1	-	-	2	1	3
CO4	3	3	3	1	3	2	1	2	2	1	1	3

High-3: Medium-2: Low-1

Semester: VI						
INDUSTRIAL AUTOMATION **(GROUP E: GLOBAL ELECTIVE)** **(THOERY)**						
Course Code	**:**	**18G6E11**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39 L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Identify the various types of Actuators, sensors and switching devices used in industrial automation.
2	Understand the fundamentals of CNC, PLC and Industrial robots.
3	Describe the functions of hardware components for automation
4	Prepare simple manual part programs for CNC and Ladder logic for PLC.
5	Demonstrate the ability to develop suitable industrial automation systems using all the concepts

Unit-I	**06 Hrs**

Overview of Automation in Industry

Basic kinds of Industrial type equipment, automation and process control, mechanization vs automation, continuous and discrete control, basic elements of an automated system, advanced automation functions, levels of automation, basic automation circuits.

Unit-II	**10 Hrs**

Sensors and Industrial Switching elements.

Sensor terminology, Classification of sensors and transducers, Limit switch, Temperature sensors, Light sensors, position sensors, inductive and capacitive proximity sensors, optical encoders, Relays, Solenoids, moving part logic elements, fluidic elements, timers, comparisons between switching elements.

Industrial Automation Synthesis

Introductory principles, basic automation examples, meaning of the electrical and mechanical latch, automation circuits with sensors, design regulations and implementation.

Unit-III	**10 Hrs**

Logical Design of Automation Circuits

Postulates and theorems of Boolean algebra, Classical state diagrams, state diagrams with sensors, step by step transition due to discrete successive signal, state diagram with time relays, components state diagram method, state diagrams and minimum realisations, sequential automation systems, Applications – Bi directional lead screw movable worktable with two speeds, Palindromic movement of a worktable with memory.

Elements of electro pneumatic actuation

Basic elements of pneumatic system, pneumatic cylinders, Symbolic representations of pneumatic and electrical switching devices, Indirect control of double acting cylinders, memory control circuit, cascading design, automatic return motion, quick exhaust valve circuit, and cyclic operation of a cylinder, pressure sequence valve and time delay valve circuits. Automatic return motion, Separating similar balls, Stamping device.

Unit-IV	**06 Hrs**

Numerical Control and Robotics

Numerical control, components of CNC, classification, coordinate systems, motion control strategies, interpolation, NC words, Simple part programming for turning, milling and drilling. Components of the robot, base types, grippers, Configurations and simple programming using VAL.

Unit-V	07 Hrs
Programmable logic control systems Internal structure, principles of operation, latching, ladder diagrams, programming instructions, types of timers, forms of counters, writing simple ladder diagrams from narrative description and Boolean logic. Programming exercises on motor control in two directions, traffic control, cyclic movement of cylinder, conveyor belt control, alarm system, sequential process, and continuous filling operation on a conveyor.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Recall and Illustrate the application of sensors actuators, switching elements and inspection technologies in industrial automation.
CO2:	Build the circuit diagrams for fluid power automation, Ladder diagrams for PLC and identify its application areas.
CO3:	Evaluate CNC part programs for 2D complex profiles, perform machining and turning centres interfaced with Robots.
CO4:	Develop a suitable industrial automated system integrating all of the above advanced automation concepts

Reference Books	
1.	Stamatios Manesis, George Nikolakopoulos, 'Introduction to Industrial Automation', CRC Press, 2018, ISBN - 978-1-4987-0540-0
2.	David W. Pessen, 'Industrial automation; Circuit design and components', Wiley India, 1st Edition, 2011, ISBN –13–978–8126529889.
3.	Joji P, 'Pneumatic Controls', Wiley India, 1st Edition, ISBN – 978–81–265–1542–4.
4.	Petruzella, Frank D, Programmable logic controllers, McGraw-Hill, 4th Edition, 2013, ISBN-13: 978-0-07-351088-0

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Experiential Learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30 (Q) + 50 (T) + 20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	2	2	-	3	1	-	-	-	1	-	1
CO2	2	2	3	2	2	-	-	-	1	2	-	1
CO3	2	2	3	3	2	-	-	-	-	2	-	-
CO4	3	3	3	2	2	-	-	-	-	2	-	1

High-3: Medium-2: Low-1

Semester: VI						
MOBILE NETWORK SYSTEM AND STANDARDS (GROUP E: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G6E12**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Hrs/Week	**:**	**40L**		**SEE Duration**	**:**	**3.00 Hrs**

Course Learning Objectives: The students will be able to

1	Understand the essential principles of cellular communication and factors that might degrade the performance.
2	Describe the second-Generation pan-European digital mobile cellular communication standards.
3	Analyze the 3G cellular technologies including GPRS and UMTS.
4	Compare the existing and future trends in Wireless technologies.

Unit-I	**07 Hrs**
Principle of Cellular Communication: Cellular Terminology, Cell Structure and Cluster, Frequency Reuse Concept, Cluster size and System Capacity, Method of Locating Co-channel cells, Frequency Reuse distance, Co-channel Interference and Signal Quality, Co-channel interference Reduction Methods.	
Unit – II	**08 Hrs**
Basic Cellular system: Consideration of components of a cellular system- A basic cellular system connected to PSTN, Main parts of a basic cellular system, Operation of a Cellular system, Performance criteria- Voice quality, Trunking and Grade of Service, Spectral Efficiency of FDMA and TDMA systems.	
Unit –III	**09 Hrs**
Second generation Cellular Technology: GSM: GSM Network Architecture, Identifiers used in GSM System, GSM channels, Authentication and Security in GSM, GSM Call Procedure, GSM Hand-off Procedures. **IS-95:** Forward Link, Reverse Link, Soft-handover in IS-95.	
Unit –IV	**08 Hrs**
3G Digital Cellular Technology: GPRS: GPRS technology, GPRS Network Architecture, GPRS signalling, Mobility Management in GPRS. **UMTS:** UMTS Network Architecture, UMTS Interfaces, UMTS Air Interface Specifications, UMTS Channels.	
Unit –V	**08 Hrs**
Wireless Personal Area Networks: Network architecture, components, Bluetooth, Zigbee, Applications. **Wireless Local Area networks:** Network Architecture, Standards, Applications. **Wireless Metropolitan Area Networks:** IEEE 802.16 standards, advantages, WMAN Network architecture, Protocol stack.	

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

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

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	-	-	2	-	-	-		-	-	
CO2	3	2	3	-	2	-	-	-	2	-	-	
CO3	3	3	-	2	2	-	-	-	2	-	-	3
CO4	3	2	2	-	2	-	-	-	2	-	-	3

High-3: Medium-2: Low-1

Semester: VI						
THIN FILM NANO DEVICE FABRICATION TECHNOLOGY (GROUP E: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G6E13**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Basic understanding of vacuum and related technology
2	Knowledge of growth, optimization and characterization of thin films and nanostructures
3	Design appropriate growth technique for desired application
4	Fabricate and Evaluate thin film nano devices for advanced applications

Unit-I	**08 Hrs**

Vacuum Technology:

Introduction (KTG, classification of Vacuum), Gas transport and pumping, Q-rate calculation, Basics of Vacuum - Principles of different vacuum pumps: Rotary, Roots, Diffusion, Turbo molecular, and Cryogenic pumps, getter pumps (NEG), sublimation pump (TSP); differential pumping, Measurement of vacuum - Concept of Capacitance Manometer, Pirani and Penning gauges.

Unit – II	**08 Hrs**

Substrate Surfaces& Thin Film Nucleation:

Atomic view of substrate surfaces, Thermodynamic aspects of nucleation, Kinetic processes in nucleation and growth, experimental studies of nucleation and growth (Brief)

Defects in Thin Films:

0-D (point defects), 1-D (line defects), 2&3-D (grain boundaries, stacking faults, crystal twins, voids and precipitates), strain mismatch, Ion implantation defects (Amorphization), Effects of defects on the film (Electrical resistivity, PN junction leakage current, diffusion, Mechanical stress), defect propagation in films

Unit –III	**08 Hrs**

Fabrication Techniques

Chemical Approaches: Electro Spinning and spin coating routes, Pulsed electro-chemical vapor deposition (PECVD)

Physical Approaches: Metalorganic chemical vapor deposition (MOCVD), Atomic Layer Deposition (ALD) - pulsed laser deposition, Arc plasma deposition.

Lithography: Photo/FIB techniques, Etching process: Dry and Wet etching

Unit –IV	**07 Hrs**

Characterization Techniques

Surface morphology measurements: Kelvin-probe Force Microscopy (KFM), Surface X-ray Diffraction (SXRD), **Vacancy type defects and interfacial surface chemistry**: Positron Annihilation Lifetime Spectroscopy (PALS), Angle Resolved X-ray Photoelectron spectroscopy (ARXPS) Point**, line defects, grain boundary studies**: Transmission Electron microscopy (TEM), UV Visible Spectroscopy (UV-Vis)

Unit –V	**08 Hrs**

Silicon wafer fabrication – Wafer to cell formation - I-V characteristics and spectral response of c-Si solar cells. Factors limiting the efficiency, Differences in properties between crystalline silicon and amorphous (a-Si) silicon

Thin Film Solar Cells: Principle of multi-junction cells, Structure and fabrication of GaInP/GaAs/Ge triple junction solar cell - Cell configuration – techniques used for the deposition of each layer- cell characteristics, optical efficiency measurements (brief)

Thin film Nano Biosensor: Biosensors and nanotechnology, Basic biosensor architecture, Biosensor

(receptor/antigen) recognition element, Biosensor transducer (electrochemical, optical, thermal, mass), Glucowatch ™, Examples in cancer detection **Field Effect Transistors**: Overview, Basic Structure, I-V Characteristics, Lateral transport of electrons in different regions of transistors.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Choose the right choice of material for the desired application
CO2:	Improve the desired nanostructures and their properties
CO3:	Fabricate appropriate Nanodevices
CO4:	Optimize the nanodevice fabrication process for repeatability.

Reference Books	
1	Solid State Physics, Ashcroft & Mermin, 2nd Edition, Brooks/Cole, 1976, ISBN-13: 978-0030839931
2	Nanotechnology for photovoltaics, Loucas Tsakalakos, 1st Edition, 2010, ISBN 9781420076745.
3	Microfabrication for Industrial Applications, Regina Luttge, 1st Edition, William Andrew,2011, ISBN: 9780815515821.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Experiential Learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	1	-	-	-	-	-	-		-	2
CO2	3	2	2	2	-	-	-	-	-		-	2
CO3	2	3	3	2	2	1	1	1	-	1	-	2
CO4	2	3	3	2	2	2	2	2	2	2	-	2

High-3: Medium-2: Low-1

Semester: VI						
CHEMISTRY OF ADVANCED ENERGY STORAGE DEVICES FOR E-MOBILITY (GROUP E: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G6E14**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the basic concepts of advanced storage devices.
2	Apply the basic concepts of storage devices for E-mobility in the area of automotive engineering.
3	Impart knowledge of electrochemistry to analyze the problems associated with electric/hybrid vehicles.
4	Develop knowledge of battery management system and recycling of storage devices.

Unit-I	**07 Hrs**
Introduction of Energy Storage Systems in Electric vehicles: Background of alternative energy sources and sustainability. Introduction of E-mobility: Overview of land, marine and space vehicle electrification. Vehicle performance and fuel economy and characteristics. Electric vehicles configuration, energy and power requirements for various HEVs and EVs Vehicles. Fundamentals of battery technology in hybrid vehicles.	
Unit – II	**08 Hrs**
Advanced Lithium ion Battery Technology for Electric-vehicles: Basic concepts of lithium batteries, Advanced Lithium batteries for E-mobility: Cell construction, battery components, principle of operation, electrode fabrication, electrolytes, battery modules and packs. Construction, working and future applications of Li-polymer batteries, Li-S battery, Li-Air battery, Li-iron sulfide cells and solid-state batteries.	
Unit –III	**08 Hrs**
Future Scope in non- Lithium Batteries: Limitations of lithium batteries. Construction, components, working and applications of Non-Lithium batteries: Sodium-battery, Magnesium battery, Nickel Metal Hydride Battery, Zebra cells, Vanadium and iron-based batteries, Ni-Hydrogen batteries. Advanced batteries for transportation: Ni-MH battery, horizontal plate Pb-Acid batteries. Advantages and applications of non-lithium batteries.	
Unit –IV	**08 Hrs**
Chemistry of Alternative Storage Devices: Introduction to super capacitor, material characteristics. Construction, working and applications of Super capacitors and Ultra capacitor for E mobility: Double layer Super capacitors, Aqueous super capacitor, organic based super capacitors, asymmetric super capacitors and Ultra capacitors. Advanced battery-super capacitor hybrids for large vehicles, Battery-Fuel cell hybridization for transportation applications, Battery-Solar Cell (Photovoltaic) hybridization, and advanced energy storage devices for back-up of solar energy.	
Unit –V	**08 Hrs**
Battery Maintenance and Recycling: Battery Management Systems (BMS), Fundamentals of battery management systems and controls. Battery Thermal Management: Passive cooling – PCM systems, Active cooling – Liquids & air systems. Battery Recycling Technologies: Technology and economic aspects of battery recycling. Environmental safety in battery recycling process. Regulations and safety aspects of high voltage batteries: battery standards, safe handling of lithium batteries.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understanding the fundamentals of advanced batteries, super capacitors and fuel cells for electric vehicles.
CO2:	Applying the chemistry knowledge used for hybridization of various energy storage and conversion devices for vehicle electrification.
CO3:	Analyses of battery management, safety, global market trends for large format batteries.
CO4:	Evaluation of efficiency of a battery with respect to cost, environmental safety, material, energy consumption, reuse and recycling.

Reference Books	
1	Battery reference book, T. R. Crompton., 3rd edition, NEWNES Reed Educational and Professional Publishing Ltd 2000, ISBN: 07506 4625 X.
2	Batteries for Electric Vehicles, D. A. J. Rand, R. Woods, and R. M. Dell, Society of Automotive Engineers, Warrendale PA, 2003. ISBN 10: 0768001277.
3	Lithium Batteries, Science and Technology, GA. Nazri and G. Pistoa, Kluwer Academic Publisher, 2003, ISBN 978-0-387-92675-9.
4	Battery Technology Handbook, H. A. Kiehne, Marcel Dekker, NYC, 2003. ISBN: 0824742494 9780824742492.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	2	-	-	-	-	1	-	1
CO2	3	3	2	2	2	-	-	-	1	1	-	1
CO3	2	2	3	3	2	-	-	-	3	1	2	1
CO4	3	3	2	3	2	-	-	-	2	1	3	1

High-3: Medium-2: Low-1

Semester: VI						
ADVANCED STATISTICAL METHODS (GROUP E: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G6E15**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Adequate exposure to understand the basic knowledge on classification and regression trees that form the foundation for analyzing data.
2	Use the concepts of cluster analysis and conjoint analysis techniques arising in various fields.
3	Apply the concepts of discriminant analysis and factor analysis which have great significance in engineering practice.
4	Demonstrate the practical importance of regression and loglinear models.

Unit-I	**07 Hrs**
Classification and Regression Trees: Introduction, the Basic Tree Model, Categorical or Quantitative Predictors, Regression Trees, Classification Trees, Stopping Rules, Pruning and Cross-Validation, Loss functions, Geometry.	
Unit – II	**07 Hrs**
Cluster Analysis: Introduction, Types of Clustering, Correlations and Distances, Hierarchical Clustering, Partitioning via K-means, Additive Trees.	
Unit –III	**08 Hrs**
Conjoint Analysis: Introduction, Additive Tables, Multiplicative Tables, Computing Table Margins based on an Additive Model, Applied Conjoint Analysis.	
Unit –IV	**08 Hrs**
Discriminant Analysis and Factor Analysis: Introduction, Linear Discriminant Model, Linear discriminant function, Discriminant analysis, Principal Component, Factor Analysis, Principal Components versus Factor Analysis, Applications and Caveats.	
Unit –V	**09 Hrs**
Logistic Regression and Loglinear Models: Introduction, Binary Logit, Multinomial Logit, Conditional Logit, Discrete Choice Logit, Stepwise Logit, Fitting a Loglinear Model.	

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

Reference Books	
1	Statistics I, SYSTAT 10.2, ISBN 81-88341-04-5.
2	Nonparametric Statistical Inference, Gibbons J., D., and Chakraborti, S., 4th Edition, 2003, Marcel Decker, New York. ISBN: 0-8247-4052-1.

3	Applied Statistics and Probability for Engineers, Douglas C. Montgomery and George C. Runger, 6th Edition, 2014, John Wiley & Sons, ISBN: 13 9781118539712, ISBN (BRV):9781118645062.
4	An Introduction to Multivariate Analysis, T. W. Anderson, 3rd Edition, 2003, John Wiley & Sons, New Jersey, ISBN: 0-471-36091-0.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	1	-	-	-	-	-	-	-	2
CO2	3	2	1	-	-	-	-	-	-	-	-	2
CO3	2	3	2	2	-	-	-	-	-	-	-	1
CO4	3	3	1	2	1	-	-	-	-	-	-	3

High-3: Medium-2: Low-1

Semester: VI						
MATHEMATICAL MODELING **(GROUP E: GLOBAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**18G6E16**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Adequate exposure to understand the basic knowledge of mathematical modeling.
2	Use the concepts of discrete process models arising in various fields.
3	Apply the concepts of modeling of nano liquids which have great significance in engineering practice.
4	Demonstrate the practical importance of graph theoretic models, variational problem and dynamic programming.

Unit-I	**07 Hrs**
Elementary Mathematical Modeling: Basic concepts. Real world problems, (Science and Engineering), Approximation of the problem, Steps involved in modeling. Linear growth and decay model, Logistic model, Model of mass-spring-dashpot (present in shock absorbed, mechanical engineering problems), Chemical reaction, Drug absorption from blood stream. Motion of a projectile, Current flow in electrical circuits (LCR).	
Unit – II	**07 Hrs**
Discrete Process Models: Introduction to Difference equations, Introduction to discrete models-simple examples, Mathematical modeling through difference equations in economics, finance, population dynamics and genetics and probability theory.	
Unit –III	**08 Hrs**
Modeling of Nano Liquids: Nano liquids-Basic concepts, Mathematical modeling of nano liquids-Buongiorno Model (Two phase model): Relative importance of the nanoparticle transport mechanisms. Conservation equation for two phase nano liquids: The Continuity equation, Momentum equation and Energy equation.	
Unit –IV	**08 Hrs**
Graph Theoretic Models: Mathematical modeling through graphs-Models in terms of undirected graphs, directed graphs, signed graphs and weighted graphs. Problems with engineering applications.	
Unit –V	**09 Hrs**
Variational Problem and Dynamic Programming: Optimization principles and techniques, Mathematical models of variational problem and dynamic programming, Problems with engineering applications.	

Course Outcomes: After completing the course, the students will be able to

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

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

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.

Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	1	-	-	-	-	-	-	-	2
CO2	3	2	1	-	-	-	-	-	-	-	-	2
CO3	2	3	2	2	-	-	-	-	-	-	-	1
CO4	3	3	1	2	1	-	-	-	-	-	-	3

High-3: Medium-2: Low-1

VI Semester						
FOUNDATIONAL COURSE ON ENTREPRENEURSHIP (GROUP E: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**18G6E17**		**CIE Marks**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives:	
1	To make participants self-discover their innate flow, entrepreneurial style, and identify problems worth solving thereby becoming entrepreneurs
2	To handhold participants on lean methodology to craft value proposition and get ready with lean canvas
3	To create solution demo by conducting customer interviews and finding problem-solution fit for building Minimum Viable Product (MVP)
4	To make participants understand cost structure, pricing, revenue types and importance of adopting shared leadership to build good team
5	To help participants build a strong brand and identify various sales channels for their products and services
6	To take participants through basics of business regulations and other legal terms along-with understanding of Intellectual Property Rights

Unit-I	**08 Hrs**
Self-Discovery and Opportunity Discovery Finding the Flow; Effectuation; Identifying the Effectuation principles used in activities; Identifying Problem Worth Solving; Design Thinking; Brainstorming; Presenting the Identified problems; Identifying the Entrepreneurial Style.	
Unit – II	**08 Hrs**
Customer, Solution and Lean Methodology Customers and Markets; Segmentation and Targeting; Identifying Jobs, Pains, and Gains and Early Adopters; Crafting Value Proposition Canvas (VPC); Presenting VPC; Basics of Business Model and Lean Approach; Sketching the Lean Canvas; Risks and Assumptions; Presenting Lean Canvas.	
Unit – III	**07 Hrs**
Problem-Solution Fit and Building MVP Blue Ocean Strategy - Plotting the Strategy Canvas; Four Action Framework: Eliminate-Reduce-Raise-Create Grid of Blue Ocean Strategy; Building Solution Demo and Conducting Solution Interviews; Problem-Solution Fit; Building MVP; Product-Market Fit; Presenting MVP.	
Unit – IV	**07 Hrs**
Financial Planning & Team Building Cost Structure - Estimating Costs; Revenues and Pricing: Revenue Streams, Revenue Types, Identifying Secondary Revenue Streams, Estimating Revenue and Price; Profitability Checks; Bootstrapping and Initial Financing; Practising Pitch; Shared Leadership; Hiring and Fitment, Team Role and Responsibilities.	
Unit – V	**09 Hrs**
Marketing, Sales, Regulations and Intellectual Property Positioning and Branding; Channels; Sales Planning; Project Management; Basics of Business	

Regulations; How to Get Help to Get Started; Patents, Trademark, Licensing, Contracts; Common Legal mistakes, Types of Permits, Tax Registration Documents, Compliance; Infringement and Remedies, Ownership and Transfer.

Course Outcomes: After completing the course, the students will be able to	
CO1	Showcase the ability to discern distinct entrepreneurial traits
CO2	Know the parameters to assess opportunities and constraints for new business ideas
CO3	Understand the systematic process to select and screen a business idea
CO4	Design strategies for successful implementation of ideas
CO5	Create Business Model and develop Minimum Viable Product

Reference Books:	
1	Running Lean: Iterate from Plan A to a Plan That Works. O'Reilly Media, Maurya, A., 2012.
2	Entrepreneurship. Roy, R., 2012. Oxford University Press
3	Intellectual Property Law in India. Gupta, T. S., 2011. Kluwer Law International
4	Flow: The Psychology of Optimal Experience. Czikszentmihalyi, M., 2008. Harper Perennial Modern Classics
5	Effectuation: Elements of Entrepreneurial Expertise. Sarasvathy, S. D., 2009. Edward Elgar Publishing Ltd.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by the way of Tests (T), Quizzes (Q),) and Experiential Learning (EL). Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. Minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The marks component for experiential learning is 20.
Total CIE is 50 (T) +30 (Q) +20 (EL) = 100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
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CO-PO Mapping												
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CO1	1	-	-	-	-	2	-	1	2	2	-	1
CO2	1	1	-	-	-	3	2	3	1	2	-	1
CO3	-	1	-	-	-	2	1	3	3	3	3	3
CO4	-	1	2	2	3	-	-	-	1	-	2	1

High-3: Medium-2: Low-1

Semester VI			
PROFESSIONAL PRACTICE – II **EMPLOYABILITY SKILLS AND PROFESSIONAL DEVELOPMENT OF ENGINEERS**			
Course Code	**18HS68**		**CIE Marks: 50**
Credits: L:T:P	**0:0:1**		**SEE Marks: 50**
Hours:	**18 Hrs/Semester**		**CIE Duration: 2.00 Hrs**

Course Learning Objectives: The students will be able to	
1	Improve qualitative and quantitative problem solving skills.
2	Apply critical and logical thinking process to specific problems.
3	Ability to verbally compare and contrast words and arrive at relationships between concepts, based on verbal reasoning.
4	Applying good mind maps that help in communicating ideas as well as in technical documentation

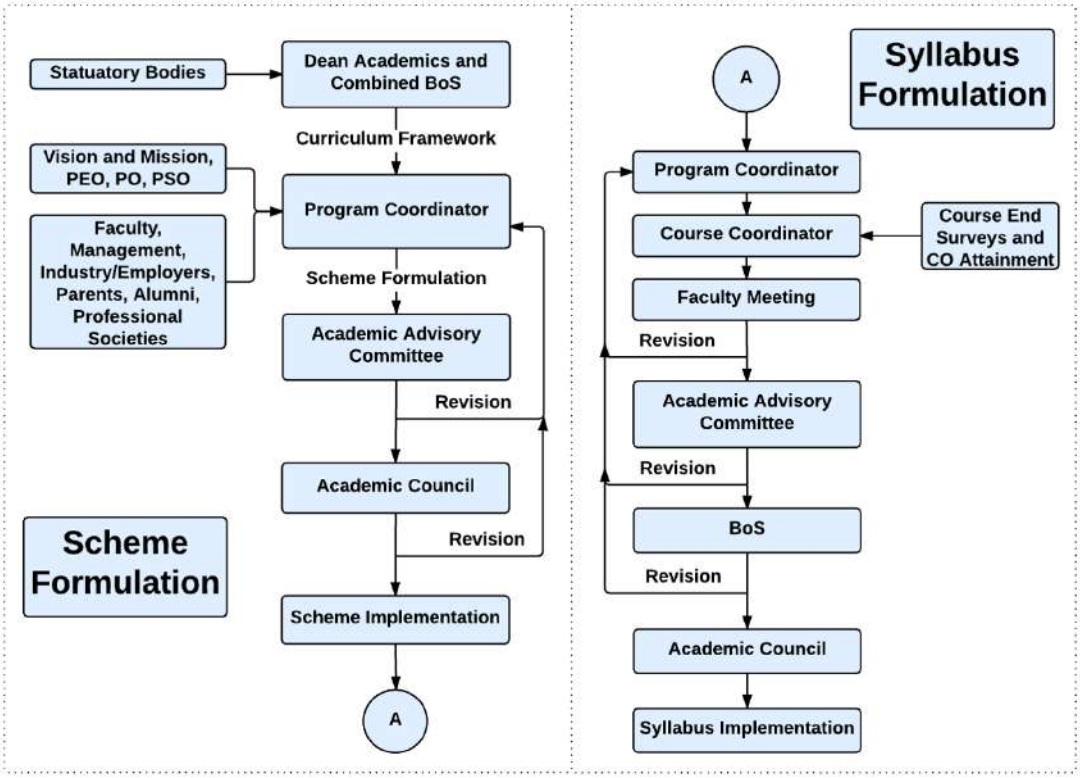
V Semester	
UNIT-I	
Aptitude Test Preparation- Importance of Aptitude tests, Key Components, Quantitative Aptitude – Problem Solving, Data Sufficiency, Data Analysis - Number Systems, Math Vocabulary, fraction decimals, digit places etc. Reasoning and Logical Aptitude, - Introduction to puzzle and games organizing information, parts of an argument, common flaws, arguments and assumptions. Analytical Reasoning, Critical Reasoning.	**06 Hrs**
UNIT-II	
Verbal Analogies - What are Analogies, How to Solve Verbal Analogies & developing Higher Vocabulary, Grammar, Comprehension and Application, Written Ability. Non-Verbal Reasoning, Brain Teasers. Creativity Aptitude. Group Discussion- Theory &Evaluation : Understanding why and how is the group discussion conducted, The techniques of group discussion, Discuss the FAQs of group discussion, body language during GD.	**06 Hrs**
UNIT-III.A	
Resume Writing- Writing Resume, how to write effective resume, Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts.	**06 Hrs**
VI Semester	
UNIT-III.B	
Technical Documentation - Introduction to technical writing- Emphasis on language difference between general and technical writing, Contents in a technical document, Report design overview & format Headings, list & special notes, Writing processes, Translating technical information, Power revision techniques, Patterns & elements of sentences, Common grammar, usage & punctuation problems.	**06 Hrs**
UNIT-IV	
Interview Skills -a) Personal Interviews , b) Group Interviews , c) Mock Interviews - Questions asked & how to handle them, Body language in interview, Etiquette, Dress code in interview, Behavioral and technical interviews, Mock interviews - Mock interviews with different Panels. Practice on stress interviews, technical interviews, General HR interviews etc.	**06 Hrs**
UNIT-V	
Interpersonal Relations - Optimal Co-existence, Cultural Sensitivity, Gender sensitivity Adapting to the Corporate Culture- Capability & Maturity Model, Decision Making Analysis, Brain Storm. Adapting to the Corporate Culture.	**06 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Inculcate employability skill to suit the industry requirement.
CO2	Analyze problems using quantitative and reasoning skills
CO3	Exhibit verbal aptitude skills with appropriate comprehension and application.
CO4	Focus on Personal Strengths and Competent to face interviews and answer
Reference Books	
1.	The 7 Habits of Highly Effective People, Stephen R Covey Free Press, 2004 Edition, ISBN: 0743272455
2.	How to win friends and influence people, Dale Carnegie General Press, 1st Edition, 2016, ISBN: 9789380914787
3.	Crucial Conversation: Tools for Talking When Stakes are High, Kerry Patterson, Joseph Grenny, Ron Mcmillan 2012 Edition, McGraw-Hill Publication ISBN: 9780071772204
4.	Ethnus, Aptimithra: Best Aptitude Book ,2014 Edition, Tata McGraw Hill ISBN: 9781259058738

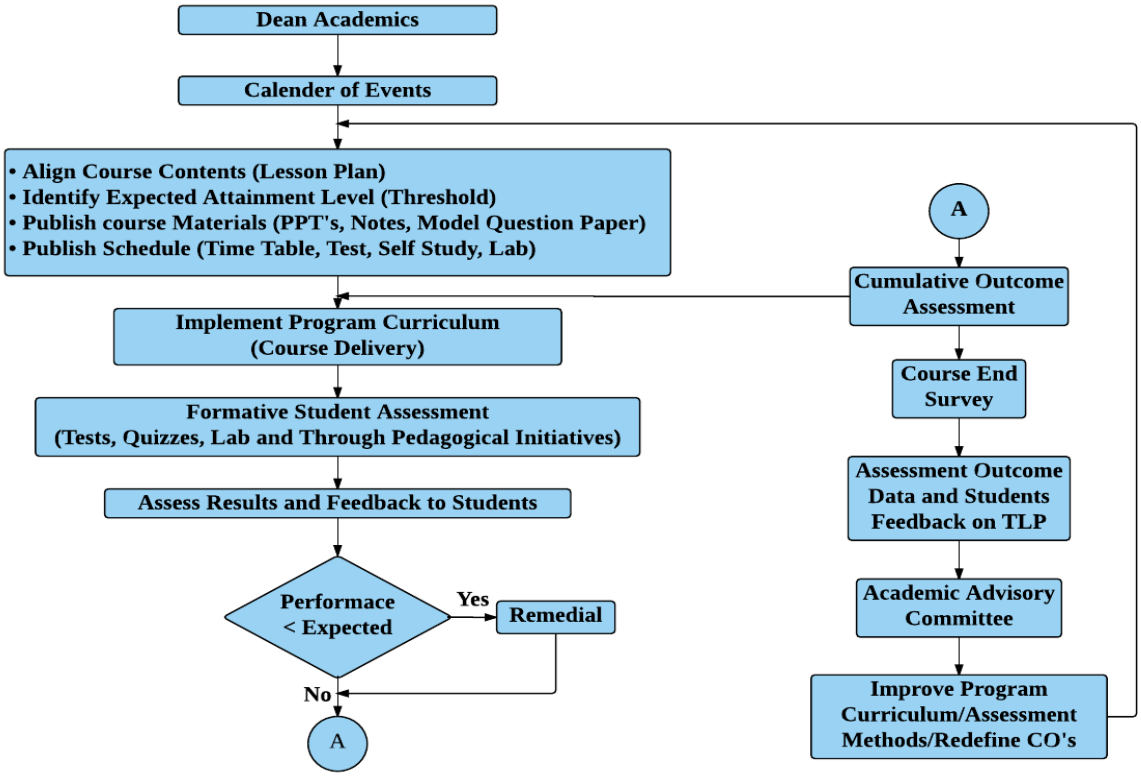
Scheme of Continuous Internal Examination and Semester End Examination

Phase	Activity	Weightage
Phase I V Sem	CIE will be conducted during the 5th semester and evaluated for 50 marks. The test will have two components. The Quiz is evaluated for 15 marks and second component consisting of questions requiring descriptive answers is evaluated for 35 marks. The test & quiz will assess the skills acquired through the training module. SEE is based on the test conducted at the end of the 5th semester The test will have two components a Quiz evaluated for 15 marks and second component consisting of questions requiring descriptive answers is evaluated for 35 marks.	50%
Phase II VI Sem	During the 6th semester a test will be conducted and evaluated for 50 marks. The test will have two components a Short Quiz and Questions requiring descriptive answers. The test & quiz will assess the skills acquired through the training module. SEE is based on the test conducted at the end of the 6th semester The test will have two components. The Quiz evaluated for 15 marks and second component consisting of questions requiring descriptive answers is evaluated for 35 marks	50%
Phase III At the end of VI Sem	At the end of the VI Sem Marks of CIE (5th Sem and 6th Sem) is consolidated for 50 marks (Average of Test1 and Test 2 (CIE 1+CIE2)/2. At the end of the VI Sem Marks of SEE (5th Sem and 6th Sem) is consolidated for 50 marks (Average of CIE 1 and CIE 2 (CIE 1+CIE2)/2.	

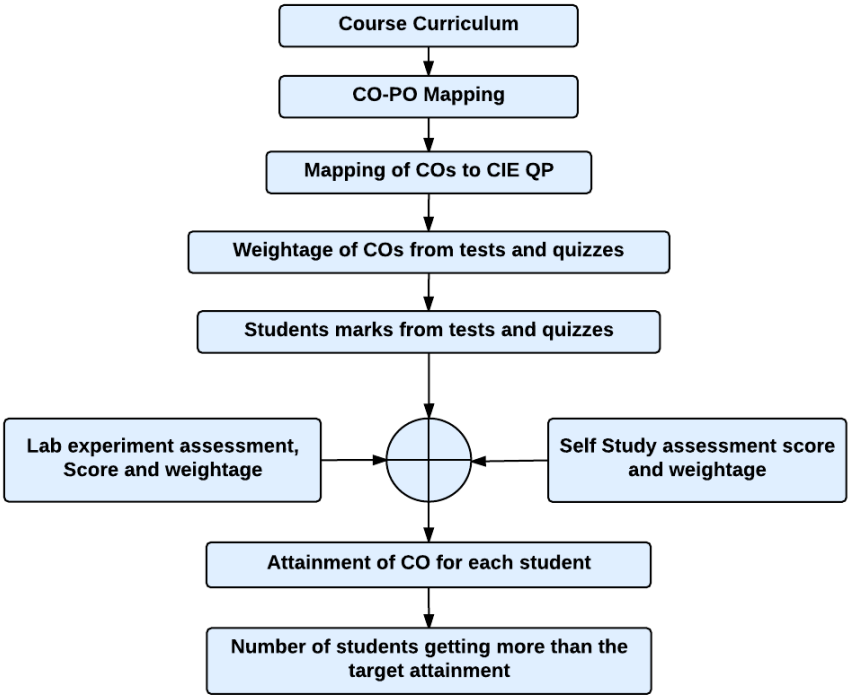
Curriculum Design Process



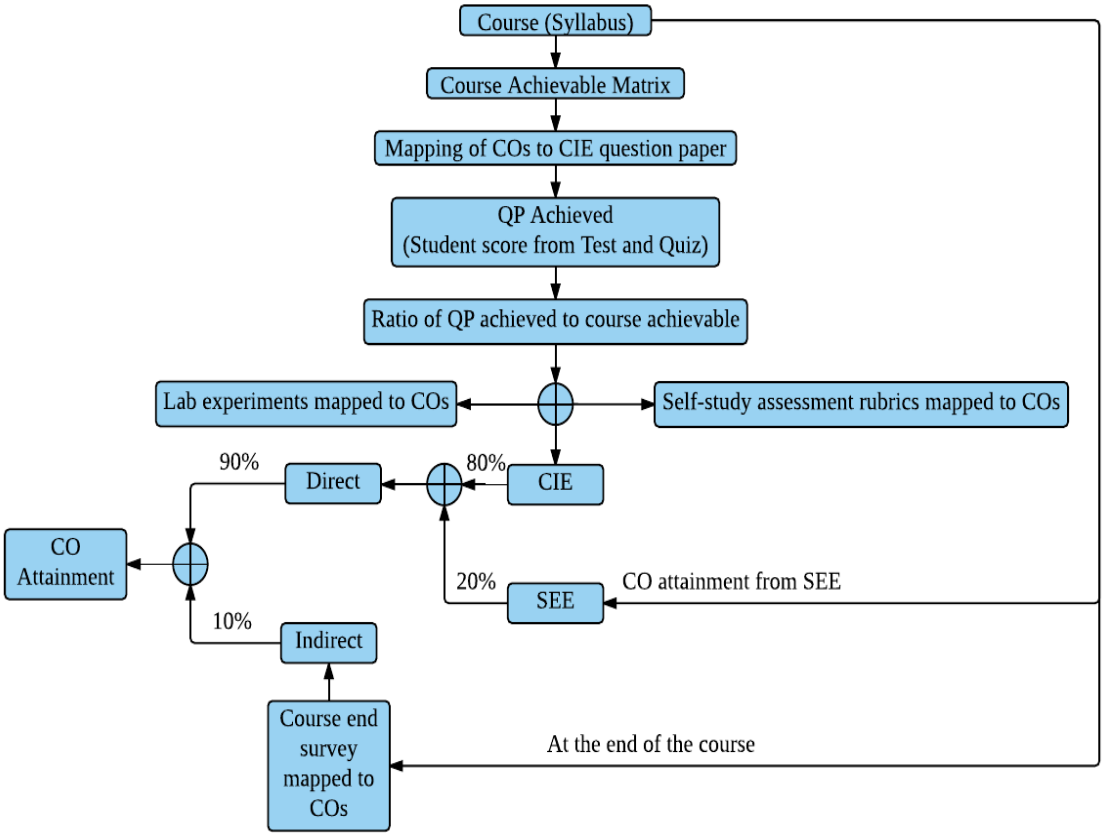
Academic Planning And Implementation



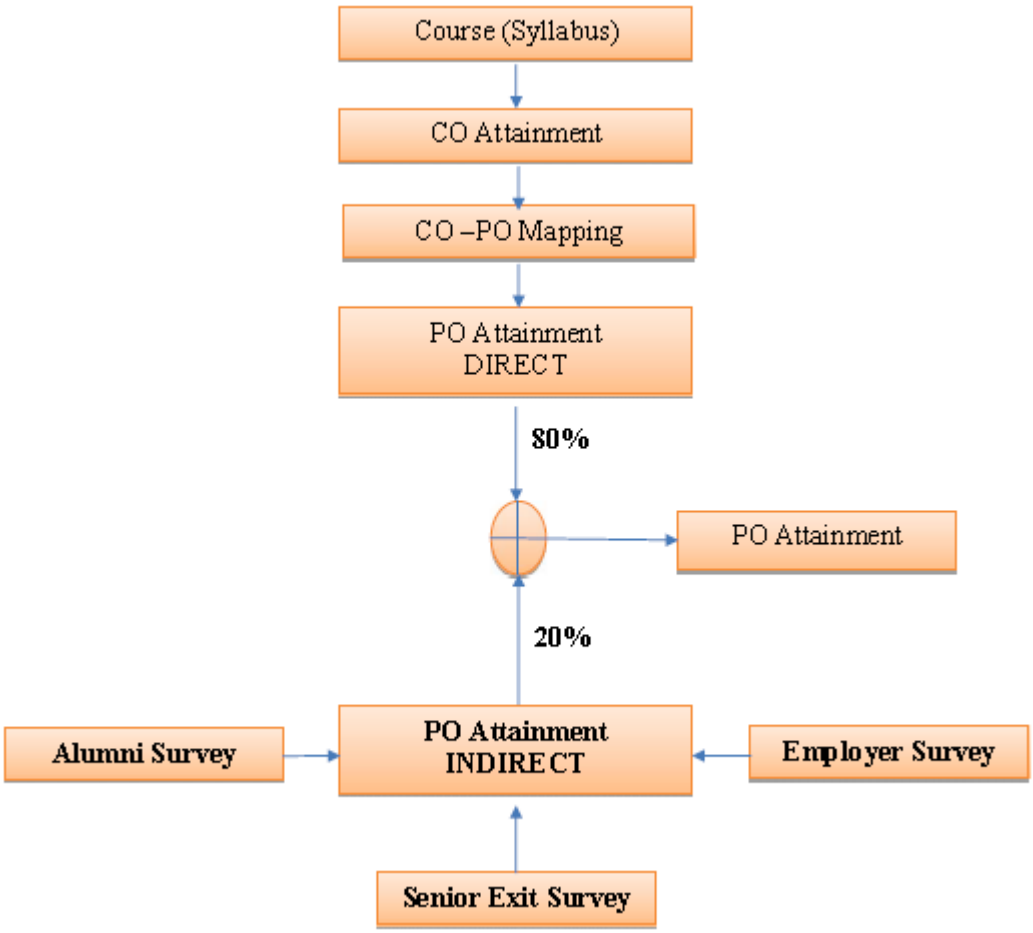
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



PROGRAM OUTCOMES (POs)

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

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

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

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

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

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

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

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

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

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

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

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