# R.V. 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 for V & VI Semesters

# 2016 SCHEME

# ELECTRONICS & COMMUNICATION ENGINEERING

## Department Vision

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

## Department Mission

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

## PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

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

**PEO2.** To design and develop interdisciplinary and innovative systems.

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

## PROGRAM SPECIFIC OUTCOMES (PSOs)

| PSO | Description |
|---|---|
| PSO1 | Should be able to clearly understand the concepts and applications in the field of Communication/networking, signal processing, embedded systems and semiconductor technology. |
| PSO2 | Should be able to associate the learning from the courses related to Microelectronics, Signal processing, Microcomputers, Embedded and Communication Systems to arrive at solutions to real world problems. |
| PSO3 | Should have the capability to comprehend the technological advancements in the usage of modern design tools to analyze and design subsystems/processes for a variety of applications. |
| PSO4 | Should possess the skills to communicate in both oral and written forms, the work already done and the future plans with necessary road maps, demonstrating the practice of professional ethics and the concerns for societal and environmental wellbeing. |

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

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

# 2016 SCHEME

# ELECTRONICS & COMMUNICATION ENGINEERING

# Abbreviations

| Sl. No. | Abbreviation | Meaning |
|---|---|---|
| 1. | VTU | Visvesvaraya Technological University |
| 2. | BS | Basic Sciences |
| 3. | CIE | Continuous Internal Evaluation |
| 4. | CS | Computer Science and Engineering |
| 5. | CV | Civil Engineering |
| 6. | CHY | Chemistry |
| 7. | EC | Electronics and Communication Engineering |
| 8. | EE | Electrical and Electronics Engineering |
| 9. | ES | Engineering Science |
| 10. | HSS | Humanities and Social Sciences |
| 11. | ME | Mechanical Engineering |
| 12. | PHY | Engineering Physics |
| 13. | SEE | Semester End Examination |
| 14. | MAT | Engineering Mathematics |
| 15. | PCE | Professional Core Elective |
| 16. | GE | Global Elective |

# INDEX

**R V COLLEGE OF ENGINEERNG, BENGALURU-560 059**
**(Autonomous Institution Affiliated to VTU, Belagavi)**

# DEPARTMENT OF
# ELECTRONICS AND COMMUNICATION ENGINEERING

| FIFTH SEMESTER CREDIT SCHEME | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sl. No** | **Course Code** | **Course Title** | **BOS** | **Credit Allocation** | | | | **Total Credits** |
| | | | | **L** | **T** | **P** | **S** | |
| 1 | 16HSI51 | IPR & Entrepreneurship | HSS | 3 | 0 | 0 | 0 | 3 |
| 2 | 16EC52 | Communication System I | ECE | 3 | 1 | 1 | 0 | 5 |
| 3 | 16EC53 | Digital VLSI Design | ECE | 3 | 1 | 1 | 0 | 5 |
| 4 | 16EC54 | Embedded System Design | ECE | 3 | 0 | 0 | 1 | 4 |
| 5 | 16EC55 | Digital Signal Processing | ECE | 3 | 0 | 0 | 1 | 4 |
| 6 | 16EC5AX | Elective A (PCE) | ECE | 3 | 0 | 0 | 1 | 4 |
| 7 | 16G5BXX | Elective B (GE)* | Respective BOS | 4 | 0 | 0 | 0 | 4 |
| **Total Number of Credits** | | | | | | | | **29** |
| **Total Number of Hours / Week** | | | | **22** | **4** | **4** | **12**** | **30** |

| SIXTH SEMESTER CREDIT SCHEME | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Course Code** | **Course Title** | **BOS** | **Credit Allocation** | | | | **Total Credits** |
| | | | | **L** | **T** | **P** | **S** | |
| 1 | 16HEM61 | Foundations of Management & Economics | HSS | 2 | 0 | 0 | 0 | 2 |
| 2 | 16EC62 | Communication System II | ECE | 4 | 0 | 1 | 0 | 5 |
| 3 | 16EC63 | Computer Communication Networks | ECE | 3 | 0 | 1 | 1 | 5 |
| 4 | 16EC64 | Analog & Mixed Signal IC Design | ECE | 3 | 1 | 0 | 0 | 4 |
| 5 | 16EC6CX | Elective C (PCE) | ECE | 3 | 0 | 0 | 1 | 4 |
| 6 | 16EC6DX | Elective D (PCE) | ECE | 3 | 0 | 0 | 1 | 4 |
| 7 | 16G6EXX | Elective E (GE)* | Respective BOS | 3 | 0 | 0 | 0 | 3 |
| 8 | 16HS68 | Professional Practice-III (Employability Skills and Professional Development of Engineers) | HSS | 1 | 0 | 0 | 0 | 1 |
| **Total Number of Credits** | | | | | | | | **28** |
| **Total Number of Hours / Week** | | | | **22** | **2** | **4** | **12**** | **28** |

*Students should take other department Global Elective courses
**Non-contact hours

| V Semester | | |
|---|---|---|
| **GROUP A: PROFESSIONAL CORE ELECTIVES** | | |
| **Sl. No.** | **Course Code** | **Course Title** |
| 1. | 16EC5A1 | Antennas and Wave Propagation |
| 2. | 16EC5A2 | Transducers & Data Acquisition Systems |
| 3. | 16EC5A3 | Artificial Neural Networks & Deep Learning |
| 4. | 16EC5A4 | Modelling of Semiconductor Devices |
| 5. | 16EC5A5 | Object Oriented Programming in C++ |
| 6. | 16EC5A6 | Computer Organization and Architecture |
| 7. | 16EC5A7 | Robotics |

| GROUP B: GLOBAL ELECTIVES | | | | |
|---|---|---|---|---|
| **Sl. No.** | **Host Dept** | **Course Code** | **Course Title** | **Credits** |
| 1. | BT | 16G5B01 | Bioinformatics | 4 |
| 2. | CH | 16G5B02 | Fuel Cell Technology | 4 |
| 3. | CV | 16G5B03 | Geoinformatics | 4 |
| 4. | CSE | 16G5B04 | Graph Theory | 4 |
| 5. | ECE | 16G5B05 | Artificial Neural Networks & Deep Learning | 4 |
| 6. | EEE | 16G5B06 | Hybrid Electric Vehicles | 4 |
| 7. | IEM | 16G5B07 | Optimization Techniques | 4 |
| 8. | E&I | 16G5B08 | Sensors & Applications | 4 |
| 9. | ISE | 16G5B09 | Introduction to Management Information Systems | 4 |
| 10. | ME | 16G5B10 | Industrial Automation | 4 |
| 11. | TCE | 16G5B11 | Telecommunication Systems | 4 |
| 12. | MAT | 16G5B12 | Computational Advanced Numerical Methods | 4 |
| 13. | AE | 16G5B13 | Basics of Aerospace Engineering | 4 |

| VI Semester | | |
|---|---|---|
| **GROUP C: PROFESSIONAL CORE ELECTIVES** | | |
| **Sl. No.** | **Course Code** | **Course Title** |
| 1. | 16EC6C1 | Cryptography & Network Security |
| 2. | 16EC6C2 | Real Time Embedded Systems |
| 3. | 16EC6C3 | Image Processing |
| 4. | 16EC6C4 | Low Power VLSI Design |
| 5. | 16EC6C5 | Data structure using C++ |
| 6. | 16EC6C6 | System Programming & Software |
| 7. | 16EC6C7 | Flexible Electronics |
| **GROUP D: PROFESSIONAL CORE ELECTIVES** | | |
| 1. | 16EC6D1 | Optical Fiber Communication & Networks |
| 2. | 16EC6D2 | ARM Cortex Processors |
| 3. | 16EC6D3 | Adaptive Signal Processing |
| 4. | 16EC6D4 | System Verilog |
| 5. | 16EC6D5 | Algorithm for VLSI Design Automation |
| 6. | 16EC6D6 | Database Management Systems (DBMS) |
| 7. | 16EC6D7 | Internet of Things (IoT) |

| GROUP E: GLOBAL ELECTIVES | | | | |
|---|---|---|---|---|
| **Sl. No.** | **Host Dept** | **Course Code** | **Course Title** | **Credits** |
| 1. | BT | 16G6E01 | Bioinspired Engineering | 3 |
| 2. | CH | 16G6E02 | Green Technology | 3 |
| 3. | CV | 16G6E03 | Solid Waste Management | 3 |
| 4. | CSE | 16G6E04 | Introduction to Web Programming | 3 |
| 5. | ECE | 16G6E05 | Automotive Electronics | 3 |
| 6. | EEE | 16G6E06 | Industrial Electronics | 3 |
| 7. | IEM | 16G6E07 | Project Management | 3 |
| 8. | E&I | 16G6E08 | Virtual Instrumentation | 3 |
| 9. | ISE | 16G6E09 | Introduction to Mobile Application Development | 3 |
| 10. | ME | 16G6E10 | Automotive Engineering | 3 |
| 11. | TCE | 16G6E11 | Mobile Network System and Standards | 3 |
| 12. | MAT | 16G6E12 | Applied Partial Differential Equations | 3 |
| 13. | AE | 16G6E13 | Aircraft Systems | 3 |

**B.E., ECE -ELECTIVE COURSES (Consolidated Stream wise)**

| **Local Elective** | **Semester V** | **Semester VI** | | **Semester VII** | **Semester VII** |
|---|---|---|---|---|---|
| **Streams** | **Sem V-1 (16EC5AX)** | **Sem VI-1 (16EC6CX)** | **Sem VI-2 (16EC6DX)** | **Sem VII-1(16EC7FX)** | **Sem VII-2(16EC7GX)** |
| **L:T:P:S** | **3:0:0:1** | **3:0:0:1** | **3:0:0:1** | **4:0:0:0** | **4:0:0:0** |
| **Communications** | Antennas & Wave Propagation | Cryptography & Network Security | Optical Fiber Communication & Networks | Satellite Communications & GPS | Radar & Navigation |
| **Embedded Systems** | Transducers & Data Acquisition Systems | Real Time Embedded Systems | ARM Cortex Processors | ARM Programming & Optimization | Automotive Electronics |
| **Signal Processing** | Artificial Neural Networks & Deep Learning | Image Processing | Adaptive Signal Processing | Speech Processing | Multimedia Communication |
| **VLSI** | Modelling of semiconductor devices | Low power VLSI Design | System Verilog/Algorithm for VLSI Design Automation | Radio Frequency Integrated Circuits Design | VLSI Testing for ICs |
| **Computer** | Object Oriented Programming in C++ /Computer Organization and Architecture | Data structure using C++/System Programming & Software | Database Management Systems (DBMS) | High Performance Computing | High Speed digital design |
| **Others** | Robotics | Flexible Electronics | Internet of Things (IoT) | Integrated Photonics/Nanoelectronics | MEMS and Smart Systems |
| **Global Elective** | Artificial Neural Networks & Deep Learning **(L:T:P:S 4:0:0:0)** | Automotive Electronics **(L:T:P:S 3:0:0:0)** | -- | Image Processing **(L:T:P:S 3:0:0:0)** | -- |

| Semester: V | | |
|---|---|---|
| **INTELLECTUAL PROPERTY RIGHTS AND ENTREPRENEURSHIP (Theory) (Common to AE, CSE, ECE, EEE, ISE, TE)** | | |
| **Course Code:** 16HSI51 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:0 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 03Hrs |

| **Course Learning Objectives: 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 equip students on the need to protect their own intellectual works and develop ethical standards governing ethical works. |
| **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** | |
|---|---|
| **Introduction:** Types of Intellectual Property, WIPO, WTO, TRIPS.<br>**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<br>**Trade Secrets:** Definition, Significance, Tools to protect Trade secrets in India. | **07 Hrs** |
| **UNIT-II** | |
| **Trade Marks:** Concept, function and different kinds and forms of Trade marks, Registrable and non- registrable marks. Registration of trade mark; Deceptive similarity; Assignment and transmission; ECO Label, Passing off; Offences and penalties. Infringement of trade mark with Case studies | **04 Hrs** |
| **UNIT-III** | |
| **Industrial Design:** Introduction, Protection of Industrial Designs, Protection and Requirements for Industrial \|Design. Procedure for obtaining Design Protection, Revocation, Infringement and Remedies, Case studies<br>**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, Case Studies.<br>**Intellectual property and cyberspace:** Emergence of cyber-crime; Grant in software patent and Copyright in software; Software piracy; Data protection in cyberspace | **09 Hrs** |
| **UNIT-IV** | |
| **Introduction to Entrepreneurship** – Learn how entrepreneurship has changed the world. Identify six entrepreneurial myths and uncover the true facts. Explore E-cells on Campus<br>**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.<br>**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.<br>**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) | **08 Hrs** |

| UNIT-V | |
|---|---|
| **Design Thinking for Customer Delight: -** Understand Design Thinking as a problem-solving process. Describe the principles of Design Thinking. Describe the Design Thinking process.<br>**Sales Skills to Become an Effective Entrepreneur: -** Understand what is customer focus 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.<br>**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).<br>**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. | **08 Hrs** |

| **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. |

| **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. |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment. 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 60. The marks component for assignment is 10. 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** | **1** | **-** | **-** | **-** | **3** | **3** | **-** | **3** | **1** | **2** | **-** | **3** |
| **CO2** | **1** | | | | **3** | **3** | **3** | **3** | **1** | **2** | **-** | **3** |
| **CO3** | **-** | **3** | **2** | **-** | **-** | **2** | **2** | **3** | **3** | **3** | **3** | **3** |
| **CO4** | **-** | **3** | **2** | **-** | **-** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **COMMUNICATION SYSTEM I (Theory & Practice)** | | |
| **Course Code:** 16EC52 | | **CIE Marks:** 100+50 |
| **Credits: L:T:P:S:** 3:1:1:0 | | **SEE Marks:** 100+50 |
| **Hours:** 36L+24T | | **SEE Duration:** 03Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Understand the concepts of FM, Low pass and bandpass sampling and Random processes to compute performance parameters |
| **2** | Analyse the concepts of sampling, quantization, encoding and apply them to voice conditioning for communication purposes. |
| **3** | Understand the concepts of information theory as a prerequisite for error detection and correction. |
| **4** | Associate the concepts of Information Theory to the principle of block error coding and decoding for different communication scenario. |

| **UNIT-I** | |
|---|---|
| **Angle (Exponential) Modulation** Nonlinear Modulations, Bandwidth of Angle-Modulated Waves, Generating of FM Waves by direct methods, Demodulation of FM, PLL.<br>**Sampling and Analog to Digital Conversion** Low Pass Sampling Theorem (Impulse, Pulse and Flat top), Bandpass and equivalent low pass signal representation, Quadrature Sampling of bandpass signals, Bandpass Sampling Theorem statement with Applications. | **07 Hrs** |
| **UNIT-II** | |
| **Review of Random Variables and their properties**<br>**Multiple Random Variables:** Properties, Operations**. Random Processes** From Random Variable to Random Process, Classification of Random Processes, properties and operations.<br>**Baseband Pulse Transmission (Line Codes) (RZ and NRZ)** Unipolar, Polar, Bipolar, Manchester signaling, Discrete form statement of Wiener – Khinchine Theorem – Applications to PSD derivations for these pulses. Highlights of other baseband pulses HDB3, B6ZS. | **07 Hrs** |
| **UNIT-III** | |
| **Digital Multiplexing and demultiplexing:** Framing with overheads, Types- Synchronous, Asynchronous, Quasi-Synchronous. Demultiplexing FSM, Retiming FSM with Plesiochronous buffering.<br>**Pulse-Code Modulation (PCM)** – Uniform Quantization, Non uniform Quantization – Optimal quantizer and Robust quantizer (μ-law and A-law), SNR derivations for all types. Differential Pulse Code Modulation (DPCM), Delta Modulation with SNR derivation, Adaptive DM with SNR statement only.<br>Sigma-delta Modulation concept. Applications to Channel Vocoders and LPC Vocoders.(Conceptual treatment) | **08 Hrs** |
| **UNIT-IV** | |
| **Introduction to Information Theory** Measure of Information, Source Encoding, Error-Free Communication over a Noisy Channel, Channel Capacity of a Discrete Memory less Channel, Channel Capacity of a Continuous memory less Channel, Practical Communication Systems in Light of Shannon's Equation, Frequency selective Channel capacity, Multiple input Multiple output Communication System. | **07 Hrs** |
| **UNIT-V** | |
| **Error Correcting Codes**<br>Redundancy for error correction, Linear Block Codes, Cyclic Codes, The effect of error correction, Burst-Error Detecting and Correcting Codes. A brief concept of RS Codes + Interleaving | **07 Hrs** |

| **Practical's: Communication Lab** | |
|---|---|
| 1. Frequency Modulation and Demodulation (Matlab)<br>2. Verification of Sampling theorem<br>3. Implementation of Convolution and DFT<br>4. Realization of FIR filter to meet given specifications (DSP kit)<br>5. Realization of IIR filter to meet given specifications (DSP kit)<br>6. Generation of Noise and study of its properties<br>7. Time Division Multiplexing ( Matlab & Circuit)<br>8. Pulse Code Modulation & Delta Modulation (Matlab & Simulink)<br>9. Linear block code and Huffman code (Matlab)<br>**10.** Line codes generation and Pe & PSD Calculation | |

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

| **Reference Books** | |
|---|---|
| **1.** | Modern Digital and Analog communication Systems, B.P.Lathi and Zhi Ding, 4th Edition, 2010 , Oxford University Press, ISBN: 9780198073802. |
| **2.** | Analog & Digital Communication Systems, Simon Haykin, 1st Edition, 2014, John Wiley & sons, , ISBN 978-0-471-64735-5. |
| **3.** | Communication Systems, Simon Haykin , 4th Edition, 2004, John Wiley, India Pvt. Ltd, ISBN 0471178691 |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment. 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 60. The marks component for assignment is 10. The total marks of CIE are 100.

**Laboratory- 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 of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. Total marks for the laboratory is 50.

**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.

**Laboratory- 50 Marks**
Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

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

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **DIGITAL VLSI DESIGN (Theory & Practice)** | | |
| **Course Code:** 16EC53 | | **CIE Marks:** 100+50 |
| **Credits: L:T:P:S:** 3:1:1:0 | | **SEE Marks:** 100+50 |
| **Hours:** 36L+24T | | **SEE Duration:** 03Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Analyze the impact of fabrication technologies: Methods for optimizing the area, speed, and power of circuit layouts. |
| **2** | Design and implement combinational circuit. |
| **3** | Design and implement sequential system by considering specifications. |
| **4** | Analyze the impact of RC effect in post simulation. |

| **UNIT-I** | |
|---|---|
| **VLSI Design Flow:** Specification, Design entry, Functional simulation, planning placement and routing, timing simulation. **MOS Transistor:** Introduction, Ideal I-V characteristics, C-V Characteristics, Simple MOS Capacitance Models, Detailed MOS Gate Capacitance Model, Non-ideal I-V Effects, Mobility Degradation and Velocity Saturation, Channel Length Modulation, Threshold Voltage Effects, Junction Leakage, Body effect, Tunneling. **DC Transfer Characteristics:** Static CMOS Inverter DC Characteristics, Beta Ratio Effect, Noise Margin, Pass Transistor DC Characteristics. | **07 Hrs** |
| **UNIT-II** | |
| **Combinational Circuit Design:** CMOS Logic, Inverter, NAND Gate, NOR Gate, Combinational Logic, Compound Gates, Pass Transistors and Transmission Gates, Tristates, Multiplexers. **Circuit Families:** Static CMOS, Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits, Complementary Pass-Transistor Logic Circuits.: **Datapath Subsystem:** Single-Bit Addition, Ripple Carry Adder, Carry Look ahead Adder, Carry Save Adder, Unsigned Array Multiplication, 2's Complement Array Multiplication, Wallace Tree Multiplication. | **08 Hrs** |
| **UNIT-III** | |
| **Sequential MOS Logic Circuitry:** Behavioral of Bistable element, SR Latch Circuitry, Clocked latch and Flip Flop Circuitry, C-MOS D-Latch and Edge Triggered Flip-Flop. **Sequencing Static Circuits:** Sequencing Methods, Max-Delay Constraints, Min-Delay Constraints Time Borrowing, Clock Skew | **07 Hrs** |
| **UNIT-IV** | |
| **Array Sub system SRAM:** Memory cell Read/Write operation, Decoder, Bit-line conditioning and column circuitry and Column Circuitry, Multi-Ported SRAM. **DRAM** Subarray Architectures, Column Circuitry **Read-Only Memory** Programmable ROMs, NAND ROMs. **Content-Addressable Memory**, **PLA** | **07 Hrs** |
| **UNIT-V** | |
| **CMOS Processing Technology:** CMOS Technologies, Wafer Formation, Photolithography, Well and Channel Formation, Silicon Dioxide (SiO2), Isolation, Gate Oxide, Gate and Source/Drain Formations, Contacts and Metallization, Passivation, Methodology**. :** Lambda Design Rules. Transistor Scaling. Inverter (nMOS and CMOS) | **07 Hrs** |
| **Practical's: VLSI Lab**<br>1.<br>a Realize CMOS Logic-universal gates.<br>b Practice question: Realize XOR/XNOR gates<br>2.<br>a Realization of CMOS - adder circuits<br>b Practice question: Realize 4-bit adder/subractor<br>3.<br>a MOS device Characterization | |

| | |
|---|---|
| b Practice question: Plot $g_m$ Vs $V_{gs}$ for NMOS/PMOS<br>4.<br>a Inverter Static Characteristics<br>b Practice question: Plot the Voltage Transfer Characteristic graph of CMOS inverter and calculate the switching voltage for the given specification<br>5.<br>a Sequential Circuit Design using Master-Slave configuration<br>b Practice question: Realize 4-bit binary counter<br>6. Inverter layout and post simulation<br>7.<br>a NOR/NAND gates layout and post simulation<br>b Practice question: Realize AND/OR gates<br>8.<br>a Common source single stage amplifier and Differential amplifier<br>b Practice question: Realize Op-amp circuit<br>9. Realize 2-bit multiplier circuit using Mixed mode<br><br>**Case study:** ASIC design flow using cadence. (Students should learn the concept and produce the relevant document) | |

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

| **Reference Books** | |
|---|---|
| **1.** | CMOS VLSI Design, Neil H.E. Weste, David Harris, Ayan Banerjee, 3rd Edition, 2006, Pearson Education, ISBN: 0321149017 |
| **2.** | CMOS Digital Integrated Circuits, Sung MO Kang, Yousf Leblebici, 3rd Edition, Tata McGrawHill, ISBN: 0-7923-7246-8 |
| **3.** | Basic VLSI Design, Douglas.A.Pucknell, Kamaran Eshraghian, 3rd Edition 2010 ,PHI, ,ISBN: 0-321-26977-2 |
| **4.** | Digital Integrated Circuits- A Design perspective, Jan M rabaey, 2nd Edition, 2005. Prentice Hall |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment. 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 60. The marks component for assignment is 10. The total marks of CIE are 100.

**Laboratory- 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 of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. Total marks for the laboratory is 50.

**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.

**Laboratory- 50 Marks**
Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

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

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **EMBEDDED SYSTEM DESIGN (Theory)** | | |
| **Course Code:** 16EC54 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 03Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Understand embedded computing system, design process and basic building blocks of an embedded system. |
| **2** | Illustrate how microprocessor, memory, peripheral components and buses build an embedded platform and their interaction. |
| **3** | Evaluate how architectural and implementation design decisions influence performance and power dissipation. |
| **4** | Explain the basic operation of a real-time operating system. |
| **5** | Building, testing the operation of real-time embedded application programs through hands-on experience with a single-board computer. |

| **UNIT-I** | |
|---|---|
| **Introduction to Embedded System Design:** Introduction, Characteristics of Embedding Computing Applications, Concept of Real time Systems, Challenges in Embedded System Design, Design Process: Requirements, Specifications, Hardware Software Partitioning, Architecture Design. **Embedded System Architecture:** Co-Processor & Hardware Accelerators, Processor performance Enhancement: Pipelining, Superscalar Execution, Multi Core CPUs. | **08 Hrs** |
| **UNIT-II** | |
| **Designing Embedded System Hardware –I:** Memory systems: Memory organization, Error detecting and correcting, memory Access times, DRAM interfaces, DRAM refresh techniques, Cache, unified versus Harvard caches, Cache coherency, Cache, Dual port and shared memory. | **07 Hrs** |
| **UNIT-III** | |
| **Designing Embedded System Hardware –II:** I/O Devices: Watchdog Timers, Interrupt Controllers, Interfacing Protocols: SPI, I2C, CAN: Frame Formats, Wiring Topology, Reset Circuits, Interfacing RTC. | **08 Hrs** |
| **UNIT-IV** | |
| **Designing Embedded System Software** Application Software, System Software, Use of High-Level Languages: C, C++, Java, Programming & Integrated Development Environment tools, Debugger, Board Support Library, Chip Support Library Analysis and Optimization: Execution Time, Energy & Power, Program Size; Embedded System Coding Standards: MISRA C 2012. | **07 Hrs** |
| **UNIT-V** | |
| **Designing Embedded System Software –II:** OS based Design, Real Time Kernel, Process& Thread, Multi-threading, Synchronization, Kernel services, Case Study: RTX-ARM. | **07 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO1: | Analyse the architecture of embedded system, functional difference between general purpose system, operational & nonoperational attributes of embedded system. |
| CO2: | Analyze the hardware requirements of an embedded system & design according to specifications. |
| CO3: | Develop software architecture & realize optimally using suitable language. |
| CO4: | Engage in self-study to formulate, design, implement, analyze and demonstrate an embedded application developed to control real world operations. |

| **Reference Books** | |
|---|---|
| **1.** | Introduction to Embedded Systems, Shibu K V, 2009, Tata McGraw Hill Education Private Limited, ISBN: 10: 0070678790 |
| **2.** | Embedded System Design, Steve Heath, 2nd Edition, 2004, Elsevier, |
| **3.** | Embedded Systems – A contemporary Design Tool ,James K Peckol, 2008, John Weily, ISBN: 0-444-51616-6 |
| **4.** | MSP430 Microcontroller Basics, John H. Davies, 2008, Newness Publishing House |

**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** | **1** | **2** | **1** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **-** | **1** |
| **CO2** | **3** | **2** | **2** | **1** | **1** | **2** | **1** | **-** | **-** | **1** | **-** | **2** |
| **CO3** | **3** | **3** | **2** | **2** | **2** | **2** | **1** | **2** | **-** | **1** | **-** | **2** |
| **CO4** | **3** | **3** | **3** | **3** | **2** | **3** | **2** | **3** | **3** | **3** | **3** | **3** |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **DIGITAL SIGNAL PROCESSING (Theory)** | | |
| **Course Code:** 16EC55 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 03Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Understand the key theoretical principles underpinning Digital Signal Processing in a design procedure through FIR and IIR filters. |
| **2** | Analyze the effect of up-sampling and down-sampling and interprets the sampling rate conversion in multistage implementation of digital filters |
| **3** | Develop the DFT filter bank using the concept of Maximally decimated DFT filter bank and Transmultiplexer. |
| **4** | Interface the digital system with different sampling rates and Sub-band Coding of Speech Signals with touch tone generation and reception for digital telephones. |

| **UNIT-I** | |
|---|---|
| **Design of IIR Filter:** Analog filter design using Butterworth and Chebyshev filter. IIR Filter design by Bilinear Transformation, digital filter designs based on the Bilinear Transformation using Analog filter. | **07 Hrs** |
| **UNIT-II** | |
| **Design of FIR Filters**: Symmetric and anti-symmetric FIR Filters, FIR Filter structure: Direct form structure, cascade form structures, frequency sampling structures, lattice structure. Design of Linear phase FIR Filters using Windows, Design of Linear phase FIR filters by frequency Sampling method. | **08 Hrs** |
| **UNIT-III** | |
| **Multirate Digital signal Processing:** Introduction, Analysis of down sampling and up-sampling, Sampling rate conversion by a rational factor, Multistage implementation of digital filters, Efficient implementation of Multirate systems | **08 Hrs** |
| **UNIT-IV** | |
| **Applications of Multirate Signal Processing**: Digital to Analog conversion, DFT filter bank, maximally decimated DFT filter bank, Transmultiplexer. | **07 Hrs** |
| **UNIT-V** | |
| **Applications of Digital Filter Banks:** Implementation of Narrow band Low pass Filters, Design of phase shifter, Interfacing of digital system with different sampling rates, Sub band Coding of Speech Signals, Touch tone generation and reception for digital telephones. | **07 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO1: | Apply appropriate mathematical skills to describe and solve problems in designing of filters and Multirate signal processing |
| CO2: | Analyse and design the fundamental blocks of Multirate signal processing and DFT filter banks. |
| CO3: | Analyze discrete system and validate the functionality of the same using simulation tool. |
| CO4: | Design discrete systems to meet specific requirement for signal processing application |

| **Reference Books** | |
|---|---|
| **1.** | Proakis G, Dimitris G. Manolakis; "Digital Signal Processing"; PHI; 4th Edition; 2007; ISBN: 978-0131873742 |
| **2.** | Roberto Cristi, "Modern digital signal Processing", Cengage learning, 2004. |
| **3.** | Lonnie C. Ludeman; "Fundamentals of Digital Signal Processing"; John Wiely & Sons; 1986; ISBN: 0471603635 |
| **4.** | Monson H.Hayes; "Digital Signal Processing"; Schaum's Outline Series; 2nd Edition; |

| | |
|---|---|
| | 2011; ISBN: 0071635092 |

**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** | **3** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **1** | **-** | **2** |
| **CO2** | **3** | **2** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **1** | **-** | **2** |
| **CO3** | **3** | **3** | **2** | **-** | **2** | **-** | **-** | **2** | **3** | **1** | **1** | **2** |
| **CO4** | **3** | **3** | **3** | **-** | **2** | **-** | **-** | **1** | **1** | **1** | **2** | **2** |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **ANTENNAS AND WAVE PROPAGATION**<br>**(Group A: Professional Core Elective)** | | |
| **Course Code:** 16EC5A1 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Analyze how an antenna radiates and capture radio wave energy from the concepts of radiation by dynamic currents, charges and retarded potentials. |
| **2** | Demonstrate properties and parameters of antenna such as radiation pattern, radiation impedance, directivity, antenna gain and effective area. |
| **3** | Apply the Friss transmission expression and reciprocity principle effectively to predict the receive power in a system consisting of transmit and receive antenna. |
| **4** | Develop an antenna system including the shape of the antenna, feed property, the requirement on the arrangement of the radiating elements in an array, given the radiation parameters such as radiation pattern, gain, operating frequency, transmit/receive power |

| **UNIT-I** | |
|---|---|
| **Antenna Basics**<br>Parameters, Patterns, Beam Solid Angle, Radiation Intensity, Directivity and Gain, Radio Communication Link, Polarization, Antenna Temperature.<br>**Types of Antennas**<br>Point Source, Monopole & Dipole, Loop Antenna, Slot Antenna, Horn Antenna, Reflector Antenna, Lens Antenna, Helical Antenna, Reflector Antennas, Smart Antennas, Diversity Reception, MIMO | **08 Hrs** |
| **UNIT-II** | |
| **Electric Dipole**<br>Short Electric Dipole, Fields, Radiation Resistance, λ/2 Dipole and its Characteristics, Folded Dipole, Rhombic Antenna and V Antenna.<br>**Antenna Arrays**<br>Linear Array, Principle of Pattern Multiplication, Broadside and End Fire Arrays, Uniform and Non- Uniform Arrays. | **07 Hrs** |
| **UNIT-III** | |
| **Special Types of Antennas**<br>Babinet's Principle and Complementary Antennas, Lens Antenna, Turnstile Antenna, Base Station and Mobile Antenna, Embedded Antenna.<br>**Broadband and Frequency Independent Antennas**<br>Basics, Biconical Antenna, Log Periodic Antenna, UWB Antennas for Digital Applications | **07 Hrs** |
| **UNIT-IV** | |
| **Micro-Strip and Patch Antennas**<br>Salient Features, Advantages and Limitations, Feed Methods, Characteristics, Array of Micro-Strip Antennas, Applications.<br>**Antenna measurements**<br>Measurement Range, Radiation Pattern Measurement, Gain and Directivity, Polarization, Power Measurements | **07 Hrs** |
| **UNIT-V** | |
| **Basics of Wave Propagation** Guided Waves, Unguided Waves, Classification of EM Spectrum, Noise, Tropo and Iono Scatter, Mobile Propagation Models<br>**Ground, Sky & Space Wave Propagation** Ground Reflection, Diffraction, Wave Tilt, Ionosphere Layers and Its Properties, Critical Frequency, MUF, LUF, Virtual Height& Skip Distance', Effect of Earth's Magnetic Field, Space Propagation, Effects of Earth's Curvature, Radio Horizon , Variation of Field Strength with Height. | **07 Hrs** |

| Course Outcomes: After completing the course, the students will be able to | |
|---|---|
| CO1: | Apply the concepts of physics to understand the mechanism of antenna radiation and working of different antennas. |
| CO2: | Apply basic concepts of electromagnetics to determine different performance parameters of antennas. |
| CO3: | Analyze the antenna parameters such as radiation pattern, directivity, gain, etc of various antennas. |
| CO4: | Design the antennas to achieve prescribe specification for different RF applications. |

| Reference Books | |
|---|---|
| **1.** | Antennas and wave propagation, John D Kraus, Ronald J Marhefka, Ahmad S Khan, 4th Edition, 2010, McGraw Hill, ISBN: 0-07-067155-9 |
| **2.** | Antennas and Wave Propagation , A.R.Harish, M.Sachidananda, 2007, Oxford University Press, ISBN: 978-0195686661 |
| **3.** | Antenna Theory: Analysis & Design ,C A Balanis, 3rd Edition, John-Wiley, ISBN: 978-0471025900 |
| **4.** | Antenna Theory & Design , Warren L. Stutzman, Gary A. Thiele, 3rd Edition ,Wiley India Pvt. Ltd, ISBN 9788126523771 |

**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** | **3** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **1** | **-** | **2** |
| **CO2** | **3** | **2** | **2** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **-** | **2** |
| **CO3** | **3** | **3** | **2** | **1** | **2** | **-** | **-** | **-** | **-** | **1** | **2** | **2** |
| **CO4** | **3** | **3** | **3** | **1** | **2** | **-** | **-** | **1** | **1** | **1** | **2** | **2** |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **TRANSDUCERS & DATA ACQUISITION SYSTEMS (Group A: Professional Core Elective)** | | |
| **Course Code:** 16EC5A2 | | **CIE Marks: 100** |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks: 100** |
| **Hours:** 36L | | **SEE Duration: 3Hrs** |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Understand the architecture & importance of data acquisition systems. |
| **2** | Impart an in-depth knowledge in sensor signal conditioning, signal conversion, data acquisition, signal processing, transmission and analysis. |
| **3** | Provide a comprehensive coverage of data acquisition methods for sensor systems and hardware interface cards available commercially. |
| **4** | Introduce the students to pSpice and LabView through practical sessions. |

| **UNIT-I** | |
|---|---|
| **Fundamentals of Data Acquisition**<br>Fundamentals of Data Acquisition-Configuration and Structure-Interface Systems-Interface Bus. Analog and Digital Signals. Review of Quantization in Amplitude and Time Axis.<br>**Signal Conditioners**<br>Signal Conditioners- Voltage and Current Amplifiers-Voltage Conditioners-Integrated Signal Conditioners for Temperature Sensors, Strain Gages, Piezoelectric Sensors and Linear Position Sensors | **08 Hrs** |
| **UNIT-II** | |
| **Mechanical Transducers**<br>Introduction, Basics of Temperature Measurement: Absolute thermodynamic or Kelvin Scale, Bimetallic Element, Basics of Pressure Measurement: Manometers, Ring Balance, Bell Type, Thin Plate diaphragms, Basics of Flow Measurement: Pitot Static Tube, Displacement to Pressure Transducer | **07 Hrs** |
| **UNIT-III** | |
| **Passive Electrical Transducers**<br>Resistance Thermometers: Thermistors, Semiconductor Temperature sensors, Errors in Temperature Measurements, Hot Wire Resistive Transducers, Capacitive transducers: Thickness transducers, Capacitive displacement Transducers, proximity Transducers, Capacitive Pressure Transducer, Capacitive Moisture Transducer. Introduction to Inductive Transducers. | **07 Hrs** |
| **UNIT-IV** | |
| **Active Electrical Transducers**<br>Introduction, Thermoelectric Transducer: Thermoelectric Phenomenon, Common Thermocouple Systems, Piezo electric Transducer: Piezoelectric Phenomenon, Piezoelectric Materials, Hall- effect Transducer, Electromechanical Transducer: Tachometers, Variable Reluctance Tachometers, Digital Transducers: Digital Displacement transducers, Optical Encoder. | **07 Hrs** |
| **UNIT-V** | |
| **Signal Processing Circuits**<br>Signal Conditioning Modules for Plug-In Board, Two-Wire Transmitter, Distributed I/O - High Speed Digital Transmitter. Field Wiring and Signal Measurement-Grounded and Floated Signal Source-Single Ended and Differential Ended Measurements. Ground Loop and System Isolation-Noise and Interference- Shielding. | **07 Hrs** |

| Course Outcomes: After completing the course, the students will be able to | |
|---|---|
| CO1: | Identify and interpret different sensor design & analyze data acquisition system |
| CO2: | Design suitable sensor front end to monitor real world signals without information loss. |
| CO3: | Realization of sensors and data acquisition system for real time application. |
| CO4: | Usage of modern engineering tools for realizing the working of sensors and data acquisition system. |

| Reference Books | |
|---|---|
| **1.** | Transducers and Instrumentation, D V S Murthy, 2nd Edition, 2008, PHI Publisher |
| **2.** | Practical Data acquisition for Instrumentation and Control, John Park and Steve Mackay, 2003, Newness publishers |
| **3.** | Data Acquisition systems- from fundamentals to Applied Design, Maurizio Di Paolo Emilio, 2013, Springer |
| **4.** | Introduction to Data Acquisition with LabVIEW, Robert H King, 2nd edition, 2012, McGraw Hill, |

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

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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 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** | **1** | **1** | **1** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **-** | **1** |
| **CO2** | **2** | **2** | **2** | **2** | **1** | **1** | **-** | **-** | **1** | **1** | **1** | **1** |
| **CO3** | **2** | **2** | **2** | **2** | **1** | **1** | **2** | **-** | **2** | **1** | **2** | **2** |
| **CO4** | **2** | **1** | **2** | **2** | **3** | **-** | **-** | **2** | **3** | **1** | **2** | **2** |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **ARTIFICIAL NEURAL NETWORKS &DEEP LEARNING (Group A: Professional Core Elective)** | | |
| **Course Code:** 16EC5A3 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Understand Neural Network and model a Neuron and Express both Artificial Intelligence and Neural Network |
| **2** | Analyze ANN learning, Error correction learning, Memory-based learning, Hebbian learning, Competitive learning and Boltzmann learning |
| **3** | Implement Simple perception, Perception learning algorithm, Modified Perception learning algorithm, and Adaptive linear combiner, Continuous perception, learning in continuous perception. |
| **4** | Analyze the limitation of Single layer Perceptron and Develop MLP with 2 hidden layers, Develop Delta learning rule of the output layer and Multilayer feed forward neural network with continuous perceptions |

| **UNIT-I** | |
|---|---|
| **Introduction to Neural Networks:** Neural Network, Human Brain, Models of Neuron, Biological Neural Network, Artificial neuron, Artificial Neural Network architecture, ANN learning process, learning tasks, Memory and Adaptation. | **08 Hrs** |
| **UNIT-II** | |
| **Machine Learning Basics:** Learning Algorithms, Capacity, Over-fitting and Under-fitting, Hyper parameters and Validation Sets, Estimators, Bias and Variance, Maximum Likelihood Estimation, Bayesian Statistics, Supervised Learning Algorithms, Unsupervised Learning Algorithms, Stochastic Gradient Descent, Building a Machine Learning Algorithm, Challenges Motivating Deep Learning. | **07 Hrs** |
| **UNIT-III** | |
| **Single layer Perception:** Introduction, Linear classifier, Simple perception, Perception learning algorithm, Learning in continuous perception. Limitation of Perception. **Multi-Layer Perceptron Networks:** Introduction, MLP with 2 hidden layers, Simple layer of a MLP, Delta learning rule of the output layer, Multilayer feed forward neural network with continuous perceptions, Generalized delta learning rule, Back propagation algorithm | **07 Hrs** |
| **UNIT-IV** | |
| **Deep Feed forward Networks:** Example: Learning XOR Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation and Other Differentiation Algorithms, Historical Notes | **07 Hrs** |
| **UNIT-V** | |
| **CNN&RNN**: The Convolution Operation, Motivatio, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the Basic Convolution Function, Structured Outputs, Data Types, Efficient Convolution Algorithms,<br>**Recurrent and Recursive Nets**: Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks. **Introduction to ResNet,** Inception, YOLO architectures | **07 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO1: | Model Neural Network, Neuron and to analyze ANN learning, and its applications. |
| CO2: | Develop Machine learning algorithms. |
| CO3: | Develop different single layer/multiple layer Perception learning algorithms |

| | |
|---|---|
| CO4: | Design of another class of layered networks using deep learning and CNN and RNN principles |

| **Reference Books** | |
|---|---|
| **1.** | Simon Haykins, Neural Network- A Comprehensive Foundation, Pearson Prentice Hall, 2nd Edition, 1999. ISBN-13: 978-0-13-147139-9/ISBN-10: 0-13-147139-2 |
| **2.** | Goodfellow, Y, Bengio, A. Courville, Deep Learning, MIT Press, 2016, ISBN-13: 978-0262035613 |
| **3.** | Vojislav Kecman, Learning & Soft Computing, Pearson Education, 1st Edition, 2004, ISBN:0-262-11255-8 |
| **4.** | S. Haykin, Neural Networks and Learning Machines, 3e, Pearson, 2008., ISBN-13: 978-0131471399 |

**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** | **3** | **2** | **-** | **-** | **-** | **1** | **1** | **-** | **-** | **1** | **-** | **1** |
| **CO2** | **3** | **2** | **2** | **1** | **-** | **1** | **1** | **-** | **-** | **1** | **-** | **1** |
| **CO3** | **3** | **3** | **2** | **2** | **2** | **1** | **1** | **-** | **-** | **1** | **-** | **1** |
| **CO4** | **3** | **3** | **3** | **3** | **2** | **1** | **1** | **-** | **-** | **1** | **-** | **1** |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **MODELLING OF SEMICONDUCTOR DEVICES (Group A: Professional Core Elective)** | | |
| **Course Code:** 16EC5A4 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Explain and apply basic concepts of semiconductor physics relevant to devices |
| **2** | Describe, explain, and analyze the operation of important semiconductor devices in terms of their physical structure |
| **3** | Explain, describe, and use physics-based device and circuit models for semiconductor devices of varying levels of complexity, select models appropriate to a specific need, and apply those models to analyze multi-component circuits |
| **4** | Analyze and design microelectronic circuits for linear amplifier and digital applications |

| **UNIT-I** | |
|---|---|
| **Charge Carriers and Transport Modelling** Crystal Structure, Semiconductor Models, Carrier Properties, State and Carrier Distributions, Equilibrium Carrier Concentrations, Drift, Diffusion, Recombination-Generation, Equations of State, Modelling & Simulation examples. | **08 Hrs** |
| **UNIT-II** | |
| **Modelling of PN Junction Diodes:** pn Junction Electrostatics, Preliminaries, Quantitative Electrostatic Relationships, I-V Characteristics, The Ideal Diode Equation, Deviations from the Ideal, Small-Signal Admittance, Reverse-Bias Junction Capacitance, Forward-Bias Diffusion Admittance, MS Contacts and Schottky Diodes, Modelling & Simulation examples. | **07 Hrs** |
| **UNIT-III** | |
| **Modelling of BJT**: Electrostatics, Performance Parameters, Ideal Transistor Analysis, General Solution, Simplified Relationships, Ebers-Moll Equations and Model, Deviations from the Ideal, Modern BJT Structures, Modelling & Simulation examples. | **07 Hrs** |
| **UNIT-IV** | |
| **Modelling of MOS:** Electrostatics, Capacitance-Voltage Characteristics, Quantitative $I_D/V_D$ Relationships, Square-Law Theory, Bulk-Charge Theory, a.c. Response, Small-Signal Equivalent Circuits, Cutoff Frequency, Small-Signal Characteristics, Modelling & Simulation examples. | **07 Hrs** |
| **UNIT-V** | |
| **Emerging semiconductor devices (Qualitative approach):** Introduction, HEMT, HBT, Fin-FET. Nanowire-FET, quantum and molecular devices, energy storage and harvesting Electronics devices | **07 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO1: | Apply semiconductor models to analyze carrier densities and carrier transport. |
| CO2: | Analyze basic governing equations to analyze semiconductor devices. |
| CO3: | Design the p-n junction, Schottky barrier diodes and emerging semiconductor devices. |
| CO4: | Simulate characteristics of a simple device using MATLAB, SPICE and ATLAS / SYNOPSYS |

| Reference Books | |
|---|---|
| **1.** | Semiconductor Device Fundamentals, Robert F. Pierret, 2006, Pearson, ISBN 9780201543933 |
| **2.** | Operation and Modeling of the MOS Transitor , Y.P. Tsividis, Colin McAndrew, 3rd Edition, 2014, Oxford Univ Press, ISBN:978-0195170153 |
| **3.** | Fundamentals of Modern VLSI Devices , Yuan Taur,Tak H. Ning,2nd edition , 2013 Cambridge University Press, ISBN: 978-1107635715 |
| **4.** | Semiconductor Simulation Tools, "https://nanohub.org/groups/semiconductors" |

**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** | **3** | **2** | **-** | **1** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO2** | **3** | **2** | **2** | **1** | **1** | **-** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO3** | **3** | **3** | **2** | **2** | **2** | **-** | **-** | **-** | **-** | **1** | **-** | **2** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **1** | **-** | **-** | **1** | **2** | **1** | **2** |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **OBJECT ORIENTED PROGRAMMING IN C++**<br>**(Group A: Professional Core Elective)** | | |
| **Course Code:** 16EC5A5 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Analyze the basic programming concepts and primitives of object-oriented programming. |
| **2** | Analyze new programming concept which should help in developing high quality software. |
| **3** | Interpret basic data structures & dimensionality of arrays to store data efficiently. |
| **4** | Design an algorithmic solution for a given problem |

| **UNIT-I** | |
|---|---|
| **Introduction to C++:** Procedure–Oriented Programming, Object Oriented Programming, Comparison of C++ with C, Input/output in C++, Bool data types, Enumerated data types, structures, Unions, Pointers, Pointer arithmetic, Pointers to different data types, Reference, Operators: new, delete, volatile, size of ,typecasting, Storage classes **Functions:** Function components, Function arguments, Function overloading, Function with default arguments, Inline function, #define macros, Function templates | **08 Hrs** |
| **UNIT-II** | |
| **Pointers & 1D Arrays**<br>Introduction, accessing array elements using pointers, pointer to strings, dynamic arrays, pointers to structures, passing pointers to functions.<br>**Classes and Objects**<br>Introduction to classes and objects, Member function and member data, Access specifiers, constructors, destructors, static members, friend function, friend class, Copy constructor, Overloaded assignment operator, this pointer, class templates. | **07 Hrs** |
| **UNIT-III** | |
| **Operator Overloading**<br>Operator overloading, overloading the increment and the Decrement operators (Prefix and Post fix), Overloading the Unary Minus and unary plus operator, Overloading the arithmetic operators, Over loading the relational operators, Overloading the insertion and extraction operator, Data Conversion using Member function. | **07 Hrs** |
| **UNIT-IV** | |
| **Data Representation using Arrays**<br>1-D arrays, arrays as a member of the class, creating array using dynamic constructors, array of object, strings, Implementation of stack and queue using arrays. **Data Representation using Linked List** Single-Linked List, Implementation of stack and queue using Linked list. | **07 Hrs** |
| **UNIT-V** | |
| **Inheritance**<br>Types of inheritance, Visibility mode, Function overriding, Need for virtual function, virtual function, Pure virtual function.<br>**Stream Handling**<br>Streams, Text Input/Output, Opening and Closing Files, Object Input/Output through Member Functions. Exception Handling in C++ | **07 Hrs** |

| Course Outcomes: After completing the course, the students will be able to | |
|---|---|
| CO1: | Explain the concepts & constructs of object-oriented programming. |
| CO2: | Analyze the basic constructs, operations, control structures and advanced features of the C++ programming language and apply this knowledge to develop algorithms for given problem. |
| CO3: | Perform analysis of real-world problems and implement C++ software solutions to meet the industry requirements with the help of modern engineering tools. |
| CO4: | Engage in self-study as a team member/individual to formulate, design, implement, analyze and demonstrate the C++ software developed for a given assignments. |

| Reference Books | |
|---|---|
| **1.** | Mastering C++, K.RVenugopal, Rajkumar, T Ravishankar, 4th Edition, 2008, Tata McGraw-Hill Pubications, ISBN-13: 978-81-7758-373-1 |
| **2.** | Object-oriented Programming in Turbo C ++, Robert Lafore, 3rd Edition,2009, Galgotia Publishing House, |
| **3.** | C++:The Complete Reference ,Herbert Schildt, 4th Edition, 2007, McGraw-Hill, , ISBN-10: 0078824761/ ISBN-13: 978-0078824760 |
| **4.** | Object Oriented Programming with C++, E.Balagurusamy, 2008, Tata McGraw-Hill Publications, ISBN-13: 9780070669079 |

**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** | | | | | **3** | | | | | | | **2** |
| **CO2** | **3** | **3** | **3** | **2** | | | | **2** | **2** | | | **2** |
| **CO3** | **3** | **2** | **3** | **3** | **3** | | | **2** | **2** | | | |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **1** | **1** | **3** | **3** | **3** | **2** | **3** |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **COMPUTER ORGANISATION AND ARCHITECTURE**<br>**(Group A: Professional Core Elective)** | | |
| **Course Code:** 16EC5A6 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Understand the fundamentals of computer System and its Organization. |
| **2** | Appreciate the functionalities of basic processing unit and its control system in processing the Instruction. |
| **3** | Understand the role of bus system. |
| **4** | Develop a clear understanding on the pipelining. |
| **5** | Present an adequate Instruction Set Architectures for better understanding of the assembly level programming. |

| **UNIT-I** | |
|---|---|
| **Basic Structures of Computers:** Functional units, Basic Operational Concepts, Bus Structures, Performance measurement. **Machine Instructions and Programs:** Numbers, Number Notation, Arithmetic operations and characters. Memory Locations and Addresses, Memory Operation, Instruction and Instruction Sequencing, Addressing Modes, implementation of Variables & Constants, Indirection & pointers, Indexing & Arrays, Relative Addressing, Example Programs. | **08 Hrs** |
| **UNIT-II** | |
| **Machine Instructions and Programs:** Additional addressing Modes, Assembly Language, Stacks & Queues, Subroutines, Subroutine Nesting & Processor Stack, Parameter passing, The stack frame. Additional Instructions, Example programs. | **06 Hrs** |
| **UNIT-III** | |
| **Input / Output Organization:** Basic Input / Output Operations, Accessing I/O devices, Interrupts: Interrupt Hardware, Enabling & Disabling Interrupt, Handling Multiple Devices, Controlling Device Requests, Exceptions, Direct Memory Access: Bus arbitration.<br>**Basics of memory:** Memory Hierarchy, Speed, Size and cost, Performance considerations: Hit Rate and miss penalty | **08 Hrs** |
| **UNIT-IV** | |
| **Arithmetic Operations:** Booth Algorithm, Fast Multiplication: Bit-pair Recording of Multipliers; Integer division; IEEE Standard for floating – point Numbers.<br>**Control Unit Logic:** Fundamental Concepts: Register Transfers, Performing an Arithmetic or Logic operation, Fetching a Word from Memory, Storing a Word in Memory, Execution of a Complete Instruction, Branch instruction. Multiple Bus Organization, Micro programmed control: Micro Instructions and its comparison with hardwired control. | **07 Hrs** |
| **UNIT-V** | |
| **Pipelining:** Basic concepts: Role of Cache Memory, Pipeline Performance; data hazards: Operand forwarding, Handling Data Hazards in software, Side Effects; Instruction Hazards: Unconditional Branches, Conditional Branches: delayed branch; Influence on Instruction sets. **Super Scalar Operation:** Out-of-order Execution, Execution Completion, Dispatch Operations. | **07 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO1: | Analyze the basic operation and organization of computer system |
| CO2: | Identify the design requirements in organizing computer system components |
| CO3: | Develop assembly language program for different instruction set architecture and its data representation |
| CO4: | Examine the different interfaces of a computer system |

| Reference Books | |
|---|---|
| **1.** | Computer Organization, Carl Hamacher, Z Vranesic& S Zaky, 5th Edition, 2011, Mc Graw Hill, ISBN 10: 1259005275 / ISBN 13: 9781259005275. |
| **2.** | Computer Organization and Architecture: Designing for Performance, William Stallings, 8th edition, 2010, Prentice Hall, ISBN-13: 978-0-13-607373-4 ISBN-10: 0-13-607373-5. |
| **3.** | Computer Organization and Design, David A. Patterson & John L. Hennessy, 5th Edition, 2013 Morgan Kaufmann, ISBN : 9780124077263 |
| **4.** | Fundamentals of Computer Organization and Architecture, Mostafa Abd-El-Barr, Hesham El-Rewini, 2005, Wiley publishers, ISBN10: 0-471-46741-3. |

**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** | **3** | **2** | **1** | **-** | **-** | **-** | **-** | **-** | **-** | **1** | **-** | **2** |
| **CO2** | **3** | **3** | **3** | **2** | **-** | **-** | **-** | **-** | **-** | **1** | **-** | **2** |
| **CO3** | **3** | **3** | **2** | **2** | **3** | **-** | **-** | **-** | **2** | **1** | **-** | **2** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **-** | **-** | **-** | **2** | **1** | **-** | **2** |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **ROBOTICS**<br>**(Group A: Professional Core Elective)** | | |
| **Course Code:** 16EC5A7 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Explain the basic principles of Robotic technology, configurations, control and programming of Robots. |
| **2** | Describe the concept of Robot kinematics and dynamics, latest algorithms & analytical Approaches. |
| **3** | Discuss and apply the concepts of dynamics for a typical Pick and Place robot |
| **4** | Choose the appropriate Sensor and Machine vision system for a given application. |

| **UNIT-I** | |
|---|---|
| **Introduction:** Automation and Robotics, Historical Development, Definitions, Basic Structure of Robots, Robot Anatomy, Complete Classification of Robots, Fundamentals about Robot Technology, Factors related to use Robot Performance, Basic Robot Configurations and their Relative Merits and Demerits, the Wrist & Gripper Subassemblies. | **07 Hrs** |
| **UNIT-II** | |
| **Kinematics of Robot Manipulator:** Introduction, Geometry Based Direct kinematics problem, Composite Rotation matrix, Homogenous Transformations, Robotic Manipulator, Joint Co-Ordinate System, Roll Pitch-Yaw (RPY) Transformation. DH Representation & Displacement Matrices for Standard Configurations, Jacobian Transformation in Robotic Manipulation. | **07 Hrs** |
| **UNIT-III** | |
| **Trajectory Planning:** – Introduction, Trajectory Interpolators, Basic Structure of Trajectory Interpolators, Cubic Joint Trajectories. General Design Consideration on Trajectories. | **07 Hrs** |
| **UNIT-IV** | |
| **Dynamics of Robotic Manipulators:** Introduction, Preliminary Definitions, Generalized Robotic Coordinates, Jacobian for a Two link Manipulator, Euler Equations, The Lagrangian Equations of motion. Dynamic Modeling of Robotic Manipulators: - Velocity of Joints, Kinetic Energy of Arm, Potential Energy of Robotic Arm, The Lagrange, Two Link Robotic Dynamics with Distributed Mass. | **07 Hrs** |
| **UNIT-V** | |
| **Robot Sensing & Controlling:** Various Sensors and their Classification, Use of Sensors and Sensor Based System in Robotics, Machine Vision System, Description, Sensing, Digitizing, Image Processing, Analysis and Application of Machine Vision System, Robotic Assembly Sensors and Intelligent Sensors. Industrial Applications: Automation in Manufacturing, Robot Application in Industry, Task Programming, Robot Intelligence and Task Planning, Modern Robots, Goals of AI Research and AI Techniques- Case Study. | **08 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO1: | Explain the basic principles of Robotic technology, configurations, control and programming of Robots. |
| CO2: | Describe the concept of Robot kinematics and dynamics, latest algorithms & analytical Approaches. |
| CO3: | Discuss and apply the concepts of dynamics for a typical Pick and Place robot |
| CO4: | Choose the appropriate Sensor and Machine vision system for a given application. |

| Reference Books | |
|---|---|
| **1.** | Robotics, control vision and intelligence, Fu, Lee and Gonzalez, 2nd edition, 2007, McGraw Hill International publication |
| **2.** | Introduction to Robotics, John J. Craig, 3rd edition, 2010, Addison Wesley Publishing |
| **3.** | Robotics for Engineers, Yoram Koren, 1st edition, 1985, McGraw Hill International |
| **4.** | Robotics Engineering-An Integrated Approach ,Klafer, Chmielewski and Negin, 1st Edition, 2009, PHI. |

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

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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 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** | **3** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **1** | **2** | **1** |
| **CO2** | **3** | **2** | **2** | **1** | **-** | **-** | **-** | **-** | **2** | **1** | **-** | **1** |
| **CO3** | **2** | **3** | **2** | **2** | **2** | **-** | **1** | **-** | **1** | **1** | **-** | **1** |
| **CO4** | **3** | **3** | **3** | **3** | **2** | **1** | **-** | **-** | **-** | **1** | **-** | **1** |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **BIOINFORMATICS (Group B: Global Elective)** | | |
| **Course Code:** 16G5B01 | | **CIE Marks:** 100 |
| **Credits :L:T:P:S:** 4:0:0:0 | | **SEE Marks:** 100 |
| **Hours:**04 | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives:** | |
|---|---|
| 1 | Understand the underlying technologies of Bioinformatics and Programming |
| 2 | Explore the various algorithms behind the computational genomics and proteomic structural bioinformatics, modeling and simulation of molecular systems. |
| 3 | Apply the tools and techniques that are exclusively designed as data analytics to investigate the significant meaning hidden behind the high throughput biological data. |
| 4 | Analyze and evaluate the outcome of tools and techniques employed in the processes of biological data pre-processing and data mining. |

| **Unit-I** | |
|---|---|
| **Biomolecules**: Introduction to Biomolecules. Structure, Types and Functions of Carbohydrates, Lipids, Nucleic Acids and Proteins. Genetic code, Codon degeneracy, Genes and Genomes. **Bioinformatics & Biological Databases:** Introduction to Bioinformatics, Goals, Scope, Applications in biological science and medicine. Biological databases – Sequence, structure, Special Databases and applications - Genome, Microarray, Metabolic pathway, motif, and domain databases. Mapping databases – genome wide maps. Chromosome specific human maps. | **09 Hrs** |
| **Unit – II** | |
| **Sequence Alignment:** Introduction, Types of sequence alignments - Pairwise and Multiple sequence alignment, Alignment algorithms (Needleman & Wunch, Smith & Waterman and Progressive global alignment). Database Similarity Searching- Scoring matrices – BLOSSUM and PAM, Basic Local Alignment Search Tool (BLAST), and FASTA. Next Generation Sequencing – Alignment and Assembly. **Molecular Phylogenetics:** Introduction, Terminology, Forms of Tree Representation. Phylogenetic Tree Construction Methods - Distance-Based & Character-Based Methods and Phylogenetic Tree evaluation. | **09 Hrs** |
| **Unit -III** | |
| **Predictive methods:** Predicting secondary structure of RNA, Protein and Genes – algorithms to predict secondary structure of RNA, Protein and Gene. Prediction of Tertiary structure of Protein, Protein identity and Physical properties of protein. **Molecular Modeling and Drug Designing:** Introduction to Molecular Modeling. Methods of Molecular Modeling and Force Fields used in Molecular Modeling. Drug designing process - deriving Pharmacophore, Receptor Mapping, Estimating Receptor-Ligand interactions and Molecular Docking. | **09 Hrs** |
| **Unit –IV** | |
| **Perl:** Introduction to Perl, writing and executing a Perl program. Operators, Variables and Special variables. Data Types – Scalar, Array and Associative array. Regular Expressions (REGEX), Components of REGEX - Operators, Metacharacters and Modifiers. Subroutines – types of functions, defining and calling functions in Perl, calling function - call by value and call by reference. Object Oriented Programming in Perl–Class and object, Polymorphism, inheritance and encapsulation. Perl Package – writing and calling package. Perl Module – writing and calling module. | **09 Hrs** |
| **Unit –V** | |
| **BioPerl:** Introduction to BioPerl, BioPerl Modules, Applications of BioPerl – Sequence retrieval from Database and submission of sequence to online Database, Indexing and accessing local databases, Transforming formats of database record, Sequence alignments BioPerl and Sequence Analysis - Pair wise and Multiple sequence alignment, Restriction mapping. Identifying restriction enzyme sites, acid cleavage sites, searching for genes and | **09 Hrs** |

| | |
|---|---|
| other structures on genomic DNA, Parsing BLAST and FASTA results. BioPerl and phylogenetic analysis, BioPerl and Phylogenetic tree manipulation, creating graphics for Sequence display and Annotation. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand the Architecture and Schema of online databases including structure of records in these databases. |
| **CO2:** | Explore the Mind crunching Algorithms, which are used to make predictions in Biology, Chemical Engineering, and Medicine. |
| **CO3:** | Apply the principles of Bioinformatics and Programming to the problems related to process simulation and process engineering in Biological system. |
| **CO4:** | Use Bioinformatics tools and Next Generation Technologies to model and simulate biological phenomenon. |

| **Reference Books** | |
|---|---|
| **1** | T. Christiansen, B. D. Foy, L. Wall, J. Orwant, Programming Perl: Unmatched power for text processing and scripting, O'Reilly Media, Inc., 4th Edition, 2012, ISBN-13: 978-0596004927 |
| **2** | B. Haubold, T. Weihe, Introduction to Computational Biology: An Evolutionary Approach, new age publishers, Paperback Edition, 2009, ISBN-13: 978-8184890624 |
| **3** | C. Bessant, I. Shadforth, D. Oakley, Building Bioinformatics Solutions: with Perl, R and MySQL, Oxford University Press, 1st edition, 2009, ISBN |
| **4** | D. C. Young. Computational Drug Design: A Guide for Computational and Medicinal Chemists,Wiley-Interscience, 1st edition, 2009, ISBN-13: 978-0470126851. |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment. 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 60. The marks component for assignment is 10. 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 | 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 | - | - |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **FUEL CELL TECHNOLOGY (Group B: Global Elective)** | | |
| **Course Code:** 16G5B02 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S::** 4:0:0:0 | | **SEE Marks:** 100 |
| **Hours:** 45L | | **SEE Duration:** 3Hrs |

| 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 | |
|---|---|
| Introduction: 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. | **09Hrs** |
| **UNIT-II** | |
| Fuel Cell Types: 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. | **09Hrs** |
| **UNIT-III** | |
| Fuel Cell Reaction Kinetics: activation kinetics, open circuit voltage, intrinsic maximum efficiency, voltage efficiency, Faradaic efficiency, overall efficiency, over-voltages and Tafel equation. | **09Hrs** |
| **UNIT-IV** | |
| Fuel Cell Characterization: current – voltage curve, in-situ characterization, current – voltage measurement, current interrupt measurement, cyclic voltammetry, electrochemical impedance spectroscopy and ex-situ characterization techniques. | **09Hrs** |
| **UNIT-V** | |
| Applications of Fuel Cells: applications of fuel cells in various sectors, hydrogen production, storage, handling and safety issues. | **09 Hrs** |

| **Course Outcomes:** After completing the course, the students will be able to | |
|---|---|
| 1 | Understand the fundamentals and characteristics of fuel cells |
| 2 | Apply chemical engineering principles to distinguish fuel cells from conventional energy systems |
| 3 | Analyze the performance of fuel cells using different characterization techniques |
| 4 | 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 Assignment. 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 60. The marks component for assignment is 10. 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 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** |
| **CO 1** | **2** | **-** | **-** | **-** | **-** | **-** | **1** | **-** | **1** | **-** | **-** | **-** |
| **CO 2** | **2** | **-** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** |
| **CO 3** | **-** | **3** | **-** | **-** | **-** | **-** | **3** | **-** | **2** | **-** | **-** | **-** |
| **CO 4** | **-** | **2** | **2** | **-** | **-** | **-** | **2** | **-** | **3** | **-** | **-** | **2** |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **GEOINFORMATICS**<br>**(Group B: Global Elective)** | | |
| **Course Code:**16G5B03 | | **CIE Marks:** 100 |
| **Credits:** L:T:P:S: 4:0:0:0 | | **SEE Marks:** 100 |
| **Credits**: 48L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | To understand concept of using photographic data to determine relative positions of points |
| **2** | To study the use of electromagnetic energy for acquiring qualitative and quantitative land information |
| **3** | To analyze the data gathered from various sensors and interpret for various applications |
| **4** | To understand the various applications of RS, GIS and GPS |

| **UNIT-I** | |
|---|---|
| **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- physical basis for spectra reflectance curve, false color composite. Platforms and sensors. Sensor resolutions. Types of satellites- Indian and other remote sensing satellites (IRS, IKONS and Landsat). Concept of image interpretation and analysis - Principle of visual interpretation, recognition elements. Fundamentals of image rectification. Digital Image classification - supervised and unsupervised | **10 Hrs** |
| **UNIT-II** | |
| **Photogrammetry:** Introduction types of Photogrammetry, Advantages of Photogrammetry, Introduction to digital Photogrammetry. Locating points from two phases determination of focal length.<br>**Aerial Photogrammetry:** Advantages over ground survey methods - geometry of vertical phographs, scales of vertical photograph. Ground coordination- relief displacement, scale ground coordinates – flight planning | **10 Hrs** |
| **UNIT-III** | |
| **Geographic Information System-** Introduction, Functions and advantages, sources of data for GIS. Database – Types, advantages and disadvantages. Data Management – Transformation, Projection and Coordinate systems. Data input methods, Data Analysis.- overlay operations, network analysis, spatial analysis. Outputs and map generation. . Introduction to GPS- components and working principles | **10 Hrs** |
| **UNIT-IV** | |
| **Applications of GIS, Remote Sensing and GPS**: Case studies on Water Resources engineering and management (prioritization of river basins, water perspective zones and its mapping), **Case studies on applications of GIS and RS in** highway alignment, Optimization of routes, accident analysis, Environmental related studies. **Case studies on applications of GIS and RS in** Disaster Management (Case studies on post disaster management - Earthquake and tsunami and pre disaster management - Landslides and floods) Urban Planning & Management - mapping of zones, layouts and infrastructures. | **09 Hrs** |
| **UNIT-V** | |
| **Applications of GIS, Remote Sensing and GPS**: Land use land cover (LULC) mapping. Case studies on infrastructure planning and management- Case studies on urban sprawl. Change detection studies – case studies on forests and urban area. Case studies on agriculture. **Applications of geo-informatics in natural resources management: Geo Technical case Studies**, site suitability analysis for various applications. | **09 Hrs** |

| Course Outcomes: After completing the course, the students will be able to | |
|---|---|
| 1 | Understand the principle of Remote Sensing (RS) and Geographical Information Systems (GIS) data acquisition and its applications. |
| 2 | Apply RS and GIS technologies in various fields of engineering and social needs. |
| 3 | Analyze and evaluate the information obtained by applying RS and GIS technologies. |
| 4 | Create a feasible solution in the different fields of application of RS and GIS. |

| Reference Books | |
|---|---|
| **1.** | Geographic Information System-An Introduction, Tor Bernharadsen, 3rd Edition, Wiley India Pvt. Ltd. New Delhi , 2009. |
| **2.** | Principles of Remote sensing and Image Interpretation, Lillesand and Kiefer, 5th Edition, John Wiley Publishers, New Delhi, 2007. |
| **3.** | Remote Sensing and GIS, Bhatta B, Oxford University Press, New Delhi, 2008 |
| **4.** | Remote Sensing, Robert A. Schowengerdt, 3rd Edition, Elsevier India Pvt Ltd, New Delhi, 2009 |

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

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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 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** | 1 | - | - | - | - | 1 | - | - | - | - | - | - |
| **CO2** | 2 | 1 | - | - | 1 | 1 | - | - | - | - | - | - |
| **CO3** | 2 | 2 | 1 | - | 2 | 1 | 1 | - | - | - | - | 1 |
| **CO4** | 2 | 2 | 1 | - | 3 | 2 | 2 | - | - | - | 1 | 1 |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **GRAPH THEORY**<br>**(Group B : Global Elective)** | | |
| **Course Code:**16G5B04 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 4:0:0:0 | | **SEE Marks:** 100 |
| **Hours:** 45L | | **SEE Duration:** 3 Hrs |

| **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** | |
|---|---|
| **Introduction to graph theory**<br>Introduction, Mathematical preliminaries, definitions and examples of graphs, degrees and regular graphs, sub graphs, directed graphs, in degrees and out degrees in digraphs.<br>**Basic concepts in graph theory**<br>Paths and cycles, connectivity, homomorphism and isomorphism of graphs, connectivity in digraphs. | **09 Hrs** |
| **UNIT-II** | |
| **Graph representations, Trees, Forests**<br>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. | **09 Hrs** |
| **UNIT-III** | |
| **Fundamental properties of graphs and digraphs**<br>Bipartite graphs, Eulerian graphs, Hamiltonian graphs, Hamiltonian cycles in weighted graphs, Eulerian digraphs.<br>**Planar graphs, Connectivity and Flows**<br>Embedding in surfaces, Euler's formula, Characterization of planar graphs, Kuratowski's theorem, Dual of a planar graphs. | **09 Hrs** |
| **UNIT-IV** | |
| **Matchings and Factors**<br>Min-Max theorem, Independent sets and covers, Dominating sets, maximum bipartite matching.<br>**Coloring of graphs**<br>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 | **09 Hrs** |
| **UNIT-V** | |
| **Graph algorithms**<br>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. | **09Hrs** |

| **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)**

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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 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** | **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** |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **ARTIFICIAL NEURAL NETWORKS &DEEP LEARNING (Group B: Global Elective)** | | |
| **Course Code:** 16G5B05 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 4:0:0:0 | | **SEE Marks:** 100 |
| **Hours:** 46L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Define what is Neural Network and model a Neuron and Express both Artificial Intelligence and Neural Network |
| **2** | Analyze ANN learning, Error correction learning, Memory-based learning, Hebbian learning, Competitive learning and Boltzmann learning |
| **3** | Implement Simple perception, Perception learning algorithm, Modified Perception learning algorithm, and Adaptive linear combiner, Continuous perception, learning in continuous perception. |
| **4** | Analyze the limitation of Single layer Perceptron and Develop MLP with 2 hidden layers, Develop Delta learning rule of the output layer and Multilayer feed forward neural network with continuous perceptions, |

| **UNIT-I** | |
|---|---|
| **Introduction to Neural Networks:** Neural Network, Human Brain, Models of Neuron, Neural networks viewed as directed graphs, Biological Neural Network, Artificial neuron, Artificial Neural Network architecture, ANN learning, analysis and applications, Historical notes. | **08 Hrs** |
| **UNIT-II** | |
| **Learning Processes:** Introduction, Error correction learning, Memory-based learning, Hebbian learning, Competitive learning, Boltzmann learning, credit assignment problem, learning with and without teacher, learning tasks, Memory and Adaptation. | **10 Hrs** |
| **UNIT-III** | |
| **Single layer Perception:** Introduction, Pattern Recognition, Linear classifier, Simple perception, Perception learning algorithm, Modified Perception learning algorithm, Adaptive linear combiner, Continuous perception, Learning in continuous perception. Limitation of Perception. | **10 Hrs** |
| **UNIT-IV** | |
| **Multi-Layer Perceptron Networks:** Introduction, MLP with 2 hidden layers, Simple layer of a MLP, Delta learning rule of the output layer, Multilayer feed forward neural network with continuous perceptions, Generalized delta learning rule, Back propagation algorithm | **10 Hrs** |
| **UNIT-V** | |
| **Introduction to Deep learning**: Neuro architectures as necessary building blocks for the DL techniques, Deep Learning & Neocognitron, Deep Convolutional Neural Networks, Recurrent Neural Networks (RNN), feature extraction, Deep Belief Networks, Restricted Boltzman Machines, Autoencoders, Training of Deep neural Networks, Applications and examples (Google, image/speech recognition) | **08 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Model Neuron and Neural Network, and to analyze ANN learning, and its applications. |
| **CO2:** | Perform Pattern Recognition, Linear classification. |
| **CO3:** | Develop different single layer/multiple layer Perception learning algorithms |
| **CO4:** | Design of another class of layered networks using deep learning principles. |

| Reference Books | |
|---|---|
| **1.** | Neural Network- A Comprehensive Foundation , Simon Haykins, 2nd Edition, 1999, Pearson Prentice Hall, ISBN-13: 978-0-13-147139-9 |
| **2.** | Introduction to Artificial Neural Systems, Zurada and Jacek M, 1992, West Publishing Company, ISBN: 9780534954604 |
| **3.** | Learning & Soft Computing, Vojislav Kecman, 1st Edition, 2004, Pearson Education, ISBN:0-262-11255-8 |
| **4.** | Neural Networks Design, M T Hagan, H B Demoth, M Beale, 2002, Thomson Learning, ISBN-10: 0-9717321-1-6/ ISBN-13: 978-0-9717321-1-7 |

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

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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 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** | **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** |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **HYBRID ELECTRIC VEHICLES**<br>**(Group B: Global Elective)** | | |
| **Course Code:** 16G5B06 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 4:0:0:0 | | **SEE Marks:** 100 |
| **Hours:** 45L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to,** | |
|---|---|
| 1 | Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals. |
| 2 | Explain plug – in hybrid electric vehicle architecture, design and component sizing and the power electronics devices used in hybrid electric vehicles. |
| 3 | Analyze various electric drives suitable for hybrid electric vehicles and Different energy storage technologies used for hybrid electric vehicles and their control. |
| 4 | Demonstrate different configurations of electric vehicles and its components, hybrid vehicle configuration by different techniques, sizing of components and design optimization and energy management. |

| **Unit-I** | |
|---|---|
| **Introduction:** Sustainable Transportation, A Brief History of HEVs, Why EVs Emerged and Failed, Architectures of HEVs, Interdisciplinary Nature of HEVs, State of the Art of HEVs, Challenges and Key Technology of HEVs.<br>**Hybridization of the Automobile:** Vehicle Basics, Basics of the EV, Basics of the HEV, Basics of Plug-In Hybrid Electric Vehicle (PHEV), Basics of Fuel Cell Vehicles (FCVs). | **07 Hrs** |
| **Unit-II** | |
| **HEV Fundamentals:** Introduction, Vehicle Model, Vehicle Performance, EV Powertrain Component Sizing, Series Hybrid Vehicle, Parallel Hybrid Vehicle, Wheel Slip Dynamics.<br>**Plug-in Hybrid Electric Vehicles:** Introduction to PHEVs, PHEV Architectures, Equivalent Electric Range of Blended PHEVs, Fuel Economy of PHEVs, Power Management of PHEVs, Component Sizing of EREVs, Component Sizing of Blended PHEVs, Vehicle-to-Grid Technology. | **10 Hrs** |
| **Unit-III** | |
| **Power Electronics in HEVs:** Power electronics including switching, AC-DC, DC-AC conversion, electronic devices and circuits used for control and distribution of electric power, Thermal Management of HEV Power Electronics.<br>**Batteries, Ultracapacitors, Fuel Cells, and Controls:** Introduction, Different batteries for EV, Battery Characterization, Comparison of Different Energy Storage Technologies for HEVs, Battery Charging Control, Charge Management of Storage Devices, Flywheel Energy Storage System, Hydraulic Energy Storage System, Fuel Cells and Hybrid Fuel Cell Energy Storage System and Battery Management System. | **10 Hrs** |
| **Unit-IV** | |
| **Electric Machines and Drives in HEVs:** Introduction, BLDC motors, Induction Motor Drives, Permanent Magnet Motor Drives, Switched Reluctance Motors, Doubly Salient Permanent Magnet Machines, Design and Sizing of Traction Motors, Thermal Analysis and Modelling of Traction Motors. **(only functional treatment to be given**) | **10Hrs** |
| **Unit-V** | |
| **Integration of Subsystems:** Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.<br>**Energy Management Strategies:** Introduction to energy management strategies used in hybrid and electric vehicle, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy strategies. | **08Hrs** |

| Course Outcomes: After completing the course, the students will be able to | |
|---|---|
| 1 | Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals. |
| 2 | Evaluate the performance of electrical machines and power electronics converters in HEVs. |
| 3 | Analyse the different energy storage devices used for hybrid electric vehicles, their technologies and control and select appropriate technology |
| 4 | Design and evaluate the sizing of subsystem components and Energy Management strategies in HEVs. |

| Reference Books: | |
|---|---|
| 1. | Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives, Mi Chris, Masrur A.and Gao D.W. Wiley Publisher, 1st Edition, 2011,*ISBN*:0-824-77653-5 |
| 2. | Ali, Modern Electric, Hybrid electric and Fuel Cell Vehicles, Ehsani Mehrdad, Gao Yimin, E. Gay Sebastien, Emadi CRC Press, 1st Edition, 2005, ISBN: *0-8493-3154-4*. |
| 3. | Modern Electric Vehicle Technology, Chan, C.C.,Chau, K.T. Oxford University Press, 2001, ISBN 0 19 850416 0. |
| 4. | Hybrid Electric Vehicles: Energy Management Strategies, Simona Onori, Lorenzo Serrao, Giorgio Rizzoni, *ISBN*: 978-1-4471-6779-2. |

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

**CIE** is executed by way of Quizzes (Q), Tests (T) and Assignment. 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 60. The marks component for assignment is 10. 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 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | 2 | 1 | 1 | 3 | 1 | - | 1 | - | 2 |
| CO2 | 3 | 3 | 2 | 2 | 3 | - | 3 | - | 2 | 1 | 2 | 1 |
| CO3 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | - | 1 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 1 | 3 |

**High-3: Medium-2: Low-1**

| Semester: V | | |
|---|---|---|
| **OPTIMIZATION TECHNIQUES (Group B: Global Elective)** | | |
| **Course Code:** 16G5B07 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 4:0:0:0 | | **SEE Marks:** 100 |
| **Hours:** 44L | | **SEE Duration:** 03 Hrs |

**Course Learning Objectives: The students will be able to**

| | |
|---|---|
| 1. | To understand the concepts behind optimization techniques. |
| 2. | To explain the modeling frameworks for solving problems using optimization techniques. |
| 3. | To design and develop optimization models for real life situations. |
| 4. | To analyze solutions obtained using optimization methods. |
| 5. | To compare models developed using various techniques for optimization. |

| UNIT – I | |
|---|---|
| **Introduction:** OR Methodology, Definition of OR, Application of OR to Engineering and Managerial problems, Features of OR models, Limitations of OR. | **09 Hrs** |
| **Linear Programming:** Definition, Mathematical Formulation, Standard Form, Solution Space, Types of solution – Feasible, Basic Feasible, Degenerate, Solution through Graphical Method. Problems on Product Mix, Blending, Marketing, Finance, Agriculture and Personnel.<br>**Simplex methods:** Variants of Simplex Algorithm – Use of Artificial Variables. | |
| **UNIT – II** | |
| **Duality and Sensitivity Analysis:** Graphical sensitivity analysis, Algebraic sensitivity analysis - changes in RHS, Changes in objectives, Primal-Dual relationships, Economic interpretation of duality, Post optimal analysis - changes affecting feasibility and optimality, Revised simplex method | **09 Hrs** |
| **UNIT – III** | |
| **Transportation Problem:** Formulation of Transportation Model, Basic Feasible Solution using North-West corner, Least Cost, Vogel's Approximation Method, Optimality Methods, Unbalanced Transportation Problem, Degeneracy in Transportation Problems, Variants in Transportation Problems<br>**Assignment Problem:** Formulation of the Assignment problem, solution method of assignment problem-Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP). | **08 Hrs** |
| **UNIT – IV** | |
| **Queuing Theory**: Queuing system and their characteristics, The M/M/I Queuing system, Steady state performance analyzing of M/M/1 queuing models. Introduction to M/M/C and M/Ek/1 queuing models<br>**Game Theory**: Introduction, Two-person Zero Sum game, Pure strategies, Games without saddle point - Arithmetic method, Graphical Method, The rules of dominance | **09Hrs** |
| **UNIT – V** | **09 Hrs** |
| **Markov chains:** Definition, Absolute and n-step transition probabilities, Classification of the states, Steady state probabilities and mean return times of ergodic chains, First passage times, Absorbing states. Applications in weather prediction and inventory management. Over view of OR software's used in practice. | |

**Course Outcomes: After going through this course the student will be able to**

| | |
|---|---|
| **CO1** | Understand the various optimization models and their areas of application. |
| **CO2** | Explain the process of formulating and solving problems using optimization methods. |
| **CO3** | Develop models for real life problems using optimization techniques. |
| **CO4** | Analyze solutions obtained through optimization techniques. |
| **CO5** | Create designs for engineering systems using optimization approaches. |

| **Reference Books:** | |
|---|---|
| 1. | Operation Research An Introduction, Taha H A, 8th Edition, 2009, PHI, ISBN: 0130488089. |
| 2. | Principles of Operations Research – Theory and Practice, Philips, Ravindran and Solberg, 2nd Edition, 2000, John Wiley & Sons (Asia) Pte Ltd, ISBN 13: 978-81-265-1256-0 |
| 3. | Introduction to Operation Research, Hiller, Liberman, Nag, Basu, 9th Edition, 2012,Tata McGraw Hill, ISBN 13: 978-0-07-133346-7 |
| 4. | Operations Research Theory and Application, J K Sharma, 4th Edition, 2009, Pearson Education Pvt Ltd, ISBN 13: 978-0-23-063885-3. |

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

CIE is executed by way of quizzes (Q), tests (T) and Assignment. 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 60. The marks component for assignment is 10. 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 | - | - | - | - | - | - | - | - | - | - | - |
| **CO2** | 2 | 2 | - | 1 | 1 | - | - | - | - | - | - | - |
| **CO3** | - | - | - | - | - | - | 1 | 1 | - | - | - | - |
| **CO4** | - | - | 3 | - | 1 | - | - | - | - | - | - | - |
| **CO5** | - | - | 2 | - | - | 1 | - | - | - | - | - | 1 |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **SENSORS & APPLICATIONS**<br>**(Group B: Global Elective)** | | |
| **Course Code:**16G5B08 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 4:0:0:0 | | **SEE Marks:** 100 |
| **Hours:**44L | | **SEE Duration:** 3Hrs |

**Course Learning Objectives: The students will be able to**

| | |
|---|---|
| **1** | Impart the principles and working modes of various types of Resistive, Inductive, Capacitive, Piezoelectric and Special transducers. |
| **2** | Give an idea about the applications of various transducers and selection criteria of a transducer for a particular application. |
| **3** | Give an insight into the static and dynamic characteristics of different orders of instruments. |
| **4** | Describe different data conversion techniques and their applications. |

| **UNIT-I** | |
|---|---|
| **Introduction:** Definition of a transducer, Block Diagram, Active and Passive Transducers, Advantages of Electrical transducers.<br>**Resistive Transducers:** Potentiometers: Characteristics, Loading effect, and problems.<br>**Strain gauge:** Theory, Types, applications and problems.<br>**Thermistor, RTD:** Theory, Applications and Problems. | **09 Hrs** |
| **UNIT-II** | |
| **Thermocouple:** Measurement of thermocouple output, compensating circuits, lead compensation, advantages and disadvantages of thermocouple.<br>**LVDT:** Characteristics, Practical applications and problems.<br>**Capacitive Transducers:** Capacitive transducers using change in area of plates, distance between plates and change of dielectric constants, Applications of Capacitive Transducers and problems. | **10 Hrs** |
| **UNIT-III** | |
| **Piezo-electric Transducers:** Principles of operation, expression for output voltage, Piezo-electric materials, equivalent circuit, loading effect, and Problems.<br>**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. | **10 Hrs** |
| **UNIT-IV** | |
| **Chemical sensors:** pH value sensor, dissolved oxygen sensor, oxidation-reduction potential sensor.<br>**Light sensors**: Photo resistor, Photodiode, Phototransistor, Photo-FET, Charge coupled device.<br>**Tactile sensors:** Construction and operation, types. | **08 Hrs** |
| **UNIT-V** | |
| **Data Converters**: Introduction to Data Acquisition System, types of DAC, Binary Weighted DAC, R-2R ladder DAC, DAC-0800, Types of ADC, Single Slope ADC and Dual-slope integrated type ADC, Flash ADC, 8-bit ADC-0808, Programmable Gain Amplifier. | **07 Hrs** |

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

| | |
|---|---|
| **CO1:** | Remember and understand the basic principles of transducers and smart sensors. |
| **CO2:** | Apply the knowledge of transducers and sensors to comprehend digital instrumentation systems. |
| **CO3:** | Analyze and evaluate the performance of different sensors for various applications. |
| **CO4:** | Design and create a system using appropriate sensors for a particular application |

| **Reference Books** | |
|---|---|
| **1** | Electrical and Electronic Measurements and Instrumentation, A.K. Sawhney, 18th Edition, 2008, Dhanpat Rai and Sons, ISBN: 81-7700-016-0. |
| **2** | Sensor systems: Fundamentals and applications, Clarence W.de Silva, 2016 Edition, CRC Press, ISBN: 9781498716246. |
| **3** | Transducers and Instrumentation, D.V.S. Murthy, 2nd Edition 2008, PHI Publication, ISBN: 978-81-203-3569-1. |
| **4** | Introduction to Measurement and Instrumentation, Arun K. Ghosh, 3rd Edition, 2009, PHI, ISBN: 978-81-203-3858-6. |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment. 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 60. The marks component for assignment is 10. The total marks of CIE are 100.

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

**SEE** for 100 marksis 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** | 3 | 2 | 1 | - | - | - | - | - | - | - | - | - |
| **CO2** | 2 | 3 | - | - | 2 | 2 | - | - | - | - | - | - |
| **CO3** | 1 | 2 | 2 | - | 1 | 1 | - | - | - | - | - | 2 |
| **CO4** | - | - | - | - | 1 | 1 | - | - | - | 3 | - | 1 |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **INTRODUCTION TO MANAGEMENT INFORMATION SYSTEMS (Group B: Global Elective)** | | |
| **Course Code:** 16G5B09 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 4:0:0:0 | | **SEE Marks:** 100 |
| **Hours :**45L | | **SEE Duration:** 3Hrs |

| 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 | |
|---|---|
| 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. | 09 Hrs |
| UNIT II | |
| 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. | 09 Hrs |
| UNIT III | |
| 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. | 09 Hrs |
| UNIT IV | |
| 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. | 09 Hrs |
| UNIT V | |
| 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. | 09 Hrs |

| **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** | Management Information System, Managing the Digital Firm, Kenneth C. Laudon and Jane P. Laudon, 14th Global Edition, 2016, Pearson Education, ISBN:9781292094007 |
| **2** | Management Information Systems, James A. O' Brien, George M. Marakas, 10th Edition, 2011, Global McGraw Hill, ISBN: 978-0072823110 |
| **3** | Information Systems The Foundation of E-Business, Steven Alter, 4th Edition, 2002, Pearson Education, 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 way of quizzes (Q), tests (T) and Assignment. 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 60. The marks component for assignment is 10. 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 | - | 1 | - | - | - | 1 | - | - | 1 | - |
| **CO2** | 1 | 2 | - | 1 | - | - | - | 1 | - | - | 1 | - |
| **CO3** | - | - | 3 | 2 | 2 | - | - | 1 | - | 1 | 1 | - |
| **CO4** | - | - | 2 | 1 | - | - | - | 1 | - | 1 | 1 | - |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **INDUSTRIAL AUTOMATION**<br>**(Group B: Global Elective)** | | |
| **Course Code:** 16GB510 | | **CIE Marks: 100** |
| **Credits: L:T:P:S:** 4:0:0:0 | | **SEE Marks: 100** |
| **Hours:** 44L | | **SEE Duration: 3 Hrs** |

| **Course Learning Objectives: The students should be able to:** | |
|---|---|
| **1** | Identify types of actuators, sensors and switching devices for industrial automation |
| **2** | Explain operation and controls of Hydraulic and Pneumatic systems |
| **3** | Understand fundamentals of CNC, PLC and Industrial robots |
| **4** | Define switching elements and sensors which are interfaced in an automation system |
| **5** | Describe functions of Industrial switching elements and Inspection technologies for automation |
| **6** | Select sensors to automatically detect motion of actuators |
| **7** | Develop manual part programs for CNC and Ladder logic for PLC |
| **8** | Develop suitable industrial automation systems using all the above concepts |

| **UNIT-I** | |
|---|---|
| **Automation in Production Systems:**<br>Manufacturing support systems, Automation principles and strategies, Levels of Automation, Production Concepts and Mathematical models, Numericals<br>**Automated Production Lines:**<br>Fundamentals, Applications, Analysis with no storage, Analysis with storage buffer, Numericals | **08 Hrs** |
| **UNIT-II** | |
| **Switching theory and Industrial switching elements**<br>Binary elements, binary variables, Basic logic gates, Theorems of switching algebra, Algebraic simplification of binary function, Karnough maps, Logic circuit design, problems. Electromechanical relays, Moving part logic elements, Fluidic elements, Timers, Comparisons between switching elements, Numericals<br>**Industrial Detection Sensors and Actuators:**<br>Introduction, Limit switches, Reed switches, Photoelectric sensors- methods of detection, Hall effect sensors, Inductive proximity sensors, Capacitive proximity sensors, Pneumatic back pressure sensors, Absolute encoder, Incremental encoder, Pressure switches and temperature switches; their working principles and applications, Brushless DC motors, Stepper motors and Servo motors | **08 Hrs** |
| **UNIT-III** | |
| **Hydraulic Control circuits**<br>Components, Symbolic representations, Control of Single and Double Acting Cylinder, Regenerative Circuit application, Pump unloading circuit, Double Pump Hydraulic System, speed control circuits, accumulator circuits<br>**Pneumatic Control circuits**<br>Components, Symbolic representations as per ISO 5599, 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. | **10 Hrs** |
| **UNIT-IV** | |
| **Introduction to CNC**<br>Numerical control, components of CNC, classification, coordinate systems, motion control strategies, interpolation, programming concepts<br>**Industrial Robotics**<br>Components of Robots, base types, classification of robots, end of arm tooling, robot precision of movement, programming, justifying the use of a robot, simple numerical | **08 Hrs** |

| UNIT-V | |
|---|---|
| **Programmable logic control systems**<br>Difference between relay and PLC circuits, PLC construction, principles of operation, latching, ladder diagrams, programming instructions, types of timers, forms of counters, writing simple ladder diagrams from narrative description and Boolean logic.<br>**Programming exercises on PLC with Allen Bradley controller**<br>Programming exercises on motor control in two directions, traffic control, annunciator flasher, cyclic movement of cylinder, can counting, conveyor belt control, alarm system, sequential process, and continuous filling operation on a conveyor. | **10 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| 1 | Illustrate applications of sensors actuators, switching elements and inspection technologies in industrial automation |
| 2 | Build circuit diagrams for fluid power automation, Ladder diagrams for PLC and identify its application areas |
| 3 | Evaluate CNC programs for 2D complex profiles performed on machining and turning centres interfaced with Robots |
| 4 | Develop suitable industrial automated system integrating all of the above advanced automation concepts |

| **Reference Books** | |
|---|---|
| **1.** | Industrial automation - Circuit design and components , David W. Pessen, 1st Edition, 2011, Wiley India, ISBN –13–978–8126529889 |
| **2.** | Pneumatic Controls , Joji P, 1st Edition, Wiley India, ISBN – 978–81–265–1542–4 |
| **3.** | Fluid Power with Applications , Anthony Esposito, 7th Edition , 2013,<br>ISBN – 13; 978– 9332518544 |
| **4.** | Automation, Production systems and Computer Integrated Manufacturing , Mikell P. Groover, 3rd Edition , 2014 , ISBN – 978–81–203–3418–2 |

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

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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 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** | 3 | | | | 2 | 1 | 2 | 1 | | | 1 | 2 |
| **CO2** | 1 | | 2 | 3 | 2 | 2 | 2 | | | 2 | | |
| **CO3** | | 1 | | 2 | 1 | | | | | 2 | | |
| **CO4** | | | 3 | 2 | 2 | 1 | | 2 | 2 | 3 | 2 | 2 |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **TELECOMMUNICATION SYSTEMS (Group B: Global Elective)** | | |
| **Course Code:** 16G5B11 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 4:0:0:0 | | **SEE Marks:** 100 |
| **Hours:** 46L | | **SEE Duration:** 03Hrs |

| **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** | |
|---|---|
| **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.<br>**The Fundamentals of Electronics**: Gain, Attenuation, and Decibels. | **09 Hrs** |
| **UNIT-II** | |
| **Modulation Schemes: Analog Modulation:** AM, FM and PM- brief review.<br>**Digital Modulation:** PCM, Line Codes, ASK, FSK, PSK, and QAM.<br>**Wideband Modulation:** Spread spectrum, FHSS, DSSS.<br>**Multiplexing and Multiple Access Techniques:** Frequency division multiplexing, Time division multiplexing<br>**Multiple Access**: FDMA, TDMA, CDMA, Duplexing. | **10 Hrs** |
| **UNIT-III** | |
| **Satellite Communication:**<br>Satellite Orbits, Satellite Communication Systems, Satellite Subsystems, Ground Stations, Satellite Applications, Global Positioning System. | **09 Hrs** |
| **UNIT-IV** | |
| **Optical Communication**: Optical Principles, Optical Communication Systems, Fiber-Optic Cables, Optical Transmitters and Receivers, Wavelength-Division Multiplexing, Passive Optical Networks. | **09 Hrs** |
| **UNIT-V** | |
| **Cell Phone Technologies:** Cellular concepts, Frequency allocation, Frequency reuse. Advanced Mobile Phone System (AMPS)<br>**Digital Cell Phone Systems:** 2G, 2.5G, 3G and 4G cell phone systems, Advanced Cell Phones.<br>**Wireless Technologies:** Wireless LAN, PANs and Bluetooth, ZigBee and Mesh Wireless Networks, WiMAX and Wireless Metropolitan-Area Networks. | **09 Hrs** |

| **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** | Compare different telecommunication generations, wired and wireless communication. |
| **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, 3rd Edition, 2008, Tata McGraw Hill, ISBN: 978-0-07-310704-2. |
| **2.** | Electronic Communication Systems, Roy Blake, 2nd Edition, 2002, Thomson/Delamar, ISBN: 978-81-315-0307-2. |
| **3.** | Electronic Communication Systems, George Kennedy, 3rd Edition, 2008, Tata McGraw Hill ISBN: 0-02-800592-9. |

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

**CIE** is executed by way of Quizzes (Q), Tests (T) and Assignment. 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 60. The marks component for assignment is 10. 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** | 1 | 1 | - | 1 | 1 | - | - | - | 1 | - | - | - |
| **CO2** | 2 | 1 | - | 1 | 1 | - | - | - | 1 | - | - | - |
| **CO3** | 2 | 1 | - | 1 | 1 | - | - | - | 2 | - | - | - |
| **CO4** | 1 | 1 | - | 1 | 1 | 1 | - | - | 1 | - | - | - |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **COMPUTATIONAL ADVANCED NUMERICAL METHODS (Group B: Global Elective)** | | |
| **Course Code:**16G5B12 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 4:0:0:0 | | **SEE Marks:** 100 |
| **Hours:** 44L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives:** | |
|---|---|
| **1** | Adequate exposure to learn alternative methods and analyze mathematical problems to determine the suitable numerical techniques. |
| **2** | Use the concepts of interpolation, eigen value problem techniques for mathematical problems arising in various fields. |
| **3** | Solve initial value and boundary value problems which have great significance in engineering practice using ordinary differential equations. |
| **4** | Demonstrate elementary programming language, implementation of algorithms and computer programs to solve mathematical problems. |

| **Unit-I** | |
|---|---|
| **Algebraic and Transcendental equations:** Roots of equations in engineering practice, Polynomials and roots of equations, Fixed point iterative method, Aitken's process, Muller's method, Chebychev method. | **08 Hrs** |
| **Unit – II** | |
| **Interpolation:** Introduction to finite differences, Finite differences of a polynomial, Divided differences and Newton's divided difference interpolation formula, Hermite interpolation, Spline interpolation–linear, quadratic and cubic spline interpolation. | **08 Hrs** |
| **Unit -III** | |
| **Ordinary Differential Equations:** Solution of second order initial value problems–Runge-Kutta method, Milne's method, Boundary value problems (BVP's)–Shooting method, Finite difference method for linear and nonlinear problems, Rayleigh-Ritz method. | **09 Hrs** |
| **Unit –IV** | |
| **Eigen value problems:** Eigen values and Eigen vectors, Power method, Inverse Power method, Bounds on Eigen values, Greschgorin circle theorem, Jacobi method for symmetric matrices, Givens method. | **09 Hrs** |
| **Unit –V** | |
| **Computational Techniques:** Algorithms and Matlab programs for Fixed point iterative method, Aitken's–process, Muller's method, Chebychev method, Newton's divided difference method, Hermite interpolation, Spline interpolation, Power method, Inverse Power method, Runge-Kutta method, Milne's method, Shooting method, Rayleigh-Ritz method, Jacobi method and Givens method. | **10 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Identify and interpret the fundamental concepts of polynomial equations, Interpolation, Eigen value problems, Differential equations and corresponding computational techniques. |
| **CO2:** | Apply the knowledge and skills of computational techniques to solve algebraic and transcendental equations, Ordinary differential equations and eigen value problems. |
| **CO3:** | Analyze the physical problem and use appropriate method to solve roots of equations, Interpolating the polynomial, Initial and boundary value problems, Eigen value problems numerically using computational techniques. |
| **CO4:** | Distinguish the overall mathematical knowledge gained to demonstrate and analyze the problems of finding the roots of equations, Interpolation, Differential equations, Eigen value 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, New Age International Publishers, 6th Edition, 2012, ISBN-13: 978-81-224-2001-2. |
| **2** | Numerical Analysis, Richard L. Burden and J. Douglas Faires, Cengage Learning, 9th Edition, 2012, ISBN-13: 978-81-315-1654-6. |
| **3** | Introductory Methods of Numerical Analysis, S. S. Sastry, PHI Learning Private Ltd., 4th Edition, 2011, ISBN: 978-81-203-2761-0. |
| **4** | Numerical Methods for Engineers, Steven C Chapra, Raymond P Canale, Tata Mcgraw Hill, 5th Edition, 2011, ISBN-10: 0-07-063416-5. |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment. 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 60. The marks component for assignment is 10. 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** | 3 | 2 | - | 1 | - | - | - | - | - | - | - | 2 |
| **CO2** | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 2 |
| **CO3** | 2 | 3 | 2 | 2 | - | - | - | - | - | - | - | 1 |
| **CO4** | 3 | 3 | 1 | 2 | 1 | - | - | - | - | - | - | 3 |

**Low-1 Medium-2 High-3**

| Semester: V | | |
|---|---|---|
| **BASICS OF AEROSPACE ENGINEERING (Group B: Global Elective)** | | |
| **Course Code:** 16GE5B13 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 4:0:0:0 | | **SEE Marks:** 100 |
| **Hours:** 44L | | **SEE Duration:** 3Hours |

| **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 a air vehicle |
| 4 | Appraise the significance of all the subsystems in achieving a successful flight |

| **Unit-I** | |
|---|---|
| **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, Introduction to Unconventional and Autonomous Air vehicles. | **08 Hrs** |
| **Unit – II** | |
| **Basics of Aerodynamics :** Bernoulli's theorem, Aerodynamic forces and moments on an Airfoil, Lift and drag, Types of drag, Centre of pressure and its significance, Aerodynamic centre, Aerodynamic Coefficients, Wing Planform Geometry, Airfoil nomenclature, Basic characteristics of airfoils, NACA nomenclature, Simple problems on lift and drag. | **08 Hrs** |
| **Unit -III** | |
| **Aircraft Propulsion:** Introduction, Classification of powerplants, Piston Engine: Types of reciprocating engines, Principle of operation of turbojet, turboprop and turbofan engines, Introduction to ramjets and scramjets, Comparative merits and demerits of different types Engines. | **07 Hrs** |

| **Unit -IV** | |
|---|---|
| **Introduction to Space Flight:** History of space flight, Evolution of Indian Space Technology, The upper atmosphere, Introduction to basic orbital mechanics, some basic concepts, Kepler's Laws of planetary motion, Orbit equation, Space vehicle trajectories**.** **Rocket Propulsion:** Principles of operation of rocket engines, Classification of Rockets, Types of rockets. | **08 Hrs** |
| **Unit -V** | |
| **Aerospace Structures and Materials:** Introduction, General types of construction, Monocoque, Semi-Monocoque and Geodesic structures, Typical wing and fuselage structure; Metallic and non-metallic materials for aircraft application. Use of aluminum alloy, titanium, stainless steel and composite materials, Low temperature and high temperature materials. | **07 Hrs** |

| **Course Outcomes:** At the end of this course the student will be able to : | |
|---|---|
| 1 | Appreciate and apply the basic principles of aviation |
| 2 | Apply the concepts of fundaments of flight, basics of aircraft structures, aircraft propulsion and aircraft materials during the development of an aircraft |
| 3 | Comprehend the complexities involved during development of flight vehicles. |
| 4 | Evaluate and criticize the design strategy involved in the development of airplanes |

| Reference Books | |
|---|---|
| 1 | John D. Anderson, Introduction to Flight, 7th Edition, 2011, McGraw-Hill Education, ISBN 9780071086059. |
| 2 | Sutton G.P., Rocket Propulsion Elements, 8th Edition, 2011, John Wiley, New York, ISBN:1118174208, 9781118174203. |
| 3 | Yahya, S.M, Fundamentals of Compressible Flow, 5th Edition, 2016, New Age International, ISBN: 8122440223 |
| 4 | T.H.G Megson, Aircraft structural Analysis, 2010, Butterworth-Heinemann Publications, ISBN: 978-1-85617-932-4 |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment. 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 60. The marks component for assignment is 10. 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** | **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: VI | | |
|---|---|---|
| **FOUNDATIONS OF MANAGEMENT AND ECONOMICS (Theory) (Common to BT, CHE, CV, E&I, IEM, ME)** | | |
| **Course Code:** 16HEM61 | | **CIE Marks:** 50 |
| **Credits: L:T:P:S:** 2:0:0:0 | | **SEE Marks:** 50 |
| **Hours:** 23L | | **SEE Duration:** 02Hrs |

| **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** | |
|---|---|
| **Introduction to Management:** Management Functions, Roles & Skills, Management History – Classical Approach: Scientific Management & Administrative Theory, Quantitative Approach: Operations Research, Behavioural Approach: Hawthorne Studies, Contemporary Approach: Systems & Contingency Theory. | **04 Hrs** |
| **UNIT-II** | |
| **Foundations of Planning:** Types of Goals & Plans, Approaches to Setting Goals & Plans, Strategic Management Process, Corporate & Competitive Strategies. | **02 Hrs** |
| **Organizational Structure & Design:** Overview of Designing Organizational Structure: Work Specialization, Departmentalization, Chain of Command, Span of Control, Centralization & Decentralization, Formalization, Mechanistic & Organic Structures. | **03 Hrs** |
| **UNIT-III** | |
| **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. | **03 Hrs** |
| **Managers as Leaders:** Behavioural 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. | **03 Hrs** |
| **UNIT-IV** | |
| **Introduction to Economics:** Concept of Economy and its working, basic problems of an Economy, Market mechanism to solve economic problems, Government and the economy,<br>**Essentials of Micro Economics:** Concept and scope, tools of Microeconomics, themes of microeconomics, Decisions: some central themes, Markets: Some central themes, Uses of Microeconomics. | **04 Hrs** |
| **UNIT-V** | |
| **Essentials of Macroeconomics:** Prices and inflation, Exchange rate, Gross domestic product (GDP) , components of GDP, the Labour 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 | **04 Hrs** |

| **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 |

| **Reference Books** | |
|---|---|
| **1.** | Management, Stephen Robbins, Mary Coulter & Neharika Vohra, 10th Edition, 2001, Pearson Education Publications, ISBN: 978-81-317-2720-1. |
| **2.** | Management, James Stoner, Edward Freeman & Daniel Gilbert Jr, 6th Edition, 1999, PHI, ISBN: 81-203-0981-2. |
| **3.** | Microeconomics, Douglas Bernheim B & Michael D Whinston, 5th Edition, 2009, TMH Pub. Co. Ltd, ISBN: 13:978-0-07-008056-0. |
| **4.** | Macroeconomics: Theory and Policy, Dwivedi.D.N, 3rd Edition, 2010, McGraw Hill Education; ISBN-13: 978-0070091450. |
| **5.** | Essentials of Macroeconomics, (www.bookboon.com), Peter Jochumzen, 1st Edition. 2010, e-book, ISBN:978-87-7681-558-5. |

**Continuous Internal Evaluation (CIE); Theory (50 Marks)**

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 05 marks adding up to 15 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 25 marks each and the sum of the marks scored from three tests is reduced to 30. The marks component for Assignment is 05. The total marks of CIE are 50.

**Semester End Evaluation (SEE); Theory (50 Marks)**

**SEE** for 50 marks are 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 10 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 08 marks adding up to 40 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 | - | - | - | - | - | - | - | - | - | - | - |
| **CO2** | 1 | - | 2 | 2 | - | - | 1 | - | - | 2 | 2 | - |
| **CO3** | 1 | - | - | - | - | - | - | 2 | 2 | 2 | 1 | - |
| **CO4** | 1 | 2 | - | - | - | 2 | - | - | - | - | - | 2 |

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **COMMUNICATION SYSTEM II (Theory & Practice)** | | |
| **Course Code:** 16EC62 | | **CIE Marks:** 100+50 |
| **Credits: L:T:P:S:** 4:0:1:0 | | **SEE Marks:** 100+50 |
| **Hours:**46L | | **SEE Duration:** 03Hrs+03Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Identify the digital communication system as a series of functional blocks and the concepts of signal and channel representation. |
| **2** | Apply the concept of signal conversion to symbols and symbol processing in transmitter and receiver blocks. |
| **3** | Compute performance issues and parameters for symbol processing and recovery in ideal and corrupted channel conditions. |
| **4** | Compute and mitigate for performance parameters in corrupted and distorted channel conditions. |

| **UNIT-I** | |
|---|---|
| **Digital Communication Transmitter:** Digital communication blocks and impediments. Review of Lowpass and Bandpass signals. Geometric Representation of Signals in terms of a low pass basis set, Gram Schmidt procedure, conversion statement to bandpass basis set. Geometric representation of baseband modulated signals as examples Geometric representation of low pass equivalents of bandpass signals - BPSK, QPSK, M-PSK, M-QAM. Transmitter Architectures and, Computation of Transmit PSD. Applications to GPRS, 3G. Orthogonal symbol modulation – Geometric representation of BFSK, MSK (Simple Cases). Applications to GSM, Training. | **10 Hrs** |
| **UNIT-II** | |
| **Communication through AWGN Channels:** Demodulation and Detection - Center point sampling, Matched Filter, and Correlation Receiver. **Estimation Basics** - MAP and MLI Estimation of Binary signals with AWGN, Probability of error for binary signaling, Probability of error for binary baseband pulses (Line codes) using center point sampling and Matched filters. **Coherent demodulation scheme** – Receiver Architecture, Probability of symbol error for BPSK, QPSK, BFSK. **Coherent Demodulation scheme for multiple signals** – M-PAM, M-PSK and M-QAM. Union Bounded Probability of error these signals, Lower and upper bounds. | **09 Hrs** |
| **UNIT-III** | |
| **Communication Through AWGN Signals** (contd) - Non-Coherent demodulation of BFSK and DPSK – Symbol representation, Block diagrams treatment of Transmitter and Receiver, Probability of error (Without derivation).<br>**Communication through Band Limited Channels:** Digital Transmission through Band limited channels - Inter Symbol Interference, Signal design for Band limited ideal channel with zero ISI – Nyquist Criterion (statement only), Sinc and Raised pulse shaping.<br>Signal design for Band limited channel with controlled ISI – Correlative coding, DB and MDB, with and without Precoding. | **09 Hrs** |
| **UNIT-IV** | |
| **Convolution Codes**: Encoding of convolution Codes, Transfer function and distance properties, Maximum Likelihood sequence decoding – Viterbi search Algorithm with Hard and soft decision, Probability of error statement only (No derivation). | **09 Hrs** |
| **UNIT-V** | |
| **Principles of Spread Spectrum (SS)** Concept of Spread Spectrum, Direct Sequence/SS, Frequency Hopped SS, Processing Gain, Interference, and probability of error statement only. **PN sequences for Spread Spectrum** – M- sequences with Properties; Gold, Kasami sequences with basic properties. Spread Spectrum Synchronization (Block diagram treatment) - Code Acquisition and Tracking. | **09 Hrs** |

| | |
|---|---|
| **Practical's: Communication systems 2 Lab**<br>1. a) Pulse Amplitude Modulation and Demodulation using MATLAB<br>b) Pulse Amplitude Modulation and Demodulation using DSP processor<br>2. a) ASK Modulation and Demodulation using MATLAB<br>b) ASK Modulation and Demodulation using DSP processor<br>3. a) BFSK Modulation and Demodulation using MATLAB<br>b) BFSK Modulation and Demodulation using DSP processor<br>4. a) BPSK Modulation and Demodulation using MATLAB<br>b) BPSK Modulation and Demodulation using DSP processor<br>5. a) QPSK Modulation and Demodulation using MATLAB<br>b) QPSK Modulation and Demodulation using DSP processor<br>6. MSK Modulation and phase trellis using MATLAB<br>7. QAM modulation and demodulation using MATLAB Communication systems toolbox<br>8. a) Duobinary and modified duobinary coding with and without precoding using MATLAB<br>b) Generation of PN Sequences for spread spectrum communication using MATLAB<br>9. a) Convolution encoding for a given input sequence using MATLAB<br>b) Convolution decoding using Viterbi hard decision decoding using MATLAB<br>10. Simulation of direct sequence Spread Spectrum and Frequency Hopped Spread Spectrum using MATLAB | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO1: | Associate and apply the concepts of Bandpass sampling to well specified signals and channels. |
| CO2: | Analyze and compute performance parameters and transfer rates for low pas and bandpass symbol under ideal and corrupted non-band limited channels. |
| CO3: | Test and validate symbol processing and performance parameters at the receiver under ideal and corrupted bandlimited channels. |
| CO4: | Demonstrate by simulation and emulation bandpass signals subjected to convolution coding and symbol processed at transmitter and correspondingly demodulated and estimated at receiver after passing through a corrupted channel. |

| **Reference Books** | |
|---|---|
| **1.** | Communication Systems, Simon Haykin and Michael Moher, 5th Edition, 2014, John Wiley and sons, ISBN-978 81 265 2151 7. |
| **2.** | Communication systems, Simon Haykin, 3rd or 4th Edition, Reprinted 2013, John Wiley & sons, ISBN 0-471- 17869-1. |
| **3.** | Modern Digital and Analog communication Systems, B.P.Lathi and Zhi Ding, 4th Edition, 2010, Oxford University Press, , ISBN: 9780198073802.. |
| **4.** | Digital Communications, Ian A. Glover, Peter M. Grant, 3rd Edition, 2010, Pearson Educations, ISBN:978-0-273-71830-7 |
| **5.** | Communication System, Bruce Carlson and P.B Chilly, 5th Edition,2011, Tata McGraw-Hill, |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment. 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 60. The marks component for assignment is 10. The total marks of CIE are 100.

**Laboratory- 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 of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. Total marks for the laboratory is 50.

**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.

**Laboratory- 50 Marks**
Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

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

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **COMPUTER COMMUNICATION NETWORKS (Theory & Practice)** | | |
| **Course Code:** 16EC63 | | **CIE Marks:** 100+50 |
| **Credits: L:T:P:S:** 3:0:1:1 | | **SEE Marks:** 100+50 |
| **Hours:** 36L | | **SEE Duration:** 03Hrs+03Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Develop awareness towards basic internetworking principles. |
| **2** | Analyze various aspects involved in multiple accesses, various data switching techniques. |
| **3** | Explain protocols operating at different layers of computer networks |
| **4** | Analyze various data compression techniques and security issues. |
| **5** | Analyze various aspects involved in network control and traffic management. |

| **UNIT-I** | |
|---|---|
| **Computer Networks and the Internet**: Internet, Protocol, Network Edge, Network Core, Access Networks and Physical Media, Delay and Loss in Packet-Switched Networks, Protocol Layers and Their Service Models, Internet Backbones, NAPs, and ISPs. Network models, OSI, TCP/IP. Physical Layer: Introduction to Guided and unguided physical media**.** | **07Hrs** |
| **UNIT-II** | |
| **Local Area Networks and Connecting Devices:**<br>Data Link layer Services, Data link control-Framing, Flow & error control, Multiple Access Protocols-Random Access protocols<br>LAN Addresses and ARP, IEEE 802.3 LANs, Ethernet, Hubs, Bridges, and Switches, Virtual LAN, PPP: The Point-to-Point Protocol, X.25 and Frame Relay. IEEE 802.11 LANs | **07 Hrs** |
| **UNIT-III** | |
| **Network Layer-Logical Addressing& Internet Protocol**<br>Network Layer, Logical Addressing, IPV4 Addresses, Structure, Address Space, Classful Addressing, Classless Addressing, Network Address Translation.<br>IPv6 Addresses, Structure, Address Space of IPV6, Transition from IPV4 to IPV6<br>Forwarding. Subnet addressing. Inter- and intra-domain routing. Datagram networks; virtual circuits. RIP, OSPF, BGP. CI | **07 Hrs** |
| **UNIT-IV** | |
| **Transport Layer:** Process to Process Delivery, Connectionless Versus Connection Oriented Service, UDP, TCP.<br>Congestion control and resource allocation-Issues in resource allocation, Queuing disciplines congestion control. Slow start. Fast retransmit. Fast recovery. Rate-based congestion control. Congestion avoidance mechanisms. Leaky Bucket Algorithm | **07 Hrs** |
| **UNIT-V** | |
| **Naming and the DNS.**<br>Cell switching & ATM service classes. Switch architectures. Switching fabrics. Space-division multiplexing vs. shared-memory switches. Source Coding. Data Compression, Security and Cryptography | **08 Hrs** |
| **Practical's: CCN Lab**<br>**Practical's: Computer Communication Networks Lab**<br>**Part –I: Experiments Using C/C++ programming.**<br>1) a)Implement Bit stuffing Algorithm<br>b)Character stuffing algorithms and<br>c)Cyclic Redundancy Check codes for error detection using C programs.<br>2) Implement Encryption and Decryption algorithms using C program.<br>3) Implement following Minimum Spanning Tree algorithms using C program<br>i) Kruskal's Algorithm | |

| | |
|---|---|
| ii) Prim's Algorithms<br>4) Implement STOP and WAIT protocol using socket programming concept using C Program.<br>5) Implement RSA algorithm using C program.<br>**Part-II: Experiments that may be carried out using QualNet/NS-3/Packet Tracer**<br>1 Simulate & Analyze CSMA/CD and CSMA/CA Protocols.<br>2 Test and verify Network configurations using Packet Tracer.<br>3 Configure Inter VLAN network using Packet Tracer<br>4 Configure and test a given network using Packet Tracer<br>Simulation of congestion control algorithms using NS-3 | |

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

| **Reference Books** | |
|---|---|
| **1.** | Computer Networks- A System Approach, Larry L Peterson, Bruce S Davie, 4th edition, 2007, ELSEVIER publication, ISBN: 978-0123705488 |
| **2.** | Data Communication and Networking, B Forouzan, 4th Edition, 2006, TMH, ISBN: 0-07-010829-3 |
| **3.** | Computer Networks, James F. Kurose, Keith W. Ross, 2nd Edition, 2003, Pearson Education, ISBN: 0199217637 |
| **4.** | Computer Communication Networks, Andrew S Tanenbaum and David J Wetherall, 5th Edition, 2010, Person Education. |
| **5.** | Introduction To Data Compression, Sayood Khalid, 3rd Edition, Elsevier, 2010, ISBN: 978-8131206249 |

**Continuous Internal Evaluation (CIE): Total marks: 100+50=150**

**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 CIE for theory is 100.

**Laboratory- 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 of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. Total marks for the laboratory is 50.

**Semester End Evaluation (SEE): Total marks: 100+50=150**

**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.

**Laboratory- 50 Marks**

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

| 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** |

**Low-1 Medium-2 High-3**

| ANALOG AND MIXED SIGNAL IC DESIGN (Theory) | | |
|---|---|---|
| **Course Code:** 16EC64 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:1:0:0 | | **SEE Marks:** 100 |
| **Hours:**36L+24T | | **SEE Duration:** 03Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Design basic amplifiers, differential amplifiers and current mirrors using MOSFETs. |
| **2** | Design different opamp topologies for a given specification using CAD tools |
| **3** | Analyze stability of OPAMPs and apply the appropriate compensation technique. |
| **4** | Analyze amplifier circuits by considering noise effects & Design and analyze sampling switches and switched capacitor amplifiers |

| **UNIT-I** | |
|---|---|
| **Introduction to Analog Integrated Design:** Models for analog design, output resistance ($r_o$), body transconductance, transition frequency: **Single-stage Amplifiers** – CS stage, diode connected load, current source load and source degeneration, review of CD and CG stages (all amplifier analysis with body effect), Cascode stage & folded cascode concepts. Design of amplifier from specifications. **Differential Amplifiers** – Half circuit analysis, Common mode response. | **08 Hrs** |
| **UNIT-II** | |
| **Current mirror –** Cascode current mirror, active current mirror – analysis.<br>**Operational Amplifiers:** General considerations – performance parameters, One-Stage Op amps – cascode opamps, telescopic opamps, folded cascode opamps, Two-Stage Op amps, Gain Boosting, Comparison of performance of various opamp topologies. Design of opamps from specifications. | **08 Hrs** |
| **UNIT-III** | |
| **Stability and Frequency Compensation:** Frequency response of CS amplifier - Miller effect, poles in a system, pole-splitting, Miller compensation. Two stage opamp - Compensation techniques, gain-phase crossovers, closed-loop stability, optimal phase margin.<br>**Noise:** MOSFET noise models, types of noise – thermal, flicker, Representation of noise in circuits, Noise in single stage amplifiers (Common source only). | **08 Hrs** |
| **UNIT-IV** | |
| **Bandgap references**: Temperature independent references - Bipolar CTAT, PTAT, Band gap references (BGR)<br>**Introduction to Switched-capacitor Circuits: Sampling** Switches – MOSFETs as switches, Distortion due to switch, Channel Charge injection, Capacitive feedthrough, bottom plate sampling, Parasitic insensitive Switched Capacitor Integrator, Switched Capacitor Common-Mode Feedback | **06 Hrs** |
| **UNIT-V** | |
| **Data Converter Fundamentals:** Digital-to-Analog Converter Specifications, Analog-to-Digital Converter Specifications. **DAC Architectures:** Current Steering DAC **ADC Architectures** - Successive Approximation ADC, Oversampling ADC - Benefits of oversampling, First Order Sigma Delta ADC. | **06 Hrs** |

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

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

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment. 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 60. The marks component for assignment is 10. 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** | **3** | **3** | **3** | **3** | **3** | **-** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO2** | **3** | **2** | **3** | **-** | **3** | **-** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO3** | **3** | **3** | **2** | **2** | **3** | **-** | **-** | **-** | **2** | **-** | **-** | **2** |
| **CO4** | **3** | **3** | **-** | **2** | **3** | **-** | **-** | **-** | **2** | **-** | **-** | **2** |

**Low-1 Medium-2 High-3**

| Semester: VI | | | |
|---|---|---|---|
| **CRYPTOGRAPHY & NETWORK SECURITY (Group C: Professional Core Elective)** | | | |
| **Course Code:** 16EC6C1 | | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | | **SEE Marks:** 100 |
| **Hours:**36L | | | **SEE Duration:** 3Hrs |
| **Course Learning Objectives: The students will be able to** | | | |
| **1** | Analyze the needs, principles and practices of cryptography and network security | | |
| **2** | Evaluate conventional encryption algorithms and design principles. | | |
| **3** | Analyze the use of conventional encryption for confidentiality & evaluate public key algorithm design issues. | | |
| **4** | Apply the knowledge of message authentication codes and hash functions to provide authentication. | | |

| UNIT-I | |
|---|---|
| **Introduction**<br>Services, Mechanism and attacks, OSI security architecture, Model for network security,<br>**Classical Encryption Techniques**<br>Symmetric cipher model, Substitution techniques, Transposition techniques, Simplified DES. Problems<br>**Block Ciphers and DES (Data Encryption Standards)**<br>Simplified DES Block, Cipher Principles, DES and strength of DES, Block cipher design principles and modes of operation, The AES Cipher. | **08 Hrs** |
| **UNIT-II** | |
| **Public Key Cryptography and RSA**<br>Principles of public key cryptosystems, RSA algorithm. Problems<br>**Other Public Key Cryptosystems and Key Management**<br>Key Management, Diffie-Hellman exchange, Elliptic curve arithmetic, Elliptic curve cryptography.<br>**Message Authentication and Hash Functions**<br>Authentication requirements, Authentication functions, Message Authentication codes, Hash functions, Security of Hash functions and MAC's | **07 Hrs** |
| **UNIT-III** | |
| **Digital Signature and Authentication Protocol:** Digital signature, Authentication protocols, Digital signature standard. **Authentication Applications** Kerberos encryption technique, Problems. | **07 Hrs** |
| **UNIT-IV** | |
| **Transport-Level Security: Web security Issues,** Security socket layer (SSL) and Transport layer Security, HTTPS and Secure Shell<br>**Wireless network security:** IEEE 802.11 Wireless LAN Overview, IEEE 802.11i Wireless LAN Security, Wireless application Protocol Overview, wireless transport layer Security, WAP End-End Security | **07 Hrs** |
| **UNIT-V** | |
| **Electronic Mail Security** Pretty good privacy, S/MIME, Data compression using ZIP, Radix-64 conversion, PGP random number generator. **IP Security** IP security architecture, Authentication header, ESP (encapsulating security pay load), Security associations, Key management, Problems | **07 Hrs** |

| Course Outcomes: After completing the course, the students will be able to | |
|---|---|
| CO1: | Identifying external and internal threats to an organization. |
| CO2: | Master fundamentals of secret, public key cryptography and Analyze advanced security issues and technologies. |
| CO3: | Evaluate & Compare different encryption algorithms. |
| CO4: | Use of modern tools for implementing different security algorithms and comparing their robustness. |

| Reference Books | |
|---|---|
| **1.** | Cryptography and Network Security, William Stallings, 5th Edition, 2003, Prentice Hall of India, ISBN 10: 0-13-609704-9/ISBN 13: 978-0-13-609704-4 |
| **2.** | Network Security: Private Communication in a Public World, Kaufman, R. Perlman, and M. Speciner, 2nd Edition, 2002, Pearson Education (Asia), ISBN13: 9780130460196 |
| **3.** | Cryptography and Network Security,Atul Kahate, 2003, Tata McGraw-Hill, ISBN 13:9781259029882 |
| **4.** | Fundamentals of Network Security, Eric Maiwald, 2003, McGraw-Hill, ISBN-13:978-0072230932 |

**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** | **3** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO2** | **3** | **2** | **2** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO3** | **2** | **3** | **2** | **2** | **-** | **-** | **-** | **-** | **-** | **1** | **-** | **2** |
| **CO4** | **2** | **3** | **3** | **-** | **-** | **-** | **-** | **-** | **-** | **1** | **-** | **2** |

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **REAL TIME EMBEDDED SYSTEMS (Theory)** | | |
| **Course Code:** 16EC6C2 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Understand functional differences between different real time systems. |
| **2** | Examine and evaluate the hardware functionality required by embedded system to achieve real-time operation. |
| **3** | Analyse, evaluate and implement task control and real-time scheduling algorithms required to perform multitasking. |
| **4** | Demonstrate the concept of real-time programming using tasks and gain knowledge and skills necessary to design and develop embedded applications by means of real-time operating systems. |

| **UNIT-I** | |
|---|---|
| **Introduction:** Overview, Architecture Real Time Systems, Real Time Services, Real Time Standards, **System Resources:** Resource Analysis, Real Time Service Utility, Cyclic Executives **Basics of RTOS:** Kernel Features, Real-time Kernels: Polled Loops System, Co-routines, Interrupt-driven System, Multi-rate System; Processes, Threads, Tasks, States, Context Switching: Cooperative Multi-tasking, Pre-emptive Multi-tasking | **08 Hrs** |
| **UNIT-II** | |
| **Processing:** Scheduling Classes, Scheduler Concepts, Pre-emptive Fixed Priority Policy, Feasibility, Rate Monotonic LUB, Necessary & Sufficient Feasibility, Dead Line Monotonic, Dynamic Priority Policies **I/O Resources:** WCET, Intermediate I/O, Execution Efficiency **Memory:** Physical Hierarchy, Cache, Memory Planning, Memory shadowing | **07 Hrs** |
| **UNIT-III** | |
| **RTOS Services:** Task Creation, Inter Task Communication: Pipes, Message Queues, Mail Box, Memory Mapped Objects; Critical Section, Shared Data Problem, Synchronization: Signals, Semaphores Mutex; Remote Procedure and Sockets, Real Time Memory Management: Process Stack Management, Dynamic Allocation | **07 Hrs** |
| **UNIT-IV** | |
| **Timer & Timer Services:** Real Time Clocks & System Clocks, Programmable Interval Timers, Timer Interrupt Service Routine, Soft-timer Handling, Soft Timers elated Task **Synchronization Issues:** Resource Classification, Racing, Deadlock, Live lock, Starvation, Priority Inversion, Priority Ceiling & Inheritance | **07 Hrs** |
| **UNIT-V** | |
| **Examples of Real Time OS:** Vx-Works, RTX-ARM: Task Management, Scheduling, Primitive Kernel Services, Application Program development using APIs | **07 Hrs** |

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

| Reference Books | |
|---|---|
| **1.** | Real-Time Embedded Systems and Components, Sam Siewert, 2007, Cengage Learning India Edition, ISBN: 9788131502532 |
| **2.** | Real time systems, Krishna CM and Kang Singh G, 2003, Tata McGraw Hill, ISBN: 0-07-114243-64 |
| **3.** | Real-Time Concepts for Embedded Systems, Qing Li and Carolyn Yao, 2003 CMP Books, ISBN:1578201241 |
| **4.** | Real Time Systems, Jane W. S. Liu, 2000, Prentice Hall, ISBN:0130996513 |

**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** | **1** | **1** | **1** | **2** | **-** | **-** | **-** | **-** | **-** | | **-** | |
| **CO2** | **3** | **2** | **2** | **1** | **2** | **1** | **-** | **-** | **-** | **1** | **-** | **1** |
| **CO3** | **3** | **3** | **2** | **2** | **3** | **1** | **1** | **1** | **-** | **1** | **-** | **1** |
| **CO4** | **2** | **3** | **2** | **2** | **1** | **1** | **2** | **2** | **2** | **2** | **2** | **1** |

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **IMAGE PROCESSING**<br>**(Group C: Professional Core Elective)** | | |
| **Course Code:** 16EC6C3 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| Course Learning Objectives: The students will be able to | |
|---|---|
| **1** | Get an introduction to basic concepts and methodologies of Digital Image processing, image formation and color image representation |
| **2** | Differentiate between the image enhancement and restoration techniques. Enhance the image by various methods in spatial and frequency domain. Perform image restoration using convolution, discrete linear operators and filters |
| **3** | Perform image segmentation using different algorithms suitable for various applications. |
| **4** | Recognize the different image patterns using supervised and unsupervised classification algorithms. |

| UNIT-I | |
|---|---|
| **Digital Image Fundamentals**<br>Fundamentals of Image Processing, Applications of Image Processing, Components of Image Processing System, Image Formation, Representation. | **08 Hrs** |
| **UNIT-II** | |
| **Image Enhancement & Restoration**<br>Distinction between image enhancement and restoration, Spatial Image Enhancement Techniques, Histogram-based Contrast Enhancement, Frequency Domain Methods of Image Enhancement, Noise Modeling, Image Restoration, Image Reconstruction. | **07 Hrs** |
| **UNIT-III** | |
| **Image Segmentation**<br>Edge, Line, and Point Detection, Edge Detector, Image Thresholding Techniques, Region Growing, Waterfall algorithm for segmentation, Connected component labeling. | **07 Hrs** |
| **UNIT-IV** | |
| **Recognition of Image Patterns**<br>Decision Theoretic Pattern Classification, Bayesian Decision Theory, Nonparametric Classification, Linear Discriminant Analysis, Unsupervised Classification Strategies – clustering, K-Means Clustering Algorithm. | **07 Hrs** |
| **UNIT-V** | |
| **Texture and Shape Analysis**<br>Introduction, Gray Level Co-occurrence Matrix, Texture Classification using Fractals, Shape Analysis, Region Based Shape Descriptors,<br>**Morphological image processing**<br>Preliminaries, Dilation and Erosion, Opening and Closing, the Hit-or-Miss Transformation, Some Basic Morphological Algorithms | **07 Hrs** |

| Course Outcomes: After completing the course, the students will be able to | |
|---|---|
| CO1: | Understand digital image processing fundamentals: hardware and software, digitization, enhancement and restoration, encoding, segmentation, feature detection |
| CO2: | Apply image processing techniques in both the spatial and frequency (Fourier) domains |
| CO3: | Write image processing programs in MATLAB |
| CO4: | Perform image segmentation using different algorithms suitable for various applications. |

| Reference Books | |
|---|---|
| **1.** | Image Processing-Principles and Applications, Tinku Acharya and Ajoy K. Ray, 2005, John Wiley & Sons Inc., ISBN: 978-0-471-71998-4. |
| **2.** | Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, 2001, Pearson Education Edition, ISBN 0-201-18075-8. |
| **3.** | Fundamentals of Digital Image Processing , Anil K. Jain, 2001, Pearson Education, PHI, ISBN: 0071412379 |
| **4.** | Digital Image Processing and Analysis , Chanda and D. Dutta Majumdar, 2nd Edition, 2003, PHI, ISBN: 9788120343252 |


**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** | **3** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **1** | **-** | **1** |
| **CO2** | **3** | **2** | **2** | **1** | **-** | **-** | **-** | **-** | **-** | **1** | **-** | **2** |
| **CO3** | **3** | **3** | **2** | **2** | **3** | **-** | **-** | **-** | **2** | **2** | **-** | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **2** | **-** | **-** | **-** | **2** | **1** | **-** | **2** |

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **LOW POWER VLSI DESIGN**<br>**(Group C: Professional Core Elective)** | | |
| **Course Code:** 16EC6C4 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Explain the need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. |
| **2** | Analyze the impact of Device Technology such as Transistor sizing & gate oxide thickness and Device innovation on Low Power. |
| **3** | Evaluate various probabilistic based power analysis techniques at various levels of abstraction. |
| **4** | Compare the trade-off between accuracy and resources for both simulations based and probability-based power analysis. |
| **5** | Apply various logic level techniques to optimize the power dissipation of the design reducing the switching activities in the design |
| **6** | Design and analyze digital circuits like combinational, sequential circuits using low power concepts. |

| **UNIT-I** | |
|---|---|
| **Introduction**<br>Need for Low Power VLSI Design, Sources of power dissipation, Physics of Power Dissipation in CMOS devices, MIS structure, long channel effect, sub-micron MOSFET, Gate induced drain leakage, Power dissipation in CMOS circuits: Short Circuit dissipation, Dynamic dissipation, load capacitance Charging and Discharging, Static Power: Leakage Currents, Static Currents, Emerging low power approaches and limits. | **08 Hrs** |
| **UNIT-II** | |
| **Power Estimation** -Signal Modeling and probability calculation, Probabilistic techniques for signal activity estimation, statistical techniques, Estimation of glitching power, sensitivity analysis, power estimation using input vector compaction, power estimation at circuit level, information theory-based approach, estimation of maximum power. | **07 Hrs** |
| **UNIT-III** | |
| **Device and Technology Impact on Low Power Electronics** Introduction, Dynamic Dissipation in CMOS, Effects of $V_{DD}$ and $V_t$ on speed, Constraints on $V_t$ Reduction, Transistor and Gate Sizing, Transistor Sizing and Optimal Gate Oxide Thickness, Impact of Technology Scaling, Equivalent Pin Ordering, Network Restructuring and Reorganization, Technology and Device Innovations, Gate Reorganization, Signal Gating, Logic Encoding, State Machine Encoding, Pre-computational Logic | **07 Hrs** |
| **UNIT-IV** | |
| **Low Power Circuit Techniques**<br>Introduction, Power consumption in circuits, Circuit design styles, Analysis of adders, multipliers, Flip-Flops and Latches, Low Power Cell Library.<br>Low power SRAM architectures: SRAM organization, MOS SRAM cells-4T and 6T, Banked organization of SRAMs, Reducing voltage swings on bit-lines, Reducing power in write driver circuits, Reducing power in sense amplifier circuits. | **07 Hrs** |
| **UNIT-V** | |
| **Synthesis for Low Power**<br>Behavioral level transforms, logic level optimizations, circuit level transforms, CMOS gates, Power Reduction in Clock Networks:power dissipation in clock distribution, single driver Vs distributed buffers, buffer and device sizing, zero sew Vs tolerable skew, CMOS Floating Nodes, Low Power Bus, Delay Balancing, Energy recovery CMOS and Adiabatic computation. | **07 Hrs** |

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

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

**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** | **1** | **2** | **2** | **1** | **1** | **1** | **-** | **-** | **1** | **1** | **-** | **3** |
| **CO2** | **2** | **2** | **2** | **1** | **1** | **1** | **-** | **-** | **1** | **1** | **-** | **3** |
| **CO3** | **2** | **2** | **2** | **1** | **3** | **2** | **-** | **-** | **2** | **1** | **-** | **3** |
| **CO4** | **2** | **2** | **2** | **1** | **3** | **2** | **-** | **-** | **2** | **1** | **-** | **3** |

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **DATASTRUCTURE USING C++**<br>**(Group C: Professional Core Elective)** | | |
| **Course Code:** 16EC6C5 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Analyze the need for data structuring techniques. |
| **2** | Implement standard data structures like stack, queue, list and tree. |
| **3** | Demonstrate the use of standard data structures using relevant applications. |
| **4** | Write appropriate data structures while building applications. |

| **UNIT-I** | |
|---|---|
| **Data Representation**:Overview of C++, Introduction to data representation, Linear Lists, Formula – Based Representation, Linked Representation, Indirect Addressing-Representation<br>**+Arrays and Matrices:** Arrays- The abstract data type, Indexing a C++ array, row and column major mapping, class Array1D, class Array2D, Matrices -definition and operations. Special Matrices-Definition and application, Diagonal Matrices, Tridiagonal Matrices, Triangular Matrices, Symmetric matrices, Sparse Matrices. | **07 Hrs** |
| **UNIT-II** | |
| **Stacks**: The Abstract Data Types, Derived Classes and Inheritance, Formula-based Representation, Linked Representation, Applications- Parenthesis matching, Towers of Hanoi. **Queues:** The Abstract Data Types, Derived Classes and Inheritance, Formula-based representation, Linked Representation, Applications- Rearranging railroad cars, Wire routing. | **07 Hrs** |
| **UNIT-III** | |
| **Skip List and Hashing:** Dictionaries, Linear List Representation- The ideal case, insertion and deletion, Assigning levels, class skipnode, the class skiplist, Skip list representation, Hash table representation-ideal hashing, hashing with linear open addressing, hash tables with chains.<br>**Binary and other Trees:** Trees, Binary Trees, Properties and Representation of Binary Trees-Formula – Based Representation, Linked Representation, Common Binary Tree Operations, Binary Tree Traversal The ADT Binary Tree, ADT and class Extensions | **08 Hrs** |
| **UNIT-IV** | |
| **Priority Queues:** Linear Lists, Heaps-Definitions, Insertion and Deletions from MaxHeap, MaxHeap Initialization, the class max Heap. Left list Trees-Height and Weight biased Min and Max lefist trees, Insertion and Deletion from a Max HBLT, Melding two max HBLTs, Initialization, the class Max HBLT | **07 Hrs** |
| **UNIT-V** | |
| **Graphs**: Definitions, Properties, Representation of Graphs, Representation of Networks, Class definitions, Graph Search methods, applications of Graphs. | **07 Hrs** |

| **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 applications built using different data structures. |

| Reference Books | |
|---|---|
| **1.** | Data Structures, Algorithms and Applications in C++, Sartaj Sahni, 2000, McGraw Hill, ISBN: 10: 007236226X. |
| **2.** | C++:The Complete Reference , Herbert Schildt, 4th Edition, 2007, McGraw-Hill, , ISBN: 0-07-213485-2 |
| **3.** | Data Structures Using C++, D.S. Malik, 2nd Edition, 2009, Cengage Learning, |
| **4.** | Mastering C++, K.R Venugopal, Rajkumar, and T Ravishankar, 4th Edition, 2008, Tata McGraw-Hill Pubications. |

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

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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 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** | **3** | **3** | **3** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **1** |
| **CO2** | **3** | **3** | **3** | **2** | **2** | **2** | **-** | **-** | **-** | **2** | **-** | **1** |
| **CO3** | **3** | **3** | **3** | **2** | **2** | **2** | **-** | **-** | **-** | **2** | **-** | **1** |
| **CO4** | **3** | **3** | **3** | **3** | **2** | **1** | **-** | **-** | **-** | **2** | **-** | **1** |

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **SYSTEM PROGRAMMING & SOFTWARE**<br>**(Group C: Professional Core Elective)** | | |
| **Course Code:** 16EC6C6 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Explain the need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. |
| **2** | Analyze the impact of Device Technology such as Transistor sizing & gate oxide thickness and Device innovation on Low Power. |
| **3** | Evaluate various probabilistic based power analysis techniques at various levels of abstraction. |
| **4** | Compare the trade-off between accuracy and resources for both simulation based and probability based power analysis. |
| **5** | Apply various logic level techniques to optimize the power dissipation of the design reducing the switching activities in the design |
| **6** | Design and analyze digital circuits like combinational, sequential circuits using low power concepts. |

| **UNIT-I** | |
|---|---|
| **Assemblers:**<br>Introduction, Basic Assembler functions, algorithms and data structures; Machine-dependent assembler features, Machine-independent assembler features, Assembler design options: One- pass and Multi-pass assemblers, Case study: MASM assembler, SPARC assembler. | **08 Hrs** |
| **UNIT-II** | |
| **Loaders and Linkers:**<br>Basic Loader functions: Absolute loader, Bootstrap loader, Machine-dependent loader features: re-location, program linking, Algorithm and Data structures of a linking loader, Machine-independent loader features, loader design options, linkage editors, dynamic linking, bootstrap loader, Case study: MS-DOS linker, SunOS linkers. | **07 Hrs** |
| **UNIT-III** | |
| **Macro-processors:**<br>Basic Macro-processor functions: macro definition and expansion, Algorithm and Data structures of macro-processor, Machine-dependent macro-processor features: concatenation of macro-processor parameter, generation of unique labels, conditional macro expansion, keyword macro parameters, macro-processor design options, recursive macro expansion, general purpose macro processors, Case study: MASM macro processor, ELENA macro processor, ANSI Macro language. | **07 Hrs** |
| **UNIT-IV** | |
| **Compilers:**<br>Basic compiler functions, Machine-dependent compiler features: intermediate form of the program, machine dependent code optimization, Machine-independent compiler features: structured variables, machine independent code optimization, storage allocation, block structured languages, Compiler design options: Interpreters, P-code compilers, Compiler-compilers, Case study: SunOS C compiler, Java compiler. | **07 Hrs** |
| **UNIT-V** | |
| **Operating Systems:**<br>Basic operating system functions, Machine-dependent operating system features: interrupt processing, process scheduling, IO supervision, Real memory management, virtual memory management, Machine-independent operating system features: File processing, Job scheduling, Resource allocation, protection, Operating system design options: Hierarchical structure, Multiprocessor OS, Distributed OS, Object oriented OS, Case | **07 Hrs** |

| | |
|---|---|
| study: MS-DOS, SunOS and Windows | |

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

| **Reference Books** | |
|---|---|
| **1.** | System Software-An Introduction to System Programming, Leland L. Beck, 3rd Edition, 2009, Pearon Education, ISBN: 978-81-317-2700-3 |
| **2.** | System Programming, John J. Donovan, 2009, Tata McGraw Hill Edition, ISBN-13: 978-0-07-460482-3 |

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

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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 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** | **1** | **2** | **1** | **1** | **1** | **-** | **-** | **1** | **1** | **-** | **3** |
| **CO2** | **2** | **1** | **2** | **1** | **1** | **1** | **-** | **-** | **1** | **1** | **-** | **3** |
| **CO3** | **2** | **1** | **2** | **1** | **1** | **1** | **-** | **-** | **1** | **1** | **-** | **3** |
| **CO4** | **2** | **1** | **2** | **1** | **1** | **1** | **-** | **-** | **1** | **1** | **-** | **3** |

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **FLEXIBLE ELECTRONICS**<br>**(Group C: Professional Core Elective)** | | |
| **Course Code:** 16EC6C7 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Realize the importance and advantages of Large Area and Flexible Electronics. |
| **2** | Understand the processes and equipments used for Large Area and Flexible Electronics. |
| **3** | Familiarization with the materials, substrates and interfaces in Large Area and Flexible Electronics. |
| **4** | Selection of materials and formulation of processes for various possible applications of Large Area and Flexible Electronics. |

| **UNIT-I** | |
|---|---|
| **Introduction to Flexible Electronics and their Materials Systems:** Background and history, trends, emerging technologies, general applications.<br>**Introduction to Semiconductors & Circuit Elements:** Carrier transport, doping, band structure, thin-film electronic devices. Thin-film Deposition and Processing Methods for Flexible Devices -CVD, PECVD, PVD, etching, photolithography, low-temperature process integration. | **08 Hrs** |
| **UNIT-II** | |
| **Materials for Flexible and Printed Electronics: Nanowire** and nanoparticle synthesis, transition metal oxides, amorphous thin films, polymeric semiconductors, structure and property relationships, paper-based electronics, textile substrates, barrier materials. | **07 Hrs** |
| **UNIT-III** | |
| **Thin Film Transistors 1: device structure and performance:** I-V characteristics, gradual channel approximation, electrical stability, lifetime extraction, characterization methods for rigid and flexible devices. Metal Oxide TFT's, Carbon Nanotube TFT's | **07 Hrs** |
| **UNIT-IV** | |
| **Solution-based Patterning Processes:** Ink-jet printing, gravure, imprint lithography, spray pyrolysis, surface energy effects, multilayer patterning, design rule considerations. Substrates for Flexible electronics | **07 Hrs** |
| **UNIT-V** | |
| **Contacts and Interfaces to Organic and Inorganic Electronic Devices** Schottky contacts, defects, carrier recombination, effect of applied mechanical strain.**Flexible Electronics Applications :**Displays, sensor arrays, memory devices, MEMS, lab-on-a-chip, and photovoltaics | **07 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO1: | Define the requirements of materials, working and fabrication for flexible electronics devices |
| CO2: | Categorize fabrication/Patterning/Printing techniques various flexible electronics application |
| CO3 | Analyze thin film devices & circuits for flexible electronics applications |
| CO4: | Engage in selfstudy for modeling & simulation of various materials & devices used in flexible electronics |

| **Reference Books** | |
|---|---|
| **1.** | Flexible Electronics – Materials and applications, William S Wong, Salleo, Alberto, 2009, Springer, ISBN 978-0-387-74363-9 |
| **2.** | Large Area and Flexible Electronics, Mario Carioni, Yong-Yong Noh, 2015, Wiley ISBN: 978-3-527-67999-7 |

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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 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** | **3** | **2** | **-** | **-** | **-** | **-** | **1** | **-** | **-** | **-** | **-** | **2** |
| **CO2** | **3** | **2** | **1** | **-** | **-** | **1** | **2** | **-** | **-** | **-** | **-** | **2** |
| **CO3** | **3** | **3** | **2** | **2** | **1** | **1** | **2** | **-** | **-** | **-** | **-** | **2** |
| **CO4** | **3** | **3** | **2** | **2** | **3** | **1** | **2** | **-** | **3** | **2** | **1** | **2** |

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **OPTICAL FIBER COMMUNICATION & NETWORKS**<br>**(Group D: Professional Core Elective)** | | |
| **Course Code:** 16EC6D1 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:**36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Analyze Optical spectral band and incorporate the standards for optical fiber communication |
| **2** | Analyze Single-mode Fibers, Graded-index Fiber Structure, Mechanical Properties of Fibers and Fiber Optic Cables |
| **3** | Demonstrate light sources using Light-Emitting Diodes (LEDs), Laser Diodes |
| **4** | Develop optimum Source-to-Fiber Power Launching & Lensing Schemes for Coupling Improvement. |

| **UNIT-I** | |
|---|---|
| **Introduction**<br>Ray theory transmission, Total internal reflection, Acceptance angle , Numerical aperture, Skew rays, Electromagnetic mode theory of optical propagation, EM waves, modes in planar guide, phase and group velocity, cylindrical fibers, SM fibers. | **08 Hrs** |
| **UNIT-II** | |
| **Transmission Characteristics of Optical Fibers**<br>Attenuation, Material absorption losses in silica glass fibers,Linear and Nonlinear Scattering losses,Fiber Bend losses, Midband and far band, infra-red transmission, Intra and inter Modal Dispersion, over all Fiber Dispersion, Polarization, nonlinear Phenomena. Optical fiber connectors**,** Fiber alignment and Joint Losses, Fiber Splices, Fiber connectors, Expanded Beam Connectors, Fiber Couplers. | **07 Hrs** |
| **UNIT-III** | |
| **Sources and Detectors**<br>Optical sources: Light Emitting Diodes, LED structures, surface and edge emitters, mono and hetero structures, internal, quantum efficiency, injection laser diode structures, comparison of LED and ILD<br>Optical Detectors: PIN Photo detectors, Avalanche photo diodes, construction, characteristics and properties, Comparison of performance, Photo detector noise, Noise sources, Signal to Noise ratio, Detector response time. | **07 Hrs** |
| **UNIT-IV** | |
| **Fiber Optic Receiver and Measurements**<br>Fundamental receiver operation, Pre-amplifiers, Error sources, Receiver Configuration, Probability of Error, Quantum limit.<br>Fiber Attenuation measurements- Dispersion measurements, Fiber Refractive index Profile measurements, Fiber cut- off Wave length Measurements, Fiber Numerical Aperture Measurements, Fiber diameter measurements. | **07 Hrs** |
| **UNIT-V** | |
| **Optical Networks**<br>Basic Networks, SONET / SDH, Broadcast and select WDM Networks, Wavelength Routed Networks, Nonlinear effects on Network performance<br>Performance of WDM + EDFA system, Solitons, Isolators, Circulators, Optical CDMA, Ultra High Capacity Networks.<br>**Self-Study:**<br>Seminars, Projects, Paper publication, etc. on emerging technologies pertaining to the subject 4 Hrs/Week: 1 Credit | **07 Hrs** |

| Course Outcomes: After completing the course, the students will be able to | |
|---|---|
| CO1: | Select the proper Optical spectral band and incorporate the standards for optical fiber communication. |
| CO2: | Analyze various WDM Concepts and Apply different Optical Network concepts and topologies and design WDM Networks. |
| CO3: | Analyze the Optical Fiber Modes and Configurations of the Single-mode Fibers, Graded-index Fiber Structure, Mechanical Properties of Fibers and Fiber Optic Cables. |
| CO4: | Design the light sources using Light-Emitting Diodes (LEDs), Laser Diodes and evaluate Light Source Linearity, and analyze the Reliability considerations. |

| Reference Books | |
|---|---|
| **1.** | Optical Fiber Communication, Gerd Keiser, 2008, Tata McGraw Hill Publication, |
| **2.** | Optical Fiber Communications, John M. Senior, "", 3rd Edition, 2007, Pearson Education, ISBN |
| **3.** | Optical Networks: A Practical Perspective, Rajiv Ramaswami, Kumar N. Sivarajan and Galen H. Sasaki, 3rd Edition, 2010, The Morgan Kaufmann Series in Networking. |
| **4.** | Fiber Optics and Optoelectronics, R.P. Khare, 2007, Oxford University Press |

**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)**

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

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **ARM CORTEX PROCESSORS**<br>**(Group D: Professional Core Elective)** | | |
| **Course Code:** 16EC6D2 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| Course Learning Objectives: The students will be able to | |
|---|---|
| **1** | Understand the architecture of different processors suitable for embedded system. |
| **2** | To gain knowledge on ARM cortex-M series CPU architecture, instruction set, exceptions, memory & special OS features. |
| **3** | Identify the design issues ARM based embedded system with the basic knowledge of firmware, embedded OS & ARM architectures. |
| **4** | Analyse the execution of instructions/program knowing the basic principles of ARM architecture and assembly language & the special features of Cortex-M3/M4 to realize signal processing applications. |

| UNIT-I | |
|---|---|
| **Introduction:** Embedded Processor Selection, PowerPC, ARM Cortex, SoC, Digital Signal Processors **ARM Cortex-2 Series Overview:** Cortex-M Processor Family, Product Portfolio, Advantages, Applications, Cortex Microcontroller Software Interface Standard (CMSIS), General Information, Features | **08 Hrs** |
| **UNIT-II** | |
| **Architecture of ARM Cortex-2 Processor:** Programmer's Model, Application Program Status Register (APSR), Memory System, Exceptions & Interrupts, System Control Block, Debug, Reset & Reset Sequence **Instruction Set-I:** Assembly Language Syntax, Suffixes for Assembly Instructions, Unified Assembly Language, Assembly Instructions | **07 Hrs** |
| **UNIT-III** | |
| **Instruction Set-II:** Cortex-M4/M7 Specific Instructions, Barrel Shifter **Memory System:** Memory Map, Connecting Cortex-M3/M4 with Memory & Peripherals, Endianness, Data Alignment & Unaligned Data Access Support, Bit Band Operations, Memory Access Attributes, Exclusive Access, Memory Barriers, Memory System in a MCU. | **07 Hrs** |
| **UNIT-IV** | |
| **Exceptions & Interrupts:** Overview of Exceptions and Interrupts, Exception Types, Interrupt Management, Vector Table & Vector Table Relocation, Interrupts Inputs & Pending Behaviors, Exceptions Sequence, Overview, Details of NVIC Registers for Interrupt Control, SCB Registers for Exceptions & Interrupt Control, Special Registers for Exceptions Masking, Procedures in Setting up Interrupts, Software Interrupts. Exception Handler in C, Stack Frames, Exception Sequences. | **07Hrs** |
| **UNIT-V** | |
| **Low Power and System Control Features:** Low Power Designs, Low Power Features, Using WFI & WFE Instructions in for Programming, Developing Low Power Applications, The SysTick Timer, Self-Reset, CPU ID Base Register, Configuration Control Register, Auxiliary Control Registers, Co-Processor Access Control Register.**OS Support Features :** Shadowed Stack Pointer, SVC Exception, PendSV Exception, Context Switching in Action, Exclusive Accesses | **07 Hrs** |

| Course Outcomes: After completing the course, the students will be able to | |
|---|---|
| CO1: | Understand the architecture, instruction set, memory organization and addressing modes of the embedded processors. |
| CO2: | Realize real time signal processing applications & primitive OS operations on different ARM architectures by making use of software libraries. |
| CO3: | Perform market survey of available embedded processors & arrive at the required processor for solving the given problem statement. |

| | |
|---|---|
| CO4: | Engage in self-study to formulate, design, implement, analyze and demonstrate an application realized on ARM development boards through assignments. |

| **Reference Books** | |
|---|---|
| **1.** | The Definitive Guide to the ARM Cortex-M3& M4 Processors, Joseph Yiu, 3rd Edition, 2014 Newnes (Elsevier), ISBN:978-93-5107-175-4 |
| **2.** | ARM System Developers Guide, Andrew N Sloss, Dominic Symes, Chris Wright, 2008, Elsevier, Morgan Kaufman publishers, ISBN-13:9788181476463 |
| **3.** | ARM System on Chip Architecture , Steve Furber, 2nd Edition, 2000, Pearson Education Limited, ISBN-13:9780201675191 |
| **4.** | Technical reference manual for ARM processor cores, including Cortex M3, M4, M7 processor families. |

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

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

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

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **ADAPTIVE SIGNAL PROCESSING**<br>**(Group D: Professional Core Elective)** | | |
| **Course Code:** 16EC6D3 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Identify applications in which it would be possible to use the different adaptive filtering approaches. |
| **2** | Design, implement and apply LMS filter to given application. |
| **3** | Design and apply optimal minimum mean square estimators and in particular linear estimators. To understand and compute their expected performance and verify it. |
| **4** | Design, implement and apply filters (FIR, non-causal, causal) and evaluate their performance. |

| **UNIT-I** | |
|---|---|
| **Adaptive Systems:** Definition and characteristics, Areas of application, General properties, Open-and closed-loop adaptation, Applications of closed-loop adaptation, Example of an adaptive system. **The Adaptive Linear Combiner:** General description, Input signal and weight vectors, Desired response and error, the performance function, gradient and minimum mean-square error, Example of a performance surface, Alternative expression of the gradient, Decorrelation of error and input components. | **08 Hrs** |
| **UNIT-II** | |
| **Quadratic Performance Surface:** Normal of the input correlation matrix, Eigen values and Eigen vectors of the input correlation matrix, an example with two weights, Significance of Eigenvectors**,** Geometrical significance of eigenvectors and Eigen values. **Searching the Performance Surface:** Methods of searching the performance surface, Basic ideas of gradient search methods, a simple gradient search algorithm and its solution, Stability and rate of convergence, the learning curve. Newton's method in multidimensional space, Steepest descent method, Comparison of learning curves. | **07 Hrs** |
| **UNIT-III** | |
| **Adaptive Modeling and System Identification:** General description, Adaptive modeling of multipath communication channel, adaptive modeling in geophysical exploration, Adaptive modeling in FIR digital filter synthesis.**Gradient Estimation and Its Effects on Adaptation:** Gradient component estimation by derivative measurement. The performance penalty, Derivative measurement and performance penalties with multiple weights, variance of the gradient estimate, effects on the weight-over solution, excess mean-square error and time constants, misadjustment, comparative performance of Newton's and steepest-descent methods, Total misadjustment and other practical considerations. | **07 Hrs** |
| **UNIT-IV** | |
| **The LMS Algorithm:** Derivation of the LMS algorithm, convergence of the weight vector, an example of convergence, learning curve, noise in the weight-vector solution, misadjustment, performance. **Adaptive Interference Canceling:** The concept of adaptive noise canceling, stationary noise-canceling solutions, effects of signal components in the reference input, The adaptive interference canceller as a notch filter, The adaptive interface canceller as a high-pass filter. | **07 Hrs** |
| **UNIT-V** | |
| **Digital Models for Speech Signals:** Process of Speech Production, Lossless tube models, Digital models for Speech signals.**Time Domain Models for Speech Processing:** Time dependent of speech, Short time average zero crossing rate, Speech vs. silence discrimination using energy and zero crossing, pitch period estimation using parallel processing approach, short time autocorrelation function, Short time average magnitude difference function, Pitch period estimation using autocorrelation function | **07 Hrs** |

| Course Outcomes: After completing the course, the students will be able to | |
|---|---|
| CO1: | Understand the concepts of linear algebra & linear adaptive systems. |
| CO2: | Applying the concepts of adaptive algorithms to various engineering problems. |
| CO3: | Analyze the effect various parameters in developing an adaptive systems. |
| CO4: | Design and implement simple adaptive systems for any computational applications. |

| Reference Books | |
|---|---|
| **1.** | Adaptive Signal Processing, Bernard Widrow and Samuel d. Stearns, 2001, Pearson Education Asia, ISBN:9788131705322 |
| **2.** | Adaptive Filter Theory, Simon Haykin, 4th Edition, 2002, Pearson Education Asia, ISBN 0-13-090126-1 |
| **3.** | Theory and Design of Adaptive Filters, John R. Treichler C. Richard Johnson, Jr. and Michael G. Larimore, 2002, Pearson Education, , ISBN-10: 0130402656 |
| **4.** | Digital Processing of Speech Signals , L R Rabiner and R W Schafer, 2004, Pearson Education, ISBN 978-1848822535 |

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

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **SYSTEM VERILOG**<br>**(Group D: Professional Core Elective)** | | |
| **Course Code:** 16EC6D4 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Build a System Verilog verification environment |
| **2** | Define test bench components using object-oriented programming |
| **3** | Develop functional coverage to measure completeness of test |
| **4** | Develop a stimulus generator to create constrained random test stimulus |

| **UNIT-I** | |
|---|---|
| **System Verilog data types, Operators, Loops, Functions**<br>Data types, Built-In Data Types, Fixed-Size Arrays, Dynamic Arrays, Queues, Associative Arrays, Linked Lists, Array Methods, Choosing a Storage Type, Creating New Types with typedef, Creating User-Defined Structures, Type conversion, Enumerated Types, Constants, Strings, Procedural Statements, Tasks, Functions, and Void Functions, Routine Arguments, Returning from a Routine. | **08 Hrs** |
| **UNIT-II** | |
| **Class and Randomization**<br>System verilog class basics, class declaration, class members and methods, class handles, class object construction, super and this keywords, object handles, user defined constructors, class extension and inheritance, chaining new() constructors, overriding class methods, extending class methods, local and protected keywords, constrained random variables, directed vs random testing, rand and randc class data types, randomize-randomizing class variables, randcase, built-in-randomization methods, randsequence and examples. | **07 Hrs** |
| **UNIT-III** | |
| **Interfaces, Program block and Clocking**<br>Interface overview, generic interfaces, interfaces Vs records, how interfaces work, requirements of good interface, interface constructs, interface modports, Fundamental test bench construction, program blocks, program block interaction with modules, final blocks, Test bench stimulus/Verification vector timing strategies, Clocking blocks, clocking skews, clocking block scheduling, fork-join processes. | **07 Hrs** |
| **UNIT-IV** | |
| **Constrained Random variables, Coverage, Methods and interfaces**<br>Randomization constraints, simple and multi-statement constraints, constraint distribution and set membership, constraint distribution operators, external constraints, cover groups, cover points, cover point bins and labels, cross coverage, cover group options, coverage capabilities. Virtual class, why to use virtual class, virtual class methods and restrictions, polymorphism using virtual methods, pure virtual methods, pure constraints, passing type parameters, virtual interfaces. | **07 Hrs** |
| **UNIT-V** | |
| **System Verilog Assertions**<br>Assertion definition, assertion benefits, system Verilog assertion types, immediate assertions, concurrent assertions, assert and cover properties and labels, overlapping and non-overlapping implications, edge testing functions, sequences, Vacuous success, property styles, System Verilog assertion system functions, Assertion severity tasks, assertion and coverage examples of an FSM design. | **07 Hrs** |

| Course Outcomes: After completing the course, the students will be able to | |
|---|---|
| CO1: | Explain the behavior of different digital blocks by writing HDL code. |
| CO2: | Apply the System Verilog verification features, including classes, constrained random stimulus, coverage, strings, queues and dynamic arrays, and learn how to utilize these features for more effective and efficient verification. |
| CO3: | Integrate various digital blocks and implement a complete digital system. |
| CO4: | Design different architectures of various digital blocks and optimize the area, speed and power. |

| Reference Books | |
|---|---|
| **1.** | System Verilog for Verification: A guide to learning the Test bench Language Features, Christian B Spear, 3rd Edition, Springer Publications. |
| **2.** | System Verilog Assertions, Vijaya Raghavan, 2005, Springer Publications, ISBN 978-0-387-26173-7 |
| **3.** | System Verilog for Design , Stuart Sutherland, Smon Davidmann Peter Flake, 2nd Edition, Springer Publications. |
| **4.** | System Verilog Primer , J Bhaskar, 2010, Star Galaxy Publishing, ISBN 13: 9780965039116 |

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

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

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **ALGORITHM FOR VLSI DESIGN AUTOMATION**<br>**(Group D: Professional Core Elective)** | | |
| **Course Code:** 16EC6D5 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Analyze the concept of digital systems, how they can be optimized for area, power and cost, why it is advantageous to use physical design tools. |
| **2** | Implement the concept of the physical design cycle and develop algorithms (tools)for each design cycle step. |
| **3** | Optimize the digital system at architectural level. |
| **4** | Synthesize a given system starting with problem requirements, identifying and designing the building blocks, and then integrating blocks designed earlier |

| **UNIT-I** | |
|---|---|
| **Architectural Level Synthesis:** Introduction, Circuit specifications for architectural synthesis, the fundamentals of architectural synthesis problems, Area and Performance Estimation, Strategies for Architectural Optimization **Scheduling Algorithms:** Introduction, A model for scheduling problems, Scheduling without and with resource constraints, Scheduling algorithms for extended sequencing models, Scheduling pipelined circuits, Resource sharing and binding. | **08 Hrs** |
| **UNIT-II** | |
| **Data Structure and Basic Algorithms:** Basic Terminology, Graph Search Algorithms, Computational Geometry Algorithms, Basic Data structures. **Partitioning:** Problem Formulation, Classification of Partitioning Algorithms, Group migration Algorithms, Simulated Annealing and evolution algorithm, other partitioning algorithms | **07 Hrs** |
| **UNIT-III** | |
| **Floor Planning and Pin Assignment:** Problem formulation, classification, Constraint based, Integer programming based, rectangular Dualization, simulated evolution floor planning algorithms. **Placement:** Problem formulation, Classification, Simulation based, Partitioning based Placement Algorithms | **07 Hrs** |
| **UNIT-IV** | |
| **Global Routing: Problem** formulation, Classification, Maze routing Algorithms, Line Probe Algorithms, shortest path-based Algorithms, Steiner tree-based Algorithms Detailed **Routing:** Problem formulation, Classification single Layer routing, General river routing, Single row routing | **07Hrs** |
| **UNIT-V** | |
| **Channel, Clock and Power Routing:** Two-layer channel routing Algorithms, Design considerations for the clocking system, delay calculation for clock trees, Problem formulation, Clock routing Algorithms, **Clock Tree Routing:** H-tree based Algorithms, MMM Algorithms, Geometric matching based Algorithms. | **07 Hrs** |

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

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

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

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **DATABASE MANAGEMENT SYSTEMS**<br>**(Group D: Professional Core Elective)** | | |
| **Course Code:** 16EC6D6 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Understand the differences between logical and physical database design. |
| **2** | Understand the context, phases and techniques for designing and building database information systems in business. |
| **3** | Analyse database requirements and determine the entities involved in the system and their relationship to one another. |
| **4** | Design and build a simple database system and demonstrate competence with the fundamental tasks involved with modelling, designing, and implementing a DBMS. |

| **UNIT-I** | |
|---|---|
| **Introduction:** An example, Characteristics of Database approach, Actors on the screen, Workers behind the scene, Advantages of using DBMS approach, A brief history of database applications. **Data models:** schemas and instances, Three-schema architecture and data independence, Database languages and interfaces, The database system environment, Centralized and client-server architectures, Classification of Database Management systems. **Entity-Relationship Model:** Using High-Level Conceptual Data Models for Database Design, An Example Database Application, Entity Types, Entity Sets, Attributes and Keys, Relationship types, Relationship Sets, Roles and Structural Constraints, Weak Entity Types, Refining the ER Design, ER Diagrams, Naming Conventions and Design Issues, Relationship types of degree higher than two. | **08 Hrs** |
| **UNIT-II** | |
| **Relational Model and Relational Algebra:** Relational Model Concepts, Relational Model Constraints and Relational Database Schemas, Update Operations, Transactions and dealing with constraint violations, Unary Relational Operations: SELECT and PROJECT, Relational Algebra Operations from Set Theory.<br>**SQL basics:** SQL Data Definition and Data Types, Specifying constraints in SQL, Basic retrieval queries in SQL. Insert, Delete and Update statements in SQL. | **07 Hrs** |
| **UNIT-III** | |
| **SQL programming:** complex SQL queries. Specifying constraints as Assertion and actions as Trigger, Views (Virtual Tables) in SQL, schema change statements in SQL.<br>**Introduction to Python:** SQL Database connection using python, Creating and searching tables, Reading and storing configurations information on database, Programming using database connections | **07 Hrs** |
| **UNIT-IV** | |
| **Database Design –1:** Informal Design Guidelines for Relation Schemas, Functional Dependencies, Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form. **Database Design -2** Properties of Relational Decompositions, Algorithms for Relational Database Schema Design, Multivalued Dependencies and Fourth Normal Form, Join Dependencies and Fifth Normal Form, Inclusion Dependencies | **07 Hrs** |
| **UNIT-V** | |
| **Transaction Management** The ACID Properties, Transactions and Schedules, Concurrent Execution of Transactions, Lock- Based Concurrency Control, Performance of locking, Transaction support in SQL, Introduction to crash recovery, 2PL, Serializability and Recoverability, Lock Management, Introduction to ARIES, The log, Other recovery-related structures, The write-ahead log protocol, Check pointing, Recovering from a | **07 Hrs** |

| | |
|---|---|
| System Crash, Media Recovery, Other approaches and interaction with concurrency control. | |
| **Course Outcomes: After completing the course, the students will be able to** | |
| CO1: | Demonstrate the understanding of the fundamentals of Data Base management system, entity-relationship model, Relational Algebra, Database Design, Transaction Management. |
| CO2: | Use an SQL interface of a multi-user relational DBMS package to create, secure, populate, maintain, and query a database. |
| CO3: | Analyse an information storage problem and derive an information model expressed in the form of an entity relation diagram and other optional analysis forms, such as a data dictionary. |
| CO4: | Design a data model that satisfies relational theory and provides users with business Queries, business forms and business reports. |

| **Reference Books** | |
|---|---|
| **1.** | Fundamentals of Database Systems, Elmasri, Navathe, 5th Edition, 2007, Pearson Education, ISBN-13: 978-0-136-08620-8 |
| **2.** | Database Management Systems, Raghu Ramakrishnan, Johannes Gehrke, 3rd Edition, 2003, McGraw-Hill, ISBN-10: 007246563 |
| **3.** | Data base System Concepts, Silberschatz, Korth, Sudharshan, 6th Edition, 2010, Mc-GrawHill, ISBN-10: 0073523321/ISBN-13: 978-0073523323 |
| **4.** | An Introduction to Database Systems, C.J. Date, A. Kannan, S. Swamynatham, 8th Edition, 2006, Pearson Education, ISBN: 9788177585568. |

**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** | **1** | **3** | **3** | **1** | **1** | **1** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO2** | **1** | **2** | **2** | **1** | **1** | **1** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO3** | **1** | **2** | **2** | **1** | **1** | **1** | **-** | **-** | **2** | **1** | **-** | **2** |
| **CO4** | **1** | **3** | **3** | **1** | **1** | **-** | **-** | **-** | **2** | **1** | **-** | **2** |

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **INTERNET OF THINGS (IOT)**<br>**(Group D: Professional Core Elective)** | | |
| **Course Code:** 16EC6D7 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:1 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Understands the mechanisms used in the design of IoT device. |
| **2** | Aware of the role and importance of the Internet of Things in the enterprise, economy and society. |
| **3** | Design the architecture and technologies needed to implement IoT devices. |
| **4** | Create software for devices equipped with sensors interacting with environment |

| **UNIT-I** | |
|---|---|
| **Introduction to IoT**, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, IoT Data Management and Compute Stack | **07 Hrs** |
| **UNIT-II** | |
| **Engineering IoT Networks**: Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Wireless Sensor Networks, Connecting Smart Objects, Communications Criteria, Range, Frequency Bands, Power Consumption, Constrained-Node Networks, Data Rate and Throughput, Latency and Determinism, Overhead and Payload | **07 Hrs** |
| **UNIT-III** | |
| **IoT Access Technologies:** IEEE 802.15.4, IEEE 802.15.4g and 802.15.4e, IEEE 1901.2a, IEEE 802.11ah, Physical Layer, MAC Layer, Topology, Security, LoRaWAN, | **07 Hrs** |
| **UNIT-IV** | |
| **IP as the IoT Network Layer,** The Need for Optimization, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, IoT Application Transport Methods, SCADA, SCADA Transport over LLNs with MAP-T, IoT Application Layer Protocols | **07 Hrs** |
| **UNIT-V** | |
| **Programming IoT using C:** Introduction to Raspberry Pi, Pi vs. Microcontroller, Getting started with IDE, Introduction to GPIO, Inputs and interrupts, Memory mapped GPIO, Programming examples. | **08 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO1: | Demonstrate the working of IoT Networks, IoT Access Technologies |
| CO2: | Analyze the different IoT Access & Network Technologies and sensing elements |
| CO3: | Design the Communications & Payload for IoT applications |
| CO4: | Design the application using sensing elements though various networks & protocol |

| **Reference Books** | |
|---|---|
| **1.** | IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things , Hanes David,Salgueiro Gonzalo, Grossetete Patrick , ,2017 ,edition 1st ,Henry Jerome 9386873743-13:978-ISBN ,Education Pearson |
| **2.** | Raspberry Pi Iot in C, Harry Fairhead , 1st edition, 2016, I/O Press;, ISBN-13: 978-1871962468. |
| **3.** | Internet of Things: A Hands-On Approach, Arsheep Bahga, Vijay Madisetti, 1st edition, 2015, Orient Blackswan Private Limited - New Delhi, ISBN-13: 978-8173719547 |
| **4.** | Getting Started with Sensors, Kimmo Karvinen ,Tero Karvinen, 1st edition 2014, O′Reilly;, ISBN-13: 978-1449367084 |

**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** | **3** | **2** | **-** | **-** | **2** | **-** | **-** | **-** | **-** | **1** | **1** | **1** |
| **CO2** | **3** | **2** | **2** | **1** | **2** | **-** | **-** | **-** | **-** | **1** | **1** | **1** |
| **CO3** | **3** | **3** | **2** | **2** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **-** |
| **CO4** | **3** | **3** | **3** | **3** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **-** |

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **BIOINSPIRED ENGINEERING (Group E: Global Elective)** | | |
| **Course Code:** 16G6E01 | | **CIE Marks: 100** |
| **Credits: L:T:P:S:** 3:0:0:0 | | **SEE Marks: 100** |
| **Hours:** 36L | | **SEE Duration: 3Hrs** |

| **Course Learning Objectives:** | |
|---|---|
| **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 bio logical analogs |
| **4** | To gain an understanding that the design principles from nature can be translated into novel devices and structures and an appreciation for how biological systems can be engineered by human design |

| **Unit-I** | |
|---|---|
| **Introduction to Biology**: Biomolecules-Proteins, carbohydrates, lipids and Nucleic acids. Cell types- Microbial, plant, animal.Organ system- Circulatory, digestive, respiratory, excretory and nervous system. Sense organs. Plant process- Photosynthesis. | **06 Hrs** |
| **Unit – II** | |
| **Introduction to Biomimetics: Wealth of invention in nature as inspiration for human innovation:** Mimicking and inspiration of nature- synthetic life. Nature as a model for structure and tools: Biological clock, honey comb as strong light weight structure. Materials and processes in biology- Spider web, honey bee as a multi-material producer, fluorescent materials in fire flies. Bird and insect as source of inspiring flight. Robotics as beneficiary for biomimetic technologies. | **08 Hrs** |
| **Unit -III** | |
| **Biological materials in Engineering mechanisms:** Introduction, Comparison of biological and synthetic materials: Silk processing and assembly by insects and spiders- High performance fibers from nature, Seashells- High performance organic and inorganic composites from nature. Shark skin- Biological approaches to efficient swimming via control of fluid dynamics, Muscles- Efficient biological conversion from chemical to mechanical engineering. | **08 Hrs** |
| **Unit –IV** | |
| **Biological inspired process and products:** Artificial neural networks, genetic algorithms, medical devices. Biosensors. Plant as Bioinspirations: Energy efficiency, Biomimetic super hydrophobic surfaces- lotus leaf effect. Bionic leaf and Photovoltaic cells. | **08 Hrs** |
| **Unit –V** | |
| **Implants in Practice**: Artificial Support and replacement of human organs-Introduction, Artificial kidney, liver, blood, lung, heart, skin and pancreas. Total joint replacements- Visual prosthesis -artificial eye. Sense and sensors: Artificial tongue and nose, Biomimetic echolation. Limitations of organ replacement systems. | **07 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO1: | Remember and explain the fundamentals of Biology |
| CO2: | Describe the basic principles of design in biological systems. |
| CO3: | Differentiate biological phenomena to support inspiration for visual and conceptual design problems |
| CO4: | Create engineered solutions to customer needs utilizing a variety of bio-inspiration techniques. |

| Reference Books | |
|---|---|
| 1 | Jenkins, C.H. Bioinspired Engineering, NY: Momentum press, 2012 ISBN: 97816066502259 |
| 2 | C.C.Chatterjee, Human Physiology Volume 1 ( 11th Edition ), 2016, ISBN 10: 8123928726 / ISBN 13: 9788123928722 |
| 3 | Yoseph Bar-Cohen, Biomimetics: Biologically Inspired technologies, 2005, CRC press, ISBN: 9780849331633 |
| 4 | Donald Voet, Charlotte W. Pratt. Principles of Biochemistry: International Student Version. Wiley John and Sons, 2012. ISBN: 1118092449. |

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

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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 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 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| **CO2** | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |
| **CO4** | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |

**High-3 : Medium-2 : Low-1**

| Semester: VI | | |
|---|---|---|
| **GREEN TECHNOLOGY**<br>**(Group E: Global Elective)** | | |
| **Course Code:** 16G6E02 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:0 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives:** | |
|---|---|
| **1** | Learn the tools of green technology |
| **2** | Know various forms of renewable energy |
| **3** | Study the environmental consequences of energy conversation |
| **4** | Understand energy audits and residential energy audit |
| **5** | Understand the application of green technology in various industries |

| **Unit-I** | |
|---|---|
| **Current Practices and Future Sustainability:** Need for green technology, fundamentals of energy and its impact on society and the environment, the mechanics, advantages and disadvantages of renewable energy sources, energy conservation and audits, zero waste technology, life cycle assessment, extended product responsibility, concept of atom economy, tools of Green technology<br>**Cleaner Production:** Promoting cleaner production, benefits and obstacles of cleaner production, cleaner production technologies. | **07 Hrs** |
| **Unit – II** | |
| **Solar Radiation and Its Measurement:** Solar constant, solar radiation at the earth's surface, solar radiation geometry, solar radiation measurements<br>**Applications of Solar Energy**: Introduction, solar water heating, space-heating (or solar heating of buildings), space cooling (or solar cooling of building), solar thermal electric conversion, agriculture and industrial process heat, solar distillation, solar pumping, solar cooking<br>**Geothermal Energy:** Resource identification and development, geothermal power generation systems, geothermal power plants case studies and environmental impact assessment. | **08 Hrs** |
| **Unit -III** | |
| **Energy From Biomass (Bio-Energy):** Introduction, biomass conversion technologies, wet Processes, dry Processes, biogas generation, factors affecting biodigestion, types of biogas plants (KVIC model & Janata model), selection of site for biogas plant<br>**Bio Energy (Thermal Conversion):** Methods for obtaining energy from biomass, thermal gasification of biomass, classification of biomass gasifiers, chemistry of the gasification process, applications of the gasifiers. | **07 Hrs** |
| **Unit –IV** | |
| **Wind Energy:** Introduction, basic components of WECS (Wind Energy Conversion system), classification of WEC systems, types of wind machines (Wind Energy Collectors), horizontal-axial machines and vertical axis machines.<br>**Ocean Thermal Energy**: OTEC-Introduction, ocean thermal electric conversion (OTEC), methods of ocean thermal electric power generation, open cycle OTEC system, the closed or Anderson, OTEC cycle, Hybrid cycle<br>**Energy from Tides**: Basic principles of tidal power, components of tidal power plants, operation methods of utilization of tidal energy, advantages and limitations of tidal power generation | **07 Hrs** |
| **Unit –V** | |
| **Hydrogen, Hydrogen Energy:** Introduction, methods of hydrogen production (principles only), storage transportation, utilization of hydrogen gas, hydrogen as alternative fuel for motor vehicle, safety and management, hydrogen technology development in India | **07 Hrs** |

| | |
|---|---|
| **Application of Green Technology:** Electronic waste management, bioprocesses, green composite materials, green construction technology<br>**Sustainability of industrial waste management:** Case studies on cement industry, iron and steel industry, petroleum sectors, marble and granite industry, sugar industry | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Recall the fundamentals of various forms of energy |
| **CO2:** | Explain the principles of various forms of renewable energy |
| **CO3:** | Apply the concept of zero waste, atom economy for waste management |
| **CO4:** | Create a waste management plan incorporating tools of green technology in various industries |

| **Reference Books** | |
|---|---|
| **1** | Non-Conventional Energy Sources, G.D.Rai, 5th Edition, 2016, Khanna Publications, ISBN: 8174090738 |
| **2** | Renewable Energy-Power for a Sustainable Future, Edited by Godfrey Boyle, 3rd Edition, 2012, Oxford University Press, ISBN: 9780199545339 |
| **3** | Energy Systems and Sustainability: Power for a Sustainable Future, Godfrey Boyle, Bob Everett, and Janet Ramage, 2nd Edition, 2012, Oxford University Press, ISBN: 0199593744 |
| **4** | Renewable Energy resources, John Twidell and Tony Weir, 3rd Edition, 2015, Routledge publishers, ISBN:0415584388 |

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

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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 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.

| Semester: VI | | |
|---|---|---|
| **SOLID WASTE MANAGEMENT (Theory)** | | |
| **Course Code:16G6E03** | | **CIE Marks: 100** |
| **Credits: L:T:P:S: 3:0:0:0** | | **SEE Marks: 100** |
| **Hours: 36L** | | **SEE Duration: 3Hrs** |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Impart the knowledge of present methods of solid waste management system and to analyze the drawbacks. |
| **2** | Understand various waste management statutory rules. |
| **3** | Analyze different elements of solid waste management, design and develop recycling options for biodegradable waste by composting. |
| **4** | Identify hazardous waste, e-waste, plastic waste and bio medical waste and their management systems. |

| **UNIT-I** | |
|---|---|
| **Introduction**: Land Pollution. Scope and importance of solid waste management. Present solid waste disposal methods. Merits and demerits of open dumping, feeding to hogs, incineration, pyrolysis, composting, sanitary landfill. Definition and functional elements of solid waste management.<br>**Sources**: Sources of Solid waste, types of solid waste, composition of municipal solid waste, generation rate, Numerical Problems.<br>**Collection and transportation of municipal solid waste:** Collection of solid waste-services and systems, Municipal Solid waste (Management and Handling) 2000 rules with 2016 amendments. Site visit to collection system. | **08 Hrs** |
| **UNIT-II** | |
| **Composting** Aerobic and anaerobic composting - process description, process microbiology, Vermicomposting, Site visit to compost plant, Numerical problems.<br>**Sanitary land filling**: Definition, advantages and disadvantages, site selection, methods, reaction occurring in landfill- Gas and Leachate movement, Control of gas and leachate movement, Site visit to landfill site. | **08 Hrs** |
| **UNIT-III** | |
| **Hazardous waste management**: Definitions, Identification of hazardous waste, Classification of hazardous waste, onsite storage, collection, transfer and transport, processing, disposal, hazardous waste (Management and handling) rules 2008 with amendments. Site visit to hazardous landfill site | **06 Hrs** |
| **UNIT-IV** | |
| **Bio medical waste management:** Classification of bio medical waste, collection, transportation, disposal of bio medical waste, Bio medical waste (Management and Handling) rules 1998 with amendments. Site visit to hospital to see the collection and transportation system and visit to biomedical waste incineration plant. | **06 Hrs** |
| **UNIT-V** | |
| **E-waste management**: Definition, Components, Materials used in manufacturing electronic goods, Recycling and recovery integrated approach. E- waste (management and handling) rules 2011.Site visit to e- waste processing facility. **Plastic waste management:** Manufacturing of plastic with norms. Plastic waste management. Plastic manufacture, sale & usage rules 2009 with amendments. | **06 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| 1 | Understand the existing solid waste management system and to identify their drawbacks. |
| 2 | Analyze drawbacks in the present system and provide recycling and disposal options for each type of waste. |

| | |
|---|---|
| 3 | Distinguish Hazardous waste, Biomedical waste, E waste and to provide scientific management system. |
| 4 | Evaluate and monitor the Biomedical waste, Hazardous waste, E waste, Plastic and Municipal waste management as per the rules laid by Ministry of Environment & Forest. |

| **Reference Books** | |
|---|---|
| **1.** | Integrated Solid Waste Management: Engineering principles and management issues George Tchobanoglous, Hilary Theisen, Samuel A Vigil, published by M/c Graw hill Education. Indian edition 2014. ISBN – 13: 978- 9339205249, ISBN-10 : 9339205243 |
| **2.** | Environmental Engineering, Howard S Peavy, Donald R Rowe and George Tchobanoglous, Tata Mcgraw Hill Publishing Co ltd., 2013, ISBN-13 9789351340263. |
| **3.** | Electronic waste management, R.E. Hester, Roy M Harrison,, Cambridge, UK, RSC Publication, 2009, ISBN 9780854041121 |
| **4.** | Municipal Solid waste (Management & Handling Rules) 2000. Ministry of Environment & Forest Notification, New Delhi, 25th Sept 2000 and 2016 amendments. |
| **5.** | Hazardous waste (management, handling) rules 2008.Ministry of Environment and Forest Notification, New Delhi, 25th February 2009. |

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

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| **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 |

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **INTRODUCTION TO WEB PROGRAMMING (Group E: Global Elective)** | | |
| **Course Code:16G6E04** | | **CIE Marks: 100** |
| **Credits: L:T:P:S: 3:0:0:0** | | **SEE Marks: 100** |
| **Hours: 36L** | | **SEE Duration: 3 Hrs** |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| 1 | Understand the basic concepts used in web programming. |
| 2 | Learn the definitions and syntax of different web technologies. |
| 3 | Utilize the concepts of JavaScripts, XML and PHP. |
| 4 | Design and develop web pages which are quick, easy and well-presented using different techniques such as CSS,XML and JavaScripts. |

| **UNIT-I** | |
|---|---|
| **Introduction to Web Concepts** Fundamentals of Web, HTML 5 - Core HTML attributes, headings, paragraphs and breaks, divisions and centering, quotations, preformatted text, lists, horizontal rules, block-level elements, text-level elements.XHTML – 1: Internet, WWW, Web Browsers and Web Servers, URLs, MIME, HTTP, Security, the Web Programmers Toolbox. XHTML: Basic syntax, Standard structure, Basic text markup, Images, Hypertext Links.XHTML (continued): Lists, Tables, Forms, Frames. | **07 Hrs** |
| **UNIT-II** | |
| **Cascading Style Sheets (CSS):** Introduction, Levels of style sheets, Style specification formats, Selector forms, Property value forms, Font properties, List properties, Color, Alignment of text, The box model, Background images, The  and  tags, Conflict resolution. **The Basics of JavaScript:** Overview of JavaScript; Object orientation and JavaScript; General syntactic characteristics; Primitives, operations, and expressions; Screen output and keyboard input; Control statements | **09 Hrs** |
| **UNIT-III** | |
| **JavaScript (continued):** Object creation and modification; Arrays; Functions; Constructor; Pattern matching using regular expressions; Errors in scripts. **JavaScript and HTML Documents:** The JavaScript execution environment; The Document Object Model; Element access in JavaScript; Events and event handling; Handling events from the Body elements, Button elements, Text box and Password elements; The DOM 2 event model; The navigator object; DOM tree traversal and modification. | **09 Hrs** |
| **UNIT-IV** | |
| **Dynamic Documents with JavaScript:** Introduction to dynamic documents; Positioning elements; Moving elements; Element visibility; Changing colors and fonts; Dynamic content; Stacking elements; Locating the mouse cursor; Reacting to a mouse click; Slow movement of elements; Dragging and dropping elements. **Introduction to PHP:** Origins and uses of PHP; overview of PHP; General syntactic characteristics; Primitives, Operations and Expressions; Output; Control statements; Arrays; Functions; Pattern Matching; Form Handling; Files; Cookies; Session Tracking. | **06 Hrs** |
| **UNIT-V** | |
| **XML:** Introduction; Syntax; Document structure; Document Type definitions; Namespaces; XML schemas; Displaying raw XML documents; Displaying XML documents with CSS; XSLT Style sheets; XML processors; Web services. | **05 Hrs** |

| Course Outcomes: After completing the course, the students will be able to | |
|---|---|
| CO1. | Understand and explore internet related concepts that are vital for web development. |
| CO2. | Apply HTML tags for designing static web pages and forms using Cascading Style Sheet. |
| CO3. | Utilize the concepts of XML, JavaScripts along with XHTML for developing web pages. |
| CO4. | Design and develop web-based applications using JavaScripts, CSS, XHTML, PHP and XML. |

| Reference Books | |
|---|---|
| 1. | Programming the World Wide Web – Robert W. Sebesta, 7th Edition, 2013, Pearson Education, ISBN-13:978-0132665810 |
| 2. | Web Programming Building Internet Applications, Chris Bates, 3rd Edition, 2006, Wiley India, ISBN : 978-81-265-1290-4 |
| 3. | Internet & World Wide Web How to H program, M. Deitel, P.J. Deitel, A. B. Goldberg, 3rd Edition,2004, Pearson Education / PHI, ISBN-10: 0-130-89550-4 |
| 4. | Thomas A Powell, The Complete Reference to HTML and XHTML, 4th Edition, 2003, Tata McGraw Hill publisher. ISBN: 978-0- 07-222942- 4. |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment. 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 60. The marks component for assignment is 10. 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** | **1** | **-** | **2** | **-** | **1** | **1** | **1** | **-** | **-** | **-** | **-** | **1** |
| **CO2** | **-** | **-** | **2** | **-** | **1** | **1** | **-** | **-** | **-** | **-** | **-** | **-** |
| **CO3** | **-** | **-** | **-** | **-** | **2** | **-** | **-** | **-** | **2** | **-** | **-** | **2** |
| **CO4** | **-** | **-** | **3** | **-** | **2** | **-** | **-** | **-** | **2** | **-** | **-** | **2** |

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **AUTOMOTIVE ELECTRONICS**<br>**(Group E: Global Elective)** | | |
| **Course Code:** 16G6E05 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:0 | | **SEE Marks:** 100 |
| **Hours:**36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Understand the application of principles of sensing technology in automotive field |
| **2** | Apply control systems in the automotive domain |
| **3** | Understand automotive specific communication protocols / techniques |
| **4** | Analyze fault tolerant real time embedded systems |

| **UNIT-I** | |
|---|---|
| **Power Train Engineering and Fundamentals of Automotive:** Fundamentals of Petrol, diesel and gas engines, electric motors and control systems. Basic Automotive System, System Components, Evolution of Electronics in Automotive. Alternators and charging, battery technology, Ignition systems. Working principles of various electronic components and accessories used in Automotive. Developments in existing engine forms and alternatives. Hybrid designs (solar power, electric/gasoline, LPG, CNG, fuel cells). Basic Transmission systems. | **08 Hrs** |
| **UNIT-II** | |
| **Sensor Technologies in Automotive:** In-vehicle sensors: Working principles, Characteristics, limitations and use within the automotive context of the following: Temperature sensing e g. coolant, air intake. Position sensing e.g. crankshaft, throttle plate. Pressure sensing e.g. manifold, exhaust differential, tyre. Distance sensing e.g. anti-Collision, Velocity sensing e.g. speedometer, anti-skid. Torque sensing e.g. automatic transmission. Vibration sensing e.g. Airbags. flow sensing and measurement e.g. fuel injection. Interfacing principles: Operation, topologies and limitations of all sensors covered in the above to in-vehicle processing or communications nodes. Use of Actuators: Types, working principle, Characteristics, limitations and use within the automotive context of each type. | **07 Hrs** |
| **UNIT-III** | |
| **Automotive Control Systems:** Control system approach in Automotive: Analog and Digital control methods, stability augmentation, control augmentation. Transmission control, System components and functions. Cruise control, traction control, actuator limiting, wind-up, gain scheduling, adaptive control. Special Control Schemes: Vehicle braking fundamentals, Antilock systems. Variable assist steering and steering control. Controls for Lighting. Wipers, Air conditioning /heating. Remote keyless Entry and Anti-theft System, Emission Course-system control. Control techniques used in hybrid system. Electronic Engine control: Motion equations, modeling of linear and non-linear systems, numerical methods, system responses Objective of Electronic Engine control. Spark Ignition and Compression Ignition Engines and their electronic controls. Engine management testing: Engine management system strategies and implementation. Simulation and implementation methods. Methods of improving engine performance and efficiency. Model Based Development (MBD) Technology. AUTOSAR: Objectives and Architecture. | **07 Hrs** |
| **UNIT-IV** | |
| **Automotive Communication Systems:** Communication interface with ECU's: Interfacing techniques and interfacing with infotainment gadgets. Relevance of internet protocols, such as TCP/IP for automotive applications. Wireless LANs standards, such as Bluetooth, IEEE802.11x. Communication protocols for automotive applications. Automotive Buses: Use of various buses such as CAN, LIN, Flex Ray. Recent trends in automotive buses (Such as OBDI1. MOST, IE, IELI.I, D2B and DSI). Application of Telematics in Automotive: Global Positioning Systems (GPS) and General Packet Radio Service (GPRS), | **07 Hrs** |

| | |
|---|---|
| for use in an automotive environment. Vehicle to Vehicle Communication Higher End Technology: Comparative Study and applications of ARM Cortex-Ascries/M-scries. ARM 9 and ARM11. | |
| **UNIT-V** | |
| **Diagnostics and Safety in Automotive:** Fundamentals of Diagnostics: Basic wiring system and Multiplex wiring system. Preliminary checks and adjustments, Self-Diagnostic system. Fault finding and corrective measures. Electronic transmission checks and Diagnosis, Diagnostic procedures and sequence. On board and off board diagnostics in Automotive. Safety in Automotive: Safety norms and standards. Passenger comfort and security systems. Future trends in Automotive Electronics. | **07 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Acquire the knowledge of automotive domain fundamentals and need of electronics in Automotive systems |
| **CO2:** | Apply various sensors and actuators for Automotive applications |
| **CO3:** | Analyze different control systems and communication interfaces used in automotive systems. |
| **CO4:** | Evaluate the performance of telematics Diagnostics and safety norms in Automotive 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, |
| **3.** | Automotive Embedded Systems Handbook, Nicolas Navet, F Simonot-Lion, Industrial Information Technology Series, CRC press. |
| **4.** | Automotive Control Systems Engine, Driveline and vehicle, Uwekiencke and lars Nielsen, Springer, 2nd Edition, 2005, ISBN 0-387-95368X |

**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** | **3** | **1** | **2** | **1** | **-** | **-** | **1** | **-** | **-** | **-** | **-** | **1** |
| **CO2** | **3** | **2** | **2** | **1** | **-** | **1** | **-** | **-** | **-** | **1** | **-** | **1** |
| **CO3** | **3** | **2** | **2** | **1** | **-** | **1** | **-** | **-** | **2** | **-** | **1** | **1** |
| **CO4** | **3** | **1** | **2** | **1** | **2** | **1** | **-** | **-** | **1** | **-** | **-** | **-** |

**Low-1 Medium-2 High-3**

| SEMESTER – VI | | |
|---|---|---|
| **INDUSTRIAL ELECTRONICS (Group E: Global Elective)** | | |
| **Course Code:** 16G6E06 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S: 3:0:0:0** | | **SEE Marks:** 100 |
| **Hours: 36L** | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Explain the working of the devices used in power electronic circuits in industrial applications |
| **2** | Analysing and designing power electronic circuits which handle the electrical energy efficiently and economically and Identify the typical practical problems with industrial exposure acquired |
| **3** | Use basic concepts of design and working of electronic circuits for conversion and control of electrical energy. |
| **4** | Apply the knowledge to work as part of teams on multidisciplinary projects and to discuss industrial problems with regard to application of Power Electronics. |

| **UNIT-I** | |
|---|---|
| **Power semi-conductor Devices and static characteristics:** Construction, working & characteristics of MOSFET, SCR, IGBT. Comparison of Power BJT, MOSFET, SCR, IGBT. Turn on methods of Power BJT, MOSFET and IGBT. Design of R, R-C, and UJT (pulse train) Gate triggering methods of SCR. | **08 Hrs** |
| **UNIT-II** | |
| **Thyristor Dynamic characteristics, Specifications and Protection:** Gate characteristics of SCR, Dynamic characteristics of SCR. Design of Snubber circuit for SCR, Line Commutation and Forced Commutation circuits with design, Gate protection & overvoltage protection of SCR. | **07 Hrs** |
| **UNIT-III** | |
| **Converters:** Single Phase Controlled Convertor- Full wave Half and Fully controlled line commutated bridge converters, Derivation of average load voltage and current. Three phase converters – Six pulse converters- with R load- Active inputs to the convertors with and without Freewheeling diode, Derivation of average load voltage and current. **Converter applications:** Industrial Applications of Half and Fully controlled converters to DC drives (Control of DC drives) | **06 Hrs** |
| **UNIT-IV** | |
| **Choppers** – Step down, step up Chopper, step up/Down Chopper, Time ratio control and Current limit control strategies –Derivation of load voltage and currents with R, RL of Step down, step up Chopper, Step up/Down Chopper – load voltage expression. Application of choppers to subway cars, Industrial drives, battery operated vehicles. | **07 Hrs** |
| **UNIT-V** | |
| **Classification of Choppers and Applications:** Type A, Type B, Type C, Type D, Type E choppers and their industrial Applications, AC Chopper –phase control type. **Inverters** – Single phase inverter – Basic series inverter – Basic parallel Capacitor inverter, bridge inverter (single phase) – Voltage control techniques for inverters Pulse width modulation techniques. – UPS-online, offline (Principle of operation only | **08 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand the comprehensive working of different devices and their applications. |
| **CO2:** | Analyze the application of skills in controlling and conversion of electrical energy. |
| **CO3:** | Evaluate and distinguish the performance of converters and inverters. |
| **CO4:** | Ability to implement their knowledge and skills in design of applications. |

| Reference Books | |
|---|---|
| **1.** | Power Electronics, M. D. Singh & K. B. Kanchandhani, Tata Mc Graw – Hill Publishing company, ISBN : 978-0-07-058389-4, 2008 |
| **2.** | Power Electronics : Circuits, Devices and Applications, M. H. Rashid, Prentice Hall of India, 2nd Edition, ISBN : 0131228153, 9780131228153, 2004 |
| **3.** | Power Electronics, P.C. Sen, Tata McGraw-Hill Publishing, ISBN: 978-0-07-462400-5, 2008. |
| **4** | Power Electronics P S Bimbra P.S Bimbra ,Khanna Publication ,ISBN:978-7409-279-3,5th Edition. |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment. 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 60. The marks component for assignment is 10. 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 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 0 | 1 |
| **CO2** | 3 | 2 | 2 | 3 | 3 | 0 | 1 | 0 | 0 | 0 | 2 | 1 |
| **CO3** | 3 | 2 | 2 | 3 | 2 | 2 | 0 | 1 | 0 | 0 | 1 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 0 | 1 | 0 | 0 | 1 |

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **PROJECT MANAGEMENT**<br>**(Group E: Global Elective)** | | |
| **Course Code:** 16G6E07 | | **CIE Marks:** 100 |

| | | |
|---|---|---|
| **Credits: L:T:P:S:** 3:0:0:0 | | **SEE Marks:** 100 |
| **Hours:** 33L | | **SEE Duration:** 03 Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| 1. | To understand the principles and components of project management. |
| 2. | To appreciate the integrated approach to managing projects. |
| 3. | To explain the processes of managing project cost and project procurements. |

| **Unit – I** | |
|---|---|
| **Introduction:** What is project, what is project management, relationships among portfolio management, program management, project management, and organizational project management, relationship between project management, operations management and organizational strategy, business value, role of the project manager, project management body of knowledge. | **06 Hrs** |
| **UNIT – II** | |
| **Organizational influences & Project life cycle:** Organizational influences on project management, project state holders & governance, project team, project life cycle.<br>**Project Integration Management:** Develop project charter, develop project management plan, direct & manage project work, monitor & control project work, perform integrated change control, close project or phase. | **08 Hrs** |
| **UNIT – III** | |
| **Project Scope Management:** Project scope management, collect requirements define scope, create WBS, validate scope, control scope.<br>**Project Time Management:** Plan schedule management, define activities, sequence activities, estimate activity resources, estimate activity durations, develop schedule, control schedule. | **07 Hrs** |
| **UNIT – IV** | |
| **Project Cost management:** Project Cost management, estimate cost, determine budget, control costs.<br>**Project Quality management:** Plan quality management, perform quality assurance, control quality. | **06 Hrs** |
| **UNIT – V** | |
| **Project Risk Management:** Plan risk management, identify risks, perform qualitative risk analysis, perform quantitative risk analysis, plan risk resources, control risk.<br>**Project Procurement Management:** Project Procurement Management, conduct procurements, control procurements, close procurement. | **06 Hrs** |

| **Course Outcomes: After going through this course the student will be able to** | |
|---|---|
| **CO1** | Understand the concepts, tools and techniques for managing large projects. |
| **CO2** | Explain various sub processes in the project management frameworks. |
| **CO3** | Analyze and evaluate risks in large and complex project environments. |
| **CO4** | Develop project plans for various types of organizations. |

**Reference Books:**


1. A Guide to the Project Management Body of Knowledge(PMBOK Guide), Project Management Institute, 5th Edition, 2013, ISBN: 978-1-935589-67-9
2. Project Planning Analysis Selection Financing Implementation & Review, Prasanna Chandra, 7th Edition, 2010, Tata McGraw Hill Publication, ISBN 0-07-007793-2.
3. Project Management A System approach to Planning Scheduling & Controlling, Harold Kerzner, 10th Edition, 2009, CBS Publishers and Distributors, ISBN 047027806.
4. Strategic Project Management Made Simple: Practical Tools for Leaders and Teams, Terry Schmidt, 1st Edition, 2009, John Wiley & Sons, ISBN: 978-0470411582


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

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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 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 | | | | | | | | | | | |
| **CO2** | 2 | 2 | | 1 | 1 | | | | | | | |
| **CO3** | | | | | | | 1 | 1 | | | | |
| **CO4** | 2 | | 3 | | 1 | | | | | | | |

**Low-1 Medium-2 High-3**

**Semester: VI**

| VIRTUAL INSTRUMENTATION<br>(Group E: Global Elective) | | |
|---|---|---|
| **Course Code:**16G6E08 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:0 | | **SEE Marks:** 100 |
| **Hours:**35L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Understand the difference between conventional and graphical programming, basic data acquisition concepts. |
| **2** | Differentiate the real time and virtual instrument. |
| **3** | Develop ability for programming in LabVIEW using various data structures and program structures. |
| **4** | Analyze the basics of data acquisition and learning the concepts of data acquisition with LabVIEW. |

| **UNIT-I** | |
|---|---|
| **Graphical Programming Environment:**<br>Basic of Virtual Instrumentation, Conventional and Graphical Programming. Introduction to LabVIEW, Components of LabVIEW and Labels.<br>**Fundamentals:** Data Types, Tool Pallets, Arranging Objects, Color Coding, Code Debugging, Context Help, Creating Sub-VIs Boolean, Mechanical action- switch, and latch actions, String data types, enum, ring, Dynamics. | **06 Hrs** |
| **UNIT-II** | |
| **Fundamentals of Virtual Instrumentation Programming:**<br>For Loop, While Loop, shift registers, stack shift register, feedback node, and tunnel.<br>**Timing function**: Timing VI, elapsed time, wait function.<br>Case structures, formula node, Sequence structures, Arrays and clusters, visual display types- graphs, charts, XY graph. Local and Global variables. | **09 Hrs** |
| **UNIT-III** | |
| **Error Handling**- error and warning, default error node, error node cluster, automatic and manual error handling.<br>**String Handling:** Introduction, String Functions, LabVIEW String Formats.<br>**File Input/ Output:** Introduction, File Formats, File I/O Functions and file Path functions.<br>**Design patterns:** Producer/consumer, event handler, derived design pattern, Queued message handler, Producer/consumer (events), Producer/consumer (state machine). | **08 Hrs** |
| **UNIT-IV** | |
| **Data Acquisition:** Introduction to data acquisition, Analog Interfacing Connecting signal to board, Analog Input/output techniques digital I/O, counters, NI-DAQmx tasks.<br>**DAQ Hardware configuration:** Introduction, Measurement and Automation Explorer, DAQ Assistants, Analysis Assistants.<br>**Interfacing Instruments: GPIB and RS232:** Introduction, RS232 Vs. GPIB, Handshaking, GPIB Interfacing, RS232C/RS485 Interfacing, and VISA. | **06 Hrs** |
| **UNIT-V** | |
| **Advanced Topics In LabVIEW:** Use of analysis tools and application of VI: Fourier transforms Power spectrum, Correlation methods, windowing & filtering. Inter-Process Communication, Notifier, Semaphore, Data Sockets.<br>**Simulation of systems using VI:** Development of Control system, Image acquisition and processing. | **06 Hrs** |

| **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** | Virtual instrumentation Using LabVIEW, Jovitha Jerome, 4th Edition, 2010, PHI Learning Pvt. Ltd., ISBN: 978-812034035. |
| **2** | Virtual Instrumentation Using LabVIEW, Sanjay Gupta & Joseph John, 2nd Edition, New Delhi, 2010,Tata McGraw Hill Publisher Ltd., ISBN: 978-0070700284 |
| **3** | LabVIEW for Everyone: Graphical Programming made easy and fun,Jeffrey Travis, Jim Kring, 3rd Edition, 2006, Prentice Hall,ISBN: 978-0131856721. |
| **4** | Data Acquisition using LabVIEW,Behzad Ehsani, 1st Edition,2017, Packt Publishing, ISBN: 978-1782172161. |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment. 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 60. The marks component for assignment is 10. The total marks of CIE are 100.

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

**SEE** for 100 marksis 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** | **1** | **1** | **1** | **2** | **-** | **-** | **-** | **2** | **2** | **-** | **1** |
| **CO2** | **1** | **1** | **1** | **1** | **2** | **-** | **-** | **-** | **2** | **2** | **-** | **1** |
| **CO3** | **1** | **-** | **1** | **1** | **2** | **-** | **-** | **-** | **2** | **2** | **-** | **1** |
| **CO4** | **2** | **1** | **1** | **2** | **3** | **-** | **-** | **-** | **2** | **2** | **-** | **2** |

**Low-1 Medium-2 High-3**

**Semester: VI**

| INTRODUCTION TO MOBILE APPLICATION DEVELOPMENT (Group E: Global Elective) | | |
|---|---|---|
| **Course Code:** 16G6E09 | | **CIE Marks**: 100 |
| **Credits: L:T:P:S:** 3:0:0:0 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Learn Android application development platform for mobile devices and use it. |
| **2** | Understand mobile application architecture and its components. |
| **3** | Define Android specific programming concepts such as activities, intents, fragments, services, broadcast receivers and content providers. |
| **4** | Describe sensors like motion sensors, environmental sensors, and positional sensors; most commonly embedded in Android devices along with their application programming interface. |

| **UNIT I** | |
|---|---|
| **Overview of Software platforms and Development:** Mobile OS: Android development platform and tools, Programming language, Emulator, SDK and Development Environments<br>**Creating Applications and Activitie**s: Introducing the Application Manifest File; Creating Applications and Activities; Architecture Patterns (MVC); Android Application Lifecycle. | **07 Hrs** |
| **UNIT II** | |
| **User Interface Design:** Fundamental Android UI Design; Introducing Layouts; Introducing Fragments. **Intents and Broadcast**s: Introducing Intents; Creating Intent Filters and Broadcast Receivers. | **07 Hrs** |
| **UNIT III** | |
| **Database and Content Providers:** Introducing Android Databases; Introducing SQLite; Content Values and Cursors; Working with SQLite Databases; Creating Content Providers; Using Content Providers; Case Study: Native Android Content Providers. | **07 Hrs** |
| **UNIT IV** | |
| **Location Based Services, Telephony and SMS:** Using Location-Based Services; Using the Emulator with Location-Based Services; Selecting a Location Provider; Using Proximity Alerts; Using the Geocoder; Example: Map-based activity; Hardware Support for Telephony; Using Telephony; Introducing SMS and MMS. | **08 Hrs** |
| **UNIT V** | |
| **Hardware Support and Devices (AUDIO, VIDEO, AND USING THE CAMERA):** Using Sensors and the Sensor Manager; Monitoring a Device's Movement and Orientation; Introducing the Environmental Sensors; Playing Audio and Video; Using Audio Effects; Using the Camera; Recording Video | **07 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Assess the basic framework and usage of SDK to build GUI and apply advanced technologies in developing Android mobile applications. |
| **CO2:** | Differentiate techniques for persisting user data, such as shared preferences, traditional file systems (internal and external storage), and SQLite database |
| **CO3:** | Articulate the communication programming features and capabilities of Android platforms. |
| **CO4:** | Design and create innovative, sophisticated mobile applications using Android platform. |

| **Reference Books** |
|---|

| | |
|---|---|
| **1.** | Professional Android 4 Application Development, Reto Meier, WROX Press, 2012, Wiley Publishing, ISBN: 9781118102275 |
| **2.** | Android Application Development: Programming with the Google SDK, John Lombardo, Blake Meike, Rick Rogers and Zigurd Mednieks, 2009, O'Reilly Media, Inc. ISBN: 9788184047332 |
| **3.** | Hello Android, Introducing Google's Mobile Development Platform, Ed Burnette, 3rd Edition, Pragmatic Programmers, LLC.ISBN: 9781934356562 |
| **4.** | Android Studio Development Essentials - Android 6, Neil Smyth, 2015, Createspace Independent Publishing Platform, ISBN: 9781519722089 |


**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 | - | - | 3 | - | - | - | - | - | - | 2 |
| **CO2** | 3 | 3 | 3 | - | 3 | 1 | - | - | - | 2 | - | 2 |
| **CO3** | - | 3 | 3 | - | 3 | 2 | - | - | - | 2 | 1 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 3 |

**Low-1 Medium-2 High-3**

**Semester: VI**

| AUTOMOTIVE ENGINEERING<br>(Group E: Global Elective) | | |
|---|---|---|
| **Course Code:** | 16G6E10 | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** | 3:0:0:0 | **SEE Marks:** 100 |
| **Hours:** | 36L | **SEE Duration:** 3Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Identify the different sub-systems in automobiles. |
| **2** | Describe the functions of each of the sub-systems and its effect. |
| **3** | Discuss fuel injection, transmission, braking, steering, suspension, air intake and exhaust systems. |
| **4** | Explain the importance of selection of suitable sub-system for a given performance requirement. |

| **UNIT-I** | |
|---|---|
| **Automobile Engines**<br>Classifications of Internal Combustion Engines based on no. of cylinders, Arrangement of cylinders, Type of fuel and no. of strokes**.** Engine construction and nomenclature. Thermodynamic principles of Otto and Diesel cycle. Operation in a 4 stroke engine. Direct and indirect injection. Combustion stages in engines. Fuels: Gasoline, Diesel, LPG and Natural Gas For automotive applications. Fuel properties- Octane number and Cetane number. Pollutants and Emission norms- Regulated pollutants and its effects, Regulations as per emission norms. | **06 Hrs** |
| **UNIT-II** | |
| **Engine Auxiliary Systems:**<br>AirIntake and Exhaust System- Working principle ofAir filters, Intake manifold, Turbocharger, Intercooler, Exhaust manifold, Catalytic convertor, Exhaust Gas Recirculation system, Muffler.<br>Cooling system- Components, working principle, Coolant.<br>Lubrication system- Components, Properties of lubricating oil, Viscosity numbers.<br>Fuel system- Working principle of Fuel Injection Pump, Injector, Nozzle, Fuel filter. Working of ignition system, Battery, Immobilizer. | **08 Hrs** |
| **UNIT-III** | |
| **Transmission:**<br>Clutch- Classification and working, Gear box- Classification, Working of sliding mesh and Synchromesh transmission, Automatic transmission. Propeller shaft, Differential assembly and rear axle- Working. Wheels and Tyres- Wheel alignment and balancing classification of tyres, Radial, Tubeless. | **08 Hrs** |
| **UNIT-IV** | |
| **Vehicular Auxiliary Systems:**<br>Suspension- Front and rear suspension working, Types of springs.<br>Brake- Classification and Components - Disc and drum brakes, Hydraulic, parking brake, Front and rear wheel brakes. Antilock Braking Systems.<br>Steering- components and operation of power steering.<br>Vehicle frame and body classification- Hatchback, Sedan, SUV.<br>Safety systems- Passive safety systems, Active safety systems- Principle of Electronic Stability Program, Air bags, Crash testing methods. | **06 Hrs** |
| **UNIT-V** | |
| **Demonstrations of Automobile Systems:** Engine performance measurement in terms of Brake power, Emission measurement and principle, Drawing Valve Timing Diagram for multi-cylinder engine, Production and properties of biodiesel. | **06 Hrs** |

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

| | |
|---|---|
| 1 | Describe the different types of automotive systems. (L1- L2) |
| 2 | Construct the Valve Timing Diagram for multi-cylinder engines. (L3) |
| 3 | Detect the automotive exhaust pollutants using gas analyzer. (L4) |
| 4 | Evaluate the performance of engines by determining Brake Power. (L6) |

| **Reference Books** | |
|---|---|
| **1.** | Automotive Engineering Fundamentals, Richard Stone and Jeffrey K. Ball, 2004 , SAE International , ISBN: 0768009871 |
| **2.** | Bosch Automotive Handbook, Robert Bosch, 9th Edition, 2004, ISBN: 9780768081527. |
| **3.** | Automotive Engineering e-Mega Reference, David Crolla, Butterworth-Heinemann, 1st Edition , 2009 , ISBN: 9781856175784. |

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

CIE is executed by way of quizzes (Q), tests (T) and Assignment. 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 60. The marks component for assignment is 10. 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** | **1** | **1** | | **1** | | | **2** | | **2** | | | **1** |
| **CO2** | | **2** | | | | | | | | | | |
| **CO3** | | **2** | **1** | | | **2** | | **1** | | | **2** | **1** |
| **CO4** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **2** | **2** | |

**Low-1 Medium-2 High-3**

| **Semester: VI** |
|---|

| MOBILE NETWORK SYSTEMS AND STANDARDS<br>(Group E: Global Elective) | | |
|---|---|---|
| **Course Code:** 16G6E11 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:0 | | **SEE Marks:** 100 |
| **Hours:** 34L | | **SEE Duration:** 03Hrs |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Understand land mobile concepts, radio link design and cellular network. |
| **2** | Compare the standards of WPAN, WLAN and WMAN. |
| **3** | Analyze WPAN, WLAN and WMAN standards and their architecture. |
| **4** | Design and demonstrate wireless networks for various applications. |

| **UNIT-I** | |
|---|---|
| **Cellular Wireless Networks:** Principles of cellular Networks, cellular system components and Operations, channel assignment, Attributes of CDMA in cellular system. | **06 Hrs** |
| **UNIT-II** | |
| **Second generation Cellular Networks:** GSM architecture, IS-95, GPRS, EDGE. | **08 Hrs** |
| **UNIT-III** | |
| **Third generation cellular systems:** WCDMA, IMT 2000 and LTE, Convergence in the network. | **06 Hrs** |
| **UNIT-IV** | |
| **Wireless Personal Area Networks:** Network architecture, components, Applications, Zigbee, Bluetooth.<br>**Wireless Local Area networks:** Network Architecture, Standards, Applications. | **08 Hrs** |
| **UNIT-V** | |
| **Wireless Metropolitan Area Networks:** IEEE 802.16 standards, advantages, WMAN Network architecture, Protocols, Applications. | **06 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1** | Describe the architectures and characteristics of different mobile networks. (L1- L2) |
| **CO2** | Apply the Network standards to a suitable application (L3) |
| **CO3** | Analyze the operation of various network technologies and standards (L4) |
| **CO4** | Evaluate the performance of various network technologies (L5) |

| **Reference Books** | |
|---|---|
| **1** | Wireless Communication, Upena Dalal, 1st Edition , 2009, Oxford higher Education, ISBN-13:978-0-19-806066-6. |
| **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 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 way of Quizzes (Q), Tests (T) and Assignment. 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 60. The marks component for assignment is 10. 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** | 3 | 2 | 2 | - | 2 | - | - | 2 | - | 2 | - | 1 |
| **CO2** | 3 | 3 | 2 | - | 2 | - | - | 2 | - | 2 | - | 1 |
| **CO3** | 3 | 3 | 3 | - | 2 | - | - | 2 | - | 2 | - | 2 |
| **CO4** | 3 | 3 | 3 | - | 3 | - | - | 2 | - | 2 | - | 2 |

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **APPLIED PARTIAL DIFFERENTIAL EQUATIONS (Group E: Global Elective)** | | |
| **Course Code:**16G6E12 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:0 | | **SEE Marks:** 100 |
| **Hours:** 35L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives:** | |
|---|---|
| **1** | Adequate exposure to learn basics of partial differential equations and analyze mathematical problems to determine the suitable analytical technique. |
| **2** | Use analytical techniques and finite element technique for the solution of elliptic, parabolic and hyperbolic differential equations. |
| **3** | Solve initial value and boundary value problems which have great significance in engineering practice using partial differential equations. |
| **4** | Identify and explain the basics of partial differential equations and use the same to analyze the behavior of the system. |

| **Unit-I** | |
|---|---|
| **Partial Differential Equations of first order:** Introduction to formation of partial differential equations, Cauchy problem, Orthogonal surfaces, First order non-linear partial differential equations-Charpit's method, Classification and canonical forms of partial differential equations. | **07 Hrs** |
| **Unit – II** | |
| **Elliptic Differential Equations:** Derivation of Laplace and Poisson equation, Separation of variable method, Dirichlet problem, Neumann problem, Solution of Laplace equation in cylindrical and spherical coordinates. | **07 Hrs** |
| **Unit -III** | |
| **Parabolic Differential Equations:** Formation and solution of Diffusion equation, Dirac-Delta function, Separation of variable method, Solution of Diffusion equation in cylindrical and spherical coordinates. | **07 Hrs** |
| **Unit –IV** | |
| **Hyperbolic Differential Equations:** Formation and solution of one dimensional wave equation, D'Alembert's solution, vibrating string, Forced vibration, Periodic solution of one dimensional wave equation in cylindrical and spherical coordinates, Vibration of Circular membrane. | **07 Hrs** |
| **Unit –V** | |
| **Numerical solutions of Partial Differential Equations:** Finite difference method for Elliptic, Parabolic and Hyperbolic partial differential equations, Introduction to the finite element method-simple problems. | **07 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Identify and interpret the fundamental concepts of formation and solution of parabolic, hyperbolic and elliptic differential equations using analytical and numerical methods. |
| **CO2:** | Apply the knowledge and skills of analytical and numerical methods to solve the parabolic, hyperbolic and elliptic differential equations arising in the field of science and engineering. |
| **CO3:** | Analyze the physical problem to establish mathematical model and use appropriate method to solve and optimize the solution using the appropriate governing equations. |
| **CO4:** | Distinguish the overall mathematical knowledge to demonstrate and analyze the solution of parabolic, hyperbolic and elliptic differential equations arising in practical situations. |

| Reference Books | |
|---|---|
| **1** | Partial Differential Equations, K. Sankara Rao, Prentice-hall of India, 3rd Edition, 2012, ISBN: 978-81-203-3217-1. |
| **2** | Advanced Engineering Mathematics, Erwin Kreyszig, Wiley, 10th Edition, 2016, ISBN: 978-81-265-5423-2. |
| **3** | Numerical methods for scientific and engineering computation, M K Jain, S. R. K. Iyengar, R. K. Jain, New Age International Publishers, 6th Edition, 2012, ISBN-13: 978-81-224-2001-2. |
| **4** | An Introduction to the finite element method, J. N. Reddy, McGraw Hill, 3rd Edition, 2005, ISBN 13: 9780072466850. |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment. 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 60. The marks component for assignment is 10. 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** | **3** | **2** | **-** | **1** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO2** | **3** | **2** | **1** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO3** | **2** | **3** | **2** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **1** |
| **CO4** | **3** | **3** | **1** | **2** | **1** | **-** | **-** | **-** | **-** | **-** | **-** | **3** |

**Low-1 Medium-2 High-3**

| Semester: VI | | |
|---|---|---|
| **AIRCRAFT SYSTEMS**<br>**(Group E: Global Elective)** | | |
| **Course Code:** 16GE6B13 | | **CIE Marks:** 100 |
| **Credits: L:T:P:S:** 3:0:0:0 | | **SEE Marks:** 100 |
| **Hours:** 36L | | **SEE Duration:** 3Hrs |

| **Course Learning Objectives:**<br>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** | |
|---|---|
| **Flight Control Systems :** Primary and secondary flight controls, Flight control linkage system, Conventional Systems, Power assisted and fully powered flight controls. | **08 Hrs** |
| **Unit – II** | |
| **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. | **08 Hrs** |
| **Unit -III** | |
| **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. | **07 Hrs** |
| **Unit -IV** | |
| **Environmental Control Systems :** Air-conditioning system, vapour cycle system, de-icing and anti-icing system, Fire detection- warning and suppression. Crew escape aids.<br>**Engine Systems :** Engine starting sequence, Starting and Ignition systems, Engine oils and a typical lubricating system. | **07 Hrs** |
| **Unit -V** | |
| **Aircraft Instruments :** Instruments displays, panels & layouts, Instrumentation grouping, Navigation instruments, Radio instruments, Hydraulic and Engine instruments.<br>**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. | **07 Hrs** |

| **Course Outcomes:** At the end of this course the student will be able to : | |
|---|---|
| 1 | Categorise the various systems required for designing a complete airplane |
| 2 | Comprehend the complexities involved during development of flight vehicles. |
| 3 | Explain the role and importance of each systems for designing a safe and efficient flight vehicle |
| 4 | Demonstrate the different integration techniques involved in the design of an air vehicle |

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

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment. 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 60. The marks component for assignment is 10. 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** | **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** |

**Low-1 Medium-2 High-3**

| Semester: V& VI | | |
|---|---|---|
| **PROFESSIONAL PRACTICE – III**<br>**COMMUNICATION SKILLS AND PROFESSIONAL ETHICS** | | |
| **Course Code:** 16HS68 | | **CIE Marks:** 50 |
| **Credits: L:T:P:S:** 1:0:0:0 | | **SEE Marks:** -- |
| **Hours:** 36 | | **SEE Duration:** -- |

| **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.<br>**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.<br>**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.** | Aptimithra: Best Aptitude Book, Ethnus,2014 Edition, Tata McGraw Hill ISBN: 9781259058738 |

**Scheme of Continuous Internal Examination (CIE)**
Evaluation of CIE will be carried out in TWO Phases.

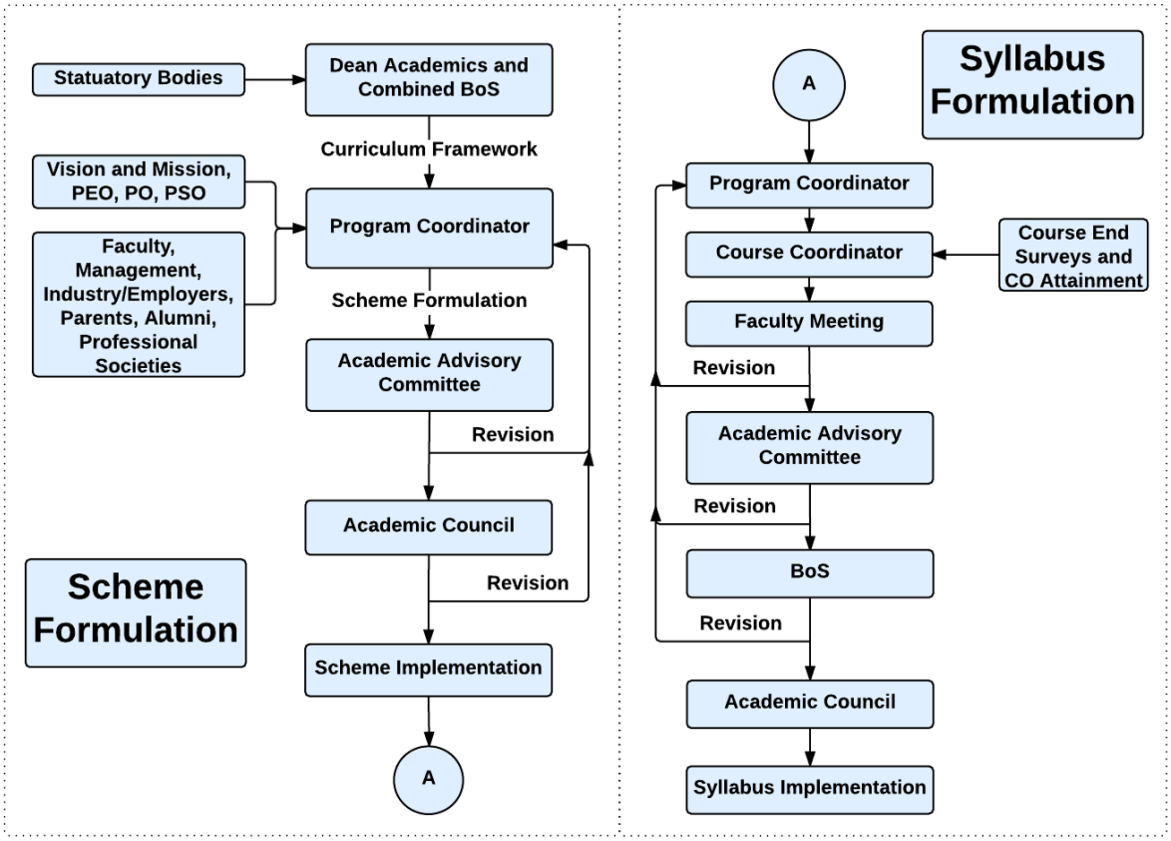
| Phase | Activity | Weightage |
|---|---|---|
| I | Test 1 is conducted in V Sem for 50 marks (15 Marks Quiz and 35 Marks Descriptive answers) after completion of Unit-1, Unit-2 and Unit -3.A for 18 hours of training sessions. | 50% |
| II | Test 2 is conducted in VI Sem for 50 marks ((15 Marks Quiz and 35 Marks Descriptive answers) after completion of Unit -3B, Unit - 4 and Unit-5 for 18 hours of training sessions. | 50% |
| | At the end of the VI sem Marks of Test 1 and Test 2 is consolidated for 50 marks (Average of Test1 and Test 2 (T1+T2/2). The grading is provided by the Coe. The final CIE marks is scrutinized by the committee comprising of HSS- Chairman, Training Co-ordinator, respective department Staff Placement co-ordinator before submitting to CoE. | |

**SEE: NA**

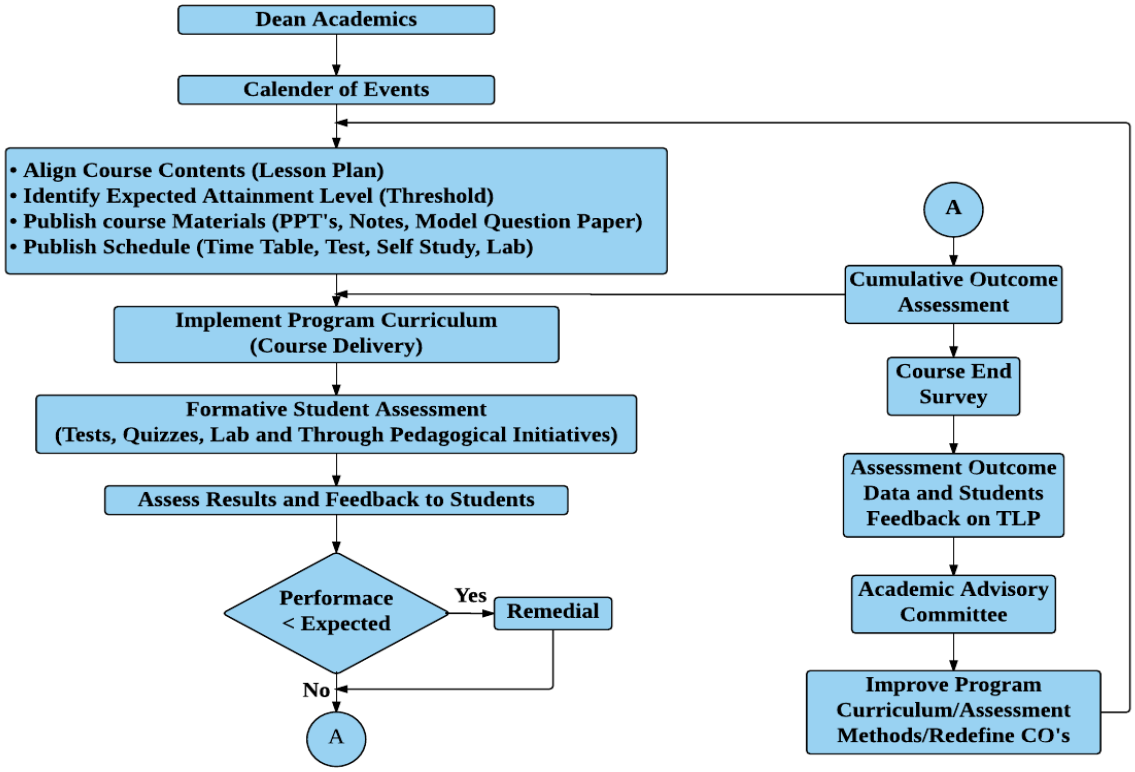
| CO-PO Mapping | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | 1 | - | - | - | - | 1 | - | 1 | 1 | 1 | 2 | 1 |
| **CO2**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

**Low-1 Medium-2 High-3**

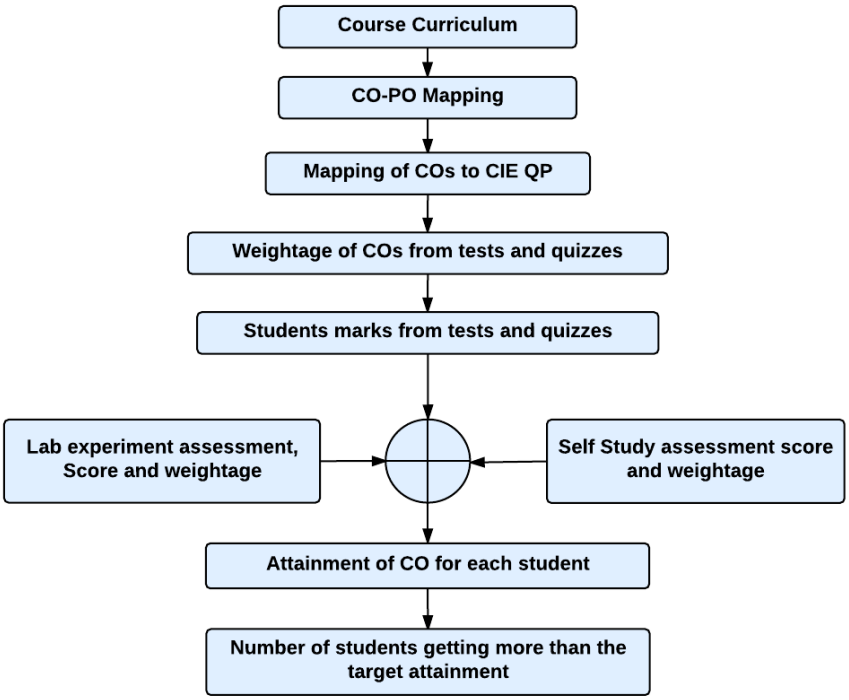
## Curriculum Design Process



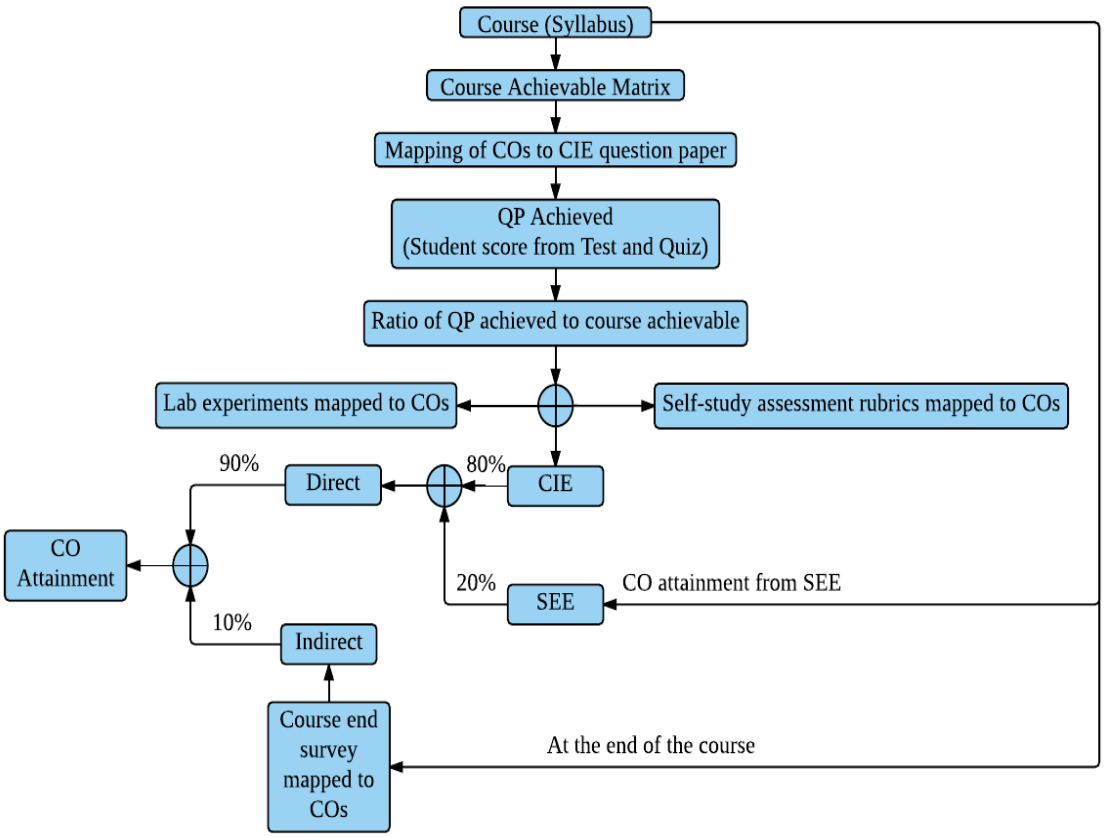

## Academic Planning and Implementation



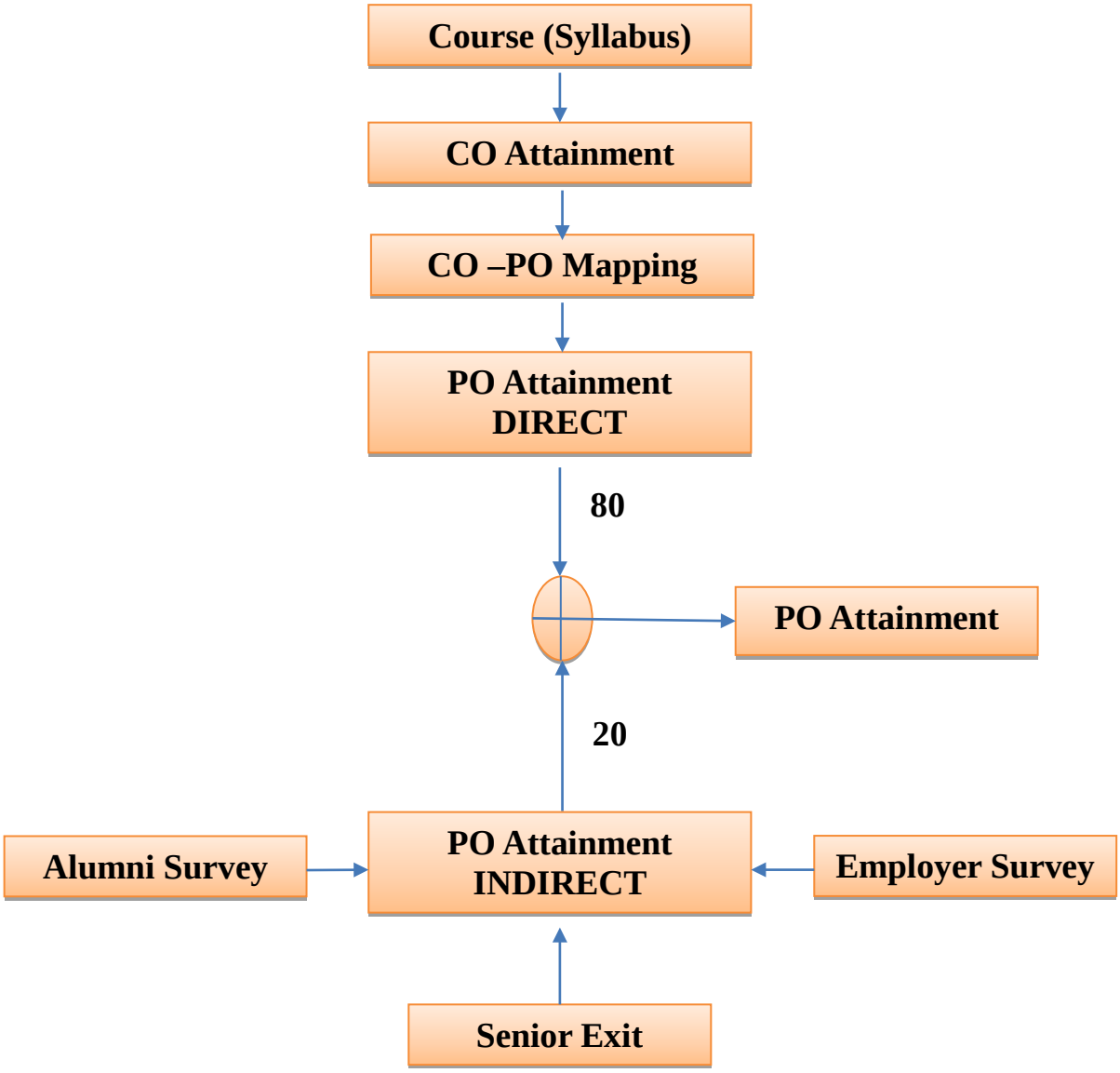
## PROCESS FOR COURSE OUTCOME ATTAINMENT




## Final CO Attainment Process



**Program Outcome Attainment Process**




Guidelines for Fixing Targets

- The target may be fixed based on last 3 years' average attainment

# 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 t h e 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 t h e society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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

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