# RV COLLEGE OF ENGINEERING®

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

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

**Bengaluru – 560 059**


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

## 2016 SCHEME

# MECHANICAL 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

# RV COLLEGE OF ENGINEERING®

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

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

**Bengaluru – 560 059**


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

# 2016 SCHEME

## DEPARTMENT OF
# MECHANICAL ENGINEERING

# DEPARTMENT VISION

Quality Education in Design, Materials, Thermal and Manufacturing with emphasis on Research, Sustainable technologies and Entrepreneurship for Societal Symbiosis

# DEPARTMENT MISSION

- Imparting knowledge in basic and applied areas of Mechanical Engineering
- Providing state-of-art laboratories and infrastructure for academics and research
- Facilitating faculty development through continuous improvement programs
- Promoting research, education and training in frontier areas of nanotechnology, advanced composites, surface technologies, MEMS and sustainable technology
- Strengthening collaboration with industries, research organizations and institutes for internship, joint research and consultancy
- Imbibing social and ethical values in students, staff and faculty through personality development programs

# PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

**PEO1.** Successful professional careers with sound fundamental knowledge in Mathematics, Physical Sciences and Mechanical Engineering leading to leadership, entrepreneurship or pursuing higher education.

**PEO2.** Expertise in specialized areas of Mechanical Engineering such as Materials, Design, Manufacturing and Thermal Engineering with a focus on research and innovation.

**PEO3.** Ability of problem solving by adopting analytical, numerical and experimental skills with awareness of societal impact.

**PEO4.** Sound communication skills, team working ability, professional ethics and zeal for life-long learning.

# PROGRAM SPECIFIC OUTCOMES (PSOS)

| PSO | Description |
|---|---|
| PSO1 | Demonstrate basic knowledge in Mathematics, basic science, Materials Science and Engineering to formulate and solve mechanical engineering problems |
| PSO2 | Design mechanical and thermal systems by adopting numerical, analytical and experimental techniques and analyse the results. |
| PSO3 | Function in multidisciplinary teams with sound communication skills. |
| PSO4 | Self-learn to acquire and apply allied knowledge and update the same by engaging in life-long learning, practice profession with ethics and promote entrepreneurship . |

## Lead Society: American Society of Mechanical Engineers – ASME

# ABBREVIATIONS

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

## INDEX

# RV COLLEGE OF ENGINEERING®

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

## MECHANICAL ENGINEERING

| SEVENTH SEMESTER CREDIT SCHEME | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sl No** | **Course Code** | **Course Title** | **BoS** | **Credit Allocation** | | | | **Total Credits** |
| | | | | **L** | **T** | **P** | **S** | |
| 1 | 16ME71 | Mechanical Vibrations | ME | 3 | 0 | 1 | 0 | 4 |
| 2 | 16ME72 | Control Engineering | ME | 3 | 0 | 0 | 0 | 3 |
| 3 | 16ME73P | Minor Project | ME | 0 | 0 | 3 | 0 | 3 |
| 4 | 16ME7FX | Elective F (PE) | ME | 4 | 0 | 0 | 0 | 4 |
| 5 | 16ME7GX | Elective G (PE) | ME | 4 | 0 | 0 | 0 | 4 |
| 6 | 16G7HXX | Elective H (GE) | Res.BoS | 3 | 0 | 0 | 0 | 3 |
| **Total No of Credits** | | | | **17** | **0** | **4** | **0** | **21** |
| **Total number of Hours/Week** | | | | **17** | **0** | **8** | **0** | |

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

| EIGHTH SEMESTER CREDIT SCHEME | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Course Code** | **Course Title** | **BoS** | **Credit Allocation** | | | | **Total Credits** |
| | | | | **L** | **T** | **P** | **S** | |
| 1 | 16MEP 81 | Major Project | ME | 0 | 0 | 16 | 0 | 16 |
| 2 | 16MES 82 | Technical Seminar | ME | 0 | 0 | 2 | 0 | 2 |
| 3 | 16HSS 83 | 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** | |

| VII Semester | | |
|---|---|---|
| **GROUP F: PROFESSIONAL ELECTIVES** | | |
| **Sl. No.** | **Course Code** | **Course Title** |
| 18. | 16ME7F1 | Automotive Systems Engineering |
| 19. | 16ME7F2 | Advanced Mechanisms Design |
| 20. | 16ME7F3 | Non-Linear Finite Element Methods |
| 21. | 16ME7F4 | Design of Heat Exchangers |
| **VII Semester** | | |
| **GROUP G: PROFESSIONAL ELECTIVES** | | |
| **Sl. No.** | **Course Code** | **Course Title** |
| 1. | 16ME7G1 | Advanced Manufacturing Practices |
| 2. | 16ME7G2 | Design for Manufacturing and Assembly |
| 3. | 16ME7G3 | Plastic Mould Design |
| 4. | 16ME7G4 | Engineering Systems Design |

| OPEN 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 Systems |
| 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. | TC | 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 | | | | | | |
|---|---|---|---|---|---|---|
| **MECHANICAL VIBRATIONS (Theory & Practice)** | | | | | | |
| **Course Code** | **:** | 16ME71 | | **CIE** | **:** | **100 +50Marks** |
| **Credits: L:T:P:S** | **:** | 3:0:1:0 | | **SEE** | **:** | **100+50 Marks** |
| **Total Hours** | **:** | 39L+26P | | **SEE Duration** | **:** | **03+03Hours** |

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

| | |
|---|---|
| **1** | Underst and of basics of vibrations in mechanical systems. |
| **2** | Comprehend the damped vibration theory. |
| **3** | Apply theory of vibration for isolation and transmissibility. |
| **4** | Evaluate there sponse of multi degrees of freedom systems. |
| **5** | Analyze continuous and Non-linear systems. |

| **Unit-I** | **07 Hrs** |
|---|---|
| **Introduction to Undamped free systems.**<br>**Damped free vibrations**: Single degree freedom systems, different types of damping, concept of critical damping and it simportance, study of response of viscous damped systems for cases of under damping, critical and over damping, logarithmic decrement. | |
| **Unit – II** | **10 Hrs** |
| **Forced Vibration with harmonic excitation:**<br>Single degree freedom systems, Steady state solution with viscous damping due to Harmonic force, solution and response. Forced Vibration with rotating unbalance and base excitation: Single degree freedom systems, reciprocating and rotating imbalance,whirling of shafts without air damping, discussion on speeds above and below critical speeds.<br>**Transmissibility and Instruments:**<br>Vibration isolation, transmissibility ratio, base excitation. Accelerometer and vibrometer. | |
| **Unit –III** | **10 Hrs** |
| **Systems with two degrees of freedom**:<br>Introduction, principal modes and normal modes of vibration, co-ordinate coupling, generalized and principal co-ordinates.<br>**Numerical methods for Multi degree Freedom systems**:<br>Introduction, influence coefficients, Maxwell reciprocal theorem, Dunkerley's equation, method of matrix iteration, method of determination of all the natural frequencies usings weeping matrix and orthogonality principle.<br>Modal analysis, Holzer's method and Stodola's method. | |
| **Unit –IV** | **06 Hrs** |
| **Continuous Vibrations**<br>Introduction, Lateral vibrations of the strings, Torsional Vibrations of uniform shaft, Longitudinal Vibrations of the bars,Transverse vibrations of beams, Effects of shear deformation and rotary inertia. | |
| **Unit –V** | **06 Hrs** |
| **Non Linear Vibrations**<br>Introduction, Difference between linear and Nonlinear vibrations, Applications of Super position principle, Examples of nonlinear systems like Hard and Soft spring, belt friction system,Variable mass system, Abruptnonlinearlity, Phase plane method, Duffing's equation. | |

| Practice | |
|---|---|
| **MECHANICAL VIBRATIONS LABORATORY** | |
| **Section I** | **26 Hrs** |
| 1. Study of longitudinal vibrations using spring-mass system without and with damping. | |
| 2. Study of torsional vibrations using circular disc and rod without and with damping. | |
| 3. Study of transverse vibrations using whirling of shafts. | |
| 4. Study of balancing of rotating masses. | |
| 5. Study of SDOF system. | |
| 6. Study of MDOF system. | |
| 7. Study of Vibration measurement using FFT analyzer. | |
| 8. Study of Modal analysis. | |
| 9. Interpretation of FFT results like finding problems like unbalance, misalignment, also | |
| 10. Study of Noise measurement | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Explain free and for cedvibrations for single,two and multidegrees offreedom systems. |
| **CO2:** | Apply the influence of damping in free and vibration isolation in forced vibration systems. |
| **CO3:** | Determine the natural frequencies in two and multidegrees offreedom systems and draw modeshapes. |
| **CO4:** | Test the principles of vibration of damping, natural frequencies in laboratory experiments. |

| **Reference Books** | |
|---|---|
| **1** | Mechanical Vibrations, Rao S.S., 5th Edition, 2007, Prentice Hall, ISBN: 0201526867 |
| **2** | Theory of Vibration with applications, ThomsonW.T., 5th Edition, 2003, Pearson Education Inc., ISBN 0044450699 |
| **3** | Schaum's Outline of Mechanical Vibrations, Graham KellyS, 1st Edition, 1996, McGraw-Hill, ISBN 0070340412 |
| **4** | Mechanical Vibrations and Industrial Noise control, LasithanL.G, 2014, PHI learning India Pvt.Ltd., ISBN-978-81-203-4779-3 |
| **5** | Mechanical Vibrations, V P Singh 7thEdition, 2010, Danpat Rai and 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 50. The marks component for Assignment/Presentation/Project 10.

**Total CIE is 30(Q) +50(T) +10(A) =100 Marks.**

**Scheme of Continuous Internal Evaluation (CIE); Practical Test for 50 Marks**
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average marks (AM) over number of weeks is considered for 40 marks. At the end of the semester a test (T) is conducted for 10 marks. Total marks for the laboratory is 50.
**Total CIE is 40(AM) +10 (T) =50 Marks.**

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

**Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks**
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

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

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

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **CONTROL ENGINEERING (Theory)** | | | | | | |
| **Course Code** | **:** | 16ME72 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 39L | | **SEE Duration** | **:** | **3.00 Hours** |

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

| | |
|---|---|
| **1** | Introduce students to the concept of close and open loop control systems. |
| **2** | Describe different elements in a control system and its functions. |
| **3** | Discuss key control system characteristics such asstability, accuracy, resolution and Response time. |
| **4** | Explain states pace method and its significance. |
| **5** | Analyze different types of control systems and its operational features. |

| **Unit-I** | **05 Hrs** |
|---|---|
| **Introduction And Applications:**<br>Types of control systems; Typical Block Diagram Performance Analysis; Applications – Boiler Control, Engine Governing, Aerospace Control, Representation of Processes and Control Elements– Mathematical Modeling. | |
| **Unit – II** | **10 Hrs** |
| **Block Diagram Representation and Signal Flow Graphs:**<br>Block Diagram Representation, Representation of Systems or Processes, Comparison Elements; Representation of Feedback Control systems – Block Diagram & Transfer Function Representation, Signal Flow Graphs.<br><br>**Transient And Steady State Response:**<br>Time Domain Representation; Response of First order and second order systems<br>For step input,Time domain specifications, steady state errors and error constants, Dynamic error co-efficients**.** | |
| **Unit -III** | **10 Hrs** |
| **Root Locus Method:**<br>Introduction, Rules for sketching root loci, Relation between Root Locus<br>Locations and Transient Response; Parametric Variation, Effect of addition of poles and zeros.<br>**State Space Analysis of Control Systems:**<br>Introduction; Generalized State Equation; Techniques for DerivingSystem State–<br>Space Equations; Transfer Function from State Equations; Solution of State Vector, State transition matrix, Controllability and observability | |
| **Unit –IV** | **07 Hrs** |
| **Frequency Response Analysis:**<br>Bode plots,Nichols Plots, Stability of control system, Characteristic Equation,<br>Nyquist's Criterion, Gain and Phase Margins. | |
| **Unit –V** | **07 Hrs** |
| **Types of Controllers:**<br>Introduction: Types of Control Action; Proportional, Integral and derivative controllers, PD, PI, PDI controllers.<br>**Compensation of Control Systems:**<br>Introduction - Types of compensation, Series, Parallel and Series – Parallel Compensation-Lead, Lag and Lag-lead Compensator. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Explain the working of control systems with block diagram and signal flow graphs. |
| **CO2:** | Apply time domain and frequency domain technique for the design of control system. |
| **CO3:** | Evaluate the performance of the control system for optimal design. |
| **CO4:** | Choose and develop the control system for control of machine tools. |

| **Reference Books** | |
|---|---|
| **1** | Modern Control Engineering, Ogata, 5th Edition , 2010, Prentice Hall of India, New Delhi.ISBN: 10: 0-13-615673-8, 13: 978-0-13-615673-4 |
| **2** | AutomaticControlSystems, Kuo, 3rd Edition, 2009, Prentice Hall of India, New Delhi, ISBN: 0-13-054973-8 |
| **3** | Control System Engineering, I.J.Nagrathand M.Gopal, 3rd Edition, 2008, New Age, New Delhi, ISBN:81-224-1192-4, |
| **4** | Control Systems, NareshK.Sinha, New Age International Publishers, NewDelhi, ISBN: 8122411681 |

**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.**

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

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

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **MINOR PROJECT** | | | | | | |
| **Course Code** | **:** | 16ME73P | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P:S** | **:** | 0:0:3:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 06 | | **SEE Duration** | **:** | **3.00 Hours** |

| **Course Learning Objectives:** To enable the students 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. |

**Mini 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 Mini Project:** | |
|---|---|
| **CO1:** | Define Specifications, Conceptualize, Design and implement a project |
| **CO2:** | Communicate the work carried out as a technical report and orally |
| **CO3:** | Work in a team and contribute to team work |
| **CO4:** | Indulge in self-learning and be motivated for life-long learning |

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **AUTOMOTIVE SYSTEMS ENGINEERING (Theory) (Group F: Professional Elective)** | | | | | | |
| **Course Code** | **:** | 16ME7F1 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 4:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 52 L | | **SEE Duration** | **:** | **3.00 Hours** |

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

| | |
|---|---|
| **1** | To introduce vehicle chassis structure. |
| **2** | To introduce vehicle subsystems e.g. steering, brake and suspension. |
| **3** | To broaden the understanding of engine sub-systems. |
| **4** | To understand the working of different fuel supply systems used in CIEngine and SI Engine. |
| **5** | To broaden the understanding of power transmission system components. |
| **6** | To introduce passenger and commercial vehicle body details and to understand the vehicle aerodynamics. |

| **Unit-I** | **10 Hrs** |
|---|---|
| **Chassis System:**<br>Integrated Body Construction–Study of loads, moments and stresses on frame members. Design of propeller shaft.<br>Design of full-floating, semi-floating and three-quarter float in grear shafts and rear axle housings<br>**Steering System:**<br>Steering geometry. Ackermann and Davis steering. Different types of steering gear boxes. Steering linkage layout for conventional and independent suspensions. Power and power assisted steering. | |
| **Unit – II** | **12 Hrs** |
| **Braking System:**<br>Types of brakes. Principle of shoe brakes, Disc brake theory, Brake Actuating system–Mechanical, Hydraulic and Pneumatic. Factors affecting brake performance viz. Operating temperature, area of brake lining, brake clearance. Power and power assisted brakes–Anti lock Braking system, Regenerative Braking system<br>**Suspension System:**<br>Types of suspension, Suspension springs–leaf springs, coil springs and torsion bar springs. Independent suspension system, Front and Rear Axle suspension system. Types of wheels. Construction of wheel assembly. Types of Tyres. Static and Rolling properties of pneumatic tyres | |
| **Unit -III** | **11 Hrs** |
| **Engine basics:**<br>Engine subsystems: Ignition system – Conventional and Electronic, Cooling systems–radiator types and lubrication systems<br>**Fuel supply systems– SI engines andCI engines**<br>**SI Engines:**Theory of carburetion–Simple carburettor–Moderncarburettor– Carburettor types. Petrol injection system types–Working principle of TBI, D- Jetronic, L-Jetronic, K-Jetronic, KE-Jetronic systems and Gasoline Direct Injection (GDI) systems.<br>**CI Engines:**Functional requirements–Components–Injector Nozzle control- Injection types–Injection pumps – Injectors. Advance Injection systems: Common Rail Direct Injection (CRDI) Systems and Xtreme Pressure Injection (XPI) Systems | |

| **Unit –IV** | **11 Hrs** |
|---|---|
| **Power Transmission System:**<br>**Clutch:**Types – Single plate clutch, Multiplatec lutch, Centrifugal clutch, Cone clutch, Electro magnetic clutch– Fluid coupling.<br>**Gear Box:**Sliding mesh,Constant mesh, Synchromesh–Overdrives–Gear shifts mechanisms. Calculation of gear ratio for vehicles.<br>**Torque Converter and Automatic Transmission:**<br>Principle of torque conversion, Multistage and Polyphase torque converters.<br>**Automatic Transmission:**Relative merits and demerits when compared to conventional transmission–Epicyclic and Hydromatic transmission– Continuously Variable Transmissions (CVTs) | |
| **Unit –V** | **10 Hrs** |
| **Body Engineering:**<br>Types of carbodies and bus bodies, Visibility: Regulations, Driver's visibility, Methods of improving visibility, Load Distribution on vehicle structure, Symmetric and Asymmetrical verticalloads in acar, Longitudinal Loads, Stress Analysis of bus body structure under bending and torsion.<br>**Vehicle Aerodynamics:**Vehicle drag and types.Various types of forces and moments.Various body optimization techniques for minimum drag. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Illustrate the basic knowledge of automobile systems and subsystems. |
| **CO2:** | Apply the engineering technology to design automotive subsystems. |
| **CO3:** | Analyze the performance of automotive systems. |
| **CO4:** | Justify the choice of a specific type of a particular subsystem. |

| **Reference Books** | |
|---|---|
| **1** | Internal Combustion Engines, V.Ganesan, 3rd Edition,, 2010, Mc Graw Hill BookCo, ISBN:13-978-0-07-064817-3 |
| **2** | Automotive Chassisand Body, CrouseW.H, 5th Edition, 1971, Mc Graw Hill, NewYork, ISBN: 0070145377 |
| **3** | Automobile Mechanics, Giri. N.K., 8thEdition, 2002, Khanna Publishers – New Delhi, ISBN: 9788174092168 |
| **4** | Steering, Suspension and Tyres, Giles. J.G, 2nd Edition, 2004, Iiiffe Book Co., London, ISBN: 139781401856304 |
| **5** | Vehicle Body Engineering, Powloski,J., 1st Edition, 1989, Business Books Ltd., ISBN: 0220689164 |
| **6** | Introduction of Internal Combustion Engines, Richard Stone, 4thEdition, 2012, McMillan, London, ISBN:1137028297 |
| **7** | Advanced Engine Technology, Heinz Heizler, Butter worth Heinemann, 2nd Edition, 2002, ISBN: 0 768010713 |
| **8** | Chassis Design, WilliamF. Milliken,DouglasL. Milliken, Maurice Olley, 2ndEdition, 2002, SAE,ISBN:0768008263 |

**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.**

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

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

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **ADVANCED MECHANISMS DESIGN (Theory) (Group F: Professional Elective)** | | | | | | |
| **Course Code** | **:** | 16ME7F2 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 3:0:1:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 39L +26P | | **SEE Duration** | **:** | **3.00 Hours** |
| **Course Learning Objectives:** The students will be able to | | | | | | |
| **1** | Underst and forces and links in mechanisms and design criteria | | | | | |
| **2** | Analyze mechanisms graphically and analytically | | | | | |
| **3** | Synthesize and design links and mechanisms | | | | | |
| **4** | Analyse kinematics of spatial mechanisms in Robotics | | | | | |

| **Unit-I** | **07 Hrs** |
|---|---|
| **Introduction:** Introduction to kinematics and mechanisms, motion, The Four-Bar Linkages, The Science of Relative Motion, Kinematics diagram, Degrees of freedom, Degree of Freedom, planar, Spherical and Spatial Mechanism, Kinetic inversion, Grashof's Law, Mechanical Advantage. Equivalent mechanism, Analysis Versus Syntheses, Problems | |
| **Unit – II** | **11 Hrs** |
| **Synthesis of Mechanisms- Analytical Method:** Type, Number and Dimensional Synthesis, Function Generation, path Generation and Body Guidance, Design of a slider-crank mechanism, Four-bar crack rocker mechanism, Crank-Rocker mechanism with optimum Transmission Angle, Precision points for Function Generation, Structural Error, Chebychev Spacing, Frudenstein's Equation for both four bar and slider-crank mechanism, Bloch's Method of Synthesis Analytic Complex Number Modeling in Kinematic Synthesis, The Dyad or Standard Form, Problems | |
| **Unit -III** | **10 Hrs** |
| **Synthesis of Mechanisms-Graphical Method:** Dead Center problems (Slider-crank and Crack-Rocker mechanisms), Synthesis of a Quick-Return Mechanisms, Crank-Rocker Mechanisms with optimum Trnasmission Angle, Three-position Synthesis, Four-Position Synthesis (Point-Position Reduction) The Overlay Method, Motion Generation Mechanism coupler as the output (two positions, Three position), Coupler - Curve Synthesis (two position, Four positions, Five position), Rober - Chevschev synthesis, Pole, Relative pole, Synthesis of Four bar and slider crank mechanism (Two position and Three position), Problems | |
| **Unit –IV** | **06 Hrs** |
| **Synthesis of Spatial Mechanism :** Introduction, Exceptions in the Mobility of Mechanisms, The position-Analysis Problem, The Eulerian Angles, introduction to Robotics, Topology arrangements of robotic arms, Forward Kinematics, Invrse Position Analysis, Inverse Velocity and Acceleration Analyses. | |
| **Unit –V** | **05 Hrs** |
| **Curvature Theory:** Introduction, Fixed and Moving Centrodes, Velocities, Accelerations, Inflection Points and the Inflection Circle, The Euler-Savary Equation, Bobillier's Constructions, The Collineation Axis, Bobillier's Theorem, Hartmann's Construction, The Bresse Circle, The Acceleration Field, The Return Circle, The Cubic of Stationary Curvature or Burmester's, Circle-Point and Center-Point Curves for Four, Infinitesimally Close Positions of the Moving Plane | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| 1 | Explain forces and links in mechanisms usingd esign criteria |
| 2 | Analyze mechanisms graphically and analytically |
| 3 | Synthesize and design links and mechanisms |
| 4 | Analyse kinematics of spatial mechanisms in Robotics |

| **ReferenceBooks** | |
|---|---|
| **1.** | Advanced Mechansim Design Analysis and Synthesis George N Sandoor / Arthur G. Erdman, (Vol.2), (2010) ISBN 0-13-011437-5 |
| **2.** | Theory of Machines and Mechanisms, John J Uicker Jr. Gordon R. Pennock, Joseph E. Shigley, , 2003, 3rd Edition, Oxford University Press. |
| **3.** | Kinematics and Dynamics of Machines, R.L.Nortron, McGrawHill, 2017, Edition, ISBN:9789351340201 |
| **4.** | Advanced Mechanism Design, N.G.Sandor and, G.A.Erdman, ,Vol.2, 3rdEdition, 1984, Prentice Hall, ISBN-13: 978-0130408723ISBN-10: 0130408727 |
| **5.** | A Ghosh and A K Mallik,Theory of Mechanism and Machines, 2008, EWLP, Delhi, ISBN:9788185938936 |
| 6 | Kinematics and Dynamics of Machinery, C E Wilson, Pearson Publications, 3rd Edition, ISBN:0201350998 |

**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.**

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

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **NON LINEAR FINITE ELEMENT METHODS (Theory) (Group F: Professional Elective)** | | | | | | |
| **Course Code** | **:** | 16ME7F3 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 4:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 52L | | **SEE Duration** | **:** | **3.00 Hours** |

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

| | |
|---|---|
| **1** | Conceptualize sources of non-linearity in structural analysis |
| **2** | Understand and develop nonlinear stress strain relationship based on different principles |
| **3** | Perform non-linear Finite Element Analysis for 2D problems |
| **4** | Perform non-linear Finite Element Analysis for beam, shell and plate elements |

| **Unit-I** | **09 Hrs** |
|---|---|

**Introduction to Non Linear Analysis**

Importance of Nonlinear Analysis,Classification of non linear analysis, Example analysis–a bracket, basic of incremental/ iterative equations, Principle of virtual working eneral non linear analysis including all material and geometric nonlinearities, requirements of equilibrium, compatibility and stress-strain law, Nodal point equilibrium versus local equilibrium, Assessment of accuracy of solution with Examples.

| **Unit – II** | **12 Hrs** |
|---|---|

**General NonLinearAnalysis:**

Principal of virtual work interms of the $2^{nd}$ Piola-Kirch off stress and Green- Langrange straintens or, Deformation of gradienttensor and physical interpretation, Green-Lagrange straintensor, $2^{nd}$ Piola-Kirch off Stresstensor, Incremental stress and strain decomposition in the total Lagrangian form, Principle of virtualwork, Line arandn on linear strain increments, initial displacement effect,finite element discretization with continuum elements and structural elements, derivation of iterative equations,modified Newton-Raphson iteration.

| **Unit -III** | **12 Hrs** |
|---|---|

**Formulation of Finite Element Analysis:**

Deformation-dependent and independent loading, materially non linear analysis, Dynamic analysis-implicit and explicit time integration, derivation of the finite element analysis for Lagrangian formulations and material non linear analysis, displacement, strain-displacement interpolation and stress matrices, Numerical integration and application of Gauss and Newton-Cotes formulas.

**2D/3D Solidelements;Plane Stress Strain Conditions:** Iso-parametric interpolation of coordinates and displacements, consistency between coordinate and displacement interpolations.

| **Unit –IV** | **09 Hrs** |
|---|---|

**Non linear finite element equations in static analysis:**

Newton-Raphsoniteration for multiple degree of freedom systems, Derivation of governing equations by Taylor series expansion, Initial stress, modified Newton- Raphson and full Newton-Raphson methods, examples, The Broyden-Fletcher- Goldfarb-Shanno (BFGS) method, Computations in the BFGS method as an effective scheme, Convergence criteria and tolerances, Automatic load step incrementation for collapse and post-buckling analysis,Constantarc-length and constant increment of work constraints, Linearized buckling analysis,solution of Eigen problem, example: collapse of anarc, collapse analysis of anelastic-plastic cylinder.

| Unit –V | 10 Hrs |
|---|---|
| **Beam, Plate and Shell Elements:**<br>The degeneration of a three-dimensional continuum to be a mand shell behavior, Basic kinematic and static assumptions used, Formulation of isoparametric general shell elements of variable thickness for large displacements and rotations, Geometry and displacement interpolations,The nodal direct or vectors, the stress- strain law in shell analysis; transformations use data shell element integration points,Shelltransition elements, modeling of transition zones between solids and shells,shell intersections, Study of solutions of straight and curved cantilevers modeled using various elements, Formulation of isoparametric beam elements for large displacements and rotations, Example analysis:180 degrees, large displacement twisting of a ring, Torsion of anelastic-plasticcross-section, Large displacement solution of a cantilever, Collapse analysis of an I-beam in torsion | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Explain sources of non-linearity in structural analysis |
| **CO2:** | Develop nonlinear stress strain relationship based on different principles |
| **CO3:** | Perform non-linear Finite Element Analysis for 2D problems |
| **CO4:** | Perform non-linear Finite Element Analysis for beam, shell and plate elements |

| **Reference Books** | |
|---|---|
| **1** | An Introduction to Non linear Finite Element Analysis, J. N. Reddy, 1 st Edition, 2004, Oxford Publications, ISBN– 978-0-19-852529-5 |
| **2** | Finite Element Methods for Nonlinear Problems, Pal G. Bergan and K.-J. Bathe, Springer Publications, 2nd Edition, 2012, ISBN-10: 3642827063, ISBN-13: 978-3642827068 |
| **3** | Non linear Finite Element Methods, Peter Wriggers, 2008, ISBN:978-3-540-71000-4 (Print) 978-3-540-71001-1 (Online) |
| **4** | Introduction to Nonlinear Finite Element Analysis, Nam-Ho Kim, 1stEdition, 2014, Springer Publications, ISBN: 978-1-4419-1745-4 |

**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.**

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

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

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **DESIGN OF HEAT EXCHANGERS (Theory) (Group F: Professional Elective)** | | | | | | |
| **Course Code** | **:** | 16ME7F4 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 4:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 52L | | **SEE Duration** | **:** | **3.00 Hours** |
| **Course Learning Objectives:** The students will be able to | | | | | | |
| **1** | To learn the thermal analysis on various parts of the heat exchangers. | | | | | |
| **2** | To analyze the sizing and rating of the heat exchangers forvarious applications. | | | | | |
| **3** | To evaluate the factors affecting heat transfer process. | | | | | |
| **4** | To quantify the heat transfer in various systems. | | | | | |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Introduction To Heat Exchanger Design:**<br>Types of heat exchangers and their applications. Flow arrangements and temperature distributions in transfer type of heat exchangers. Overall heat transfer coefficient;- Cleanoverallheattransfer coefficient, dirtf actor dirt over all heat transfer coefficient, dirt factors for various process services. Basic design equation. Mean temperature difference Concept:-LMTD for parallel flow and counter flow arrangement, the correction factor for LMTD for cross flow and multi– pass heat exchangers. | |
| **Unit – II** | **12 Hrs** |
| **Shell And Tube Heat Exchangers**<br>Constructional features. Applications. Effectiveness-NTU method for heat Exchanger design/analysis. Rating and sizing problem. Correlations for tube side pressure drop and heat transfer coefficients. Pressure drop and heat transfer coefficient correlations forshell side flow.<br>**ByPass And Leakage Calculation Procedure For Shell And Tube Heat Exchanger**<br>Heat balance equations: LMTD: reference temperature calculations: evaluation of Fluid properties: flow assignments: tube side flow area calculations; viscosity correction factor, shell side equivalent diameter, calculation of shell side heat transfer coefficient, evaluation for wall temperature,evaluation of overall heat transfer coefficient, Calculation of surface area.Calculations of tube side and shell side pressure drops. | |
| **Unit -III** | **11 Hrs** |
| **Steam Condensers**<br>Specifications of other details as per TEMA standards.Flow arrangement for increased heat recovery: - lack of heat recovery in 1-2 exchangers true temperature difference in a 2-4 exchanger. Calculation procedure for steam condensers.<br>**Double Pipe Heat Exchangers**<br>Constructional features. Applications. Design parameters:- tube side and shell Side film coefficients cut and twist factor, fin efficiency, over all heat transfer coefficient, mean temperature difference, available surface area, fin geometry fin height, number of fins, tube side and shell side pressure drop. Calculation procedure for the design/analysis of double pipe heat exchanger. | |
| **Unit –IV** | **10 Hrs** |
| **Compact Heat Exchangers**<br>Introduction; definition of Geometric Terms:plate fin surface geometries and Surface performance data; correlation of heat transfer and friction data; Goodness factor comparisons; specification of rating and sizing problems; calculation procedure for a rating problem. | |
| **Unit –V** | **10 Hrs** |
| **Air-Cooled Heat Exchangers**<br>Air as coolant for industrial processes; custom-built units; fin-tube systems for air coolers; fin-tube bundles; thermal rating; tube side flow arrangements; cooling air supply by fans; cooling air supply in natural draft towers. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Select appropriate heat exchangers for the given application. |
| **CO2:** | Identify how to design common type of heat exchangers. |
| **CO3:** | Analyze single and multi0phase heat transfer systems and friction coefficient correlation. |
| **CO4:** | Develop sizing of condenser and air cooled heat exchangers. |

| **Reference Books** | |
|---|---|
| **1** | Heat exchangers election, rating and thermal design Sadik Kakaland Hongtan Liu, 2012, 3rd Edition CRC Press, ISBN: 9781439849903 |
| **2** | Heat Exchangers-Theory and practice, T.Taborek,G.F.Hewitt and N.Afgan, 1980, 1st Edition, Mc Graw Hill Book Co., ISBN:978-0070628069. |
| **3** | Industrial Heat Exchangers–ABasicGuide, Walkers, 1980, 1st Edition, McGraw Hill Book Co.,ISBN:10:-0891162305 |
| **4** | Heat Exchanger Design, Arthur,P.Frass, 1989, 2nd Edition, JohnWileyandSons, ISBN:978-0-471-62868-2 |

**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.**

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

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

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **ADVANCED MANUFACTURING PRACTICES (Theory) (Group G: Professional Elective)** | | | | | | |
| **Course Code** | **:** | 16ME7G1 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 4:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 52L | | **SEE Duration** | **:** | **3.00 Hours** |
| **Course Learning Objectives:** The students will be able to | | | | | | |
| **1** | Understand the principles and the practice in industry related to advanced Manufacturing practices such as JIT, Kanban, TQC,Lean etc | | | | | |
| **2** | Develop an appreciation of best manufacturing practice implementation using tools such as TPS,Lean, JITetc | | | | | |
| **3** | Relate the concepts in TPS, JIT etcin real time applications. | | | | | |
| **4** | Design an automated production system using these concepts. | | | | | |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Just In Time** – Introduction –The spread of JIT Movement, some definitions of JIT, core Japanese practices of JIT, Creating continuous Flow Manufacture, Enabling JIT to occur, Basic elements of JIT, Benefits of JIT.<br>**Just in Time Production**: Primary purpose, profit through cost reduction, Elimination of over production,Quality control, Quality Assurance, Respect for Humanity, Flexible work Force, JIT Production Adapting to changing production Quantities, process layout for shortened lead Times, Standardization of operation, Automation. | |
| **Unit – II** | **12 Hrs** |
| **Just-in-Time Production with Total Quality Control:** Just In Time concept, Cutting lot sizes, cuttingset-uptimes, cutting purchase order costs, the JIT cause-Effectchain,Scrap/Quality Improvements, Motivational effects, Responsibility effects, small Group improvement Activities, withdrawal of Buffer Inventory, the total Quality Control Concept, PokaYokein shop floor production and Kaizen. **Sequence and scheduling used by suppliers:** Monthly and daily Information. Sequenced withdrawal system by sequenced schedule table, problems and counter measures in applying the Kanban system to sub contractors. | |
| **Unit -III** | **12 Hrs** |
| **Toyota Production System (TPS)**<br>The philosophy of TPS, Basic Framework of TPS, Kanban, Determining the Number of Kanban in Toyota Production System. Kanban Number under Constant Quantity Withdrawal System. Constant Cycle, Non-constant Quantity Withdrawal System. Supplier Kanbanand the Sequence Schedule for Use by Suppliers. Later Replenishment System by Kanban. Sequenced Withdrawal System.Circulation of the Supplier Kanban with in Toyota. Production Smoothing in TPS, Production Planning, Production Smoothing Adaptability to Demand Fluctuations, Sequencing Method for the Mixed Model Assembly LinetoRealize Smoothed Production ofGoal. | |
| **Unit –IV** | **10 Hrs** |
| **Total Quality Control**<br>Introduction-Total Quality Control concepts, responsibility, learning from the west, TQC concepts categorized, Goals, Habit of improvement, perfection, Basics using 5S, process control, Easy to see Quality control as facilitator, Small lot sizes, House keeping, Less than full capacity scheduling, Daily machine checking, Techniques and Aids, Exposure of problems, Fool proof Devices, Tools of Analysis, QC Circles,TQC in Japanese-owned US Electronics plant, TQC in Japanese-owned Automotive plants. | |

| Unit –V | 09 Hrs |
|---|---|
| **Plant Configurations**: Introduction - Ultimate plant configuration, Job shop Fabrication, Frame Welding, Dedicated production lines,Overl applied production, Daily schedule, Forward Linkage by means of Kanban, Physical merger of processes, Adjacency, Mixed Models, Conveyors and stacker Cranes | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Build awareness and appreciate the best practices in manufacturing related to JIT,TPS, TQC, Kanban etc. |
| **CO2:** | Apply concepts related to world class manufacturing practices by deploying techniques Such as TPS and similar concepts towards Lean manufacturing. |
| **CO3:** | Compare different manufacturing plants and units on the basis of globally accepted performance criteria and their level of maturity in implementation of advanced manufacturing practices. |
| **CO4:** | Design systems using advanced manufacturing practices for a new manufacturing Facility using Lean principles integrated with quality systems. |

| **Reference Books** | |
|---|---|
| **1** | Toyota Production system–An integrated approach to Justin time, Yasuhiro Monden, Hardcover, 1993, 4th Edition, ISBN:9781439820971 |
| **2** | Lean Thinking 1997, 1St Edition, James Womack, Simon & Schuster, Limited Publication, ISBN: 0-7432-4927-5 |
| **3** | The machine that changed the World–The story of Lean production James P.Womack, Danie Lt Jones,and Daniel Roos, 1991,1st Edition, Harper Perennial Publication, , ISBN: |
| **4** | Just in time manufacturing (manual), Kargoanker, 2000, Macmillan Publication, ISBN: 9780333926635 |

**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.**

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

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

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **DESIGN FOR MANUFACTURING AND ASSEMBLY (Theory) (Group G: Professional Elective)** | | | | | | |
| **Course Code** | **:** | 16ME7G2 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 4:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 52L | | **SEE Duration** | **:** | **3.00 Hours** |

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

| | |
|---|---|
| **1** | Understanding of the major manufacturing processes, including machining, casting, Forming and assembly. |
| **2** | Analyze there lationships between customer desires, project materials, product design, and manufacturing process selection. |
| **3** | Develop anappreciation ofproduct design and manufacturing process trade-offs. |
| **4** | Determine how products were manufactured. |

| **Unit-I** | **09 Hrs** |
|---|---|

**Introduction to DFMA**: History of DFMA, Steps for applying DFMA during Product design, Advantages of applying DFMA during product design, Reasons for not implementing DFMA,

**Introduction to Manufacturing Process**: Classification of manufacturing process, Basic manufacturing processes, Mechanical properties of material: Tensile properties, Engineering stress-strain,Truestress strain, Compression properties, Shear properties,

**Introduction to materials and material selection**: Classification of Engineering Materials, Material selection for product design.

| **Unit – II** | **12 Hrs** |
|---|---|

**Sand casting**: Introductiontos and casting,Typical characteristics of a sand cast part, Design recommendation for sand casting.

**Investment casting**: Introduction, Steps in investment casting, Design consideration of Investment casting, Typical characteristics and applications.

**Die casting**:Introduction to die casting, Advantages of the die casting process, Disadvantages of the die casting process, Applications, Suitable material consideration, General design consideration.

**Injection moulding**: Introduction to injection moulding, Typical characteristics of injection moulded parts, Effect of shrinkage, Suitable materials, Design recommendations.

| **Unit -III** | **12 Hrs** |
|---|---|

**Design for machining**:Introduction to machining, Recommended materials for machinability, Design recommendations, Design for tuning operation: Process description,Typical characteristics and applications, Suitable materials, Design recommendations, Design for machining round holes: Introduction, Suitable materials, Design recommendations and Recommended tolerances.

**Parts produced by milling**: Process description, Characteristics and applications of parts produced on milling machines, Design recommendations for milling, Dimensional factors and tolerances, Parts produced by planning,shaping and slotting: Process description, Design recommendation planning.

| **Unit –IV** | **10 Hrs** |
|---|---|

**Introduction to Assembly**: The assembly process, Characteristics and applications, Example of common assembly, Economic significance of assembly, General taxonomies of assembly operation and systems, Assembling a product, Design for Assembly: Introduction, Design consideration,Design for Fasteners: Introduction, Design recommendation for fasteners.

| Unit –V | 09 Hrs |
|---|---|
| **Introduction to CAD**: Geometric Representation in CAD, Extraction of part feature information from CAD Model: Introduction, Feature recognition techniques, Free Form Features, Hybrid Techniques, Reference, Extraction of assembly feature in formation from CAD Model: Introduction, Assembly features, Definition of assembly feature attributes, Characterization of assembly feature. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Describe the role of manufacture and assembly within the over all design process |
| **CO2:** | Evaluate and select manufacturing and assembly processes relevant to the aerospace industry. |
| **CO3:** | Quantify cost and metrics for manufacturing and assembly processes relevant to the Aerospace industry. |
| **CO4:** | Design a complex, well-defined component accounting for manufacture and assembly. |

| **Reference Books** | |
|---|---|
| **1** | Product Design for Manufacture and Assembly Geoffrey Boothroyd, Peter Dewhurst and Winston A. Knight. 2010, Standards media..ISBN-13: 978-1420089271 |
| **2** | Product Design and Development , Karl T.Ulrich and Steven D.Eppinger. 2011, 5$^{th}$Edition. Mc Graw- Hill Education;. ISBN-13: 978-0073404776 |
| **3** | Product Design and Manufacturing 2011, ; 5$^{th}$Edition. Chitale A.K and GuptaR.C. Prentice Hall India Learning Private Ltd. ISBN-13: 978-8120342828 |

**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.**

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

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **PLASTIC MOULD DESIGN (Theory) (Group G: Professional Elective)** | | | | | | |
| **Course Code** | **:** | 16ME7G3 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 4:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 52L | | **SEE Duration** | **:** | **3.00 Hours** |

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

| | |
|---|---|
| **1** | Understand the techniques for manufacturing of plastic components. |
| **2** | Identify the parting surface, feed system and ejection systems for the components. |
| **3** | Apply the basic principle of system formould design. |
| **4** | Design mould for thermos and thermos set components for industrial applications. |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Mould Construction:** Design of various Injection mould elements, cores, cavities, inserts, fitting core and cavity inserts, pillars and bushes.<br>**Parting Surfaces:** Straight, stepped, curved parting surface. | |
| **Unit – II** | **12 Hrs** |
| **Feed and Ejector System:** Design of optimum Gates, Runners, Impressions, Layout, Sprue, Spruepullers.<br>**Ejector System:** Types of ejection, Ejectorgrids, ejection methods, Ejector Pin, Sleeve ejection, plate ejection, Blade ejection, Air ejection, Ejection from fixed half, Double ejection, Delayed ejection.<br>**Cooling System:** Need for cooling, cooling solid cores and cavities, insert cooling, cooling long cores, cooling elements, baffles, bubblers etc., and cooling calculation | |
| **Unit -III** | **12 Hrs** |
| **Extrusion:** Introduction, principles, classification of extruders, single screw extruder, specification, screw nomenclature, types of screws, L/D ratio, compression ratio, back pressure, output and factors affecting output, heating & cooling systems, screw& hopper cooling, die entry effects and trouble shooting the defects.<br>**Twin screw extruder**: principle, types, process, merits & demerits,Vented barrel extruder, hopper loading devices, Drying equipments, Process, Machinery, Dies for producing products such as film, blow film, cast film, sheets, Tubes and pipes. | |
| **Unit –IV** | **10 Hrs** |
| **Blow Moulding:** Microprocessor / CNC controlled blow moulding machine, injection stretch blow moulding of PET, Trouble shooting.<br>**Molds with External and internal Under Cuts:** Split molds, Actuation of splits, Guiding of splits, side cores, Form pins. External threads, internal threads, Moulds with loose cores,Automaticunscrewingtypeofmolds. | |
| **Unit –V** | **09 Hrs** |
| **Compression and Transfer Moulding:** Principle, Process, Machine Specification, Material Recommendation,Bulk factor, Moulding powder, Pre- forms and Preheating Techniques, Process Variables, Flash Mould, Positive mould, Semi Positive mould, Flow Characters & Curing Time, Mould Heating and Cooling System, Trouble Shooting.<br>**Special Moulds**: Under feed mould, 3plate mould, Hotrunner mould (runner less mould), Multi color moulding tool, Rotational moulding. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand Injection moulding, Extrusion, Lamination, Blow moulding and Special Moulding techniques. |
| **CO2:** | Analyse the plastic components and challenges in selection of feed system and its Subsystems involved in different molds, their limitations and applications. |
| **CO3:** | Apply the engineering knowledge for the selection of types of mould for plastic components. |
| **CO4:** | Design various moulds and dies for engineering components. |

| **Reference Books** | |
|---|---|
| **1** | Harper, Hand book of Plastic Processes, CharlesA., 2006, A JohnWiley&Sons, Inc., Publication, ISBN-13: 978-0-471-66255-6 |
| **2** | Injection Mould Design, R.G.WPye, 2000, 4$^{th}$Edition, Affiliated East-West Press Pvt.Ltd.-New Delhi, ISBN: 9788176710107, 8176710105 |
| **3** | Extrusion:The Definitive Processing Guide and Handbook, Harold F.Giles, 2004, William 2$^{nd}$Edition, Andrew Publisher, ISBN: 9780815517115 |
| **4** | Blow Molding Hand book: The Complete Blow Molding Operation, Dominick V. Rosato, 2003, 2$^{nd}$Edition, Hanser Gardner Publications, ISBN-13: 9781569903438 |

**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.**

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

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **ENGINEERING SYSTEMS DESIGN**<br>**(Theory)**<br>**(Group G: Professional Elective)** | | | | | | |
| **Course Code** | **:** | 16ME7G4 | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | 4:0:0:0 | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | 52L | | **SEE Duration** | **:** | **3.00 Hours** |
| **Course Learning Objectives:** The students will be able to | | | | | | |
| **1** | Explain the significance of systems engineering for real world applications. | | | | | |
| **2** | Describe the structure of complex systems. | | | | | |
| **3** | Apply the system engineering principles for solving complex problems. | | | | | |
| **4** | Determine the best concepts among the alternatives. | | | | | |

| **Unit-I** | **10 Hrs** |
|---|---|
| **System Engineering and the world of modern systems:** Definition of system engineering, Origins of system engineering, Examples of Systems requiring systems engineering, Systems engineering view point, Systems engineering as a profession, Power of a systems engineering, Numericals. **Structure of complex systems:** Systems building blocks and inter faces, Hierarchy of complex systems, System environment, Interfaces and interactions, Numericals. | |
| **Unit – II** | **12 Hrs** |
| **The system development process:** Systems engineering through the system life cycle, Evolutionary characteristics of the development process, System engineering method, Testing through out system development, Numericals. **System engineering management:** Managing systems development and risks, Work breakdown structure (WBS), Systems engineering management plan (SEMP), Risk management, Organization of system engineering, System engineering capability maturity assessment, system engineering standards, Numericals. | |
| **Unit -III** | **12 Hrs** |
| **Needs analysis:** Originating a new system, Operations analysis, Functional analysis, Feasibility definition, Needs validation,System operational requirements, Numericals. **Concept exploration:** Developing the system requirement, Operational requirements analysis, Performance requirements formulation, Implementation concept exploration, Performance requirements validation, Numericals. | |
| **Unit –IV** | **09 Hrs** |
| **Concept definition:** Selecting the system concept, Performance of system concept, Functional Analysis and formulation, Concept selection, Concept validation, System development planning, System functional specifications. **Advanced development:** Reducing program risks,Requirements analysis, Functional analysis and design, Prototype development,Development testing, Risk reduction,Numericals. | |

| Unit –V | 09 Hrs |
|---|---|

**Engineering design:**

Implementing the system building blocks, Requirements analysis, Functional analysis and design, Component design, Design validation, Configuration management, Numericals.

**Integration and Evaluation:**

Integrating, Testing and Evaluating the total system, Test planning and preparation, System integration, Development system testing ,Operational test and evaluation, Numericals. Case studies of system design approach for project texecution, Role of system Design approach in initiatives such as 'Make In India'.

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Understand the principles and tools of systems analysis and design. |
| **CO2:** | Identify and describe the phases of the systems development life cycle. |
| **CO3:** | Develop a feasibility analysis of a proposed system. |
| **CO4:** | Apply the system design approach during execution of project. |

| **Reference Books** | |
|---|---|
| **1** | Systems Engineering: Principles and Practice , Alexander Kossaik off, William N Sweet, 2011, Wiley India, ,ISBN-13: 978-0470405482 |
| **2** | The engineering Design of Systems: Models and Methods, Dennis M Beude, 2009, 2nd Edition, Wiley India, , 2009,ISBN-13: 978-0470164020 |
| **3** | Whole System Design: An Integrated Approach to Sustainable Engineering, Peter Stasinopoulos, 2009, 1st Edition, Earth scan Publishers,ISBN-978-1-84407-642-0 |
| **4** | Systems Engineering: Design Principles and Models, Dahai Liu, 2016, CRC 1st Edition, press, ISBN-13: 978-1-4822-8246-7 |

**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 50. The marks component for Assignment/Presentation/Project 10.

**Total CIE is 30(Q) +50(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 | 3 | 3 | 2 | - | 1 | - | 2 | 1 | 1 | - |
| **CO2** | - | 3 | 3 | - | 2 | - | - | - | - | - | 1 | 1 |
| **CO3** | - | 2 | 3 | 3 | - | 1 | - | - | - | 2 | 2 | - |
| **CO4** | - | 2 | 2 | - | - | - | 1 | 1 | - | 2 | 1 | 2 |

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

| Semester: IV | | | | | | |
|---|---|---|---|---|---|---|
| **NANOTECHNOLOGY (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H01 | | **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** | 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** |
| .<br>**Micro & Nano-Electromechanical systems 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)**
**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 | | | | | | |
|---|---|---|---|---|---|---|
| **INDUSTRIAL SAFETY AND RISK MANAGEMENT (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H02 | | **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** | 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 SYSTEMS (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 60 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 |

**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 60 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** | **3** | **3** | **3** | **3** | **2** | **2** | **1** | **2** | **-** | **2** | **2** |
| **CO2** | **3** | **3** | **3** | **3** | **3** | **2** | **2** | **1** | **2** | **-** | **2** | **2** |
| **CO3** | **3** | **3** | **3** | **3** | **3** | **2** | **1** | **1** | **2** | **-** | **2** | **2** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **1** | **2** | **1** | **1** | **1** | **2** | **2** |

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

| Semester: 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:**<br>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:**<br>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**<br>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**<br>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**<br>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. |

**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 | | | | | | |
|---|---|---|---|---|---|---|
| **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 **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. **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. |

**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.

| VII Semester | | | | | | |
|---|---|---|---|---|---|---|
| **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. |

**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 | | | | | | |
|---|---|---|---|---|---|---|
| **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. |

**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 60 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 | | | | | | |
|---|---|---|---|---|---|---|
| **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: Open 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:** Need for Smart Manufacturing, Advantages, Emerging technologies in Smart manufacturing, CAD Architecture surrounding 3D Models (B-repand 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-** 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** 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** Simulation - system entities, input variables, performance measures, and Functional relationships, types of simulation. Predictive modeling and simulation tools, Knowledge Modelling –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 Modelling 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** | ZongweiLuo, Smart Manufacturing Innovation and Transformation: Interconnection And Intelligence, IEdition, IGIGlobalPublications, 2014,ISBN-13: 978-1466658363 ISBN-10: 1466658363 |
| **2** | Yan Lu. KC Morris, Simon Frechette, Smart Manufacturing Standards, NIST, 1stEdition, 2016, Project report. |

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

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **SPACE TECHNOLOGY AND APPLICATIONS (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H11 | | **CIE** | **:** | **100 Marks** |
| **Credits:** | **:** | 3 : 0 : 0 : 0 | | **SEE** | **:** | **100 Marks** |
| **Hrs/Week** | **:** | 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, Tele-medicine, 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** | **07Hrs** |
| **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)**
**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 | | | | | | |
|---|---|---|---|---|---|---|
| **ADVANCED LINEAR ALGEBRA (Group G: 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. |

**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 60 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 | - | - | - | - | - | - | - | 2 |
| **CO2** | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 2 |
| **CO3** | 2 | 3 | 2 | 2 | - | - | - | - | - | - | - | 1 |
| **CO4** | 3 | 3 | 1 | 2 | 1 | - | - | - | - | - | - | 3 |

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

| Semester: VII | | | | | | |
|---|---|---|---|---|---|---|
| **THIN FILM NANOTECHNOLOGY (Group G: 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 |

**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 60 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** |
| **CO2** | | | | **2** | | | | | | | | **2** |
| **CO3** | | | | | **2** | | | | | | | **2** |
| **CO4** | | | **2** | **2** | **2** | | **2** | | **2** | **2** | | **2** |

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

| **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**<br>**Surface Coating materials**:<br>Synthesis and applications of Polymer coating materials: Teflon, Silicone films Polyvinyl chloride & its copolymers, Poly vinyl acetate, Poly ethylene-HDPE, LDPE, Polyurethane.<br>Properties required in a pigment and extenders.<br>Inorganic pigments-titanium dioxide, zinc oxide, carbon black, chromate pigments, chrome green, ultramarine blue, iron blue, cadmium red.<br>**Corrosion inhibiting pigments-** zinc phosphate, zinc and barium chromate pigments, ceramic pigments, metal flake pigments, extenders.<br>Developments in new polymers such as dendrimers, biopoplymers & biodegradable polymers.<br>**Packaging materials:**<br>Food products: Cellulosic and Polymeric packaging materials and their properties – including barrier properties, strength properties, optical properties. Glass, aluminium, tin, paper, plastics, composites.<br>**Pharmaceutical products:** Injectibles and tablet packaging materials. | |
| **UNIT-II** | **07 Hrs** |
| **Adhesives**<br>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**<br>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.<br>**Ion exchange resins and membranes**<br>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 techniques and 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 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 | | | | | | |
|---|---|---|---|---|---|---|
| **APPLIED PSYCHOLOGY FOR ENGINEERS (Group H: Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H15 | | **CIE** | **:** | **100** |
| **Credits: L:T:P** | **:** | 3:0:0 | | **SEE** | **:** | **100** |
| **Total Hours** | **:** | 35 | | **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) | |

| |
|---|
| 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. |

| **Scheme of Continuous Internal Evaluation (CIE):** |
|---|
| CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100. |
| **Scheme of Semester End Examination (SEE):** |
| SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level. |

| VII Semester | | | | | | |
|---|---|---|---|---|---|---|
| **FOUNDATIONAL COURSE ON ENTREPRENEURSHIP (Group : Global Elective)** | | | | | | |
| **Course Code** | **:** | 16G7H16 | | **CIE Marks** | **:** | **100 Marks** |
| **Credits: L:T:P:S** | **:** | 3:0:0:0 | | **SEE Marks** | **:** | **100 Marks** |
| **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. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

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

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

| **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)**

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

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

| Semester VIII | | | |
|---|---|---|---|
| **Major Project (Common to all Programs)** | | | |
| **Course Code : 16ME81** | | **CIE : 100 Marks** | |
| **Credits: L:T:P:S : 0:0:16:0** | | **SEE : 100 Marks** | |
| **Hrs/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 |

| **CO-PO Mapping** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO1** | **3** | **3** | **3** | **3** | **2** | **2** | **1** | **2** | **2** | **2** | **2** | **2** |
| **CO2** | **3** | **3** | **3** | **3** | **2** | **2** | **1** | **2** | **2** | **2** | **2** | **2** |
| **CO3** | **3** | **3** | **3** | **3** | **2** | **2** | **1** | **2** | **2** | **2** | **2** | **2** |
| **CO4** | **1** | **1** | **11** | **1** | **1** | **1** | **1** | **2** | **1** | **2** | **1** | **1** |

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

| Semester VIII | | | | | | |
|---|---|---|---|---|---|---|
| **Technical Seminar (Common to all Programs)** | | | | | | |
| **Course Code** | **:** | **16ME82** | | **CIE** | **:** | **100 Marks** |
| **Credits: L: T: P: S** | **:** | **0:0:2:0** | | **SEE** | **:** | **100 Marks** |
| **Hrs/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** |

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

| **VIII Semester** | | | | | | |
|---|---|---|---|---|---|---|
| **Innovation & Social Skills (Common to all Programs)** | | | | | | |
| **Course Code** | **:** | **16HS83** | | **CIE** | **:** | **NA** |
| **Credits: L: T: P: S** | **:** | **0:0:1:0** | | **SEE** | **:** | **NA** |
| **Hrs/week** | **:** | **02** | | **SEE Duration** | **:** | **NA** |

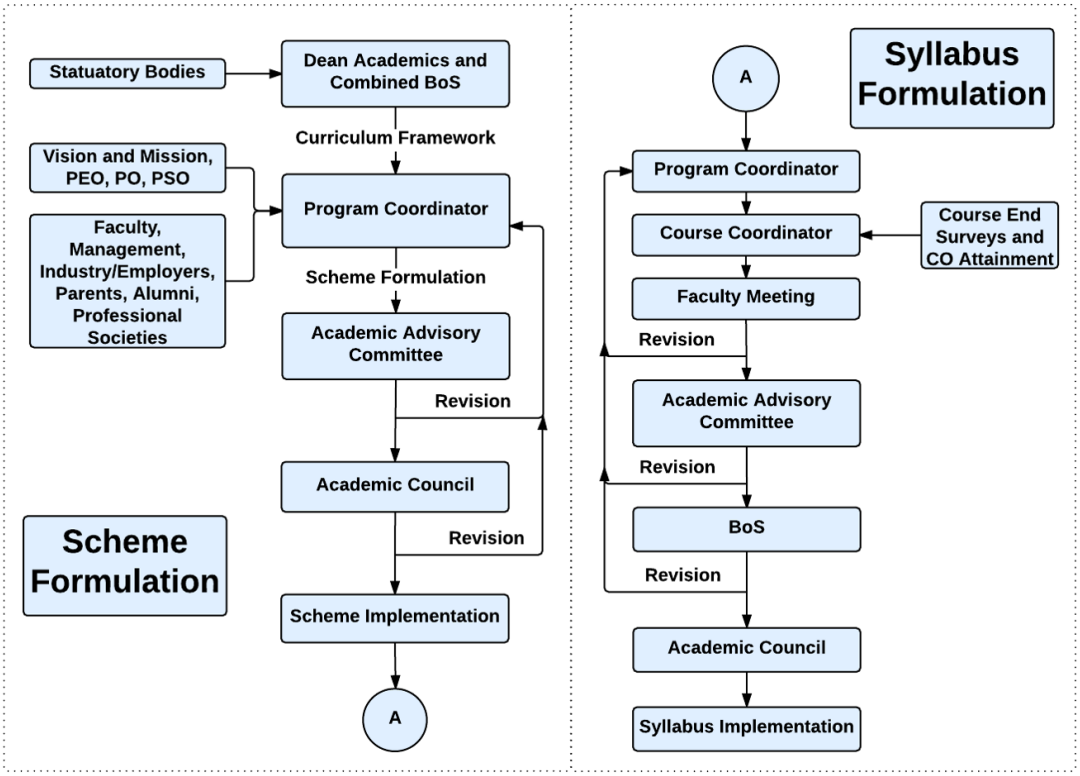
| **Course Learning Objectives: The students will be able to** | |
|---|---|
| **1** | To provide a platform for the students to exhibit their organizational capabilities, team building, ethical values and extra mural abilities. |
| **2** | To encourage to carryout innovative ideas and projects. |
|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

**Guidelines**

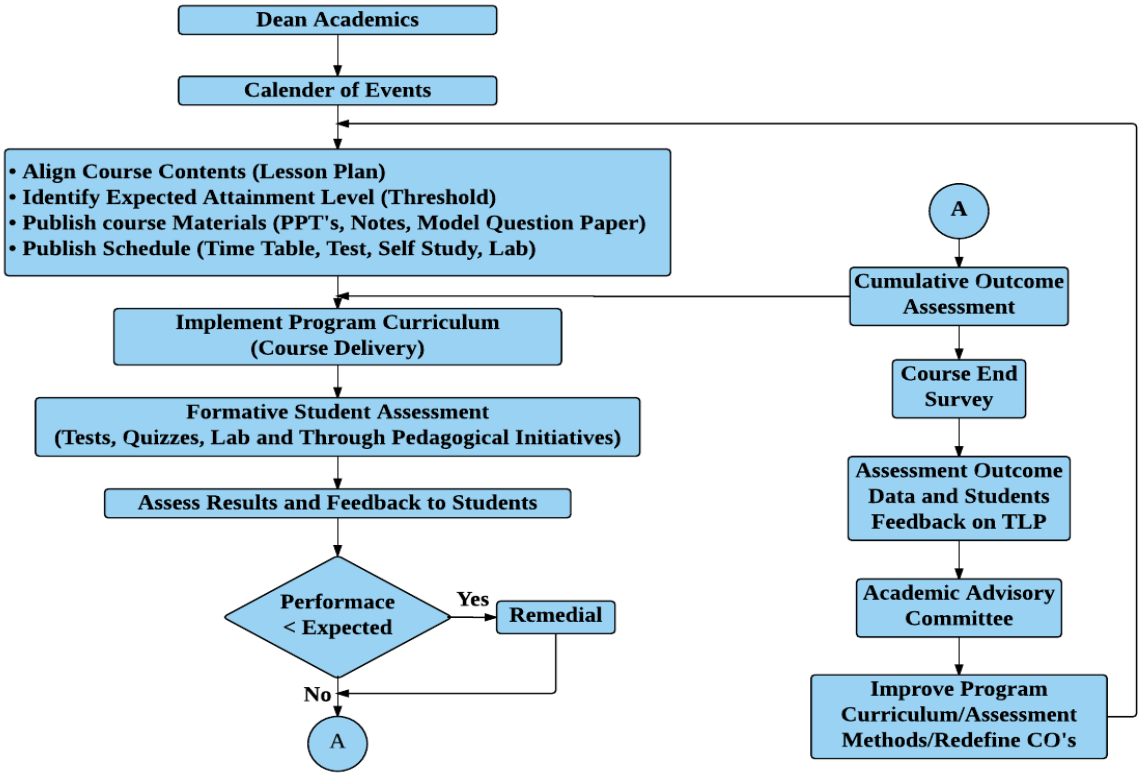
1. The HSS will be evaluated individually based on the broad parameters which include the progress made by student during 3rd& 4th year in innovative projects, Seminar, Paper Presentation, Field activity & other Co-curricular activities.
2. Students shall submit a report and documents as a proof his/her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

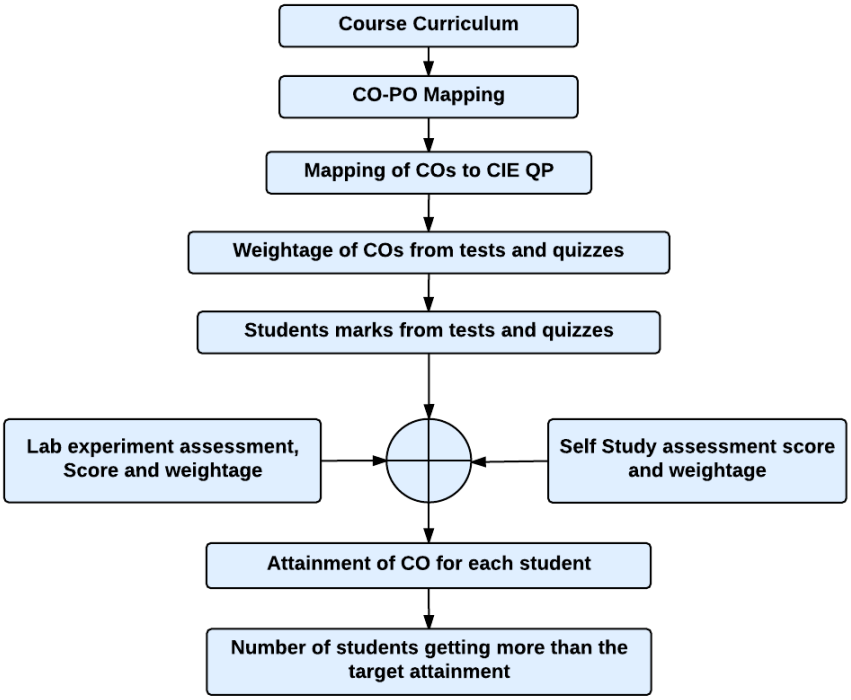
## Curriculum Design Process



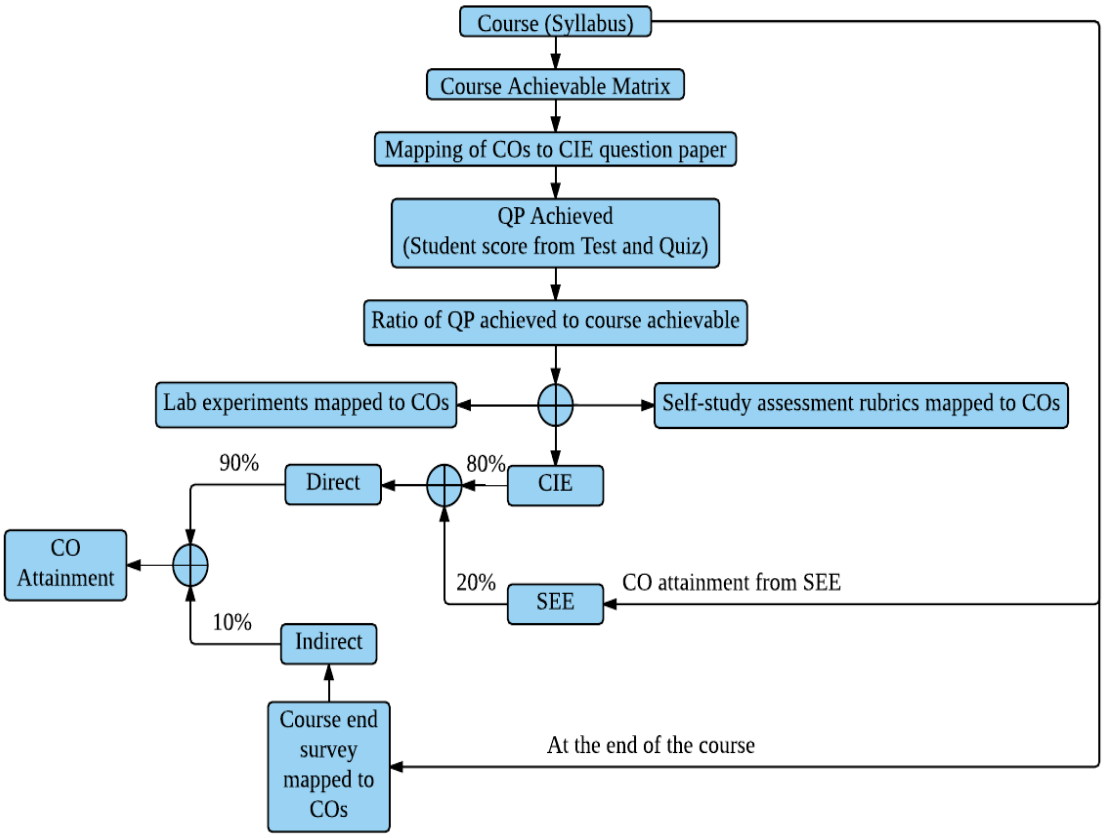

## Academic Planning And Implementation



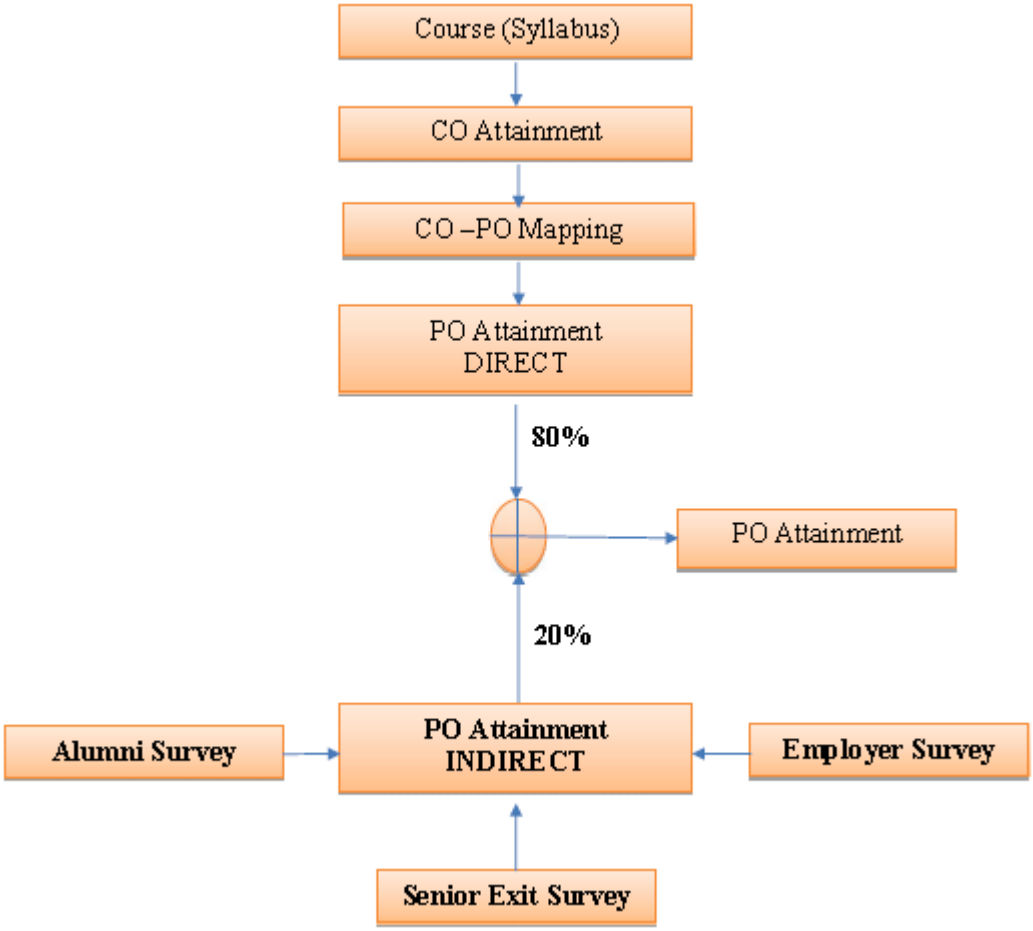
## Process For Course Outcome Attainment




## Final CO Attainment Process



## Program Outcome Attainment Process



## PROGRAM OUTCOMES (POs)

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

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

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

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

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

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

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

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

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

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

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

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