# RV COLLEGE OF ENGINEERING®

**(Autonomous Institution Affiliated to VTU, Belagavi)**

**R.V. Vidyaniketan Post, Mysore Road**

**Bengaluru – 560 059**


# Bachelor of Engineering (B.E.)
# Scheme and Syllabus for VII & VIII Semesters

# 2016 SCHEME

# ELECTRONICS & INSTRUMENTATION ENGINEERING

# VISION

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

# MISSION

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

# QUALITY POLICY

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

# CORE VALUES

Professionalism, Commitment, Integrity, Team Work, Innovation

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## Bachelor of Engineering (B.E.)
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# 2016 SCHEME

## DEPARTMENT OF
## ELECTRONICS & INSTRUMENTATION ENGINEERING

# DEPARTMENT VISION

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

# DEPARTMENT MISSION

- To create an environment for students to excel in domain areas and get motivated to involve in interdisciplinary research by utilizing state of the art infrastructure.
- To impart technical knowledge, encourage experiential learning and develop future professional leaders.
- To establish industry-academia networking and develop industry-ready students and future entrepreneurs, to meet societal & industrial challenges.
- To motivate lifelong learning and research in sustainable technologies to find improved solutions for the betterment of society.

# PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

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

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

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

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

# PROGRAM SPECIFIC OUTCOMES (PSOs)

| PSO | Description |
|---|---|
| PSO1 | Design, analyze and practice the instrumentation, controls and automation concepts and techniques required for industrial and/or research pursuits resulting in product development, publications or patents. |
| PSO2 | Demonstrate the knowledge of basic science, mathematics, electronic system design and programming for real-time applications, towards developing industrial solutions and become technology leaders of future. |

## Lead Society: International Society of Automation (ISA)

# ABBREVIATIONS

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

## INDEX

# RV COLLEGE OF ENGINEERING®

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## ELECTRONICS AND INSTRUMENTATION ENGINEERING

| SEVENTH SEMESTER CREDIT SCHEME | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sl. No** | **Course Code** | **Course Title** | **BOS** | **Credit Allocation** | | | | **Total Credits** |
| | | | | **Lecture** | **Tutorial** | **Practical** | **SS** | |
| 1 | 16EI71 | Industrial Automation Technology | EI | 4 | 0 | 1 | 0 | 5 |
| 2 | 16EI72 | ARM Processor | EI | 4 | 0 | 1 | 0 | 5 |
| 3 | 16EI73P | Minor Project** | EI | 0 | 0 | 3 | 0 | 3 |
| 4 | 16EI7FX | Elective F | EI | 4 | 0 | 0 | 0 | 4 |
| 5 | 16EI7GX | Elective G | EI | 4 | 0 | 0 | 0 | 4 |
| 6 | 16G7HXX | Elective H (GE)* | Respective BOS | 3 | 0 | 0 | 0 | 3 |
| **Total No. of Credits** | | | | **19** | **0** | **5** | **0** | **24** |
| **No. Of Hrs.** | | | | **19** | **0** | **10** | **0** | **29** |

*Students should take other department Global Elective courses;
** Minor Project-6 hours per week;

| EIGTH SEMESTER CREDIT SCHEME | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Course Code** | **Course Title** | **BOS** | **Credit Allocation** | | | | **Total Credits** |
| | | | | **Lecture** | **Tutorial** | **Practical** | **SS** | |
| 1. | 16EI81 | Major Project | EI | 0 | 0 | 16 | 0 | 16 |
| 2. | 16EI82 | Technical Seminar | EI | 0 | 0 | 2 | 0 | 2 |
| 3. | 16HS83 | Innovation and Social Skills | HSS | 0 | 0 | 2 | 0 | 2 |
| **Total No. of Credits** | | | | **0** | **0** | **20** | **0** | **20** |
| **No. Of Hrs.** | | | | **0** | **0** | **40** | **0** | **40** |

| VII Semester | | |
|---|---|---|
| **GROUP F: PROFESSIONAL ELECTIVES** | | |
| **Sl. No.** | **Course Code** | **Course Title** |
| 1. | 16EI7F1 | Optimization Techniques |
| 2. | 16EI7F2 | Robotics |
| 3. | 16EI7F3 | Product Design Technology |
| 4. | 16EI7F4 | Real time Operating systems (RTOS) |
| **VII Semester** | | |
| **GROUP G: PROFESSIONAL ELECTIVES** | | |
| **Sl. No.** | **Course Code** | **Course Title** |
| 1. | 16EI7G1 | Simulation & Modelling |
| 2. | 16EI7G2 | System on Chip (SoC) |
| 3. | 16EI7G3 | Safety Instrumentation |
| 4. | 16EI7G4 | Wireless Instrumentation |

| GLOBAL ELECTIVES | | | |
|---|---|---|---|
| **Sl. No.** | **Host Dept** | **Course Code** | **Course Title** |
| 1. | BT | 16G7H01 | Nanotechnology |
| 2. | CH | 16G7H02 | Industrial Safety and Risk Management |
| 3. | CV | 16G7H03 | Intelligent Transport System |
| 4. | CS | 16G7H04 | Intelligent Systems |
| 5. | EC | 16G7H05 | Image Processing and Machine Learning |
| 6. | EE | 16G7H06 | Design of Renewable Energy Systems |
| 7. | IM | 16G7H07 | Systems Engineering |
| 8. | EI | 16G7H08 | MEMS and Applications |
| 9. | IS | 16G7H09 | Introduction to Internet of Things |
| 10. | ME | 16G7H10 | Industry 4.0 – Smart Manufacturing for The Future |
| 11. | TE | 16G7H11 | Space Technology and Applications |
| 12. | MA | 16G7H12 | Advanced linear Algebra |
| 13. | PY | 16G7H13 | Thin Film Nanotechnology |
| 14. | CY | 16G7H14 | Engineering Materials for Advanced Technology |
| 15. | HSS | 16G7H15 | Applied Psychology for Engineers |
| 16. | HSS | 16G7H16 | Foundational Course on Entrepreneurship |
| 17. | AS | 16G7H17 | Unmanned Aerial Vehicles |

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **INDUSTRIAL AUTOMATION TECHNOLOGY (Theory and Practice)** | | | | | | |
| **Course Code** | **:** | 16EI71 | | **CIE** | **:** | **100+50 Marks** |
| **Credits: L:T:P:S** | **:** | 4:0:1:0 | | **SEE** | **:** | **100+50 Marks** |
| **Total Hours** | **:** | 45L+26P | | **SEE Duration** | **:** | **3.00+3.00 Hours** |

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

| | |
|---|---|
| **1** | Remember the basics of process control and understand the basic concepts of Industrial Automation. |
| **2** | Understand the Advanced Process control system concepts and Intelligent control strategies. |
| **3** | Analyze and evaluate the concepts of DCS, PLC & PAC to different types of Industries. |
| **4** | Comprehend the features of communication protocols used in Automation Systems. |

| **UNIT – I** | **09 Hrs** |
|---|---|
| **Introduction:** Concept and Scope of Industrial Automation, Goals, Types, Reasons for Automation, Current trends in Computer Control of Process Plants, Centralized Vs. Distributed Computer Control System. Expert Systems.<br>**Advanced process control strategies:** Introduction, Cascade control, Adaptive control, Intelligent Control & Artificial Intelligence, Optimal control and applications. | |
| **UNIT – II** | **09 Hrs** |
| **Introduction to Automation:** Application of Automation to Industry, PLC, Functional Block diagram, PLC I/O configuration, the input and output status files, Sixteen point I/O modules. PLC memory.<br>**PLC Hardware: Input modules,** Discrete input modules, Discrete DC Input module, Discrete AC Input Module, **Output Module:** Discrete & solid-state output module switching, relay output modules. | |
| **UNIT – III** | **09 Hrs** |
| **Basics of PLC Programming**: PLC Programming languages, Modes of PLC operation, Bit or Relay Instruction, OSR Instruction, Output latching instructions, Internal Bit type Instruction.<br>**Special programming Instructions:** Timer and Counter Instructions: On delay and Off delay and retentive timer instructions, PLC Counter up and down instructions, Data handling instructions, Data manipulation Instructions, Programming sequence output instructions.<br>**Case Studies:** Temperature control, Valve Sequencing, Material Sorting, Elevator System Problems. | |
| **UNIT – IV** | **09 Hrs** |
| **Distributed Digital Control System (DCS):** History of DCS, Concept of DCS, Functional Requirements, Hardware and Software, DCS Structure, Process level, Unit, Group, Operational Control Levels, DCS Sub-Systems, Local Field Station.<br>**Displays:** Normal, Continuous Process, Batch-Sequence Operation, Process Upset, Control System Mal-Function Displays.<br>**DCS: Industrial Applications:** Introduction, Configuring DCS for Cement plant, Thermal Power, Steel Plants. | |
| **UNIT – V** | **09 Hrs** |
| **SCADA:** Introduction to Supervisory Control and Data Acquisition (SCADA), Elements of SCADA, Simple SCADA Programming, Remote Terminal Unit, SCADA Applications.<br>**Industrial Network Data Communications**: HART Communication: Protocol Layers, Field bus**:** Modbus**,** Profibus, Foundation Field bus, IEEE1394 Standard for Industrial Automation. | |

**Lab Experiments:**

1. PLC logic gate experiments using CODESYS software.
2. PLC Simulation experiments using Timer operation.
3. PLC Simulation experiments using counter operation.

4. PLC Simulation experiments using data handling operation.
5. PLC experiment for automatic material sorting using conveyor.
6. PLC experiment for automatic bottle filling,
7. PLC experiment for automatic Elevator control System.
8. SCADA Programming for industrial applications, using Wonderware software.
9. Simulation experiments for industrial applications, using HMI software.
10. Open ended experiments for Industrial applications.

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand & remember the basic concepts of Automation systems & advanced control strategies. |
| **CO2:** | Apply advanced automation strategies for optimal control of plants. |
| **CO3:** | Analyze the performance of automated systems and communication protocols. |
| **CO4:** | Design the advanced control system for complex process performance optimization. |

| **Reference Books** | |
|---|---|
| **1** | Introduction to Programmable Logic Controllers,Garry Dunning, 3rd Edition, 2006, CENGAGE Learning, ISBN: 9-781-4018-8426-0. |
| **2** | Computer based Industrial Control,Krishna Kant, 6th Edition, 2004, PHI, ISBN: 1-203-11237. |
| **3** | Computer - Aided Process Control, S. K.Singh, PHI, 3rd Reprint, 2004, ISBN: 978-81-203-2282-7. |
| **4** | PC-Based Instrumentation Concepts and Practice, N. Mathivanan, 1st Edition, 2009, PHI, ISBN: 978–81–203–23073–4. |

**Continuous Internal Evaluation (CIE): Theory (100 Marks)**
**CIE** is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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 Assignment/Presentation/Project 10.
**Total CIE is 30(Q) +50(T) +10(A) =100 Marks.**

**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**

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

**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** | **2** | **1** | **-** | **0** | **0** | **-** | **-** | **-** | **-** | **-** | **-** | **1** |
| **CO2** | **1** | **1** | **-** | **0** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **1** |
| **CO3** | **1** | **2** | **1** | **1** | **1** | **-** | **-** | **-** | **-** | **-** | **-** | **1** |
| **CO4** | **1** | **-** | **1** | **1** | **1** | **-** | **-** | **-** | **1** | **1** | **1** | **1** |

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

| **Semester: VII** | | | | | | |
|---|---|---|---|---|---|---|
| **ARM PROCESSOR (Theory and Practice)** | | | | | | |
| **Course Code** | **:** | 16EI72 | | **CIE** | **:** | **100+50 Marks** |
| **Credits: L:T:P:S** | **:** | 4:0:1:0 | | **SEE** | **:** | **100+50 Marks** |
| **Total Hours** | **:** | 45L+26P | | **SEE Duration** | **:** | **3.00+3.00 Hours** |
| **Course Learning Objectives:** The students will be able to | | | | | | |
| **1** | Understand ARM design philosophy and ARM processor architecture and fundamentals. | | | | | |
| **2** | Learn the ARM Instruction set of ARM microcontroller and to learn the assembly programming. | | | | | |
| **3** | Understand Thumb instructions of ARM controller. | | | | | |
| **4** | Understand Various Interrupts and exception handling in ARM controller. | | | | | |

| **UNIT – I** | **09 Hrs** |
|---|---|
| **ARM embedded systems:** The RISC design philosophy, The ARM design philosophy, embedded system hardware, embedded system software, ARM Architecture.<br>**ARM processor fundamentals:** Registers, current program status register, pipeline, core extensions, Architecture revisions, ARM processor families. | |
| **UNIT – II** | **09 Hrs** |
| **Introduction to ARM instruction Set:** Data Processing Instructions, Branch Instructions, Load Store Instructions, Software Interrupt Instruction, Program Status Register Instructions, Loading Constants, ARMv5E Extensions, and Conditional Execution. | |
| **UNIT – III** | **09 Hrs** |
| **Introduction to the THUMB Instruction set:** Thumb register Usage, ARM-Thumb Interworking, other branch instructions, Data Processing Instructions, Single register Load–store Instructions, Multiple register Load Store Instructions, Stack Instructions, and Software Interrupt Instruction and programming. | |
| **UNIT – IV** | **09 Hrs** |
| **Interrupts & Exception Handling:** Exceptions, Exception Handling**,** Interrupts, Interrupt handling schemes, vector table. | |
| **UNIT – V** | **09 Hrs** |
| **LPC 2148:**Design of system using GPIO's Blink a group of 8 LEDs with a delay, Stepper motor control, DC motor control LCD interface, 4 x 4 Keypad, Timers, ADC, DAC, UART. | |

**Lab Experiments:**

**A WITHOUT INTERFACING PROGRAMS**

1. Write a program to move a block of 10 data stored in one memory to another block
2. Write a Program to Exchange block of 10 data
3. Write a Program to find the smallest number out of 5 data stored in memory
4. Write a Program to sort 10 data stored in Memory
5. Write a Program to add two 64 bit numbers
6. Write a program to find factorial of given number using LOOK UP TABLE
7. Write a program to convert 3 digit Hex to BCD

**B WITH INTERFACING PROGRAMS**

1. Design and develop an interfacing program for LEDs with a delay.
2. Design and develop an interfacing program for Stepper motor control.
3. Design and develop an interfacing program for DC motor control Interfacing.

4 Design and develop an interfacing program for LCD.
5 Design and develop an interfacing program for 4 x 4 Keypad.
6 Design and develop an interfacing program for ADC.
7 Design and develop an interfacing program for DAC.

**C OPEN-ENDED EXPERIMENT**

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand the Design of a system as per needs and specifications using ARM controller. |
| **CO2:** | Apply suitable code and interface to solve engineering problems using ARM controller. |
| **CO3:** | Analyze and evaluate the different coding techniques to design compact code. |
| **CO4:** | Develop a system for real time applications. |

| **Reference Books** | |
|---|---|
| **1** | ARM system developers guide,Andrew N Sloss, Dominic Symes and Chris Wright, Elsevier, 2008, Morgan Kaufman publishers, ISBN:1558608745. |
| **2** | LPC 2148 User Manual |
| **3** | ARM System on chip Architecture, Addison Wesley, Formatted: paperback, 2008, ISBN: 978- 0201675191. |
| **4** | Embedded Systems: An Integrated Approach, Lyla B Das, 2013, Pearson Education, ISBN: 978-81-317-8766-3. |

**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** | **2** | **1** | **-** | **0** | **0** | **-** | **-** | **-** | **-** | **-** | **-** | **1** |
| **CO2** | **1** | **1** | **-** | **0** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **1** |
| **CO3** | **1** | **2** | **1** | **1** | **1** | **-** | **-** | **-** | **-** | **-** | **-** | **1** |
| **CO4** | **1** | **-** | **1** | **1** | **1** | **-** | **-** | **-** | **1** | **1** | **1** | **1** |

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **MINOR PROJECT** | | | | | | |
| **Course Code** | **:** | 16EI73P | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P:S** | **:** | 0:0:3:0 | | **SEE** | **:** | **100 Marks** |
| **Hours / Week** | **:** | 06 | | **SEE Duration** | **:** | **3.00 Hours** |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Create interest in innovative developments and preferably interdisciplinary field. |
| **2** | Work independently, analyze, evaluate and solve the given problem. |
| **3** | Inculcate the skills for good presentation and improve the technical report writing skills. |
| **4** | Recognize the need for planning, preparation, management and financial budgeting. |
| **5** | Acquire collaborative skills through working in a team to achieve common goals. |

**Minor Project Guidelines:**

1. Each project group will have two to four students, they can form their groups amongst their class.
2. Each group has to select a current topic that will use the technical knowledge of their program of study after intensive literature survey.
3. Guides will be allotted by the department based on the topic chosen.
4. The project should result in system/module which can be demonstrated, using the available resources in the college.
5. The CIE evaluation will be done by the committee constituted by the department. The committee shall consist of respective guide & two senior faculty members as examiners. The evaluation will be done for each student separately.
6. The final copy of the report should be submitted after incorporation of any modifications suggested by the evaluation committee

**Guidelines for Evaluation:**

**CIE Assessment:**

**Evaluation will be carried out in three phases:**

| Phase | Activity | Weightage |
|---|---|---|
| I | Synopsis submission, approval of the selected topic, formulation of objectives | 20% |
| II | Mid-term evaluation to review the progress of work and documentation | 30% |
| III | Submission of report, Final presentation and demonstration | 50% |

The following are the weightages given for the various stages of the project:

1. Selection of the topic and formulation of objectives: 10%
2. Design and Development of Project methodology: 30%
3. Execution of Project: 30%
4. Presentation, Demonstration and Discussion: 20%
5. Report Writing:10%

**SEE Assessment:**

The following are the weightages given during SEE Examination:

1. Written presentation of synopsis:10%
2. Presentation/Demonstration of the project: 30%
3. Methodology and Discussion: 30%

4. Technical Report: 10%
5. Viva Voce: 20%

| **Course Outcomes of Minor Project:** | |
|---|---|
| **1** | Define Specifications, Conceptualize, Design and implement a project |
| **2** | Communicate the work carried out as a technical report and orally |
| **3** | Work in a team and contribute to team work |
| **4** | Indulge in self-learning and be motivated for life-long learning |

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

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

| **Semester: VII** | | | | | | |
|---|---|---|---|---|---|---|
| **OPTIMIZATION TECHNIQUES (Group F:Professional Elective)** | | | | | | |
| **Course Code** | **:** | 16EI7F1 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P:S** | **:** | 4:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45L | | **SEE Duration** | **:** | **3.00 Hours** |

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

| | |
|---|---|
| **1** | Understand the concepts of optimization techniques. |
| **2** | Explain the modelling frameworks for solving problems using optimization techniques. |
| **3** | Develop and promote research interest in applying optimization techniques in problems of Engineering and Technology. |
| **4** | Apply the mathematical results and numerical techniques of optimization theory to various Engineering problems in real world situations. |

| **UNIT – I** | **09 Hrs** |
|---|---|
| **Optimization Techniques:** Statement of an Optimization problem, design vector, design constraints, constraint surface, objective function, objective function surfaces, classification of Optimization problems, Single variable Optimization, multi variable Optimization without constraints, necessary and sufficient conditions for minimum/maximum multivariable Optimization with equality constraints. Solution by method of Lagrange multipliers, multivariable Optimization with inequality constraints, Kuhn, Tucker conditions.<br>**Operations Research**: Introduction, Scope of operation research, phases of operations research, models in operations research, advantages, characteristics of good model, classification of models, uses and limitation of operations research, operation research and decision making. | |
| **UNIT – II** | **09 Hrs** |
| **Linear Programming:** Two-variable LP Model, Graphical LP Solution, Graphical Sensitivity Analysis, Computer Solution of LP Problems, Analysis of Selected LP Models.<br>**Simplex Method:** Simplex Method, Artificial starting solution, Special cases in simplex Method Application. | |
| **UNIT – III** | **09 Hrs** |
| **Transportation Problem:** Finding initial basic feasible solution by north — west corner rule, least cost method and Vogel's approximation method testing for optimality of balanced transportation problems.<br>Assignment Problems: Formulation of the assignment problem, solution method of assignment problem- Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP). | |
| **UNIT – IV** | **09 Hrs** |
| **Queuing Theory:** Queuing system and their characteristics, the M/M/I Queuing system, Steady state performance analyzing of M/M/I queuing models. Introduction to M/M/C and $M/E_k$ /I 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. | |
| **UNIT – V** | **09 Hrs** |
| **Replacement Models:** Introduction, Replacements of items that deteriorate with time, To find the optimal Replacement Policy, Replacements of equipments that fail suddenly.<br>**Decision Theory:** Introduction, Decision making environment, decision under uncertainty, Decision tree analysis. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand basic theoretical principles in optimization. |
| **CO2:** | Apply and formulate the optimization models to various applications. |
| **CO3:** | Analyse the various optimization techniques applicable for wide range of engineering problems |

| | |
|---|---|
| **CO4:** | Evaluate and choose the appropriate optimization techniques to real world electrical and electronics problems and applications. |

| **Reference Books** | |
|---|---|
| **1** | Operations Research: An Introduction,H.A.Taha, Seventh Edition, 2016, Prentice Hall PTR, ISBN: 0134444019. |
| **2** | Operations Research with C programs,S Kalavathy, 4th Edition, 2013, Vikas Publishing House Pvt.Ltd., ISBN: 978-93-259-6347-4. |
| **3** | Engineering optimization: Theory and practice, Singeresu. S. Rao, 4th Edition, 2009, John Willy and Sons Publishers, ISBN: 978-0-470-18352-6. |
| **4** | Optimization Methods in Operations Research and systems Analysis, K.V. Mittal and C. Mohan, 2004, New Age International (P) Limited, ISBN: 81-224-0873-7. |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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/Presentation/Project 10.

**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

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

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

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

| **Semester: VII** | | | | | | |
|---|---|---|---|---|---|---|
| **ROBOTICS (Group F:Professional Elective)** | | | | | | |
| **Course Code** | **:** | 16EI7F2 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P:S** | **:** | 4:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45L | | **SEE Duration** | **:** | **3.00 Hours** |

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

| | |
|---|---|
| **1** | Understand the generic technology and principles associated with robotics and automation systems. |
| **2** | Understand the principles and operations of different sensors used for robotic applications. |
| **3** | Understand the kinematics and dynamics aspects of robotic system |
| **4** | Give an insight into the different types of trajectories. |

| **UNIT – I** | **08 Hrs** |
|---|---|
| **Introduction:** Robot definition, classification of robot, history, robot components, robot degrees of freedom, robot joints, coordinates, reference frames, asimov's laws of robotics, robot programming modes, characteristics, applications. | |
| **UNIT – II** | **10 Hrs** |
| **Robot drivers, sensors and vision:** Drives for robots: electrical, hydraulic and pneumatic. Sensors: proximity and range, tactile force and torque End effectors, position and velocity measurement Robot vision: introduction to techniques, image acquisition and processing. | |
| **UNIT – III** | **10 Hrs** |
| **Robot kinematics:** Rotation matrix, homogenous transformation matrix, Denavit-Hartenberg convention, Euler angles RPY representation, Direct and inverse kinematics for industrial robots for position and orientation. | |
| **UNIT – IV** | **08 Hrs** |
| **Robot dynamics:** Langrangian formulation, Newton Euler formulation, recursive Newton Euler algorithms. | |
| **UNIT – V** | **08 Hrs** |
| **Trajectory planning**: Introduction, General considerations on Trajectory planning, joint-interpolated Trajectories, calculation of a 4-3-4 Joint trajectory, Cubic Spline Trajectory. | |

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

| | |
|---|---|
| **CO1:** | Understand a generic technology and principles associated with robotics and automation systems. |
| **CO2:** | Apply the principles and operations of different sensors used for robotic applications. |
| **CO3:** | Analyze the kinematics and dynamics aspects of robotic system. |
| **CO4:** | Develop the necessary skill base to explore and implement a robotic system. |

**Reference Books**


| | |
|---|---|
| **1** | Introduction to Robotics, S.K Saha, 2nd Edition, 2014, Tata McGraw-Hill Education, ISBN 13: 9789332902800. |
| **2** | Robotics control sensing Vision and Intelligence, K.S.Fu, R.C.Gonzalez, C.S.G. Lee,2013 Mcgraw-Hill College, ISBN 13: 9780070226258. |
| **3** | Introduction to Robotics, Saeed B Niku, 2nd Edition, 2005, Prentice Hall of India, ISBN-13: 978-0130613097. |
| **4** | Robot Technology Fundamentals, James G.Keramas, 1st Edition, 2008, Cengage learning Publishers, ISBN-13: 978-0827382367.9 |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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/Presentation/Project 10.

**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

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

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

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **PRODUCT DESIGN TECHNOLOGY (Group F:Professional Elective)** | | | | | | |
| **Course Code** | **:** | 16EI7F3 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P:S** | **:** | 4:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45L | | **SEE Duration** | **:** | **3.00 Hours** |

| **Course Learning Objectives:** The students will be able to | |
|---|---|
| **1** | To develop skills and concepts on economic product development and development of Organization. |
| **2** | To understand customer needs and converting them to specifications. |
| **3** | To know the PCB testing procedures and PC based automation of PCB making for large numbered PCBs. |
| **4** | To design automatic soldering techniques. |

| **UNIT – I** | **09 Hrs** |
|---|---|
| **Introduction:** Characteristics of successful product development, who Designs and develops products, duration and cost of product development, the challenges of product development<br>**Development Processes and Organizations:** A generic development process, concept development: the front-end process, adapting the generic product development process.<br>**Product Planning:** The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre-project planning. | |
| **UNIT – II** | **09 Hrs** |
| **Identifying Customer Needs:** Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.<br>**Product Specifications:** What are specifications, when are specifications established, establishing target specifications, setting the final specifications.<br>**Concept Generation and Selection:** The activity of concept generation, clarifies the problem search externally, search internally, explore systematically, and reflect on the results and the process**.** Concept screening, concept scoring. | |
| **UNIT – III** | **09 Hrs** |
| **PCB Technology:** Introduction to PCB, Types of PCB, PCB layout design and artwork generation Using CAD. Properties of copper clad sheets, materials used for fabrication of copper clad sheet, PCB film, properties of film, film master preparation. | |
| **UNIT – IV** | **09 Hrs** |
| **Image Transfer**, **Etching Process, Tin coating, Drilling:** Transfer of Image on to the copper clad sheet, wet & dry film techniques, Etching, Types of etchants, etching process. Tin coating. Drilling.<br>**Multilayer PCB Design:** Introduction, multilayer PCB design and test consideration, multilayered construction, equipment, laminating process, further processing | |
| **UNIT – V** | **09 Hrs** |
| M**echanical Machining Operations Solders and Soldering Techniques:** Introduction, Grinding, milling, principal of solder connection, solder alloys, solder fluxes, deferent soldering techniques, solder mask, Reflow of soldering practice. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand principles and concepts of effective product design. |
| **CO2:** | Apply concept of adaptive and original redesign of engineering and consumer products. |
| **CO3:** | Develop pattern transfer and Etching as per engineering specifications required by customers. |
| **CO4:** | Implement Multilayer PCB design and Artwork by using engineering specification knowledge as per customer needs through a team work. |

| **Reference Books** | |
|---|---|
| **1** | Product Design and Development, Karl.T.Ulrich, Steven D Eppinger, 5th Edition, 2011, Tata McGraw-Hill, ISBN : 978 - 0073404776 |
| **2** | Printed Circuit Boards: Design and Technology,Walter C Boshart, 29th reprint, 2009, McGraw-Hill, ISBN: 978 – 0074515495. |
| **3** | Product Design and Manufacturing, C Chitale and R C Gupta,5th Edition. 2011, PHI, ISBN : 978 - 8120342828 |
| **4** | New Product Development, Timjones, Butterworth Heinmann, 1996, Oxford. UCI, ISBN: 978 – 0750624275. |

**Continuous Internal Evaluation (CIE); Theory (100 Marks)**
**CIE** is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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/Presentation/Project 10.
**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

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

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **REAL TIME OPERATING SYSTEMS (Group F:Professional Elective)** | | | | | | |
| **Course Code** | **:** | 16EI7F4 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P:S** | **:** | 4:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45L | | **SEE Duration** | **:** | **3.00 Hours** |

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

| | |
|---|---|
| **1** | Explore through the basics of RTS and to master the essential command set that can be used to work comfortably. |
| **2** | Impart knowledge of real time concepts like semaphores, mutex, thread, process, priorities, etc. |
| **3** | Combine commands to perform tasks that are not possible to achieve using single command. |
| **4** | Acquire knowledge of real time memory management. |

| **UNIT – I** | **09 Hrs** |
|---|---|
| **Introduction to OS and RTOS**<br>Architecture of OS (Monolithic, Microkernel, Layered, Exo-kernel and Hybrid kernel structures), Operating system objectives and functions, Virtual Computers, Interaction of OS & hardware architecture, Batch, multi programming. Multitasking, Multiuser, parallel, distributed & real –time OS. | |
| **UNIT – II** | **09 Hrs** |
| **Process Management of OS/RTOS**<br>Uniprocessor Scheduling: Types of scheduling, scheduling algorithms: FCFS, SJF, Priority, Round Robin, UNIX Multi-level feedback queue scheduling, Thread Scheduling, Multiprocessor Scheduling concept, Real Time Scheduling concepts. | |
| **UNIT – III** | **09 Hrs** |
| **Process Synchronization**<br>Concurrency: Principles of Concurrency, Mutual Exclusion H/W Support, software approaches, Semaphores and Mutex, Message Passing, Monitors, Classical Problems of Synchronization: Readers-Writers Problem, Producer Consumer Problem, Dining Philosopher problem. Deadlock: Principles of deadlock, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, An Integrated Deadlock Strategies. | |
| **UNIT – IV** | **09 Hrs** |
| **Memory & I/O Management**<br>Memory Management requirements, Memory partitioning: Fixed, dynamic, partitioning, Buddy System Memory allocation Strategies (First Fit, Best Fit, Worst Fit, Next Fit), Fragmentation, Swapping, Segmentation, Paging, Virtual Memory, Demand paging.<br>I/O Management and Disk Scheduling: I/O Devices, Organization of I/O functions, Operating System Design issues, I/O Buffering, Disk Scheduling (FCFS, SCAN, C-SCAN, SSTF), Disk Caches. | |
| **UNIT – V** | **09 Hrs** |
| **RTOS Application Domains**<br>Comparison and study of RTOS: Vxworks and µCOS – Case studies: RTOS for Image Processing – Embedded RTOS for voice over IP – RTOS for fault Tolerant Applications – RTOS for Control Systems. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand the fundamental concepts of real-time operating systems. |
| **CO2:** | Apply the different techniques to develop an application through RTOS. |
| **CO3:** | Analyze the use of multitasking techniques in real-time systems. |
| **CO4:** | Design/Create the algorithms pertaining to real time operating systems on specific area. |

| **Reference Books** | |
|---|---|
| **1** | Operating Systems –Internals and Design Principles, William Stallings, 7th Edition, Prentice Hall, 2012, ISBN: 978-0-13-230998-1. |
| **2** | Modern Operating Systems, Tanenbaum,4th Edition 2007, Pearson, ISBN: 978-013-359162-0. |
| **3** | Embedded Systems-Architecture, Programming and Design, Raj Kamal, 2nd Edition, McGraw Hill Publishing Company,2008, ISBN: 978-0-07-066764-8. |
| **4** | Operating Systems Concepts, Abraham Silberschatz, 9th Edition, John & Wiley Publication, 2013, ISBN: 978-1-118-06333-0. |

**Continuous Internal Evaluation (CIE); Theory (100 Marks)**
**CIE** is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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/Presentation/Project 10.
**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

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

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

| **Semester: VII** | | | | | | |
|---|---|---|---|---|---|---|
| **SIMULATION & MODELLING (Group G:Professional Elective)** | | | | | | |
| **Course Code** | **:** | 16EI7G1 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P:S** | **:** | 4:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45L | | **SEE Duration** | **:** | **3.00 Hours** |

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

| | |
|---|---|
| **1** | Define the basics of simulation modeling and replicating the practical situations in organizations. |
| **2** | Generate random numbers and random varieties using different techniques. |
| **3** | Analysis of Simulation models using input analyzer, and output analyzer. |
| **4** | Develop and validate the simulation model. |

| **UNIT – I** | **09 Hrs** |
|---|---|
| **Introduction to Simulation:** Simulation, Advantages, Disadvantages, Areas of application, System environment, components of a system, Model of a system, types of models, steps in a simulation study.<br>**Simulation Examples:** Waveform generator, speed control of dc motor, stepper motor control. | |
| **UNIT – II** | **09 Hrs** |
| **General Principles:** Concepts in discrete-event simulation, event scheduling/ Time advance algorithm, simulation using event scheduling.<br>**Random Numbers:** Properties, Generations methods, Tests for Random number- Frequency test, Runs test, Autocorrelation test. | |
| **UNIT – III** | **09 Hrs** |
| **Random Variant Generation:** Inverse Transform Technique- Exponential, Uniform, Weibull, Triangular distributions, Direct transformation for Normal and log normal Distributions, convolution methods- Erlang distribution, Acceptance Rejection Technique<br>**Optimization Via Simulation:** Meaning, difficulty, Robust Heuristics, Random Search. | |
| **UNIT – IV** | **09 Hrs** |
| **Analysis of Simulation Data Input Modeling:** Data collection, Identification and distribution with data, parameter estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series analysis.<br>**Verification and Validation of Model:** Model Building, Verification, Calibration and Validation of Models. | |
| **UNIT – V** | **09 Hrs** |
| **Output Analysis:** Types of Simulations with Respect to Output Analysis, Stochastic Nature of output data, Measures of Performance and their estimation, Output analysis of terminating simulation, Output analysis of steady state simulations.<br>**Simulation Software:** Selection of Simulation Software, Simulation packages, Trend in Simulation Software. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand and remember the role of important elements of discrete event simulation and modeling paradigm. |
| **CO2:** | Apply the simulation software to construct and execute goal-driven system models. |
| **CO3:** | Analyze the real-world situations related to systems development decisions, originating from source requirements and goals. |
| **CO4:** | Develop a simulation model for real time application. |

| **Reference Books** | |
|---|---|
| **1** | Discrete Event system Simulation, Jerry Banks, John S Carson, II, Berry L Nelson, David M Nicol,5th Edition,2013,PearsonNew International,Asia,ISBN: 1292037261, 9781292037264. |
| **2** | System Simulation, Geoffrey Gordon, 2nd Edition, 1978, Prentice Hall publication,ISBN: 81-203-0140-4. |
| **3** | Simulation Modelling & Analysis, Averill M Law, W David Kelton, 4th Edition, 2014, McGraw Hill International Editions– Industrial Engineering series,ISBN: 0077595963, 9780077595968. |
| **4** | Systems Simulation and Modelling,Shankar Sen Gupta, 2013, Pearsons Publishers, ISBN: 978813774472 , ISBN: 9789332514195. |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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/Presentation/Project 10.

**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

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

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

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

| **Semester: VII** | | | | | | |
|---|---|---|---|---|---|---|
| **SYSTEM ON CHIP (SOC)**<br>**(Group G:Professional Elective)** | | | | | | |
| **Course Code** | **:** | 16EI7G2 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P:S** | **:** | 4:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45L | | **SEE Duration** | **:** | **3.00 Hours** |

| **Course Learning Objectives:** The students will be able to | |
|---|---|
| **1** | Understand how Systems-on-Chip (SoC) are designed at the system-level which includes processors, memories, peripheral controllers, and connectivity sub-systems. |
| **2** | Describe how hardware and software are to be co-designed, co-simulated, and co-verified. |
| **3** | Verify SoC at each design levels, how SoC testing is to be performed, and how configurable processors are to be used in SoC design. |
| **4** | Provide an appreciation for the motivation behind SoC design, the challenges of SoC design, and the overall SoC design flow. |

| **UNIT – I** | **09 Hrs** |
|---|---|
| **Introduction to the concept of a SOC:** Microprocessor and Microcontroller based systems, Embedded systems. Differences between Embedded systems and SOCs. System design, Concept of system, importance of system architectures, introduction to IMD, SSID, MIMD and MISD architectures, concept of pipelining and parallelism.<br>**Motivation for SoC Design:** Review of Moore's law and CMOS scaling, benefits of system-on-chip integration in terms of cost, power, and performance. Comparison on System-on-Board, System-in-Package and System-on-Chip. Typical goals in SoC design – cost reduction, power reduction, design effort reduction, performance maximization. | |
| **UNIT – II** | **09 Hrs** |
| **System buses:** Introduction to busses used in SOCs. Introduction to AMBA bus. Detailed studies of IBM's core connect bus, concept of PLB-processor local bus and OPB-on chip peripheral bus.<br>**Processors used in SOCs:** Introduction to CISC, RISC, Von Neuman and Harward Architecture. Concept of Soft processors and study of Microblaze RISC processor. Study of IBM's power PC, SOC implementation. | |
| **UNIT – III** | **09 Hrs** |
| **Embedded Memories:** Some Basic Concepts, Semiconductor RAM Memories, Read Only Memories cache memories, flash memories, embedded DRAM. Topics related to cache memories. Cache coherence. MESI protocol and Directory-based coherence. Study of features like embedded RAM's, multipliers, Digital clock management etc. Performance Considerations, Virtual Memories. | |
| **UNIT – IV** | **09 Hrs** |
| **System On Chip Design Process:** A canonical SoC Design, SoC Design flow, waterfall vs spiral, top down vs bottom up, Specification requirement, Types of Specification, System Design Process, System level design issues, Soft IP vs Hard IP, IP verification and Integration, Hardware-Software code sign, Hardware Accelerators in Soc. Productivity gap issues and the ways to improve the gap – IP based design and design reuse. | |
| **UNIT – V** | **09 Hrs** |
| **Introduction to Network on Chip:**<br>On chip buses and interfaces. Bus architecture and its limitations. Network on Chip (NOC) topologies. Mesh-based NoC. Routing in an NoC. Packet switching and wormhole routing.<br>MPSoCs:What, Why, How MPSoCs, Techniques for designing MPSoCs, Performance and flexibility for MPSoCs design. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1** | Understand components of digital hardware, analog hardware and embedded software. |
| **CO2** | Apply the concept to understand the design flows for digital hardware, analog hardware and |

| | |
|---|---|
| | embedded software. |
| **CO3** | Analysis and evaluate the architectures and trade-offs concerning performance, cost and power consumption of single chip and embedded systems using tools and techniques in these three domains. |
| **CO4** | Develop a simulation model of SoC for a particular application. |

| **Reference Books** | |
|---|---|
| **1** | Computer System Design: System on Chip,Michael J. Flynn, 2012, Wiley India Pvt Ltd, ISBN 13: 9788126535682. |
| **2** | Introduction to system on package sop- Miniaturization of the Entire System,Rao R. Tummala, Madhavan Swaminathan, 2008, McGraw-Hill, ISBN: 9780071459068 |
| **3** | CMOS Digital Integrated Circuits,Sung-Mo Kang, Yusuf Leblebici,3rd Edition,Tata McGraw-Hill, ISBN: 978007246537. |
| **4** | Reuse Methodology Manual for System on Chip designs,Michael Keating, Pierre Bricaud, 2nd Edition, 2008, Kluwer Academic Publishers,ISBN13: 9780306476402. |

**Continuous Internal Evaluation (CIE); Theory (100 Marks)**
**CIE** is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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/Presentation/Project 10.
**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

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

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

| **Semester: VII** | | | | | | |
|---|---|---|---|---|---|---|
| **SAFETY INSTRUMENTATION (Group G:Professional Elective)** | | | | | | |
| **Course Code** | **:** | 16EI7G3 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P:S** | **:** | 4:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45L | | **SEE Duration** | **:** | **3.00 Hours** |

| **Course Learning Objectives:** The students will be able to | |
|---|---|
| **1** | Understand the importance of industrial safety concepts. |
| **2** | Analyze and evaluate system failures and reliability engineering fundamentals. |
| **3** | Comprehend the various safety integrated levels and System Architectures. |
| **4** | Apply the concepts of SIF, SIL & SIS for oil and gas industry. |

| **UNIT – I** | **09 Hrs** |
|---|---|
| **Introduction to Safety Instrumented Systems:** Scope-Safety Technology in Process Automation-Factory Automation-Machine Automation-Robotics—Fire Triangle-, Fire& Gas Detection, Learning From Major Accidents-Basic Process control & Safety Instrumented Systems -Definitions – Acronyms- Overview of Standards and Regulations. | |
| **UNIT – II** | **09 Hrs** |
| **Introduction to Reliability engineering:** Equipment failure, Failure rate, time dependent failure rate, confidence factor, mean time between failure, Mean time to restore, relationship between MTBF, MTTR and failure rate. Relationship between reliability and unreliability, Probability of failure on demand.<br>**System Reliability engineering:** Reliability block diagram, series and parallel configuration, fault tree analysis, Markov modeling, Markov solution technique. | |
| **UNIT – III** | **09 Hrs** |
| **The concept of Safety integrity:** HAZOP (Hazard and operability study), Layer of protection (LOPA), As low as reasonably practical (ALARP), Different levels of Safety integrity level and the target requirements.<br>**System Architectures**: MooN architecture, redundancy and voting logic, Common Mode failure, importance of redundancy and diversity, Hardware design principles for functional safety (Meeting IEC 61508 Standard Part 2) fault tolerance, Safety PLCs, Safety requirements, Failure mode effect analysis, identification of safe faults, and dangerous faults. | |
| **UNIT – IV** | **09 Hrs** |
| **Software design principles for functional safety** (Meeting IEC 61508 Standard Part 3): Software requirements for SIS, Introduction to Safe failure fraction, software verification requirements. Reduction of systematic faults using quality management. | |
| **UNIT – V** | **09 Hrs** |
| **Application in a gas detection industry:** Typical SIF solutions for SIL1 and SIL2, Calculation of PFD Avg for SIL1 architecture, Application in oil and gas production facilities, Individual well controls, high pressure SIF, SIF PFD Avg calculation. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand the operation of safety systems and their applications. |
| **CO2:** | Apply the principle of industrial safety during process design |
| **CO3:** | Analyze the standards of various safety mechanisms |
| **CO4:** | Conceptualize and design industrial system safety. |

| **Reference Books** | |
|---|---|
| **1** | Safety Instrumented Systems Verification: Practical Probabilistic Calculations, Harry Cheddie, W.M. Goble, 2004, ISA Publication,ISBN: 155617909X. (Chapters 1, 2, |

| | |
|---|---|
| | 3,4,5,12,13**,** Appendix E & F). |
| **2** | The Safety Critical Systems Handbook, A Straightforward Guide to Functional Safety: IEC 61508, IEC 61511 and Related Guidance, David Smith, 4th Edition, ISBN: 9780081008973. (Chapter 3.1 to 3.6, 4.1 to 4.6.) |
| **3** | Safety Integrity Level Selection,Edward M. Marsza, 2002, ISA Publication, ISBN: 1556177771. |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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/Presentation/Project 10.

**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

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

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

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **WIRELESS INSTRUMENTATION (Group G:Professional Elective)** | | | | | | |
| **Course Code** | **:** | 16EI7G4 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P:S** | **:** | 4:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 45L | | **SEE Duration** | **:** | **3.00 Hours** |

| **Course Learning Objectives:** The students will be able to | |
|---|---|
| **1** | Emphasize the basic design principles and applications of intelligent sensors using case studies and numerical examples. |
| **2** | Discuss signal processing operations such as linearization, calibration, and compensation on which intelligent sensors rely. |
| **3** | Focuses on the hardware components, design, and inner working principles of the system itself. |
| **4** | Investigate artificial intelligence as a critical component of intelligent sensors in real-world applications. |

| **UNIT – I** | **09 Hrs** |
|---|---|
| **Intelligent Sensors:** Introduction, classification, smart sensors, cogent sensors, soft or virtual sensors, self adaptive sensors, self validating sensors, VLSI sensors, Temperature compensating intelligent sensors, indirect sensing.<br>**Sensor with Artificial Intelligence:** Introduction, artificial intelligence, multidimensional intelligent sensors, artificial intelligence for profrostic instrumentation, ANN based intelligent sensors. | |
| **UNIT – II** | **09 Hrs** |
| **Intelligent Sensor Standards & Protocols:** Introduction, IEEE 1451 Standard, network topologies, LAN talk, CEBUS communication protocol for smart home, J1850 bus, MI bus, plug-in-play smart sensor protocol.<br>**Basic principle of Radio frequency identification:** Basics of RFID, passive and active RFID systems, classification of RFID, application and frequency selection. | |
| **UNIT – III** | **09 Hrs** |
| **Smart sensor system:** Third Industrial Revolution. Definitions for Several Kinds of Sensors. Automated Production Machines. Automated Consumer Products.<br>**Optical sensors:** Introduction, Photon Absorption in Silicon. The Interface: Photon Transmission Into Silicon. Photon Detection in Silicon Photoconductors. Photon Detection in Silicon pn Junctions. Detection Limit. Photon Detectors with Gain. Application Examples. Future Trends.<br>**Data Acquisition for Frequency- and Time-domain Sensors:** Introduction.DAQ Boards: State of the Art.DAQ Board Design for Quasi-digital Sensors Universal Frequency-to-digital Converters (UFDC) Applications and Examples. | |
| **UNIT – IV** | **09 Hrs** |
| **Wireless Instrument and Sensor Networks:** Wireless Sensor Architecture and Network Design, Wireless Instrument Architecture and Network Design, Wireless Sensor and Instrument Network Design, Wireless Integrated Network Sensors, Plug-and-Play Sensors and Networks, Industrial Wireless Networks and Automation. | |
| **UNIT – V** | **09 Hrs** |
| **Wireless Sensor and Instrument Applications:** Application-Specific Wireless Sensors and Instruments, Application-Specific Wireless Sensors and Networks, Application Commercial Wireless Sensors and Instruments, Wireless Instruments and Sensor Networks in Research and Development, Industrial Wireless Sensor and Instrument Networks, Wireless Human Health Monitoring and Environmental Applications, Radio Frequency Identification, Consumer Products and Other Applications.. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand and remember the comprehensive review of both groundbreaking technology as well as applications in the field of smart sensors**.** |
| **CO2:** | Apply the smart sensor technology to the real-world applications. |
| **CO3:** | Analyze the response of the smart sensors for various applications. |
| **CO4:** | Develop a wireless system for a specific application. |

| **Reference Books** | |
|---|---|
| **1** | Intelligent Instrumentation, Manabendra Bhayan, Special Indian Edition, 2016, CRC Press, ISBN 9781420089530. |
| **2** | RFID Design Fundamentals and Applications,Albert Lozano, Nicto, 2011, CRC Press, ISBN 9781420091250. |
| **3** | Wireless Sensors and Instruments Networks, Design, and Applications, Halit Eren,2006,CRC Taylor & Francis Group,ISBN 978-0-8493-3674-4. |
| **4** | Smart sensor systems,Gerardc M Meijer, 2008. ISBN: 978-0-470-86691-7. |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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/Presentation/Project 10.

**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

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

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

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

| **Semester: VII** | | | | | | |
|---|---|---|---|---|---|---|
| **NANOTECHNOLOGY (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H01 | | **CIE** | **:** | 100 Marks |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | 100 Marks |
| **Total Hours** | **:** | 36L | | **SEE Duration** | **:** | 3.00 Hours |

| **Course Learning Objectives:** The students will be able to | |
|---|---|
| **1** | To have the basic knowledge of nanomaterials and the process. |
| **2** | Describe methods of nanoscale manufacturing and characterization can be enabled. |
| **3** | To learn about Nano sensors and their applications in mechanical, electrical, electronic, Magnetic, Chemical field. |
| **4** | To understand the concept for a nanoscale product based on sensing, transducing, and actuating mechanism. |
| **5** | To have awareness about the nanoscale products used in multidisciplinary fields. |

| **Unit-I** | **06 Hrs** |
|---|---|
| **Introduction to Nanomaterials**: History of Nanotechnology, structures and properties of carbon based: Fullerenes (Bucky Ball, Nanotubes), metal based: Nano Shells, Quantum Dots, Dendrimers, Diamond like carbon(DLC) Nanocarriers, bionanomaterails: protein & DNA based nanostructures, Hybrids: hybrid biological/inorganic, Nanosafety Issues: Toxicology health effects caused by nanoparticles. | |
| **Unit – II** | **08 Hrs** |
| **Characterization of Nanostructures: Spectroscopy**: UV-Visible spectroscopy, Fourier Transform infrared spectroscopy (FTIR), Raman Spectroscopy, X-ray spectroscopy. **Electron microscopy**: Scanning electron microscopy (SEM), Transmission electron microscopy (TEM).**Scanning probe microscopy**: Atomic Force microscopy (AFM), Scanning tunnel microscopy (STM).<br>**Nano Synthesis and Fabrication**: Introduction & overview of Nanofabrication: Bottom up and Top down approaches using processes like Ball milling, Sol-gel Process, Chemical Vapour deposition (CVD), plsma arching and various lithography techniques (Hard & Soft lithography). | |
| **Unit –III** | **09 Hrs** |
| **Nanosensors:** Overview of nanosensors, prospects and market. Types of Nanosensors and their applications. Electromagnetic nanosensors: Electronic nose and electronic tongue, Magnetic nanosensors. Mechanical nanosensors: Cantilever Nanosensors, Mechanics of CNTs, Biosensors: Biosensors in modern medicine. | |
| **Unit –IV** | **06 Hrs** |
| **Micro & Nano-Electromechanical system**s **and Microfluidics**: MEMS/NEMS: Magnetic, Chemical and Mechanical Transducers –Sensing and Actuators. Microfludics: Laminar flow, Hagen-Peouiselle equation, basic fluid ideas, Special considerations of flow in small channels, mixing, microvalves & micropumps. | |
| **Unit –V** | **07 Hrs** |
| **Applications of Nanotechnology:** Molecular electronics, molecular switches, mechanical cutting tools, machine components, DLC coated grinding wheels. solar cells, Batteries, fuel cells, Nanofilters. Medical nanotechnology: in Diagnostics, Therapeutics, Drug delivery and Nanosurgery. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Remember, understand, and apply knowledge about of nanomaterials and their uses. |
| **CO2:** | Interpret and apply the techniques of manufacturing and characterization processes |
| **CO3:** | Apply the knowledge of Nanosensors, related to nanosensors in electronics, mechanical, chemical, and biological systems. |
| **CO4:** | Create and evaluate nano Design, Devices and Systems in various disciplines |

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

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

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**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **INDUSTRIAL SAFETY AND RISK MANAGEMENT (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H02 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 36L | | **SEE Duration** | **:** | **3.00 Hours** |

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

| | |
|---|---|
| **1** | Understand the basics of risk assessment methodologies |
| **2** | Select appropriate risk assessment techniques |
| **3** | Analyze public and individual perception of risk |
| **4** | Relate safety, ergonomics and human factors |
| **5** | Carry out risk assessment in process industries |

| **Unit-I** | **08 Hrs** |
|---|---|
| **General Risk Identification Methods – I:** Hazard identification methodologies, risk assessment methods-PHA, HAZOP, MCA, consequence analysis, hazards in workplaces-nature and type of work places, types of hazards, hazards due to improper housekeeping, hazards due to fire in multi floor industries and buildings. | |
| **Unit – II** | **07 Hrs** |
| **Risk Assessment Methods – II:** Risk adjusted discounted rate method, certainty equivalent coefficient method, quantitative analysis, probability distribution, coefficient of variation method, Simulation method, Shackle approach, Hiller‟s model, Hertz Model. | |
| **Unit –III** | **07 Hrs** |
| **Risk Management – III:** Emergency relief Systems, Diers program, bench scale experiments, design of emergency relief systems, risk management plan, mandatory technology option analysis, risk management alternatives, risk management tools, risk management plans, risk index method, Dowfire and explosion method, Mond index Method. | |
| **Unit –IV** | **07 Hrs** |
| **Risk Assurance and Assessment – IV:** Property insurance, transport insurance, liability insurance, risk Assessment, low Probability high consequence events. Fault tree analysis, Event tree analysis. | |
| **Unit –V** | **07Hrs** |
| **Risk Analysis in Chemical Industries– V:** Handling and storage of chemicals, process plants, personnel protection equipment's. International environmental management system. | |

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

| **Reference Books** | |
|---|---|
| **1** | Kirkcaldy K.J.D Chauhan, Functional Safety in the Process Industry : A Handbook of practical Guidance in the application of IEC61511 and ANSI/ISA-84,North corolina, Lulu publication,2012,ISBN:1291187235 |
| **2** | Goble and William M. Safety Instrumented Systems Verification Practical probabilistic calculations, Pensulvania ISA publication,2005,ISBN:155617909X |
| **3** | Laird Wilson and Doug Mc Cutcheon. Industrial safety and risk Management,The University of Alberta press,Canada, 1st Edition,2003,ISBN: 0888643942. |

| | |
|---|---|
| **4** | Sincero A P and Sincero G A Environmental Engineering – A Design Approach,Prentice Hall of India, New Delhi,1996, ISBN: 0024105643 |
| **5** | Pandya C G, Risks in Chemical units, Oxford and IBH publications, New Delhi,1992,ISBN: 8120406907 |

**Continuous Internal Evaluation (CIE); Theory (100 Marks)**
**CIE** is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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/Presentation/Project 10.
**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

| **Semester: VII** | | | | | | |
|---|---|---|---|---|---|---|
| **INTELLIGENT TRANSPORT SYSTEM (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H03 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 36L | | **SEE Duration** | **:** | **3.00 Hours** |

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

| | |
|---|---|
| **1** | Understand basic traffic flow and control for ITS |
| **2** | Understand user services for application in transportation system |
| **3** | Understand ITS architecture and its planning at various levels |
| **4** | Evaluate user services at various levels |

| **Unit – I** | **8 Hrs** |
|---|---|
| **Introduction:** –Historical Background, Definition, Future prospectus, ITS training and educational needs.<br>**Fundamentals of Traffic Flow and Control**- Traffic flow elements, Traffic flow models, Shock waves in Traffic streams, Traffic signalization and control principles, Ramp metering, Traffic simulation | |
| **Unit – II** | **6 Hrs** |
| **ITS User services**-User services bundles, Travel and Traffic management, Public Transportation Operations, Electronic Payment, Commercial Vehicles Operations, Emergency Management, Advanced Vehicle Control and safety systems, Information Management, Maintenance and construction Management | |
| **Unit –III** | **7 Hrs** |
| **ITS Applications and their benefits**-Freeway and incident management systems-objectives, functions, traffic Surveillance and incident detection, Ramp control, incident management, Advanced arterial traffic control systems- historical development, Adaptive traffic control algorithms, Advanced Public Transportation Systems-Automatic vehicle location systems, Transit Operations software and information systems, Electronic fare payment systems, Multimodal Traveler Information systems | |
| **Unit –IV** | **7 Hrs** |
| **ITS Architecture**-Regional and Project ITS Architecture, Need of ITS architecture, concept of Operations, National ITS Architecture, Architecture development tool.<br>**ITS Planning**-Transportation planning and ITS, Planning and the National ITS Architecture, Planning for ITS, Integrating ITS into Transportation Planning, relevant case studies. | |
| **Unit –V** | **8 Hrs** |
| **ITS Standards**-Standard development process, National ITS architecture and standards, ITS standards application areas, National Transportation Communications for ITS Protocol, Standards testing.<br>**ITS Evaluation** – Project selection at the planning level, Deployment Tracking, Impact Assessment, Benefits by ITS components, Evaluation Guidelines, Challenges and Opportunities. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Identify various applications of ITS |
| **CO2:** | Apply ITS applications at different levels. |
| **CO3:** | Examine ITS architecture for planning process. |
| **CO4:** | Define the significance of ITS for various levels |

| **Reference Books** | |
|---|---|
| **1** | Choudury M A and Sadek A, "Fundamentals of Intelligent Transportation Systems Planning" Artech House publishers (31 March 2003); ISBN-10: 1580531601 |
| **2** | Bob Williams, "Intelligent transportation systems standards" ,Artech House, London, 2008. ISBN-13: 978-1-59693-291-3. |
| **3** | Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio García Zuazola "Intelligent Transport Systems: Technologies and Applications" Wiley Publishing ©2015, ISBN:1118894782 9781118894781 |
| **4** | ITS Hand Book 2000 Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles. |
| **5** | Dominique Luzeaux ,Jean-René Ruault, Michel Chavret "Intelligent Transport Systems" 7 MAR 2013 Copyright © 2010 by John Wiley & Sons, Inc DOI: 10.1002/9781118557495.ch6 |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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/Presentation/Project 10.

**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

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

| **Semester: VII** | | | | | | |
|---|---|---|---|---|---|---|
| **INTELLIGENT SYSTEMS (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H04 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 36L | | **SEE Duration** | **:** | **3.00 Hours** |

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

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

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand and explore the basic concepts and challenges of Artificial Intelligence. |
| **CO2:** | Analyze and explain basic intelligent system algorithms to solve problems. |
| **CO3:** | Apply Artificial Intelligence and various logic-based techniques in real world problems. |
| **CO4:** | Assess their applicability by comparing different Intelligent System techniques |

| **Reference Books** | |
|---|---|
| **1** | AI – A Modern Approach ,Stuart Russel, Peter Norvig , 2nd Edition, Pearson Education, 2010, ISBN-13: 978-0137903955. |
| **2** | Artificial Intelligence (SIE) ,Kevin Night, Elaine Rich, Nair B., ,McGraw Hill, 1st Edition, 2008, ISBN: 9780070087705 |

| | |
|---|---|
| **3** | Introduction to AI and ES ,Dan W. Patterson, Pearson Education, 1st Edition ,2007. ISBN: 0132097680 |
| **4** | Introduction to Expert Systems ,Peter Jackson, 3rd Edition, Pearson Education, 2007, ISBN-978-0201876864 |

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**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

| **Semester: VII** | | | | | | |
|---|---|---|---|---|---|---|
| **IMAGE PROCESSING AND MACHINE LEARNING (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H05 | | **CIE** | **:** | 100 Marks |
| **Credits: L:T:P:S** | **:** | 3:0:0:0 | | **SEE** | **:** | 100 Marks |
| **Total Hours** | **:** | 40L | | **SEE Duration** | **:** | 03 Hours |

| **Course Learning Objectives:** The students will be able to | |
|---|---|
| **1** | Understand the major concepts and techniques in image processing and Machine Learning |
| **2** | To explore, manipulate and analyze image processing techniques |
| **3** | To become familiar with regression methods, classification methods, clustering methods. |
| **4** | Demonstrate image processing and Machine Learning knowledge by designing and implementing algorithms to solve practical problems |

| **Unit-I** | **08 Hrs** |
|---|---|
| **Introduction to image processing:** Images, Pixels, Image resolution, PPI and DPI, Bitmap images, Lossless and lossy compression, Image file formats, Color spaces, Bezier curve, Ellipsoid, Gamma correction, Advanced image concepts | |
| **Unit – II** | **08 Hrs** |
| **Basics of Python & Scikit image:** Basics of python, variables & data types, data structures, control flow & conditional statements, uploading & viewing an image, Image resolution, gamma correction, determining structural similarities. | |
| **Unit –III** | **08 Hrs** |
| **Advanced Image processing using Open CV** Blending Two Images, Changing Contrast and Brightness Adding Text to Images Smoothing Images , Median Filter ,Gaussian Filter ,Bilateral Filter ,Changing the Shape of Images ,Effecting Image Thresholding ,Calculating Gradients , Performing Histogram Equalization | |
| **Unit –IV** | **08 Hrs** |
| **Machine Learning Techniques in Image Processing** Bayesian Classification, Maximum Likelihood Methods, Neural Networks; Non-parametric models; Manifold estimation, Support Vector Machines, Logistic Regression | |
| **Unit –V** | **08 Hrs** |
| **Introduction to object Tracking , Modeling & Recognition** Exhaustive vs. Stochastic Search, Shapes, Contours, and Appearance Models. Mean-shift tracking; Contour-based models, Adaboost approaches: Face Detection / Recognition, Tracking. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Gain knowledge about basic concepts of Image Processing |
| **CO2:** | Identify machine learning techniques suitable for a given problem |
| **CO3:** | Write programs for specific applications in image processing |
| **CO4:** | Apply different techniques for various applications using machine learning techniques. |

| **Reference Books** | |
|---|---|
| **1** | Practical Machine Learning and Image Processing: For Facial Recognition, Object Detection, and Pattern Recognition Using Python", by Himanshu Singh, Apress publisher. |
| **2** | Pattern Recognition and Machine Learning, by Christopher Bishop, Springer, 2008 |
| **3** | Computer Vision: A modern Approach" by David Forsyth and Jean Ponce, Prentice Hall India 2004. |
| **4** | Machine Vision : Theory Algorithms Practicalities ,by E.R. Davies Elsevier 2005. |
| **5** | Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods Pearson Education, Ed, 2001. |

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**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **DESIGN OF RENEWABLE ENERGY SYSTEMS (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H06 | | **CIE Marks** | **:** | **100** |
| **Credits: L:T:P:S** | **:** | 3:0:0 | | **SEE Marks** | **:** | **100** |
| **Total Hours** | **:** | 40L | | **SEE Duration** | **:** | **3.00 Hours** |

| **Course Learning Objectives:** | |
|---|---|
| **1** | To provide opportunity for students to work on multidisciplinary projects. |
| **2** | To familiarize the students with the basic concepts of nonconventional energy sources and allied technological systems for energy conversion |
| **3** | To impart skill to formulate, solve and analyze basic Non – conventional energy problems and prepare them for graduate studies. |
| **4** | To enable the student to design primarily solar and wind power systems. |
| **5** | To expose the students to various applications of solar, wind and tidal systems. |

| **UNIT – I** | **07 Hrs** |
|---|---|
| **An introduction to energy sources:** Industry overview, incentives for renewable, utility perspective, Relevant problems discussion, current positions of renewable energy conditions | |
| **UNIT – II** | **09 Hrs** |
| **PV Technology:** photovoltaic power, PV projects, Building-integrated PV system, PV cell technologies, solar energy maps, Technology trends, **Photovoltaic Power Systems**: PV cell, Module and Array, Equivalent electrical circuit, open-circuit voltage and short-circuit current, I-V and P-V curves, Array design (different methodologies), peak-power operation, system components. | |
| **UNIT – III** | **09 Hrs** |
| **Wind Speed and Energy:** Speed and power relations, power extracted from the wind, Air density, Global wind patterns, wind speed distribution (parameters calculations) , wind speed prediction, **Wind Power Systems :** system components , turbine rating , power vs. speed and TSR, maximum energy capture, maximum power operation, system-design trade-offs , system control requirements, environmental aspects. | |
| **UNIT – IV** | **07 Hrs** |
| **Geothermal and ocean energy:** Geothermal power, geo pressured sources, Geothermal well drilling, advantages and disadvantages, Comparison of flashed steam and total flow concept<br>**Energy from ocean**: OTEC power generation, OPEN and CLOSED cycle OTEC. Estimate of Energy and power in simple single basin tidal and double basin tidal system | |
| **UNIT – V** | **08 Hrs** |
| **Stand alone system:** PV stand-alone, Electric vehicle, wind standalone, hybrid systems (case study), system sizing, wind farm sizing.<br>**Grid-Connected Systems: i**ntroduction**,** interface requirements, synchronizing with the grid, operating limit, Energy storage and load scheduling**,** Grid stability issues**,** distributed power generation. | |

**Course outcomes:**

CO1: Demonstrate an understanding of the scientific principles of methodology of Non-conventional energy.

CO2: Acquire working knowledge of different Renewable energy science-related topics.

CO3: Ability to analyze the system related concepts effectively in the wind energy designing.

CO4: Students will be able to decide the appropriate procedures to ensure that the working model has developed properly.

| **Reference Books** | |
|---|---|
| 1. | Wind and Solar Power Systems Design, Analysis and operation, Mukund R Patel, 2nd Edition, 2006, Taylor and Francis publishers, ISBN 978-0-8493-1570-1. |
| 2. | Non-Conventional sources of energy, G.D.Rai, 4th Edition, 2009, Khanna Publishers, ISBN 8174090738, 9788174090737, |
| 3. | Solar Energy, Sukhatme, 4th Edition, 2017, McGraw Hill Education, **ISBN-13:** 978-9352607112 |
| 4. | Renewable energy sources, John Twidell, Tony Weir, 3rd Edition, 2015, Routledge Publisher, ISBN-13: 978-0415584388. |

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**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

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

| Semester :VII | | | | | | |
|---|---|---|---|---|---|---|
| **SYSTEMS ENGINEERING (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | **16G7H07** | | **CIE Marks** | **:** | **100** |
| **Credits: L:T:P:S** | **:** | **3:0:0:0** | | **SEE Marks** | **:** | **100** |
| **Total Hours** | **:** | **33L** | | **SEE Duration** | **:** | **03 Hours** |

| **Course Learning Objectives:** | |
|---|---|
| **1** | Develop an appreciation and understanding of the role of systems engineering processes and systems management in producing products and services. |
| **2** | Document systematic measurement approaches for generally cross disciplinary development effort. |
| **3** | Discuss capability assessment models to evaluate and improve orgnizational systems engineering capabilities. |

| **Unit-I** | **07 Hrs** |
|---|---|
| **System Engineering and the World of Modem System:** What is System Engineering?, Origins of System Engineering, Examples of Systems Requiring Systems Engineering, System Engineering viewpoint, Systems Engineering as a Profession, The power of Systems Engineering, problems.<br>**Structure of Complex Systems:** System building blocks and interfaces, Hierarchy of Complex systems, System building blocks, The system environment, Interfaces and Interactions.<br>**The System Development Process:** Systems Engineering through the system Life Cycle, Evolutionary Characteristics of the development process, The system engineering method, Testing throughout system development, problems. | |
| **Unit – II** | **07 Hrs** |
| **Systems Engineering Management:** Managing systems development and risks, Work breakdown structure (WBS), System Engineering Management Plan (SEMP), Risk Management, Organization of Systems Engineering, Systems Engineering Capability Maturity Assessment, Systems Engineering standards, Problem.<br>**Needs Analysis:** Originating a new system, Operations analysis, Functional analysis, Feasibility analysis, Feasibility definition, Needs validation, System operational requirements, problems.<br>**Concept Exploration:** Developing the system requirements, Operational requirements analysis, Performance requirements formulation, Implementation concept exploration, Performance requirements validation, problems. | |
| **Unit – III** | **07 Hrs** |
| **Concept Definition:** Selecting the system concept, Performance requirements analysis, Functional analysis and formulation, Concept selection, Concept validation, System Development planning, System Functional Specifications, problems<br>**Advanced Development:** Reducing program risks, Requirements analysis, Functional Analysis and Design, Prototype development, Development testing, Risk reduction, problems. | |
| **Unit – IV** | **06 Hrs** |
| **Engineering Design:** Implementing the System Building blocks, requirements analysis, Functional analysis and design, Component design, Design validation, Configuration Management, problems.<br>**Integration and Evaluation:** Integrating, Testing and evaluating the total system, Test planning and preparation, System integration, Developmental system testing, Operational test and evaluation, problems. | |
| **Unit – V** | **06 Hrs** |
| **Production:** Systems Engineering in the factory, Engineering for production, Transition from development to production, Production operations, Acquiring a production knowledge base, problems.<br>**Operations and support**: Installing, maintenance and upgrading the system, Installation and test, In-service support, Major system upgrades: Modernization, Operational factors in system development, problems. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1** | Understand the Life Cycle of Systems. |
| **CO2** | Explain the role of Stake holders and their needs in organizational systems. |
| **CO3** | Develop and Document the knowledge base for effective systems engineering processes. |
| **CO4** | Apply available tools, methods and technologies to support complex high technology systems. |
| **CO5** | Create the frameworks for quality processes to ensure high reliability of systems. |

| **Reference Books** | |
|---|---|
| **1** | Systems Engineering – Principles and Practice, Alexander Kossoakoff, William N Sweet, 2012, John Wiley & Sons, Inc, ISBN: 978-81-265-2453-2 |
| **2** | Systems Engineering and Analysis, Blanchard, B., and Fabrycky W, 5th Edition, 2010, Saddle River, NJ, USA: Prentice Hall. |
| **3** | Handbook of Human Systems Integration, Booher, H. (ed.) 2003. Hoboken, NJ, USA: Wiley. |
| **4** | Systems Engineering: A 21st Century Methodology, Hitchins, D., 2007. Chichester, England: Wiley. |

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| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **MEMS AND APPLICATIONS (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H08 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 35L | | **SEE Duration** | **:** | **3.00 Hours** |

| **Course Learning Objectives:** The students will be able to | |
|---|---|
| **1** | Understand the rudiments of Micro fabrication techniques. |
| **2** | Identify and associate the various sensors and actuators to applications. |
| **3** | Analyze different materials used for MEMS. |
| **4** | Design applications of MEMS to disciplines. |

| **Unit - I** | **06 Hrs** |
|---|---|
| **Overview of MEMS & Microsystems:** MEMS and Microsystems, Typical MEMS and micro system products, Evolution of micro fabrication, Microsystems and microelectronics, Multidisciplinary nature of Microsystems, Design and manufacture, Applications of Microsystems in automotive, healthcare, aerospace and other industries.<br>**Working Principle of Microsystems**: Biomedical and biosensors. Micro sensors: Acoustic, Chemical, Optical, Pressure, Thermal. | |
| **Unit – II** | **08 Hrs** |
| **Micro actuation:** Using thermal forces, shape memory alloys, Piezoelectric crystals and electrostatic forces. MEMS with micro actuators: Microgrippers, micromotors, microvalves and micropumps, microaccelerometers, microfluidics**.**<br>**Introduction to Scaling:** Scaling in Geometry, Scaling in Rigid body dynamics, Scaling in Electrostatic forces, scaling in electromagnetic forces and scaling in fluid mechanics. | |
| **Unit – III** | **08 Hrs** |
| **Materials for MEMS and Microsystems:** Substrates and wafers, Active substrate materials, Silicon as substrate material, Silicon Compounds, Si-Piezoresistors, GaAs, Quartz, Piezoelectric Crystals, Polymers and packaging materials. Three level of Microsystem packaging, Die level packaging, Device level packaging, System level packaging. Interfaces in microsystem packaging. Essential packaging technologies: die preparation, Surface bonding, Wire bonding, Sealing, 3D packaging. | |
| **Unit – IV** | **06 Hrs** |
| **Microsystem Fabrication Process**: Introduction to microsystems, Photolithography, Ion Implantation, Diffusion, Oxidation, CVD,PVD-Sputtering, Deposition of Epiaxy, Etching, LIGA process: General description, Materials for substrates and photoresists, Electroplating and SLIGA process. | |
| **Unit – V** | **07 Hrs** |
| Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia, Acoustic, Tactile and Flow sensors.<br>**Overview, Application, Fabrication Process in Applications:**<br>Silicon Capacitive Accelerometer, Piezo resistive Pressure sensor, Electrostatic Comb drive, Portable blood analyzer, Piezo electric Inkjet Print head, Micromirror array for Video projection. | |

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

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

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

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| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **INTRODUCTION TO INTERNET OF THINGS (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H09 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 39L | | **SEE Duration** | **:** | **3.00 Hours** |

| **Course Learning Objectives:** The students will be able to | |
|---|---|
| **1** | Learn the fundamentals of IoT |
| **2** | Understands the hardware, networks & protocols used in IoT development |
| **3** | Illustrate smart applications using IoT devices and building applications |
| **4** | Know more advanced concepts like cloud connectivity in IoT |
| **5** | Learn the fundamentals of IoT |

| **Unit-I** | **06 Hrs** |
|---|---|
| **Fundamentals Of IOT:** Introduction, Physical design of IoT, Logical design of IoT, IoT Enabling technologies, IoT Levels and Deployment Templates, , IoTvs M2M | |
| **Unit – II** | **06 Hrs** |
| **IOT Design Methodology:** Need for IoT systems management, IoT Design Methodology<br>**Internet of Things Strategic Research and Innovation Agenda:** Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Smart-X Applications, Internet of Things and Related Future Internet Technologies. | |
| **Unit –III** | **11 Hrs** |
| **IOT Systems** - Logical Design using Python: Provides an introduction to Python, installing Python, Python data types & data structures, control flow, functions, modules, packages, file input/output, data/time operations and classes. | |
| **Unit –IV** | **09 Hrs** |
| **IOT Physical Devices & Endpoints**: What is an IoT device, Raspberry Pi device, About the board, Linux on Raspberry Pi, Raspberry Pi interfaces, Programming Raspberry Pi with Python. | |
| **Unit –V** | **07 Hrs** |
| **IOT Physical Servers & Cloud Offerings:** Provides an introduction to the use of cloud platforms and frameworks such as Xively and AWS for developing IoT applications. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand the fundamentals of IoT. |
| **CO2:** | Analyse the IoT devices, programming, networking requirements and protocols for building IoT products. |
| **CO3:** | Apply the concepts to design and develop IoT applications |
| **CO4:** | Creating applications of IoT using physical devices and interfacing with cloud. |

| **Reference Books** | |
|---|---|
| **1** | Internet of Things (A Hands-on-Approach), Vijay Madisetti and ArshdeepBahga, 1st Edition, VPT, 2014, ISBN-13: 978-0996025515. |
| **2** | Internet of Things – From Research and Innovation to Market Deployment, OvidiuVermesan, Peter Friess, River Publishers Series in Communication, River Publishers, 2014, ISBN: ISBN: 978-87-93102-94-1 (Hard copy), 978-87-93102-95-8 (Ebook) (UnitsII 2nd part) |
| **3** | Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, Francis daCosta, , 1st Edition, Apress Publications, 2013, ISBN-13: 978-1430257400. |
| **4** | Meta products - Building the Internet of Things, WimerHazenberg, Menno Huisman, BIS Publishers, 2012, ISBN: 9789863692515. |

**Continuous Internal Evaluation (CIE); Theory (100 Marks)**
**CIE** is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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/Presentation/Project 10.
**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **INDUSTRY 4.0– SMART MANUFACTURING FOR THE FUTURE (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H10 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 39L | | **SEE Duration** | **:** | **3.00 Hours** |

| **Course Learning Objectives:** The students will be able to | |
|---|---|
| **1** | Understand the importance and role of Smart Manufacturing Systems, IoT and IIoT |
| **2** | Explain importance of automation technologies, sensors, Robotics and Machine vision. |
| **3** | Understand application of artificial intelligence and the need for data transformation, handling, storing and security. |
| **4** | Understand simulation, predictive and knowledge modeling along with analysis |
| **5** | Learn networking, sustainable technology and factory networks. |

| **Unit-I** | **06 Hrs** |
|---|---|
| **Smart Manufacturing and Industry 4.0**<br>Need for Smart Manufacturing, Advantages, Emerging technologies in Smart manufacturing, CAD Architecture surrounding 3D Models (B-rep and CSG), MEMS, Industry 4.0–Interoperability, Information transparency, Technical assistance, Decentralized decision-making, Internet of Things(IoT), Industry Internet of Things (IIoT), Future of Manufacturing industries | |
| **Unit – II** | **09 Hrs** |
| **Manufacturing Automation**<br>Technology intensive manufacturing and cyber-physical systems, Automation using Robotics, Data storage, retrieval, manipulation and presentation; Mechanisms for sensing state and modifying processes, Material handling systems, controlling material movement and machine flow, Mechatronics, Transducers and sensors, Proximity sensors, Biosensors, Acceleration Machine Vision–Flaw detection, Positioning, Identification, Verification and Measurement–Application of Machine Vision in industries | |
| **Unit –III** | **09 Hrs** |
| **Data handling using Embedded Systems**<br>Data transformation–Mathematical functions, Regression, Need for different functions, Data merging–Discrete and Random variables, Transformation languages, Interfacing systems-Microprocessors, Direct memory access, Data transfer schemes and systems, Communication systems–Modulation, Time domain and frequency domain, Industrial Network Data Communications, Data Security Artificial Intelligence – Intelligent systems, Fuzzy logics, Neural networks – Supervised, Unsupervised and Reinforced learning | |
| **Unit –IV** | **06 Hrs** |
| **Simulation, Modeling and Analysis**<br>Simulation - system entities, input variables, performance measures, and Functional relationships, types of simulation. Predictive modeling and simulation tools, Knowledge Modeling –types and technology options, Functional analysis of control systems – Linear and Non-linear, Functional decomposition, Functional sequencing, Information / dataflow, Interface | |
| **Unit –V** | **09 Hrs** |
| **Performance Measures of Smart Manufacturing Systems-** Smart manufacturing- Sensing and Perception, Manipulation, Mobility and Autonomy, Factory Networks, Information Modeling and Testing, Performance Measurement and Optimization, Engineering System integration, Production Network integration, Production network data quality, Sustainable Processes and Resources, Integration Infrastructure for Sustainable Manufacturing | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Explain role and importance of Smart Manufacturing Systems, IoT and IIoT |
| **CO2:** | Explain importance of automation technologies, sensors, robotics and machine vision |
| **CO3:** | Illustrate the application of artificial intelligence and need for data transformation, handling |
| **CO4:** | Explain analytical and simulation for performance study of smart technologies and networks |

| **Reference Books** | |
|---|---|
| **1** | Zongwei Luo, Smart Manufacturing Innovation and Transformation: Interconnection And Intelligence, 1st Edition, IGI Global Publications, 2014,ISBN-13: 978-1466658363 ISBN-10: 1466658363 |
| **2** | Yan Lu. KC Morris, Simon Frechette, Smart Manufacturing Standards, NIST, 1st Edition, 2016, Project report. |

**Continuous Internal Evaluation (CIE); Theory (100 Marks)**
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**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **SPACE TECHNOLOGY AND APPLICATIONS (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H11 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 35L | | **SEE Duration** | **:** | **3.00 Hours** |

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

| | |
|---|---|
| **1** | Define the earth environment and its behavior, launching vehicles for satellites and its associated concepts. |
| **2** | Analyze satellites in terms of technology, structure and communications. |
| **3** | Use satellites for space applications, remote sensing and metrology. |
| **4** | Apply the space technology, technology mission and advanced space systems to nation's growth. |

| **UNIT-I** | **07 Hrs** |
|---|---|
| **Earth's environment:** Atmosphere, ionosphere, Magnetosphere, Van Allen Radiation belts, Interplanetary medium, Solar wind, Solar- Earth Weather Relations.<br>**Launch Vehicles:** Rocketry, Propellants, Propulsion, Combustion, Solid, Liquid and Cryogenic engines, Control and Guidance system, Ion propulsion and Nuclear Propulsion. | |
| **UNIT-II** | **07 Hrs** |
| **Satellite Technology:** Structural, Mechanical, Thermal, Power control, Telemetry, Telecomm and Quality and Reliability, Payloads, Space simulation.<br>**Satellite structure:** Satellite Communications, Transponders, Satellite antennas. | |
| **UNIT-III** | **07 Hrs** |
| **Satellite Communications:** LEO, MEO and GEO orbits, Altitude and orbit controls, Multiple Access Techniques.<br>**Space applications:** Telephony, V-SAT, DBS system, Satellite Radio and TV, Tele-Education, Telemedicine, Satellite navigation, GPS. | |
| **UNIT-IV** | **07 Hrs** |
| **Remote Sensing:** Visual bands, Agricultural, Crop vegetation, Forestry, water Resources, Land use, Land mapping, geology, Urban development resource Management, and image processing techniques.<br>**Metrology:** Weather forecast (Long term and Short term), weather modelling, Cyclone predictions, Disaster and flood warning, rainfall predictions using satellites. | |
| **UNIT-V** | **07 Hrs** |
| **Satellite payloads:** Technology missions, deep space planetary missions, Lunar missions, zero gravity experiments, space biology and International space Missions.<br>**Advanced space systems:** Remote sensing cameras, planetary payloads, space shuttle, space station, Inter-space communication systems. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1** | Explain different types of satellites, orbit and associated subsystems. |
| **CO2** | Apply the basics of launching vehicles, satellites and sub systems for space applications. |
| **CO3** | Analyze the applications of satellite in the area of communication, remote sensing, metrology etc., |
| **CO4** | Study technology trends, satellite missions and advanced space systems. |

| **Reference Books** | |
|---|---|
| **1** | Atmosphere, weather and climate, R G Barry, Routledge publications, 2009, ISBN- 10 :0415465702. |
| **2** | Fundamentals of Satellite Communication, K N Raja Rao, PHI, 2012, ISBN:9788120324015. |
| **3** | Satellite Communication, Timothy pratt, John Wiley, 1986 ISBN: 978-0- 471- 37007 -9, ISBN 10: 047137007X. |
| **4** | Remote sensing and applications, B C Panda, VIVA books Pvt. Ltd., 2009, ISBN: 108176496308. |

**Continuous Internal Evaluation (CIE); Theory (100 Marks)**
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**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **ADVANCED LINEAR ALGEBRA (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H12 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 39L | | **SEE Duration** | **:** | **3.00 Hours** |

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

| | |
|---|---|
| **1** | Adequate exposure to learn the fundamental concepts to model a system of linear equations and to obtain the solution of system of linear equations. |
| **2** | Analyze and extend the structure of vector spaces, linear transformations, Symmetric matrices, quadratic forms required in applications of Business, Science and Engineering. |
| **3** | Apply the concept of Eigenvalues to study differential equations and dynamical systems. Apply the concept of Orthogonality to examine some of the least-squares problems. |
| **4** | Apply Linear Programming to Network problems and Game theory. |

| **Unit-I** | **07 Hrs** |
|---|---|
| **System of linear equations**<br>Matrices and system of linear equations, Geometry of linear equations, Linear models in Business, Science and Engineering-Input-Output model in Economics, Balancing chemical equations and Electrical networks. | |
| **Unit – II** | **09 Hrs** |
| **Vector spaces and linear transformations**<br>Revision of Vector Spaces, Subspaces, Linear independence, Basis, Dimension and Change of basis. Applications to Difference equations, Markov chains. Intersection, Sum, Product of spaces and Tensor product of two vector spaces. Introduction to Linear transformations, Geometrical interpretations in 2-dimensions and 3-dimensions. | |
| **Unit –III** | **09 Hrs** |
| **Orthogonality, Eigen values and Eigen vectors**<br>Orthogonality, Inner product spaces, Applications to Weighted least-squares and Fourier series, Fast Fourier transform. Eigen values and Eigen vectors, Applications to Differential equations, Discrete dynamical systems. | |
| **Unit –IV** | **07 Hrs** |
| **Symmetric matrices and quadratic forms**<br>Introduction to symmetric matrices, Quadratic forms, Test for Positive definiteness, Constrained Optimization, Singular Value Decomposition. Applications to image processing. | |
| **Unit –V** | **07 Hrs** |
| **Linear programming and game theory**<br>A Geometrical introduction to Linear programming, Simplex method and its geometrical meaning, Network models-Max flow-min cut theorem, Payoff matrix and Matrix games. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Identify and interpret the fundamental concepts of linear equations, vector spaces, linear transformations, Orthogonality, Eigen values, symmetric matrices, quadratic forms, linear programming and game theory. |
| **CO2:** | Apply the knowledge and skills of Linear algebra to solve linear equations, difference and differential equations, constrained optimization problems, linear programming problems and related problems. |
| **CO3:** | Analyze the input-output models, Markov chains, discrete dynamical systems, singular value decomposition, network models and related problems. |
| **CO4:** | Using the overall mathematical knowledge of Linear Algebra to solve problems arising in practical situations. |

| **Reference Books** | |
|---|---|
| **1** | David C Lay; Linear Algebra and Its Applications; Pearson Education; III Edition; 2003; ISBN: 978-81-775-8333-5. |
| **2** | Gareth Williams; Linear Algebra with Applications; 6th edition; 2008; Narosa publications; ISBN: 978-81-7319-981-3. |
| **3** | Gilbert Strang; Linear Algebra and Its Applications; IV Edition; Cengage Learning India Edition; 2006; ISBN: 81-315-0172-8. |
| **4** | Howard Anton and Chris Rorres; Elementary Linear Algebra Applications Version; Wiley Global Education; 11th Edition; 2013; ISBN: 9781118879160. |

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**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

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

| **Semester: VII** | | | | | | |
|---|---|---|---|---|---|---|
| **THIN FILM NANOTECHNOLOGY (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H13 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 39L | | **SEE Duration** | **:** | **3.00 Hours** |

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

| | |
|---|---|
| **1** | Understand the importance of vacuum in thin film fabrication |
| **2** | Acquire the knowledge of thin film preparation by various techniques |
| **3** | Analyze the properties of thin films using different characterization methods |
| **4** | Optimize the process parameter and property dependence |
| **5** | Apply the knowledge for developing thin film devices. |

| **Unit-I** | **08 Hrs** |
|---|---|

**Vacuum Technology:** Basics of Vacuum - Principles of different vacuum pumps: Rotary, Roots, Diffusion, Turbo molecular and Cryogenic pumps; Measurement of vacuum - Concept of Capacitance Manometer, Pirani and Penning gauges - Vacuum Systems & Applications.

| **Unit – II** | **08 Hrs** |
|---|---|

**Methods of thin film preparation**

Physical Vapor Deposition (PVD) Techniques**:**

*Evaporation*: Thermal evaporation, Electron beam evaporation, Laser ablation, and Cathode arc deposition. *Sputtering*: DC sputtering, RF Sputtering, Magnetron sputtering, Reactive Sputtering, and Ion beam sputtering.

Chemical Vapor Deposition (CVD) Techniques**:** Conventional CVD, Plasma Enhance CVD (PECVD) and Atomic layer deposition (ALD).

Other Methods: Spin coating and Spray Pyrolysis.

| **Unit –III** | **07 Hrs** |
|---|---|

**Surface Modification and Growth of Thin Films:**

Surface preparation & Engineering for Thin film growth: Cleaning, Modification, Masking & Patterning, Base Coats and Top Coats.

Thin Film growth: Sequence of thin film growth, Defects and impurities, Effect of Deposition Parameters on film growth.

| **Unit –IV** | **08 Hrs** |
|---|---|

**Properties and Characterization of Thin Films**

Film thickness (Quartz crystal thickness monitor and Stylus Profiler);
Film Adhesion (Tape, Cross-hatch test, and Humidity methods);
Surface morphology and topography (SEM and AFM);
Film composition (X-ray Photoelectron Spectroscopy);
Film structure (X-ray diffraction and Raman studies);
Electrical characterization (Four Probe and Semiconductor Analyzer); and
Optical characterization (Spectrophotometer).

| **Unit –V** | **08 Hrs** |
|---|---|

**Thin Film Applications:**

- Electrodes: Deposition of a Metal film, Ex: Aluminum.
- Transparent conducting oxides (TCO) – Preparation and Optimization of a semiconducting film, Ex: ZnO.
- Optimization of a dielectric film, Ex: $Al_2O_3$ or $Si_3N_4$.

**Thin Film Devices**:

- Thin Film Transistors (TFT),
- Thin Film Sensors
- Thin Film Capacitors

- Thin film Solar Cells,
- Thin film Solar Absorbers

- Diamond-like carbon (DLC) coating
- EMI Shielding coatings
- Hard coatings
- Coatings on Plastics/Polymers.

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1** | Understand the importance of vacuum technology for thin film growth |
| **CO2** | Prepare various kinds of thin films using different deposition techniques |
| **CO3** | Characterize the deposited films for various properties |
| **CO4** | Fabricate thin film based devices. |

| **Reference Books** | |
|---|---|
| **1.** | Vacuum Technology by A. Roth, Elsevier, 3rd Edition, 1976, ISBN: 9780444880109, 9780444598745, |
| **2.** | Thin Film Phenomenon by K.L. Chopra, McGraw-Hill, 1st Edition, 1969, ISBN: 0070107998, 978-0070107991 |
| **3.** | Materials Science of Thin Films by Milton Ohring, Elsevier, 2rdEdition, 2001, **ISBN:** 9780125249751 |
| **4.** | Thin-Film Deposition: Principles and Practice by Donald Smith, McGraw-Hill, 1st Edition, 1995, ISBN: 0070585024, 9780070585027 |

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**Semester End Evaluation (SEE); Theory (100 Marks)**
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| **Semester: VII** | | | | | | |
|---|---|---|---|---|---|---|
| **ENGINEERING MATERIALS FOR ADVANCED TECHNOLOGY (Group H: Global Elective)** | | | | | | |
| **Course Code:** | **:** | 16G7H14 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 39L | | **SEE Duration** | **:** | **3.00 Hours** |
| **Course Learning Objectives:** The students will be able to | | | | | | |
| **1** | Aapply the basic concepts of Chemistry to develop futuristic materials for high-tech applications in the area of Engineering. | | | | | |
| **2** | Impart sound knowledge in the different fields of material chemistry so as to apply it to the problems in engineering field. | | | | | |
| **3** | Develop analytical capabilities of students so that they can characterize, transform and use materials in engineering and apply knowledge gained in solving related engineering problems. | | | | | |

| **UNIT-I** | **08 Hrs** |
|---|---|

**Coating and packaging materials**

**Surface Coating materials**:

Synthesis and applications of Polymer coating materials: Teflon, Silicone films Polyvinyl chloride & its copolymers, Poly vinyl acetate, Poly ethylene-HDPE, LDPE, Polyurethane.

Properties required in a pigment and extenders.

Inorganic pigments-titanium dioxide, zinc oxide, carbon black, chromate pigments, chrome green, ultramarine blue, iron blue, cadmium red.

**Corrosion inhibiting pigments-** zinc phosphate, zinc and barium chromate pigments, ceramic pigments, metal flake pigments, extenders.

Developments in new polymers such as dendrimers, biopoplymers & biodegradable polymers.

**Packaging materials:**

Food products: Cellulosic and Polymeric packaging materials and their properties – including barrier properties, strength properties, optical properties. Glass, aluminium, tin, paper, plastics, composites.

**Pharmaceutical products:** Injectibles and tablet packaging materials.

| **UNIT-II** | **07 Hrs** |
|---|---|

**Adhesives**

Introduction-Classification of Adhesives-Natural adhesives, synthetic adhesives-drying adhesives, pressure sensitive adhesives, contact adhesives, hot adhesives. One part adhesives, multi part adhesives. Adhesive Action. Development of Adhesive strength- Physical factors influencing Adhesive Action-surface tension, surface smoothness, thickness of adhesive film, elasticity and tensile strength. Chemical Factors Influencing Adhesive action - presence of polar groups, degree of polymerization, complexity of the adhesive molecules, effect of pH. Adhesive action- specific adhesive action, mechanical adhesive action, fusion adhesion. Development of adhesive strength-adsorption theory and diffusion theory. Preparation, curing and bonding Processes by adhesives-with reference to Epoxy, phenolics, Silicone, Polyurethane, Acrylic adhesives, Poly vinyl alcohol, Polyvinyl acetate.

| **UNIT-III** | **08 Hrs** |
|---|---|

**Optical fibre materials**

Fiber Optics, Advantages of optical fiber communication over analog communication, Classification based on refractive index of the core- step index and graded index optical fibres, Classification based on core radius-single mode and multimode optical fibres, Fibre fabrication.-Methods to manufacture optical glass fibres. Double crucible method and preform methods. Manufacture of perform- Chemical Vapour Deposition (CVD), Modified vapour deposition (MCVD) Plasma activated vapour deposition (PCVD), Outside vapour deposition (OVD)-Vapour-phase axial deposition (VAD). Drawing the fibres from perform, coating and jacketing process.

**Ion exchange resins and membranes**

Ion exchange resins-Introduction, Types, physical properties, chemical properties-capacity, swelling, kinetics, stability, ion exchange equilibrium, regeneration. Applications of ion exchange resins-softening of water, demineralization of water, advantages and disadvantages of ion exchange resins-

| |
|---|
| calcium sulphate fouling, iron fouling, adsorption of organic matter, bacterial contamination. Ion exchange membranes, Types, Classification, Fabrication of ion exchange cottons- anion exchange cotton and cation exchange cotton. Application of ion exchange membranes in purification of water by electro dialysis method. |
| **UNIT-IV** **08 Hrs** |
| **Spectroscopic Characterization of materials:**<br>Electromagnetic radiation, interaction of materials with electromagnetic radiation.<br>UV- visible spectrophotometry:Introduction-Electronic transitions- factors influencing position and intensity of absorption bands-absorption spectra of dienes, polyene and α,β-unsaturated carbonyl compounds, Working of UV-Vis spectrophotometer, Theoretical calculation of $\lambda_{max}$ by using Woodward-Fieser rules- for cyclic and α,β-unsaturated carbonyl compounds.<br>IR Spectroscopy: Introduction, principle, molecular vibrations, vibrational frequency, number of fundamental vibrations, factors influencing fundamental vibrations, instrumentation of IR spectrophotometer, sampling techniquesand application of IR spectroscopy in characterization of functional groups. |
| **UNIT-V** **08 Hrs** |
| **NMR spectroscopy**:<br>$H^1$ NMR Spectroscopy: Basic concepts- relaxation process. NMR spectrometer-FT NMR-Solvents used in NMR, internal standards-Chemical equivalence -Integrals and Integrations- chemical shift-Factors affecting chemical shifts- shielding and deshielding effects – chemical and magnetic equivalent –magnetic anisotropy-spin-spin splitting rules- Application of NMR on various compounds such as alkanes, alkenes, alkynes, alkyl halides, alcohols, ethers, amines, aldehydes, ketones, carboxylic acids, esters, amides & mono substituted aromatic compounds. Problems on prediction of structure of compounds. |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1** | Identify sustainable engineering materials and understand their properties. |
| **CO2** | Apply the basic concepts of chemistry to develop futuristic materials for high-tech applications in different areas of engineering. |
| **CO3** | Analyze and evaluate the specific application of materials. |
| **CO4** | Design the route for synthesis of material and its characterization. |

| **Reference Books** | |
|---|---|
| **1.** | Materials Science, G.K.Narula, K.S.Narula & V.K.Gupta. 38th Edtion, 2015, Tata McGraw-Hill Publishing Company Limited ISBN: 978-0-07-451796-3. |
| **2.** | Solar Lighting, Ramachandra Pode and Boucar Diouf, Springer e-book, 2011, ISBN: 978-1-44-712133-6 (Print) 978-1-44-712134-3 (Online), |
| **3.** | Spectroscopy of organic compounds, P.S.Kalsi, 6th Edition, 2013, New Age International(P) ltd,publisher, ISBN: 978-1-22-415438-6. |
| **4.** | Food Packaging Materials, Mahadeviah M & Gowramma RV,6th Edition, 1996, Tata McGraw Hill Publishing Company Ltd, ISBN :746-2-23-82 9780-0. |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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/Presentation/Project 10.

**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

**SEE** for 100 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks cov-

ering 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: VII | | | | | | |
|---|---|---|---|---|---|---|
| **APPLIED PSYCHOLOGY FOR ENGINEERS**<br>**(Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H15 | | **CIE** | **:** | **100** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100** |
| **Total Hours** | **:** | 35L | | **SEE Duration** | **:** | **3 Hours** |

| **Course Learning Objectives:** The students will be able to | |
|---|---|
| **1** | To appreciate human behavior and human mind in the context of learner's immediate society and environment. |
| **2** | To understand the importance of lifelong learning and personal flexibility to sustain personal and Professional development as the nature of work evolves. |
| **3** | To provide students with knowledge and skills for building firm foundation for the suitable engineering professions. |
| **4** | To prepare students to function as effective Engineering Psychologists in an Industrial, Governmental or consulting organization. |
| **5** | To enable students to use psychological knowledge, skills, and values in occupational pursuits in a variety of settings that meet personal goals and societal needs. |

| **Unit – I** | **7 Hrs** |
|---|---|
| **Introduction to Psychology**: Definition and goals of Psychology: Role of a Psychologist in the Society: Today's Perspectives (Branches of psychology). Psychodynamic, Behavioristic, Cognitive, Humanistic, Psychological Research and Methods to study Human Behavior: Experimental, Observation, Questionnaire and Clinical Method. | |
| **Unit - II** | **7 Hrs** |
| **Intelligence and Aptitude:** Concept and definition of Intelligence and Aptitude, Nature of Intelligence. Theories of Intelligence – Spearman, Thurston, Guilford Vernon. Characteristics of Intelligence tests, Types of tests. Measurement of Intelligence and Aptitude, Concept of IQ, Measurement of Multiple Intelligence – Fluid and Crystallized Intelligence. | |
| **Unit – III** | **7 Hrs** |
| **Personality**: Concept and definition of personality, Approaches of personality- psychoanalytical, Socio- Cultural, Interpersonal and developmental, Humanistic, Behaviorist, Trait and type approaches. Assessment of Personality: Self- report measures of Personality, Questionnaires, Rating Scales and Projective techniques, its Characteristics, advantages & limitations, examples. Behavioral Assessment. Psychological Stress: a. Stress- Definition, Symptoms of Stress, Extreme products of stress v s Burnout, Work Place Trauma. Causes of Stress – Job related causes of stress. Sources of Frustration, Stress and Job Performance, Stress Vulnerability-Stress threshold, perceived control. | |
| **Unit – IV** | **7 Hrs** |
| **Application of Psychology in Working Environment:** The present scenario of information technology, the role of psychologist in the organization, Selection and Training of Psychology Professionals to work in the field of Information Technology. Distance learning, Psychological consequences of recent developments in Information Technology. Type A and Type B Psychological Counseling - Need for Counseling, Types – Directed, Non- Directed, Participative Counseling. | |
| **Unit – V** | **7 Hrs** |
| **Learning:** Definition, Conditioning – Classical Conditioning, Basics of Classical Conditioning (Pavlov), the process of Extinction, Discrimination and Generalization. Operant Conditioning (Skinner expt). The basics of operant conditioning, Schedules of reinforcement. Cognitive – Social approaches to learning – Latent Learning, Observational Learning, Trial and Error Method, Insightful Learning. | |

| **Experimental Psychology (Practicals)- Self Study 2 Hrs /Week** |
|---|
| 1.Bhatia's Battery of Performance and intelligence test<br>2.Multidimensional Assessment of Personality<br>3.David's Battery of Differential Abilities ( Aptitude test)<br>4.Bilateral Transfer of Training Mirror drawing apparatus with Electronic Digital Reset Error Counter (Performance)<br>5. Student Stress Scale. |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO1 | Describe the basic theories, principles, and concepts of applied psychology as they relate to behaviors and mental processes. |
| CO2 | Define learning and compare and contrast the factors that cognitive, behavioral, and Humanistic theorists believe influence the learning process. |
| CO3 | Develop understanding of psychological attributes such as intelligence, aptitude, creativity, resulting in their enhancement and apply effective strategies for self-management and self-improvement. |
| CO4 | Apply the theories into their own and others' lives in order to better understand their personalities and experiences. |
| CO5 | Understand the application of psychology in engineering and technology and develop a route to accomplish goals in their work environment. |

| **Reference Books:** |
|---|
| 1. . Understanding Psychology Feldman R. S, IV edition, (1996) McGraw Hill India |
| 2. Psychology Robert A. Baron, III edition (1995) Prentice Hall India. |
| 3. Organizational Behaviour , Stephen P Robbins Pearson Education Publications, 13th Edition, ISBN – 81-317 – 1132 – 3 |
| 4. Organisational Behaviour : Human Behaviour at Work ,John W.Newstrem and Keith Davis. Tata McGraw Hill India, 10th Edition, ISBN 0-07-046504-5 |
| 5. Psychology-themes and variations , Wayne Weiten, IV edition, Brooks / Cole Publishing Co. |

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

**CIE** is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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/Presentation/Project 10. **Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **FOUNDATIONAL COURSE ON ENTREPRENEURSHIP (Group H : Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H16 | | **CIE Marks** | **:** | **100** |
| **Credits: L:T:P:S** | **:** | 3:0:0:0 | | **SEE Marks** | **:** | **100** |
| **Total Hours** | **:** | 36L | | **SEE Duration** | **:** | **03 Hours** |

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

| **Unit-I** | **07 Hrs** |
|---|---|
| **Self Discovery and Opportunity Discovery**<br>Finding the Flow; Effectuation; Identifying the Effectuation principles used in activities; Identifying Problem Worth Solving; Design Thinking; Brainstorming; Presenting the Identified problems; Identifying the Entrepreneurial Style. | |
| **Unit – II** | **07 Hrs** |
| **Customer, Solution and Lean Methodology**<br>Customers and Markets; Segmentation and Targeting; Identifying Jobs, Pains, and Gains and Early Adopters; Crafting Value Proposition Canvas (VPC); Presenting VPC; Basics of Business Model and Lean Approach; Sketching the Lean Canvas; Risks and Assumptions; Presenting Lean Canvas. | |
| **Unit – III** | **07 Hrs** |
| **Problem-Solution Fit and Building MVP**<br>Blue Ocean Strategy - Plotting the Strategy Canvas; Four Action Framework: Eliminate-Reduce-Raise-Create Grid of Blue Ocean Strategy; Building Solution Demo and Conducting Solution Interviews; Problem-Solution Fit; Building MVP; Product-Market Fit; Presenting MVP. | |
| **Unit – IV** | **06 Hrs** |
| **Financial Planning & Team Building**<br>Cost Structure - Estimating Costs; Revenues and Pricing: Revenue Streams, Revenue Types, Identifying Secondary Revenue Streams, Estimating Revenue and Price; Profitability Checks; Bootstrapping and Initial Financing; Practising Pitch; Shared Leadership; Hiring and Fitment, Team Role and Responsibilities. | |
| **Unit – V** | **09 Hrs** |
| **Marketing, Sales, Regulations and Intellectual Property**<br>Positioning and Branding; Channels; Sales Planning; Project Management; Basics of Business Regulations; How to Get Help to Get Started; Patents, Trademark, Licensing, Contracts; Common Legal mistakes, Types of Permits, Tax Registration Documents, Compliance; Infringement and Remedies, Ownership and Transfer. | |

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

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

**Continuous Internal Evaluation (CIE); Theory (100 Marks)**
**CIE** is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). 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/Presentation/Project 10.
**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **UNMANNED AERIAL VEHICLES (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H17 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 36L | | **SEE Duration** | **:** | **3.00 Hours** |

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

| | |
|---|---|
| **1** | Get an overview of the history of UAV systems |
| **2** | Understand the importance of aerodynamics, propulsion, structures and avionics in the design of UAV |
| **3** | Demonstrate ability to address the various mission payloads - on-board & off-board, propulsion systems, integration with manned systems |
| **4** | Assess the performance and airworthiness of the designed UAV |

| **Unit-I** | **06 Hrs** |
|---|---|
| **Introduction to Flight Vehicles**:<br>History of Flight Vehicles and UAVs, Classifications, Woking principles of flight vehicle.<br>**Introduction to Unmanned Aircraft Systems**<br>Types of UAVs, configurations and their advantages disadvantages, System Composition, Applications of UAVs, Characteristics of Aircraft | |
| **Unit – II** | **07 Hrs** |
| **Design of UAV Systems: Governing aspects:**<br>**a. Aerodynamics, b. Propulsion, C. structure, d. Controls**<br>**Aerodynamics:**<br>Introduction basic Aerodynamics, lift, drag, Aerofoils, wing area optimization.<br>**Propulsion:**<br>Introduction to propulsion system in UAV, Propulsion system for fixed wing UAV and VTOL (Vertical take-off and landing) UAV, Advanced propulsion systems, fuel cells, generators based systems. | |
| **Unit -III** | **07Hrs** |
| **Structures of UAV:**<br>Mechanic loading, basics of types of load calculation and structural engineering, Material used for UAV (general introduction), FRP and methods of usage in UAV, Testing of FRP specimens for UAV, selection criteria for structure, Types of structural elements used in UAV their significance and characteristics, Methods of manufacturing UAV structure. | |
| **Unit -IV** | **07 Hrs** |
| **Controls, Avionics, Hardware, Communication, Payloads:**<br>Basics of control system and Systems for control system in UAV, PID control, simulation introduction to Hardware in loop system (HILS), Avionics: Autopilot (AP) – architecture of AP, sensors, actuators, power supply, integration, installation, configuration, and testing.<br>**Hardware, Communication**<br>Electronics Hardware in UAV, Communication methods, communication antenna and their significance.<br>**Payloads:**<br>Payload types and their applications | |
| **Unit -V** | **09 Hrs** |
| **Design of UAV Systems**:<br>Fixed wing UAV and Rotary wing UAV (VTOL)<br>Task specific, activity based exercise | |

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

| | |
|---|---|
| **CO1** | Appraise the evolution of UAVs and understand the current potential benefits of UAVs |

| | |
|---|---|
| **CO2** | Apply the principles of Aerospace Engineering in design and development of UAVs |
| **CO3** | Determine and evaluate the performance of UAV designed for various Missions and applications |
| **CO4** | Assess the performance and airworthiness of the designed UAV |

| **Reference Books** | |
|---|---|
| **1** | Unmanned Aircraft Systems UAV design, development and deployment, Reg Austin, 1st Edition, 2010, Wiley, ISBN 9780470058190. |
| **2** | Flight Stability and Automatic Control, Robert C. Nelson, 2nd Edition, October 1, 1997, McGraw-Hill, Inc, ISBN 978-0070462731. |
| **3** | Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy, Kimon P. Valavanis, 1st Edition,2007, Springer ISBN 9781402061141 |
| **4** | Introduction to UAV Systems, Paul G Fahlstrom, Thomas J Gleason, 4th Edition, 2012, Wiley, ISBN: 978-1-119-97866-4 |
| **5** | Design of Unmanned Air Vehicle Systems, Dr. Armand J. Chaput, 3rd Edition, 2001, Lockheed Martin Aeronautics Company, ISBN: 978-1-60086-843-6 |

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

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**Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

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

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

| Semester: VIII | | | | | | |
|---|---|---|---|---|---|---|
| **MAJOR PROJECT (Common to all Programs)** | | | | | | |
| **Course Code** | **:** | 16EI81 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P:S** | **:** | 0:0:16:0 | | **SEE** | **:** | **100 Marks** |
| **Hours / Week** | **:** | 32 | | **SEE Duration** | **:** | **3.00 Hours** |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Acquire the ability to make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task. |
| **2** | Acquire the skills to communicate effectively and to present ideas clearly and coherently to a specific audience in both written and oral forms. |
| **3** | Acquire collaborative skills through working in a team to achieve common goals. |
| **4** | Self-learn, reflect on their learning and take appropriate action to improve it. |
| **5** | Prepare schedules and budgets and keep track of the progress and expenditure. |

**Major Project Guidelines:**

1. The project topic, title and synopsis have to be finalized and submitted to their respective internal guide(s) before the beginning of the 8th semester.
2. The detailed Synopsis ***(approved by the department Project Review Committee***) has to be submitted during the 1st week after the commencement of 8th semester.

**Batch Formation:**

- Students are free to choose their project partners from within the program or any other program;
- Each student in the team must contribute towards the successful completion of the project. The project may be carried out In-house / Industry / R & D Institution;
- ***The project work is to be carried out by a team of two to four students , in exceptional cases where a student is placed in a company and offered an internship through the competitive process or student is selected for internship at national or international level through competitive process,*** the student can work independently.
- ***The students are allowed to do either a project for full 5 days in the industry or full 5 days in the college.***
- ***In case the project work is carried out outside Bengaluru, such students must be available during Project Evaluation process scheduled by the respective departments and they must also interact with their guide regularly through Email / Webinar / Skype etc.***

**Project Topic Selection:**

The topics of the project work must be in the *field of respective program areas or in line with CoE's (Centre of Excellence) identified by the college* or List of project areas as given by industry/Faculty. The projects as far as possible should have societal relevance with focus on sustainability.

**Project Evaluation:**

- Continuous monitoring of project work will be carried out and cumulative evaluation will be done.
- The students are required to meet their internal guides once in a week to report their progress in project work.
- **Weekly Activity Report** (WAR) has to be maintained in the form of a diary by the project batch and the same has to be discussed with the Internal Guide regularly.
- In case of **Industry project**, during the course of project work, the internal guides will have continuous interaction with external guides and will visit the industry at least twice during the project period.

- For CIE assessment the project groups must give a final seminar with the draft copy of the project report.
- The presentation by each group will be for 20-30 minutes and every member of the team needs to justify the contributions to the project.
- The project team is required to submit Hard copies of the detailed Project Report in the prescribed format to the department.
- For CIE 50% weightage should be given to the project guide and 50% weightage to the project evaluation committee.
- Before the final evaluations the project group is required to produce a No dues certificate from Industry, Central Library and Department.

| **Course Outcomes of Major Project:** | |
|---|---|
| **1** | Apply knowledge of mathematics, science and engineering to solve respective engineering domain problems. |
| **2** | Design, develop, present and document innovative/multidisciplinary modules for a complete engineering system. |
| **3** | Use modern engineering tools, software and equipment to solve problem and engage in life-long learning to follow technological developments. |
| **4** | Function effectively as an individual, or leader in diverse teams, with the understanding of professional ethics and responsibilities. |

**CIE Assessment:**

The following are the weightings given for the various stages of the project.

1. Selection of the topic and formulation of objectives 10%
2. Design and Development of Project methodology 25%
3. Execution of Project 25%
4. Presentation, Demonstration and Results Discussion 30%
5. Report Writing & Publication 10%

**SEE Assessment:**

The following are the weightages given during Viva Examination.

1. Written presentation of synopsis 10%
2. Presentation/Demonstration of the project 30%
3. Methodology and Experimental Results & Discussion 30%
4. Report 10%
5. Viva Voce 20%

**Calendar of Events for the Project Work:**

| Week | Event |
|---|---|
| Beginning of 7th Semester | Formation of group and approval by the department committee. |
| 7th Semester | Problem selection and literature survey |
| Last two weeks of 7th Semester | Finalization of project and guide allotment |
| II Week of 8th Semester | Synopsis submission and preliminary seminar |
| III Week | First visit of the internal guides to industry (In case of project being carried out in industry) |
| III to VI Week | Design and development of project methodology |
| VII to IX Week | Implementation of the project |
| X Week | Submission of draft copy of the project report |
| XI and XII Week | Second visit by guide to industry for demonstration. Final seminar by Department project Committee and guide for internal assessment. Finalization of CIE. |

**Evaluation Scheme for CIE and SEE**

| **Scheme of Evaluation for CIE** | | **Scheme of Evaluation for SEE** | |
|---|---|---|---|
| **Particulars** | **%Marks** | **Particulars** | **%Marks** |
| **Project Evaluation I** | 10% | Project Synopsis (Initial Write up) | 10% |
| **Project Evaluation II** | 25% | Project Demo / Presentation | 30% |
| **Project Evaluation III** | 25% | Methodology and Results Discussion | 30% |
| **Project Evaluation Phase-IV (**Submission of Draft Project Report for Verification**)** | 30% | Project Work Report | 10% |
| **Project Evaluation Phase-V (**Project Final Internal Evaluation**)** | 10% | Viva-voce | 20% |
| **Total** | 100 | Total | 100 |

| Semester: VIII | | | | | | |
|---|---|---|---|---|---|---|
| **TECHNICAL SEMINAR (Common to all Programs)** | | | | | | |
| **Course Code** | **:** | 16EI82 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P:S** | **:** | 0:0:2:0 | | **SEE** | **:** | **100 Marks** |
| **Hours / Week** | **:** | 04 | | **SEE Duration** | **:** | **3.00 Hours** |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | Recognize recent developments in specific program and in multidisciplinary fields. |
| **2** | Summarize the recent technologies and inculcate the skills for literature survey. |
| **3** | Demonstrate good presentation skills. |
| **4** | Plan and improve the Technical Report writing skills. |
| **5** | Support Group discussion and Team work. |

**General Guidelines for the Seminar**

1. The seminar has to be presented by individual student.
2. The topic of the seminar should be from current thrust area along with consultation with the guide.
3. The topic can be based on standard papers (like IEEE/ACM/CSI etc.) in the thrust area for the selected topic.
4. Presenting/publishing this paper in conference/ Journal will be given weightage in CIE.
5. The student needs to submit both hard & soft copy of the seminar report.
6. **As Outcome of Technical Seminar, each student has to prepare a technical paper out of seminar topic.**

| **Course Outcomes of Technical Seminar:** | |
|---|---|
| **1** | Communicate effectively on complex engineering problems and demonstrate contextual knowledge to assess societal and environmental contexts. |
| **2** | Identify, formulate, review research literature, analyze and Design solutions for complex engineering problems using appropriate techniques with effective documentation. |
| **3** | Analyze, interpret and synthesize the information to provide valid conclusions with innovative ideas and ethical principles. |
| **4** | Apply the knowledge of engineering specialization to suggest solutions to complex engineering problems and recognize the need for technological changes. |

**Evaluation of CIE Marks:**

1. Relevance of the topic 10%
2. Literature Survey 10%
3. Presentation 40%
4. Report 20%
5. Paper Publication 20%

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

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

| Semester: VIII | | | | | | |
|---|---|---|---|---|---|---|
| **INNOVATION & SOCIAL SKILLS (Common to all Programs)** | | | | | | |
| **Course Code** | **:** | 16HS83 | | **CIE** | **:** | **NA** |
| **Credits: L:T:P:S** | **:** | 0:0:1:0 | | **SEE** | **:** | **NA** |
| **Hours / Week** | **:** | 02 | | **SEE Duration** | **:** | **NA** |

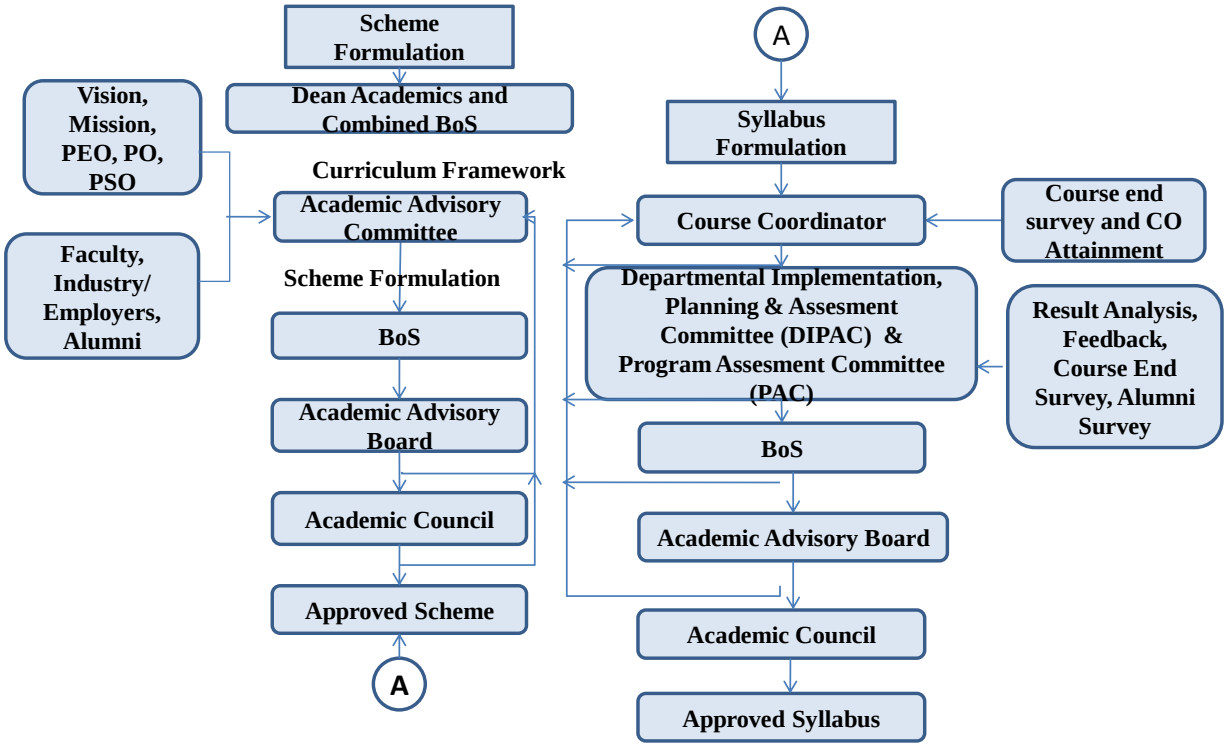
| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | To provide a platform for the students to exhibit their organizational capabilities, team building, ethical values and extra mural abilities. |
| **2** | To encourage to carryout innovative ideas and projects. |
| **3** | Take part in societal and community building activities. |
| **4** | Make self-learning, ethics and lifelong learning a motto. |

**Guidelines**

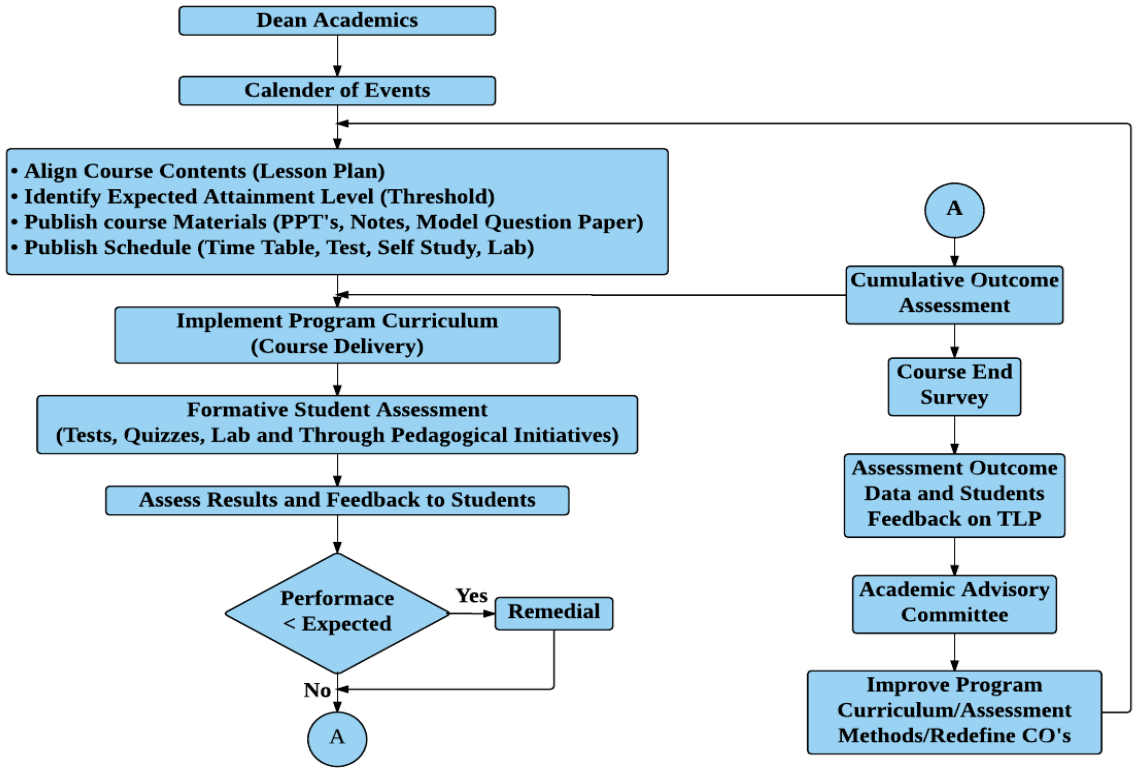
1. The HSS will be evaluated individually based on the broad parameters which include the progress made by student during 3rd& 4th year in innovative projects, Seminar, Paper Presentation, Field activity & other Co-curricular activities.
2. Students shall submit a report and documents as a proof his/her achievements.

| **Course Outcomes of Innovation & Social Skills:** | |
|---|---|
| **1** | Apply the knowledge and skills for solving societal issues |
| **2** | Plan to work in team in various areas with inclusive effort and sustainability |
| **3** | Organize various events and use managerial and budgeting abilities |
| **4** | Demonstrate leadership qualities and ethics |

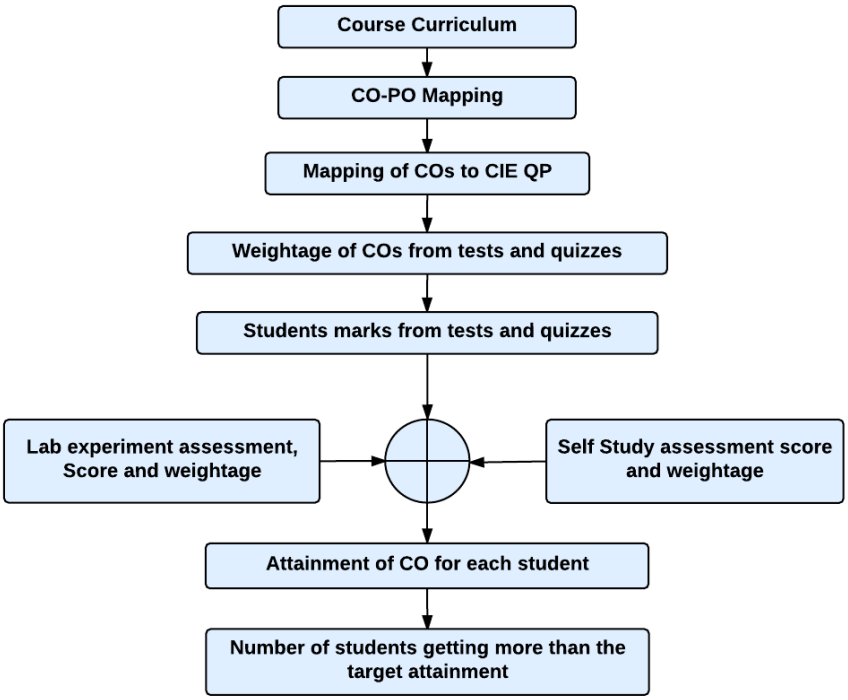
# Curriculum Design Process



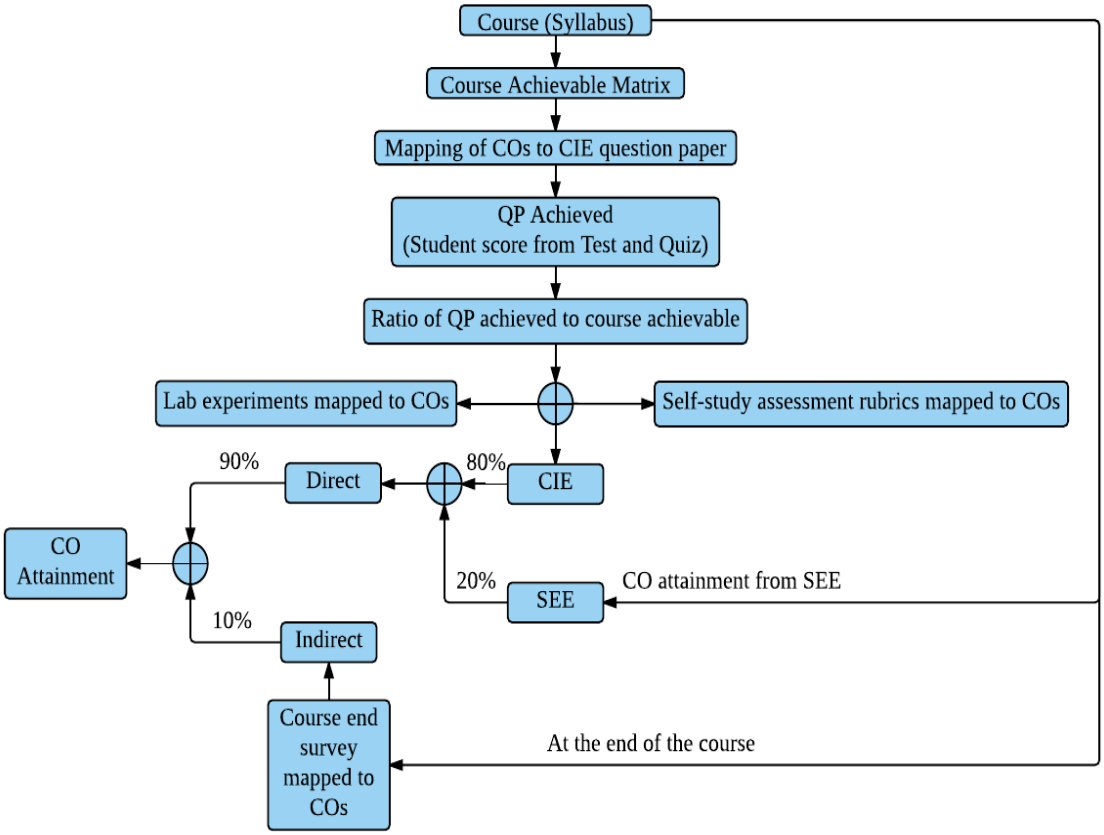

# Academic Planning and Implementation



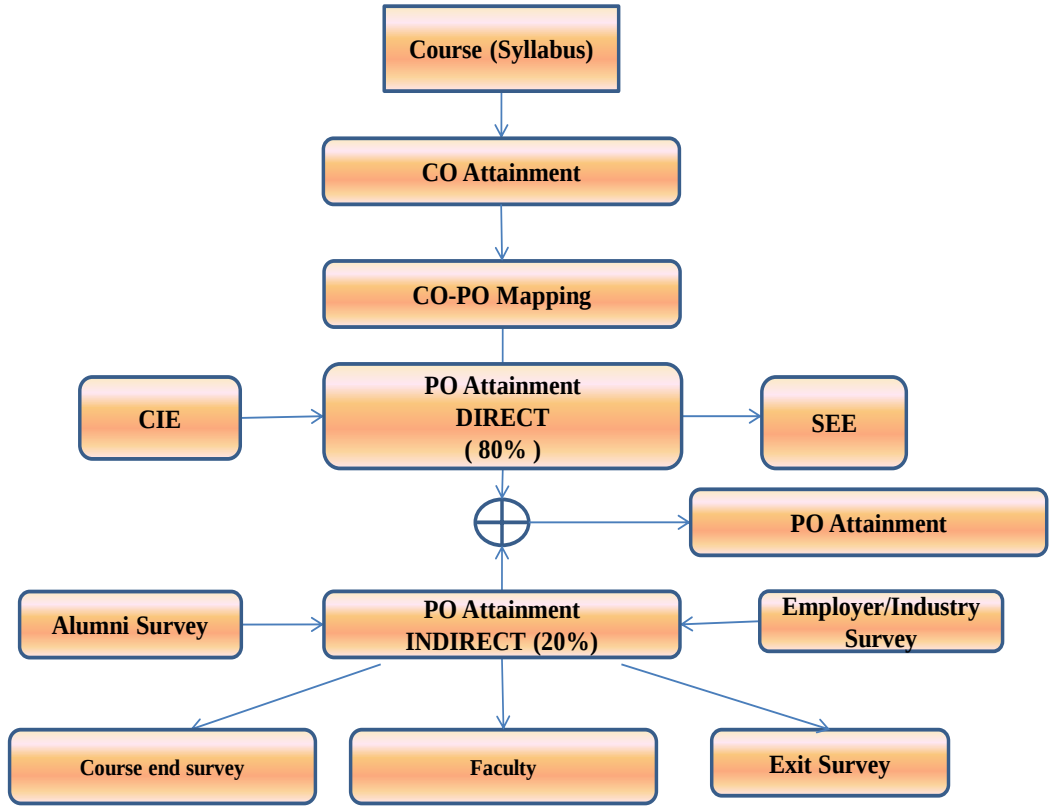
# PROCESS FOR COURSE OUTCOME ATTAINMENT




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

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

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