# SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur, Chengalpattu Dt.-603203, Tamil Nadu.

## DEPARTMENT OF

## MECHANICAL ENGINEERING

# UNDER GRADUATE

# CURRICULA AND SYLLABI

# (REGULATIONS 2019)

# SRM VALLIAMMAI ENGINEERING COLLEGE

**(An Autonomous Institution, Affiliated to Anna University, Chennai)**

**B.E.- MECHANICAL ENGINEERING**

**REGULATION – 2019**

## PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

**PEO1:** To prepare our students for successful placement and career in industries besides, pursuing higher studies.

**PEO2:** To formulate our students with fundamental knowledge in mechanical engineering in order to understand, analyse, design and create products/processes concerning environment.

**PEO3:** To develop our students to have a deep and wide knowledge in multidisciplinary subjects.

**PEO4:** To concoct our students with professional attitude as an individual or team member with consideration for society.

**PEO5:** To create interest among our students for life-long learning through self-study for effective communication, leadership and research.

## PROGRAMME OUTCOMES (POs):

| POs | Graduate Attribute | Programme Outcome |
|---|---|---|
| 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 | Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. |

**PROGRAM SPECIFIC OUTCOMES (PSOs):**

Upon completion of Mechanical Engineering program students can be able to;

1. Analyse and solve problems related to mechanical engineering.
2. Apply thermal, fluid, design, electrical & electronics engineering principles to mechanical engineering applications.
3. Apply the tools and techniques of quality management to manufacturing and service processes.
4. Use the concept of process planning and cost estimation to manufacture different products.

## 4. PEO / PO Mapping:

| PROGRAMME EDUCATIONAL OBJECTIVES | PROGRAMME OUTCOMES | | | | | | | | | | | | PROGRAM SPECIFIC OUTCOMES | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| I | ✓ | | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | ✓ | | |
| II | ✓ | ✓ | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| III | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| IV | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | | | | |
| V | | ✓ | | | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | | | |

## MAPPING – UG- MECHANICAL ENGINEERING

| | | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year I | Sem I | Communicative English | 3 | 3 | 2 | 2 | 2 | 1 | 1 | | | 3 | | 1 | 1 | 1 | 1 | 1 |
| | | Engineering Mathematics - I | 3 | 2 | 2 | 1 | | | | | | | | 1 | | | | |
| | | Engineering Physics | 3 | 1 | 1 | | | 1 | 1 | | | | | 1 | 3 | | | |
| | | Engineering Chemistry | 2 | 1 | 2 | | 1 | 1 | 1 | | | | | 2 | 2 | 2 | 2 | 1 |
| | | Problem Solving and Python Programming | 1 | | 1 | | 1 | | | | | 1 | | | | 1 | 1 | 1 |
| | | Basic Electrical and Electronics Engineering | 3 | 2 | 2 | 2 | 2 | 1 | | | 1 | | | 2 | 1 | | | 2 |
| | | Physics and Chemistry Laboratory | 3 | 1 | 1 | 1 | | 1 | | 1 | 1 | | | | 1 | | | |
| | | Problem Solving and Python Programming Laboratory | 1 | | | | | | | | | | | | 1 | | | |
| Year I | Sem II | Technical English | 3 | 2 | 1 | 1 | | | | | 1 | 2 | | 1 | 2 | 1 | 1 | |
| | | Engineering Mathematics - II | 3 | 3 | 3 | | | | | | 3 | | | | | | | |
| | | Physics for Mechanical Engineering | 3 | 1 | 1 | 1 | | | 1 | | | | | 2 | 1 | 3 | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Environmental Science and Engineering | 1 | 2 | 2 | | | 1 | 3 | | 2 | | | 2 | 1 | 2 | 2 | 1 |
| | | Programming in - C | 2 | 1 | 1 | | 1 | | | | 1 | | | | 1 | 1 | | 1 |
| | | Engineering Graphics | 2 | | 3 | | | | | | 1 | 3 | | 1 | 2 | 1 | 1 | 1 |
| | | C - Programming Laboratory | 1 | | 1 | | | | | 1 | | | | | 1 | | | |
| | | Engineering Practices Laboratory | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | |
| | | Applied Physics and Environmental Chemistry Laboratory | 3 | 2 | 2 | 2 | | 1 | | 1 | 1 | | | | 2 | | | |
| | | NSS/NCC/YRC /NSO | | | | | | | | | | | | | | | | |

| | | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Transforms and Partial Differential Equations | 3 | 3 | 3 | | | | | 3 | 3 | | | | | | | |
| | | Engineering Mechanics | 3 | 2 | 3 | 1 | | | | | | | | 2 | 3 | 1 | 2 | 3 |
| Year II | Sem III | Engineering Thermodynamics | 3 | 3 | 2 | 2 | | | 1 | 1 | | 1 | | 2 | 2 | 1 | | |
| | | Manufacturing Processes | 3 | | | | | | 2 | | | | | 1 | 2 | 2 | | 1 |
| | | Fluid Mechanics and Machinery | 3 | 3 | 3 | 1 | 2 | | | | | | | | 3 | 3 | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Manufacturing Technology Laboratory | 2 | | | | | | 2 | | | | | 1 | 2 | 1 | 2 | 1 |
| | | Fluid Mechanics and Machinery Laboratory | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | 3 | 3 | | | 1 | 2 | 2 | 2 |
| | | Communication Skills Laboratory - Project Based | 3 | 3 | 1 | 1 | 1 | | 1 | | | 3 | | 1 | 2 | 2 | 1 | 1 |
| Year II | Sem IV | Statistics and Numerical Methods | 3 | 3 | | | | | | | | | | | 1 | | | |
| | | Kinematics of Machinery | 3 | 2 | 2 | | 2 | | | 1 | | | | 1 | 3 | | 1 | |
| | | Metal Cutting and Machine Tools | 2 | 2 | 1 | 2 | 2 | | | | | | | | 1 | 2 | 2 | |
| | | Strength of Materials | 2 | 1 | 2 | | | | | | | | | | 2 | | | |
| | | Applied Thermodynamics | 3 | 2 | 1 | 1 | | | | | | | | | 2 | 1 | | |
| | | Professional Ethics | | | | | | 2 | 2 | 2 | | | | | | | | |
| | | Computer Aided Machine Drawing Practices Laboratory | | | | | 3 | | | | | 2 | | 3 | | | 2 | 2 |
| | | Strength of Material Laboratory | 3 | 1 | 2 | | | | | | | | | | 2 | | | |

| | | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year III | Sem V | Thermal Engineering | 3 | 3 | | 3 | | 2 | 2 | 1 | | | | | 3 | 3 | | |
| | | Design of Machine Elements | 2 | 2 | 3 | | | | | 1 | | | | 2 | 3 | 3 | | |
| | | Metrology and Measurements | 2 | 1 | 1 | | 1 | 1 | | | | | | | 2 | 2 | 2 | |
| | | Dynamics of Machines | 2 | 2 | 2 | | | | 2 | | | | | | 3 | 3 | | |
| | | Professional Elective - I | 1 | 2 | 2 | 1 | 1 | | | | | | | | 2 | 1 | 1 | 3 |
| | | Open Elective - I | | | | | | | | | | | | | | | | |
| | | Dynamics and Metrology Laboratory | 1 | 1 | 1 | 2 | | | | | | | | | 1 | | 1 | |
| | | Thermal Engineering Laboratory | 3 | 3 | | 3 | | 2 | 2 | 1 | | | | | 3 | 3 | | |
| | | Professional Communication | 3 | 2 | 1 | 2 | 1 | | 1 | | | 3 | | 1 | 1 | 1 | 1 | 1 |
| Year III | Sem VI | Design of Transmission System | 2 | 2 | 3 | | | | | 1 | | | | 2 | 3 | 3 | | |
| | | Heat and Mass Transfer | 2 | 2 | 1 | 1 | 1 | 1 | | 1 | | 1 | | 1 | 0 | 1 | | |
| | | Finite Element Analysis | 3 | 3 | 2 | 2 | 1 | 1 | | | 1 | 2 | | 2 | 3 | 3 | | |
| | | Professional Elective - II | | | | | | | | | | | | | | | | |
| | | Professional Elective - III | | | | | | | | | | | | | | | | |
| | | CAD / CAM and Analysis Laboratory | 2 | 2 | 1 | | 3 | | | 1 | | | | 1 | 1 | | 1 | |
| | | Design and | 2 | 1 | 1 | 1 | 1 | | | | | | 1 | 1 | 2 | 1 | 2 | 2 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fabrication Project | | | | | | | | | | | | | | | | |
| | | Heat Transfer Laboratory | 3 | 3 | | 3 | | 2 | 2 | 1 | | | | | 3 | 3 | | |

| | | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year IV | Sem VII | Electric Vehicles | 1 | | 1 | 1 | 1 | 1 | | | 1 | | | | | | 1 | 1 |
| | | Process Planning and Cost Estimation | 1 | | 1 | | | 1 | | | 1 | | 1 | | 1 | 1 | | 1 |
| | | Mechatronics and Automation | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | | | | 1 | 1 | 1 | |
| | | Professional Elective – IV | | | | | | | | | | | | | | | | |
| | | Professional Elective – V | | | | | | | | | | | | | | | | |
| | | Open Elective - II | | | | | | | | | | | | | | | | |
| | | Mechatronics and Automation Laboratory | 3 | 1 | 1 | 1 | 1 | | | | | | | | 2 | 1 | | 1 |
| | | Project Work – Phase I | 3 | 3 | 3 | 2 | 3 | 1 | 3 | 1 | 3 | 3 | 3 | 1 | 3 | 2 | 1 | 1 |
| | | Internship | 3 | 2 | 2 | 3 | 3 | | | | | | 3 | | 3 | 2 | 1 | 3 |
| Year IV | Sem VIII | Green Manufacturing | 1 | 2 | 2 | | | | | | | | | | 3 | | | 3 |
| | | Professional Elective - VI | | | | | | | | | | | | | | | | |
| | | Project Work Phase II | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

# SRM VALLIAMMAI ENGINEERING COLLEGE

**(An Autonomous Institution, Affiliated to Anna University, Chennai)**

## B.E. – MECHANICAL ENGINEERING
## REGULATION – 2019
## CHOICE BASED CREDIT SYSTEM
## CURRICULA & SYLLABI (I TO VIII SEMESTERS)

### SEMESTER - I

| SL NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | 1919101 | Communicative English | HS | 3 | 3 | 0 | 0 | 3 |
| 2. | 1918102 | Engineering Mathematics - I | BS | 4 | 3 | 1 | 0 | 4 |
| 3. | 1920103 | Engineering Physics | BS | 3 | 3 | 0 | 0 | 3 |
| 4. | 1921104 | Engineering Chemistry | BS | 3 | 3 | 0 | 0 | 3 |
| 5. | 1901005 | Problem Solving and Python Programming | ES | 3 | 3 | 0 | 0 | 3 |
| 6. | 1901106 | Basic Electrical and Electronics Engineering | ES | 3 | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | | | |
| 7. | 1901108 | Physics and Chemistry Laboratory | BS | 4 | 0 | 0 | 4 | 2 |
| 8. | 1901009 | Problem Solving and Python Programming Laboratory | ES | 4 | 0 | 0 | 4 | 2 |
| **TOTAL** | | | | **27** | **18** | **1** | **8** | **23** |

### SEMESTER - II

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | 1919201 | Technical English | HS | 3 | 3 | 0 | 0 | 3 |
| 2. | 1918202 | Engineering Mathematics - II | BS | 4 | 3 | 1 | 0 | 4 |
| 3. | 1920204 | Physics for Mechanical Engineering | BS | 3 | 3 | 0 | 0 | 3 |
| 4. | 1921203 | Environmental Science and Engineering | BS | 3 | 3 | 0 | 0 | 3 |
| 5. | 1901006 | Programming in - C | ES | 3 | 3 | 0 | 0 | 3 |
| 6. | 1901007 | Engineering Graphics | ES | 6 | 2 | 0 | 4 | 4 |
| **PRACTICAL** | | | | | | | | |
| 7. | 1901010 | C - Programming Laboratory | ES | 4 | 0 | 0 | 4 | 2 |
| 8. | 1901208 | Engineering Practices Laboratory | ES | 4 | 0 | 0 | 4 | 2 |
| 9. | 1901209 | Applied Physics and | BS | 4 | 0 | 0 | 4 | 2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Environmental Chemistry Laboratory | | | | | | |
| 10. | | NSS/NCC/YRC/NSO | PCD | 1* | 0 | 0 | 0 | 1 |
| ** conducted after college hours* | | | **TOTAL** | **34** | **17** | **1** | **16** | **27** |

## SEMESTER - III

| SL. No. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | 1918301 | Transforms and Partial Differential Equations | BS | 4 | 3 | 1 | 0 | 4 |
| 2. | 1909301 | Engineering Mechanics | ES | 4 | 3 | 1 | 0 | 4 |
| 3. | 1909302 | Engineering Thermodynamics | PC | 3 | 3 | 0 | 0 | 3 |
| 4. | 1909303 | Manufacturing Processes | PC | 3 | 3 | 0 | 0 | 3 |
| 5. | 1909304 | Fluid Mechanics and Machinery | ES | 3 | 3 | 0 | 0 | 3 |
| **PRACTICALS** | | | | | | | | |
| 6. | 1909305 | Manufacturing Technology Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 7. | 1909306 | Fluid Mechanics and Machinery Laboratory | ES | 4 | 0 | 0 | 4 | 2 |
| 8. | 1919001 | Communication Skills Laboratory - Project Based | EEC | 2 | 0 | 0 | 2 | 0 |
| | | | **TOTAL** | **27** | **15** | **2** | **10** | **21** |

## SEMESTER - IV

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | 1918405 | Statistics and Numerical Methods | BS | 4 | 3 | 1 | 0 | 4 |
| 2. | 1909401 | Kinematics of Machinery | PC | 3 | 3 | 0 | 0 | 3 |
| 3. | 1909402 | Metal Cutting and Machine Tools | PC | 3 | 3 | 0 | 0 | 3 |
| 4. | 1909403 | Strength of Materials | ES | 3 | 3 | 0 | 0 | 3 |
| 5. | 1909404 | Applied Thermodynamics | PC | 3 | 3 | 0 | 0 | 3 |
| 6. | 1915001 | Professional Ethics | HS | 3 | 3 | 0 | 0 | 3 |
| **PRACTICALS** | | | | | | | | |
| 7. | 1909405 | Computer Aided Machine Drawing Practices Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 8. | 1909406 | Strength of Material Laboratory | ES | 4 | 0 | 0 | 4 | 2 |
| | | | **TOTAL** | **27** | **18** | **1** | **8** | **23** |

## SEMESTER - V

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | 1909501 | Thermal Engineering | PC | 3 | 3 | 0 | 0 | 3 |
| 2. | 1909502 | Design of Machine Elements | PC | 3 | 3 | 0 | 0 | 3 |
| 3. | 1909503 | Metrology and Measurements | PC | 3 | 3 | 0 | 0 | 3 |
| 4. | 1909504 | Dynamics of Machines | PC | 3 | 3 | 0 | 0 | 3 |
| 5. | 19xxxxx | Professional Elective - I | PE | 3 | 3 | 0 | 0 | 3 |
| 6. | 19xxxxx | Open Elective - I | OE | 3 | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | | | |
| 7. | 1909513 | Dynamics and Metrology Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 8. | 1909514 | Thermal Engineering Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 9. | 1919002 | Professional Communication | EEC | 2 | 0 | 0 | 2 | 1 |
| | | | **TOTAL** | **28** | **18** | **0** | **10** | **23** |

## SEMESTER - VI

| SL. No. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | 1909601 | Design of Transmission System | PC | 3 | 3 | 0 | 0 | 3 |
| 2. | 1909602 | Heat and Mass Transfer | PC | 4 | 3 | 1 | 0 | 4 |
| 3. | 1909603 | Finite Element Analysis | PC | 4 | 3 | 1 | 0 | 4 |
| 4. | 19xxxxx | Professional Elective - II | PE | 3 | 3 | 0 | 0 | 3 |
| 5. | 19xxxxx | Professional Elective - III | PE | 3 | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | | | |
| 6. | 1909609 | CAD / CAM and Analysis Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 7. | 1909610 | Design and Fabrication Project | EEC | 4 | 0 | 0 | 4 | 2 |
| 8. | 1909611 | Heat Transfer Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| | | | **TOTAL** | **29** | **15** | **2** | **12** | **23** |

## SEMESTER - VII

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | 1909701 | Electric Vehicles | PC | 3 | 3 | 0 | 0 | 3 |
| 2. | 1909702 | Process Planning and Cost Estimation | PC | 3 | 3 | 0 | 0 | 3 |
| 3. | 1909703 | Mechatronics and Automation | PC | 3 | 3 | 0 | 0 | 3 |
| 4. | 19xxxxx | Professional Elective - IV | PE | 3 | 3 | 0 | 0 | 3 |
| 5. | 19xxxxx | Professional Elective - V | PE | 3 | 3 | 0 | 0 | 3 |
| 6. | 19xxxxx | Open Elective - II | OE | 3 | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | | | |
| 7. | 1909714 | Mechatronics and Automation Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 8. | 1909715 | Project Work – Phase I | EEC | 4 | 0 | 0 | 4 | 2 |
| 9. | 1909716 | Internship | EEC | 0 | 0 | 0 | 0 | 1 |
| | | | **TOTAL** | **26** | **18** | **0** | **8** | **23** |

## SEMESTER - VIII

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | 1909801 | Green Manufacturing | PC | 3 | 3 | 0 | 0 | 3 |
| 2. | 19xxxxx | Professional Elective - VI | PE | 3 | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | | | |
| 3. | 1909807 | Project Work - Phase II | EEC | 12 | 0 | 0 | 12 | 6 |
| | | | **TOTAL** | **18** | **6** | **0** | **12** | **12** |

## HUMANITIES AND SOCIAL SCIENCES (HS)

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1919101 | Communicative English | HS | 3 | 3 | 0 | 0 | 3 |
| 2. | 1919201 | Technical English | HS | 3 | 3 | 0 | 0 | 3 |
| 3. | 1919801 | Environmental Science and Engineering | HS | 3 | 3 | 0 | 0 | 3 |
| 4. | 1915001 | Professional Ethics | HS | 3 | 3 | 0 | 0 | 3 |

## BASIC SCIENCE (BS)

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1918102 | Engineering Mathematics - I | BS | 4 | 3 | 1 | 0 | 4 |
| 2. | 1920103 | Engineering Physics | BS | 3 | 3 | 0 | 0 | 3 |
| 3. | 1921104 | Engineering Chemistry | BS | 3 | 3 | 0 | 0 | 3 |
| 4. | 1921203 | Environmental Science and Engineering | BS | 3 | 3 | 0 | 0 | 3 |
| 5. | 1901108 | Physics and Chemistry Laboratory | BS | 4 | 0 | 0 | 4 | 2 |
| 6. | 1918202 | Engineering Mathematics - II | BS | 4 | 3 | 1 | 0 | 4 |
| 7. | 1920204 | Physics for Mechanical Engineering | BS | 3 | 3 | 0 | 0 | 3 |
| 8. | 1918301 | Transforms and Partial Differential Equations | BS | 4 | 3 | 1 | 0 | 4 |
| 9. | 1918405 | Statistics and Numerical Methods | BS | 4 | 3 | 1 | 0 | 4 |
| 10. | 1901209 | Applied Physics and Environmental Chemistry Laboratory | BS | 4 | 0 | 0 | 4 | 2 |

## ENGINEERING SCIENCES (ES)

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1901005 | Problem Solving and Python Programming | ES | 3 | 3 | 0 | 0 | 3 |
| 2. | 1901007 | Engineering Graphics | ES | 6 | 2 | 0 | 4 | 4 |
| 3. | 1901009 | Problem Solving and Python Programming Laboratory | ES | 4 | 0 | 0 | 4 | 2 |
| 4. | 1901106 | Basic Electrical and Electronics Engineering | ES | 3 | 3 | 0 | 0 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5. | 1901006 | Programming in – C | ES | 3 | 3 | 0 | 0 | 3 |
| 6. | 1901208 | Engineering Practices Laboratory | ES | 4 | 0 | 0 | 4 | 2 |
| 7. | 1901010 | C - Programming Laboratory | ES | 4 | 0 | 0 | 4 | 2 |
| 8. | 1909301 | Engineering Mechanics | ES | 4 | 3 | 1 | 0 | 4 |
| 9. | 1909304 | Fluid Mechanics and Machinery | ES | 3 | 3 | 0 | 0 | 3 |
| 10. | 1909306 | Fluid Mechanics and Machinery Lab | ES | 4 | 0 | 0 | 4 | 2 |
| 11. | 1909403 | Strength of Materials | ES | 3 | 3 | 0 | 0 | 3 |
| 12. | 1909406 | Strength of Material Laboratory | ES | 4 | 0 | 0 | 4 | 2 |

**PROFESSIONAL CORE (PC)**

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1909302 | Engineering Thermodynamics | PC | 3 | 3 | 0 | 0 | 3 |
| 2. | 1909303 | Manufacturing Processes | PC | 3 | 3 | 0 | 0 | 3 |
| 3. | 1909305 | Manufacturing Technology Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 4. | 1909307 | Applied Fluid Mechanics and Thermodynamics | PC | 3 | 3 | 0 | 0 | 3 |
| 5. | 1909308 | Theory of Machines | PC | 3 | 3 | 0 | 0 | 3 |
| 6. | 1909401 | Kinematics of Machinery | PC | 3 | 3 | 0 | 0 | 3 |
| 7. | 1909402 | Metal Cutting and Machine Tools | PC | 3 | 3 | 0 | 0 | 3 |
| 8. | 1909404 | Applied Thermodynamics | PC | 3 | 3 | 0 | 0 | 3 |
| 9. | 1909405 | Computer Aided Machine Drawing Practices Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 10. | 1909407 | Farm Tractors | PC | 3 | 3 | 0 | 0 | 3 |
| 11. | 1909501 | Thermal Engineering | PC | 3 | 3 | 0 | 0 | 3 |
| 12. | 1909502 | Design of Machine Elements | PC | 3 | 3 | 0 | 0 | 3 |
| 13. | 1909503 | Metrology and Measurements | PC | 3 | 3 | 0 | 0 | 3 |
| 14. | 1909504 | Dynamics of Machines | PC | 3 | 3 | 0 | 0 | 3 |
| 15. | 1909513 | Dynamics and Metrology Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 16. | 1909514 | Thermal Engineering Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 17. | 1909515 | Design of Basic Machine Elements | PC | 3 | 0 | 0 | 0 | 3 |
| 18. | 1909601 | Design of Transmission System | PC | 3 | 3 | 0 | 0 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 19. | 1909602 | Heat and Mass Transfer | PC | 4 | 3 | 1 | 0 | 4 |
| 20. | 1909603 | Finite Element Analysis | PC | 4 | 3 | 1 | 0 | 4 |
| 21. | 1909612 | Refrigeration and Air conditioning for Agricultural Engineers | PC | 3 | 3 | 0 | 0 | 3 |
| 22. | 1909609 | CAD / CAM and Analysis Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 23. | 1909611 | Heat Transfer Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 24. | 1909701 | Electric Vehicles | PC | 3 | 3 | 0 | 0 | 3 |
| 25. | 1909702 | Process Planning and Cost Estimation | PC | 3 | 3 | 0 | 0 | 3 |
| 26. | 1909703 | Mechatronics and Automation | PC | 3 | 3 | 0 | 0 | 3 |
| 27. | 1909714 | Mechatronics and Automation Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 28. | 1909717 | Heat and Mass Transfer for Agricultural Engineers | PC | 3 | 3 | 0 | 0 | 3 |
| 29. | 1909801 | Green Manufacturing | PC | 3 | 3 | 0 | 0 | 3 |

**EMPLOYABILITY ENHANCEMENT COURSES [EEC]**

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1909610 | Design and Fabrication Project | EEC | 4 | 0 | 0 | 4 | 2 |
| 2. | 1919001 | Communication Skills Laboratory-Project Based | EEC | 2 | 0 | 0 | 2 | 0 |
| 3. | 1919002 | Professional Communication | EEC | 2 | 0 | 0 | 2 | 1 |
| 4. | 1909715 | Project Work - Phase I | EEC | 4 | 0 | 0 | 4 | 2 |
| 5. | 1909716 | Internship | EEC | 0 | 0 | 0 | 0 | 1 |
| 6. | 1909807 | Project Work - Phase II | EEC | 12 | 0 | 0 | 12 | 6 |

## PROFESSIONAL ELECTIVES FOR B.E., [MECHANICAL ENGINEERING]

**SEMESTER- V, ELECTIVE- I, [Manufacturing Engineering- Domain]**

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1909505 | Welding Technology | PE | 3 | 3 | 0 | 0 | 3 |
| 2. | 1909506 | Unconventional Machining Processes | PE | 3 | 3 | 0 | 0 | 3 |
| 3. | 1909507 | Additive Manufacturing | PE | 3 | 3 | 0 | 0 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4. | 1909508 | Micro Electro Mechanical Systems | PE | 3 | 3 | 0 | 0 | 3 |
| 5. | 1909509 | Quality Control and Reliability Engineering | PE | 3 | 3 | 0 | 0 | 3 |

**SEMESTER- VI, ELECTIVE – II, [Humanities and Management – Domain]**

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1915002 | Principles of Management | PE | 3 | 3 | 0 | 0 | 3 |
| 2. | 1915003 | Total Quality Management | PE | 3 | 3 | 0 | 0 | 3 |
| 3. | 1915004 | Human Rights | PE | 3 | 3 | 0 | 0 | 3 |
| 4. | 1915005 | Entrepreneurship Development | PE | 3 | 3 | 0 | 0 | 3 |
| 5. | 1904606 | Intellectual Property Rights | PE | 3 | 3 | 0 | 0 | 3 |
| 6. | 1903612 | Disaster Management | PE | 3 | 3 | 0 | 0 | 3 |

**SEMESTER- VI, ELECTIVE –III, [Fluid &Thermal Power Engineering - Domain]**

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1909604 | Turbo Machinery | PE | 3 | 3 | 0 | 0 | 3 |
| 2. | 1909605 | Computational Fluid Dynamics | PE | 3 | 3 | 0 | 0 | 3 |
| 3. | 1909606 | Gas Dynamics and Space Propulsion | PE | 3 | 3 | 0 | 0 | 3 |
| 4. | 1909607 | Refrigeration and Air Conditioning | PE | 3 | 3 | 0 | 0 | 3 |
| 5. | 1909608 | Power Plant Engineering | PE | 3 | 3 | 0 | 0 | 3 |

**SEMESTER- VII, ELECTIVE- IV, [Automotive & Design Engineering - Domain]**

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1909704 | Geometric Dimensioning and Tolerancing | PE | 3 | 3 | 0 | 0 | 3 |
| 2. | 1909705 | Design of Jigs, Fixtures and Press Tools | PE | 3 | 3 | 0 | 0 | 3 |
| 3. | 1909706 | Hydraulics and Pneumatics | PE | 3 | 3 | 0 | 0 | 3 |
| 4. | 1909707 | Automobile Engineering | PE | 3 | 3 | 0 | 0 | 3 |
| 5. | 1909708 | Alternative Fuels & Emission Control for Automobile | PE | 3 | 3 | 0 | 0 | 3 |

**SEMESTER -VII, ELECTIVE- V, [Materials and Automation Engineering - Domain]**

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1909709 | Non Destructive Testing and Evaluation | PE | 3 | 3 | 0 | 0 | 3 |
| 2. | 1909710 | Composite Materials and Mechanics | PE | 3 | 3 | 0 | 0 | 3 |
| 3. | 1909711 | Surface Engineering | PE | 3 | 3 | 0 | 0 | 3 |
| 4. | 1909712 | Mechanical Behavior of Materials | PE | 3 | 3 | 0 | 0 | 3 |
| 5. | 1909713 | Industrial Robotics Technology | PE | 3 | 3 | 0 | 0 | 3 |
| 6. | 1920001 | Fundamental of Nanoscience | PE | 3 | 3 | 0 | 0 | 3 |

**SEMESTER-VIII, ELECTIVE-VI, [Industrial Engineering- Domain]**

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1909802 | Computer Integrated Manufacturing Systems | PE | 3 | 3 | 0 | 0 | 3 |
| 2. | 1909803 | Production Planning and Control | PE | 3 | 3 | 0 | 0 | 3 |
| 3. | 1909804 | Industrial Safety | PE | 3 | 3 | 0 | 0 | 3 |
| 4. | 1909805 | Industry 4.0 | PE | 3 | 3 | 0 | 0 | 3 |
| 5. | 1909003 | Operations Research | PE | 3 | 3 | 0 | 0 | 3 |

**DEPARTMENT OF MECHANICAL ENGINEERING COURSE OFFERING TO THE OTHER DEPARTMENT**

**SEMESTER – III: – CORE SUBJECT**

| SL. NO | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1909307 | Applied Fluid Dynamics and Thermodynamics - **EIE** | PC | 3 | 3 | 0 | 0 | 3 |
| 2. | 1909308 | Theory of Machines – **Agri. Engg.** | PC | 3 | 3 | 0 | 0 | 3 |

## SEMESTER –IV: – CORE SUBJECT

| SL. NO | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1909407 | Farm Tractors – **Agri. Engg.** | PC | 3 | 3 | 0 | 0 | 3 |

## SEMESTER- V: – CORE SUBJECT

| SL.NO | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1909515 | Design of Basic Machine Elements – **Agri. Engg.** | PC | 3 | 3 | 0 | 0 | 3 |

## SEMESTER –VI:-PROFESSIONAL ELECTIVE – III

| SL. NO | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1909612 | Refrigeration and Air Conditioning for Agricultural Engineers. – **Agri. Engg.** | PE | 3 | 3 | 0 | 0 | 3 |

## SEMESTER –VII: - PROFESSIONAL ELECTIVE – IV

| SL. NO | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1909717 | Heat and Mass Transfer for Agricultural Engineers. - **Agri. Engg.** | PE | 3 | 3 | 0 | 0 | 3 |
| 2. | 1909003 | Operations Research – **EEE** | PE | 3 | 3 | 0 | 0 | 3 |

## SEMESTER –V: - OPEN ELECTIVE- I

| SL. NO | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1909510 | Product Design and Development | OE | 3 | 3 | 0 | 0 | 3 |
| 2. | 1909511 | Vibration and Noise Control | OE | 3 | 3 | 0 | 0 | 3 |
| 3. | 1909512 | Industrial Safety Engineering | OE | 3 | 3 | 0 | 0 | 3 |

## SEMESTER –VII: - OPEN ELECTIVE- II

| SL. NO | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1909718 | Robotics | OE | 3 | 3 | 0 | 0 | 3 |
| 2. | 1909719 | Testing of Materials | OE | 3 | 3 | 0 | 0 | 3 |
| 3. | 1909720 | Design of Electric Vehicles | OE | 3 | 3 | 0 | 0 | 3 |

## OPEN ELECTIVE – I (V SEMESTER)

| SL NO. | COURSE CODE | COURSE TITLE | Course offering Department | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1902512 | Environment and Agriculture | AGRI | 3 | 3 | 0 | 0 | 3 |
| 2. | 1902513 | Production Technology of Agricultural Machinery | AGRI | 3 | 3 | 0 | 0 | 3 |
| 3. | 1903514 | Air Pollution and Control Engineering | CIVIL | 3 | 3 | 0 | 0 | 3 |
| 4. | 1903515 | Participatory Water Resources Management | CIVIL | 3 | 3 | 0 | 0 | 3 |
| 5. | 1904007 | Data Structures | CSE | 3 | 3 | 0 | 0 | 3 |
| 6. | 1904504 | Geographic Information System | CSE | 3 | 3 | 0 | 0 | 3 |
| 7. | 1904508 | Database Management System | CSE | 3 | 3 | 0 | 0 | 3 |
| 8. | 1904509 | Cloud Computing | CSE | 3 | 3 | 0 | 0 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 9. | 1906505 | Photonic Networks | ECE | 3 | 3 | 0 | 0 | 3 |
| 10. | 1906506 | Telecommunication Network Management | ECE | 3 | 3 | 0 | 0 | 3 |
| 11. | 1906507 | Entertaintronics | ECE | 3 | 3 | 0 | 0 | 3 |
| 12. | 1907503 | Sensors and Transducers | EIE | 3 | 3 | 0 | 0 | 3 |
| 13. | 1907504 | Instrumentation in Biomedical Engineering | EIE | 3 | 3 | 0 | 0 | 3 |
| 14. | 1908001 | 3D Printing and Design | IT | 3 | 3 | 0 | 0 | 3 |
| 15. | 1908002 | Scripting Languages | IT | 3 | 3 | 0 | 0 | 3 |
| 16. | 1905001 | Energy Conservation and Management | EEE | 3 | 3 | 0 | 0 | 3 |
| 17. | 1905508 | Renewable Energy Sources | EEE | 3 | 3 | 0 | 0 | 3 |
| 18. | 1905509 | SCADA System Management | EEE | 3 | 3 | 0 | 0 | 3 |
| 19. | 1910504 | Principles of Food Preservation | MEDICAL ELECTRONICS | 3 | 3 | 0 | 0 | 3 |
| 20. | 1920501 | Nanotechnology | PHYSICS | 3 | 3 | 0 | 0 | 3 |
| 21. | 1920502 | Microscopy | PHYSICS | 3 | 3 | 0 | 0 | 3 |
| 22. | 1921501 | Advanced Engineering Chemistry | CHEMISTRY | 3 | 3 | 0 | 0 | 3 |
| 23. | 1921502 | Industrial Nanotechnology | CHEMISTRY | 3 | 3 | 0 | 0 | 3 |

## OPEN ELECTIVE – II (VII SEMESTER)

| SL NO. | COURSE CODE | COURSE TITLE | Course offering Department | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | 1903706 | Green Building Design | CIVIL | 3 | 3 | 0 | 0 | 3 |
| 2. | 1903716 | Environmental and Social Impact Assessment | CIVIL | 3 | 3 | 0 | 0 | 3 |
| 3. | 1904010 | Object Oriented Programming | CSE | 3 | 3 | 0 | 0 | 3 |
| 4. | 1904703 | Tamil Computing | CSE | 3 | 3 | 0 | 0 | 3 |
| 5. | 1904712 | Software Engineering | CSE | 3 | 3 | 0 | 0 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6. | 1906705 | Acoustics | ECE | 3 | 3 | 0 | 0 | 3 |
| 7. | 1906706 | Visual Communication | ECE | 3 | 3 | 0 | 0 | 3 |
| 8. | 1906707 | MEMS and NEMS | ECE | 3 | 3 | 0 | 0 | 3 |
| 9. | 1907001 | Transducers Engineering | EIE | 3 | 3 | 0 | 0 | 3 |
| 10. | 1907003 | Process Modeling and Simulation | EIE | 3 | 3 | 0 | 0 | 3 |
| 11. | 1907708 | State Variable Analysis and Design | EIE | 3 | 3 | 0 | 0 | 3 |
| 12. | 1908003 | Software Quality Management | IT | 3 | 3 | 0 | 0 | 3 |
| 13. | 1908004 | C # and . Net Programming | IT | 3 | 3 | 0 | 0 | 3 |
| 14. | 1908005 | Virtual Reality | IT | 3 | 3 | 0 | 0 | 3 |
| 15. | 1905711 | Electrical Circuits | EEE | 3 | 3 | 0 | 0 | 3 |
| 16. | 1905712 | Renewable Energy Systems | EEE | 3 | 3 | 0 | 0 | 3 |
| 17. | 1905713 | Electric Vehicles and Power Management | EEE | 3 | 3 | 0 | 0 | 3 |
| 18. | 1910703 | Clinical Trials | MEDICAL ELECTRONICS | 3 | 3 | 0 | 0 | 3 |
| 19. | 1910704 | Regulatory Requirements in Pharmaceutical Industries | MEDICAL ELECTRONICS | 3 | 3 | 0 | 0 | 3 |
| 20. | 1910705 | Microbiology | MEDICAL ELECTRONICS | 3 | 3 | 0 | 0 | 3 |
| 21. | 1920701 | Analytical Methods and Instrumentation | PHYSICS | 3 | 3 | 0 | 0 | 3 |
| 22. | 1920702 | Medical Physics | PHYSICS | 3 | 3 | 0 | 0 | 3 |
| 23. | 1920703 | Electronic Materials | PHYSICS | 3 | 3 | 0 | 0 | 3 |
| 24. | 1921701 | Waste Water Treatment | CHEMISTRY | 3 | 3 | 0 | 0 | 3 |

## SUMMARY

| SL. NO. | SUBJECT AREA | CREDITS PER SEMESTER | | | | | | | | CREDITS TOTAL | Percentage [%] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI | VII | VIII | | |
| 1. | HS | 3 | 3 | - | 3 | - | | - | - | 9 | 5.14% |
| 2. | BS | 12 | 14 | 4 | 4 | - | - | - | - | 34 | 19.42 % |
| 3. | ES | 8 | 9 | 9 | 5 | - | - | - | - | 31 | 17.71% |
| 4. | PC | - | - | 8 | 11 | 16 | 15 | 11 | 3 | 64 | 36.57% |
| 5. | PE | - | - | - | - | 3 | 6 | 6 | 3 | 18 | 10.29% |
| 6. | OE | - | - | - | - | 3 | - | 3 | - | 6 | 3.42% |
| 7. | EEC | - | - | - | - | 1 | 2 | 3 | 6 | 12 | 6.86% |
| 8. | PCD | - | 1 | - | - | - | - | - | - | 1 | 0.57% |
| | Total | 23 | 27 | 21 | 23 | 23 | 23 | 23 | 12 | 175 | |
| | Non Credit / Mandatory | | | ✓ | | | | | | | |

**TOTAL NUMBER OF CREDITS TO BE EARNED FOR AWARD OF THE DEGREE = 175**

## FIRST SEMESTER

**1919101 COMMUNICATIVE ENGLISH L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To develop the basic reading and writing skills of first year engineering and technology students.
- To help learners develop their listening skills, which will, enable them listen to lectures and comprehend them by asking questions; seeking clarifications.
- Comprehend content - asking questions; seeking clarifications.
- To help learners develop their speaking skills and speak fluently in real contexts.
- To help learners develop vocabulary of a general kind by developing their reading skills.

**UNIT-I: SHARING INFORMATION RELATED TO ONESELF/FAMILY& FRIENDS 9**

Reading– short comprehension passages, practice in skimming-scanning and predicting- Writing– Blog/film review/quora/Twitter/Facebook– developing hints. Listening– short texts- short formal and informal conversations. Speaking- introducing oneself – exchanging personal information- Language development– Wh- Questions- asking and answering-yes or no questions- parts of speech. Vocabulary development— prefixes- suffixes – word formation: making sentences of your own.

**UNIT-II: GENERAL READING AND FREE WRITING 9**

Reading – Story with questions and answers- Writing – paragraph writing- topic sentence- main ideas- free writing, short narrative descriptions using some suggested vocabulary and structures – Listening– Listening to a speech – answering questions. Speaking – Presentation with PPT - Language development – prepositions, Vocabulary development- guessing meanings of words in contexts – articles.

**UNIT –III: GRAMMAR AND LANGUAGE DEVELOPMENT 9**

Reading– short texts (close reading) Writing- understanding text structure- use of reference words and discourse markers-coherence-jumbled sentences Listening –listening to stories to answer questions. Speaking– asking about routine actions and expressing opinions. Language development– Adjectives, degrees of comparison- conjunctions and connectives - Vocabulary development – single word substitutes- adverbs.

**UNIT- IV: READING AND LANGUAGE DEVELOPMENT 9**

Reading- Newspaper articles- answering questions Writing– letter writing, informal or personal letters- congratulating/ thanking/requesting help/ e-mails-forward a mail to Staff on given topic- Listening– listen to different sounds and differentiate the sounds with different words. Speaking- speaking about oneself- speaking about one‘s friend- Language development- Modals -Tenses - Vocabulary development– synonyms-antonyms- phrasal verbs.

**UNIT – V: EXTENDEND WRITING 9**

Reading- longer texts- close reading –Writing– brainstorming -writing short essays – developing an outline- identifying main and subordinate ideas- dialogue writing-Listening – listening to talks- Note taking- Speaking – participating in conversations- short group conversations-Language development- correction of errors- Vocabulary development-collocations- fixed and semi-fixed expressions.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

At the end of the course, learners will be able to:

- Read articles of a general kind in magazines and newspapers.
- Participate effectively in informal conversations.
- Introduce themselves and their friends and express opinions in English.
- Comprehend conversations and short talks delivered in English
- Write short essays of a general kind and personal letters and emails in English.

**TEXT BOOKS:**

1. Board of Editors. Using English A Course book for Undergraduate Engineers and Technologists. Orient Black Swan Limited, Hyderabad: 2015
2. Richards, C. Jack. Interchange Students' Book-2 New Delhi: CUP, 2015.

**REFERENCE BOOKS:**

1. Bailey, Stephen. Academic Writing: A practical guide for students. New York: Rutledge, 2011.
2. Means,L. Thomas and Elaine Langlois. English & Communication for Colleges. Cengage Learning ,USA: 2007

3. Redston, Chris & Gillies Cunningham Face 2 Face (Pre-intermediate Student‘s Book & Workbook) Cambridge University Press, New Delhi: 2005
4. Comfort, Jeremy, et al. Speaking Effectively: Developing Speaking Skills for Business English. Cambridge University Press, Cambridge: Reprint 2011
5. Dutt P. Kiranmai and Rajeevan Geeta. Basic Communication Skills, Foundation Books: 2013.
6. Preliminary English Test – Cambridge University Press ESOL
7. Key English Test - Cambridge University Press ESOL.
8. Pronunciation Dictionary - Daniel Jones.

| CO | PO | | | | | | | | | | | | PSO | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** | **4** |
| **1** | 3 | 3 | 2 | 3 | 3 | - | - | - | - | 3 | - | 1 | 1 | 1 | 2 | 2 |
| **2** | 3 | 2 | 3 | 2 | 2 | - | 2 | - | - | 3 | - | 1 | 1 | 1 | 1 | 1 |
| **3** | 3 | 3 | - | 2 | - | - | - | - | - | 3 | - | 1 | 2 | 1 | 1 | 1 |
| **4** | 3 | 3 | - | - | - | - | 3 | - | - | 3 | - | 1 | 1 | 1 | 1 | 1 |
| **5** | 3 | 3 | 3 | 2 | 3 | 3 | 2 | - | - | 3 | - | 1 | 1 | 1 | 2 | 1 |

**1918102 ENGINEERING MATHEMATICS - I L T P C**

**3 1 0 4**

**OBJECTIVES:**

- To understand and apply matrix techniques for engineering applications.
- To familiarize the student with basic calculus and traditions of traditional calculus.
- To solve the problems in single and multivariable calculus and plays an important role in science, economics, engineering.
- To acquaint the student with mathematical tools needed in evaluating integrals.
- To familiarize the student with multiple integrals and their usage in find the area and volume of two and three dimensional objects.

**UNIT-I: MATRICES 9L+3T**

System of equations – consistency and inconsistency- Eigen values and Eigen vectors of a real matrix - Characteristic equation - Properties of Eigen values and Eigen vectors - Statement and Applications of Cayley-Hamilton Theorem - Reduction of a quadratic form into canonical form by orthogonal transformation.

**UNIT- II: DIFFERENTIAL CALCULUS FOR FUNCTIONS OF ONE VARIABLE 9L+3T**

Limit of a function - Continuity – Differentiability - Differentiation rules – Rolle's theorem and Mean Value theorem – Taylor's series- Maxima and Minima of functions of one variable.

**UNIT- III: FUNCTIONS OF SEVERAL VARIABLES 9L+3T**

Partial derivatives - Total derivatives - Jacobians and properties - Taylor's series for functions of two variables - Maxima and Minima of functions of two variables - Lagrange's method of undetermined multipliers.

**UNIT- IV: INTEGRAL CALCULUS FOR FUNCTION OF ONE VARIABLE 9L+3T**

Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration by partial fractions- Improper integrals.

**UNIT-V: MULTIPLE INTEGRALS 9L+3T**

Double integrals in Cartesian and polar coordinates - Change of order of integration - Area enclosed by plane curves - Change of variables in double integrals (Polar coordinates) - Triple integrals - Volume of solids.

**TOTAL: 45L+15T:60 PERIODS**

**OUTCOMES:**

- To apply the idea of reducing complex problems into simple form using matrix technique.
- Basic application of calculus in engineering problems and to tackle for different geometries.
- This course equips the students to have basic knowledge and understanding of fundamental statistics to analyse and interpret data.
- To apply Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration by partial fractions in Engineering Problems.
- Basic application of Double and Triple integrals used in Engineering real life problems.

**TEXT BOOKS:**

1. Grewal. B.S, "Higher Engineering Mathematics", 41st Edition, Khanna Publications, Delhi, 2011.
2. Veerarajan. T, "Engineering Mathematics", McGraw Hill Education (India) Private Limited, 2019.
3. Gupta S.C and Kapoor V.K, "Fundamentals of Mathematical Statistics", S. Chand Private Ltd., 11th Edition, 2005.

**REFERENCE BOOKS:**

1. Kreyszig Erwin, "Advanced Engineering Mathematics", John Wiley and Sons, 10thEdition, New Delhi, 2016
2. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2008.
3. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015. [For Units I & III - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

| CO | PO | | | | | | | | | | | | PSO | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 1 | - | - | - | - |
| 2 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 1 | - | - | - | - |
| 3 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 1 | - | - | - | - |
| 4 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 1 | - | - | - | - |
| 5 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 1 | - | - | - | - |

**1920103 ENGINEERING PHYSICS**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To understand the stress, strain and the concept of Hooke's law for the modulus of elasticity values .

- To facilitate the knowledge about basics of laser, optical fiber sources and transmission techniques.
- To enrich the idea of transfer and measurement of heat and uses of heat exchangers.
- To explore the basics of quantum theory and atomic and subatomic particles.
- To enhance the fundamental knowledge crystal Physics and its applications

**UNIT- I: PROPERTIES OF MATTER 9**

Elasticity – Hooke's law-Stress-strain diagram and its uses –Poisson ratio-factors affecting elastic modulus and tensile strength – twisting couple - torsion pendulum: theory and experiment (regular body) - bending of beams - bending moment – cantilever: theory and experiment – uniform and non-uniform bending: theory and experiment - I-shaped girders.

**UNIT-II: LASERS AND FIBER OPTICS 9**

Lasers: population of energy levels, Einstein's A and B coefficients derivation – resonant cavity, optical amplification (qualitative) – Nd-YAG laser-Semiconductor lasers: homojunction and heterojunction – Applications. Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index, and mode) – losses associated with optical fibers– Fiber optic communication- fibre optic sensors: pressure and displacement- Endoscope.

**UNIT-III: THERMAL PHYSICS 9**

Transfer of heat energy – thermal conduction, convection and radiation – Newton's law cooling (qualitative) -heat conductions in solids – thermal conductivity - Forbe's and Lee's disc method: theory and experiment - conduction through compound media (series and parallel) – thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters.

**UNIT-IV: QUANTUM PHYSICS 9**

Black body radiation – Planck's theory (derivation)- deduction of Wien's and Rayleigh jeans law – Compton effect: theory and experimental verification – wave particle duality – electron diffraction – concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent equations – particle in a one-dimensional - three dimensional potential box– tunnelling (qualitative) - scanning tunnelling microscope.

**UNIT-V: CRYSTAL PHYSICS 9**

Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter-planar distances- coordination number and packing factor for SC, BCC, FCC, HCP and diamond structure (qualitative) - crystal imperfections: point defects, line defects – Burger vectors, stacking faults – growth of single crystals: solution and melt growth techniques - Importance of crystal physics.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course,

- The students will gain knowledge on the basics of properties of matter and its applications.
- The students will acquire knowledge on the concepts of optical devices and their applications in fibre optics.
- The students will have adequate knowledge on the concepts of thermal properties of material and their applications in heat exchanger and electrical appliances.
- The students will get knowledge on advanced physics concepts of quantum theory and its applications in tunnelling microscopes.
- The students will understand the basics of crystals, their structures and different crystal growth techniques.

**TEXT BOOKS:**


1. Bhattacharya, D.K. & Poonam, T. “Engineering Physics”. Oxford University Press, 2015.
2. Gaur, R.K. & Gupta, S.L. “Engineering Physics”. Dhanpat Rai Publishers, 2012.
3. Pandey, B.K. &Chaturvedi, S. “Engineering Physics”. Cengage Learning India, 2012.
4. Brijlal and Subramanyam, “Properties of Matter”, S .Chand publishing, 2002.


**REFERENCE BOOKS:**


1. Halliday, D., Resnick, R. & Walker, J. “Principles of Physics”. Wiley, 2015.
2. Serway, R.A. & Jewett, J.W. “Physics for Scientists and Engineers”. Cengage Learning, 2010.
3. Tipler, P.A. & Mosca, G. “Physics for Scientists and Engineers with Modern Physics’. W.H.Freeman, 2007.
4. Shatendra Sharma & Jyotsna Sharma, “Engineering Physics”. Pearson, 2018.

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**1921104 ENGINEERING CHEMISTRY L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To make the students acquainted with boiler feed water requirements, related problems and domestic water treatment techniques.
- To understand the basic mechanism of surface phenomenon.
- To acquaint the student with the principles of electrochemical reactions, methods for corrosion prevention and protection of materials.
- To make the student conversant with the basics of polymers, cement and glass.
- To acquaint the students with the basics of nanomaterials, their properties and applications.

**UNIT-I: WATER AND ITS TREATMENT 9**

Hardness of water – types – expression of hardness – units - Boiler feed water-boiler troubles - scale and sludge, priming and foaming, caustic embrittlement, boiler corrosion. Treatment of boiler feed water – Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning). External treatment – Ion exchange process – domestic water treatment (break point chlorination) – Desalination of brackish water – Reverse Osmosis.

**UNIT-II: SURFACE CHEMISTRY AND CATALYSIS 9**

Adsorption: Types of adsorption – adsorption of gases on solids – adsorption of solute from solutions – adsorption isotherms. Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – Contact theory. Kinetics of surface reactions, unimolecular reactions, Langmuir –

applications of adsorption on pollution abatement. Catalysis: Catalyst – types of catalysis – Criteria – Autocatalysis – Catalytic poison and catalytic promoters – Acid base catalysis – Applications (3 way catalytic convertor) – Enzyme catalysis– Michaelis – Menten equation.

**UNIT-III: ELECTROCHEMISTRY, CORROSION AND PROTECTIVE COATINGS 9**

Electrochemical cell - redox reaction, electrode potential - origin of electrode potential - oxidation potential - reduction potential, measurement and applications - Electrochemical series and its significance - Nernst equation (derivation and problems). Corrosion – causes – factors – types - chemical, electrochemical corrosion (galvanic, differential aeration), corrosion control – material selection and design aspects – Electrochemical protection – sacrificial anode method and impressed current cathodic method. Protective coatings: Metallic coatings – Electroplating of Cu - electroless plating of Ni. Organic coatings: Paints - constituents and function.

**UNIT-IV: ENGINEERING MATERIALS 9**

Cement: Definition – classification of cement – Portland cement - manufacture and properties - setting and hardening of cement - special cement, water proof, white and sorel cement – properties and uses – Glass: Manufacture, types, properties and uses (laminated, safety and flint glass) - Polymers: Classification - types of polymerization - mechanism - methods of polymerization - Engineering polymers: Nylon-6, Nylon-6,6, Teflon, Kevlar and PEEK - preparation, properties and uses - Plastic and its types - Conducting polymers: Types and applications - Polymers in medicine and surgery (applications).

**UNIT-V: NANOCHEMISTRY 9**

Basics - distinction between molecules, nanoparticles and bulk materials; size-dependent properties (surface to volume ratio, melting point, optical and electrical). Nanoparticles, Nanocluster, Nanorods, Nanotube (CNT: SWNT and MWNT) and Nanowire, Synthesis - precipitation, thermolysis, hydrothermal, electrodeposition, chemical vapour deposition, laser ablation, sol-gel process and applications.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student should be able to:

- Gain idea about various methods available for water treatment.
- Explain the materials surface engineering.
- Understand the process of electrochemistry and its application to corrosion.

- Appreciate the nature and novelty of engineering materials.
- Ability to understand the nature and uses of nanomaterials.

**TEXT BOOKS:**

1. Shikha Agarwal, “Engineering Chemistry”-Fundamentals and Applications, Cambridge University Press, Delhi, 2015.
2. P. C. Jain and Monika Jain, “Engineering Chemistry” Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2015.
3. S. Vairam, P. Kalyani and Suba Ramesh, “Engineering Chemistry”, Wiley India PVT, LTD, New Delhi, 2013.

**REFERENCE BOOKS:**

1. Friedrich Emich, “Engineering Chemistry”, Scientific International PVT, LTD, New Delhi, 2014.
2. S.S. Dara and S.S. Umare, “A Text Book of Engineering Chemistry”, S. Chand & Company LTD, New Delhi, 2015.
3. B. Sivasankar, “Engineering Chemistry”, Tata McGraw-Hill Publishing Company LTD, 2012.

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| 4 | 1 | 1 | 2 | 1 | 1 | | 1 | | | | | 2 | 2 | 3 | 3 | 1 |
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**1901005 PROBLEM SOLVING AND PYTHON PROGRAMMING** **L T P C**

(Common to all branches of B.E. / B.Tech. Programmes) **3 0 0 3**

**OBJECTIVES:**

- To know the basics of algorithmic problem solving
- To read and write simple Python programs.
- To develop Python programs with conditionals and loops.

- To define Python functions and call them.
- To use Python data structures – lists, tuples, dictionaries.

**UNIT-I: ALGORITHMIC PROBLEM SOLVING, DATA TYPES 9**

Algorithms: building blocks of algorithms (statements, control flow, functions), notation (pseudo code, flow chart). Python interpreter and interactive mode; values and types: int, float, Boolean, string, and list; variables, operators and expressions, statements, tuple assignment, precedence of operators, comments, Illustrative programs: Algorithm for Arithmetic expression (addition and subtraction).

**UNIT-II: CONTROL FLOW STATEMENTS AND FUNCTIONS 9**

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; functions, function definition and use. Fruitful functions: return values, parameters, local and global scope, recursion. Illustrative programs: exchange the values of two variables square root, printing n numbers iteratively

**UNIT-III: LIST& TUPLES 9**

Lists: list operations, list slices, list methods, list loop, mutability, list parameters; Tuples: tuple assignment, tuple as return value. Comparison of Lists and tuples. Illustrative programs: selection sort, insertion sort, Quick sort.

**UNIT-IV: STRINGS, DICTIONARIES & SET 9**

Strings: string slices, immutability, string functions and methods, string module. Dictionaries: Operations (create, access, add, remove) and methods. (Insert, delete).Set operation (Access, Add, Remove).Comparison of dictionary and set.

**UNIT-V: FILES, MODULES & PACKAGES 9**

Files and exception: text files, reading and writing files, format operator; errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

At the end of the course, learners will be able to:

- Develop algorithmic solutions to simple computational problems.
- Structure simple Python programs for solving problems.
- Decompose a Python program into functions.

- Represent compound data using Python lists, tuples, Set and dictionaries.
- Read and write data from/to files in Python Programs.

**TEXT BOOKS:**


1. Reema Thareja, "Python Programming using Problem solving Approach" ,Oxford Higher Education, 2017
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
3. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python" – Revised and updated for Python 3.2, Network Theory Ltd., 2011.


**REFERENCE BOOKS:**


1. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus", Wiley India Edition, 2013.
2. John V Guttag, "Introduction to Computation and Programming Using Python'', Revised and expanded Edition, MIT Press , 2013
3. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012.
4. Paul Gries, Jennifer Campbell and Jason Montojo, "Practical Programming: An Introduction to Computer Science using Python 3", Second edition, Pragmatic Programmers, LLC, 2013.
5. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach", Pearson India Education Services Pvt. Ltd., 2016.


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**1901106 BASIC ELECTRICAL AND ELECTRONICS ENGINEERIN L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To explain the basic theorems used in Electrical circuits and measuring instruments.
- To explain the different components and function of electrical machines.
- To explain the fundamentals of semiconductor and applications.
- To explain the principles of digital electronics
- To impart knowledge of communication.

**UNIT- I: ELECTRICAL CIRCUITS& MEASURMENTS 9**

Fundamental laws of electrical circuits – Steady State Solution of DC Circuits – Introduction to AC Circuits – Sinusoidal steady state analysis – Power and Power factor – Single Phase and Three Phase Balanced Circuits - Operating Principles of indicating instruments.

**UNIT- II: ELECTRICAL MECHANICS 9**

Construction - Principle of Operation - Basic Equations and Applications of DC Generators, DC Motors - Single and three Phase Transformer – single and three phase induction Motor-Synchronous Motor.

**UNIT- III: SEMICONDUCTOR DEVICESANDAPPLICATIONS 9**

Introduction - Characteristics of PN Junction Diode – Zener Effect – Zener Diode and its Characteristics – Half wave and Full wave Rectifiers – Voltage Regulation. Bipolar Junction Transistor – CB, CE, CC Configurations and Characteristics.

**UNIT- IV: DIGITALELECTRONICS 9**

Binary Number System – Logic Gates – Boolean Algebra theorems – Digital circuits –Introduction to sequential circuits - Flip-Flops – Registers and Counters – A/D and D/A Conversion.

**UNIT-V: FUNDAMENTALS OF COMMUNICATION ENGINEERING 9**

Introduction – Elements of communication systems - Modulation and Demodulation: Principles of Amplitude and Frequency Modulations. Digital Communication - Communication Systems: Radio, TV, Fax, ISDN, Microwave, Satellite and Optical Fibre (Block Diagram Approach only).

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Ability to identify and explain about electrical circuits and measuring instruments.
- Ability to identify and explain the construction and working of electrical machines.
- Ability to identify electronics components and explain its characteristics.
- Ability to acquire knowledge on digital electronics.
- Ability to acquire knowledge on fundamentals of communication systems.

**TEXT BOOKS:**

1. D.P.Kothari and I.J. Nagarath, “Basic Electrical and Electronics Engineering”, McGraw Hill Education Private Limited, Third Reprint, 2016.
2. S.K. Bhattacharya, “Basic Electrical and Electronics Engineering”, Pearson India, 2011.
3. Sedha R.S., “Applied Electronics”, S. Chand & Co., 2008.

**REFERENCES BOOKS:**

1. A.E., Fitzgerald, David E Higginbotham and Arvin Grabel, “Basic Electrical Engineering”, McGraw Hill Education (India) Private Limited, 2009.
2. Nagsarkar T K and Sukhija M S, “Basics of Electrical Engineering”, Oxford press2007.
3. Mehta V K, “Principles of Electronics”, S. Chand & Company Ltd,2008.
4. Mahmood Nahvi and Joseph A. Edminister, “Electric Circuits”, Schaum’ Outline Series, McGraw Hill,2002.
5. Del Toro, “ Electrical Engineering Fundamentals”, Pearson Education, New Delhi, 2007.
6. Leonard S Bobrow, “Foundations of Electrical Circuits”, Schaum’s Outline Series, McGraw Hill, 2010.

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| **4** | 3 | 2 | 2 | 3 | 3 | 1 | | | 1 | | | 2 | 3 | | | 2 |
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| 1901108 | PHYSICS AND CHEMISTRY LABORATORY | L | T | P | C |
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| | (Common to all branches of B.E. / B.Tech. Programmes) | **0** | **0** | **4** | **2** |

## PHYSICS LABORATORY

**COURSE OBJECTIVES:**

- To study the behaviour of material under shear stress.
- To learn the basics concept understanding the deformation due to linear stress
- To explore the photons to measure the physical parameters.
- To introduce experiments to test thermal conductivity of bad conductor.
- To study the spectrum of white light.

**LIST OF EXPERIMENTS: (Any 5 Experiments)**

1. Determination of rigidity modulus – Torsion pendulum.
2. Determination of Young's modulus by non-uniform bending method.
3. (a) Determination of wavelength and particle size using Laser.
   (b) Determination of acceptance angle and numerical aperture in an optical Fiber.
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5. Determination of velocity of sound and compressibility of liquid and Solid – Ultrasonic Interferometer
6. Determination of wavelength of mercury spectrum – spectrometer grating
7. Determination of thickness of a thin wire – Air wedge method

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

- Measure the rigidity modulus of the material.
- Calculate the deformation due to linear stress and Young's Modulus
- Use laser to measure the physical parameters.
- Calculate the thermal conductivity of bad conductor by lees disc.
- Measure the wavelength of the mercury the spectrum.

**REFERENCE BOOKS:**


1. Wilson J.D. and Hernaandez Hall C.A. – "Physics Laboratory Experiments", Houghton Mifflin Company, New York, 2005.
2. S. Srinivasan, "A Text Book of Practical Physics", S. Sultan Chand publications. 2005
3. R. Sasikumar, "Practical Physics", PHI Learning Pvt. Ltd, New Delhi, 2011.


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| **3** | 3 | 1 | 1 | 1 | - | 2 | - | 1 | 1 | - | - | - | 2 | - | - | - |
| **4** | 3 | 1 | 1 | 1 | - | 1 | - | 1 | 1 | - | - | - | 2 | - | - | - |
| **5** | 3 | 1 | 1 | 1 | - | 1 | - | 1 | 1 | - | - | - | 1 | - | - | - |

## CHEMISTRY LABORATORY

**COURSE OBJECTIVES:**

- To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis.
- To acquaint the students with the determination of molecular weight of a polymer by viscometery.
- To make the student conversant with the corrosion defects experimentally.
- To develop and understand the basic concepts of acidic and basic nature using pH.
- 5 To make the student familiar with the properties and nature of alloys experimentally.

**LIST OF EXPERIMENTS: (Any 5 Experiments)**

1. Estimation of HCl using $Na_2CO_3$ as primary standard and determination of alkalinity in water sample.
2. Estimation of copper content of the given solution by iodometry.
3. Determination of strength of given hydrochloric acid using pH meter.
4. Determination of strength of acids in a mixture of acids using conductivity meter.
5. Estimation of iron content of the given solution using potentiometer.

6. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
7. Pseudo first order kinetics-ester hydrolysis.
8. Corrosion experiment-weight loss method.
9. Conductometric titration of strong acid Vs strong base.

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES:**

- Obtain the hands-on knowledge in the quantitative chemical analysis of water quality related parameters.
- Understand the experimental concepts in the mixture of acids and bases.
- Appreciate the need of iodometry in the estimation of metals.
- Explore the drawbacks of corrosion by weight loss method.
- Design and carry out the scientific experiments related to boiler troubles.

**TEXTBOOKS:**

1. Vogel's Textbook of Quantitative Chemical Analysis (8th Edition, 2014)

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**1901009 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY**

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**COURSE OBJECTIVES:**

- To write, test, and debug simple Python programs.
- To implement Python programs with conditionals and loops.
- Represent compound data using Python lists, tuples, and dictionaries.
- Use functions for structuring Python programs.
- Read and write data from/to files in Python.

**LIST OF PROGRAMS:**

1. Compute the GCD of two numbers.
2. Find the square root of a number (Newton‘s method)
3. Exponentiation (power of a number)
4. Find the maximum of a list of numbers
5. Linear search and Binary search
6. Selection sort, Insertion sort
7. How to create, slice, change, delete and index elements using Tuple.
8. Find First n prime numbers
9. How to create, slice, change, add, delete and index elements using list.
10. Write a program to calculate the length of a string.
11. Write a program to reverse the string
12. How to change, delete, add and remove elements in Dictionary
13. Find the most frequent words in a text read from a file
14. Simulate elliptical orbits in Pygame
15. Simulate bouncing ball using Pygame

**PLATFORM NEEDED:**

Python 3 interpreter for Windows/Linux

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, learners will be able to:

- Write, test, and debug simple Python programs.
- Implement Python programs with conditionals and loops.

- Develop Python programs step-wise by defining functions and calling them.
- Use Python lists, tuples, dictionaries for representing compound data.
- Read and write data from/to files in Python.

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## SECOND SEMESTER

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| **1919201** | **TECHNICAL ENGLISH** | **L T P C** |
| | (Common to all branches of B.E. / B.Tech. Programmes) | **3 0 0 3** |

**OBJECTIVES:**

The Course prepares Second semester Engineering & Technology students to:

- Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
- Foster their ability to write convincing job applications and effective reports.
- Develop their speaking skills to make technical presentations,
- Participate in group discussions.
- Strengthen their listening skill which will help them comprehend lectures and talks in their areas of specialization.

**UNIT-I: INTRODUCTION** **9**

Listening – Listening to talks mostly of a scientific/technical nature and completing information – gap exercises- Speaking – Asking for and giving directions – Reading – reading short technical texts from journals- newspapers – Writing– purpose statements – Technical Jargons, homophones – issue – writing instructions – checklists-recommendations-Vocabulary Development – technical vocabulary Language Development – subject verb agreement – compound words.

**UNIT-II: READING AND STUDY SKILLS** **9**

Listening – Listening to a technical conversation and filling the gaps – Speaking – describing a process – Reading – reading longer technical texts- identifying the various transitions in a text- paragraphing – Writing – interpreting charts, graphs – Vocabulary Development – vocabulary used in formal letters/emails and reports Language Development – impersonal passive voice, numerical adjectives.

**UNIT-III: TECHNICAL WRITING AND GRAMMAR** **9**

Listening – Listening to classroom lectures/ talks on engineering/technology – Speaking – mechanics of presentations – Reading – longer texts both general and technical, practice in speed reading; Writing – Describing a process, use of sequence words – Vocabulary Development – Misspelt words. Language Development – homonyms.

**UNIT-IV: REPORT WRITING 9**

Listening – Listening to documentaries and making notes. Speaking – introduction to technical presentations – Reading – reading for detailed comprehension – Writing – Product description – job application – cover letter – Résumé preparation (via email and hard copy)- Issue based essays and official circulars – Vocabulary Development – finding suitable synonyms – paraphrasing – Language Development – clauses – if conditionals.

**UNIT-V: GROUP DISCUSSION AND JOB APPLICATIONS 9**

Listening – TED/INK talks, answering the questions; Speaking – participating in a group discussion – Reading – reading and understanding technical articles. Writing – Writing reports – minutes of a meeting – Letter Writing- Letter to the Editor – Letter seeking permission for an Industrial visit/ Internship – Business Letters, asking for quotation/clarification – seeking orders, thanking for the order given, Complaint letters – Vocabulary Development – verbal analogies Language Development – reported speech.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

At the end of the course, learners will be able to:

- Read technical texts and write area- specific texts effortlessly.
- Listen and comprehend lectures and talks in their area of specialisation successfully.
- Speak appropriately and effectively in varied formal and informal contexts.
- Participate in group discussions
- Write reports and winning job applications.

**TEXT BOOKS:**

1. Board of Editors. "Fluency in English – A Course book for Engineering and Technology", Orient BlackSwan Limited, Hyderabad: 2016.
2. Sudharshana. N.P and Saveetha. C. "English for Technical Communication", Cambridge University Press: New Delhi, 2016.

## REFERENCE BOOKS:


1. Raman, Meenakshi and Sharma, Sangeetha – “Technical Communication Principles and Practice”, Oxford University Press: New Delhi, 2014.
2. Kumar, Suresh. E. “Engineering English”. Orient Blackswan: Hyderabad, 2015.
3. Booth-L. Diana, “Project Work”, Oxford University Press, Oxford: 2014.
4. Grussendorf, Marion, “English for Presentations”, Oxford University Press, 2007.
5. Means, L. Thomas and Elaine Langlois, “English & Communication For Colleges”.
6. IELTS - Cambridge University Press.
7. BEC - Cambridge University Press.


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**1918202 ENGINEERING MATHEMATICS - II L T P C**

**3 1 0 4**

## OBJECTIVES:

- This course is designed to cover topics such as Ordinary Differential equation, Vector Calculus, Complex Analysis and Laplace Transform.
- ODE is the powerful tools to solve practical problems in the field of engineering.
- Vector calculus can be widely used for modeling the various laws of physics.
- The various methods of complex analysis helps us to evaluate contour integration.
- Laplace transforms can be used for efficiently solving the problems that occur in various branches of engineering.

**UNIT-I: ORDINARY DIFFERENTIAL EQUATIONS 9L+3T**

First order linear differential equations – Exact differential equations - Second order linear differential equations with constant coefficients – Method of variation of parameters – Homogenous equation of Euler's and Legendre's type.

**UNIT-II: VECTOR CALCULUS 9L+3T**

Gradient and directional derivative – Divergence and curl – Irrotational and Solenoidal vector fields - Green's, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals.

**UNIT-III: LAPLACE TRANSFORMS 9L+3T**

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.

**UNIT-IV: ANALYTIC FUNCTIONS 9L+3T**

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian coordinates – Properties – Harmonic conjugates – Construction of analytic function – Conformal mapping – Mapping by functions $w = Cz, C+z, 1/z, z^2$ - Bilinear transformation.

**UNIT-V: COMPLEX INTEGRATION 9L+3T**

Complex Integration – Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour.

**TOTAL: 45L +15T: 60 PERIODS**

**OUTCOMES:**

- Apply complex variables in finding, Gradient, divergence, curl of a vector point function.
- Evaluation of line, surface and volume integrals using Gauss, Stokes and Green's theorems and their verification.
- Analytic functions, conformal mapping and complex integration are evaluated.

- Laplace transform and inverse transform of simple functions, properties, are studied.
- Apply various techniques in solving Ordinary differential equations with constant coefficients.

**TEXT BOOKS:**

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd edition, 2014.
2. Veerarajan. T, "Engineering Mathematics", McGraw Hill Education (India) Private Limited 2019.

**REFERENCE BOOKS:**

1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.
3. O'Neil, P.V. "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007.

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**1920204** **PHYSICS FOR MECHANICAL ENGINEERING** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To understand the concept of various phase diagrams and their applications.
- To facilitate the knowledge about Iron carbide system and its micro structures.
- To enrich the idea of mechanical properties and Hardness measurements.
- To explore the basics of magnetic and dielectric properties of materials.
- To enhance the basic knowledge on ceramics, composites and nanomaterials.

**UNIT- I: PHASE DIAGRAMS** **9**

Solid solutions - Hume Rothery's rules – the phase rule - single component system - one-component system of iron - binary phase diagrams - isomorphous systems - the tie-line rule - the lever rule - application to isomorphous system - eutectic phase diagram - peritectic phase diagram - other invariant reactions – free energy composition curves for binary systems - microstructural change during cooling.

**UNIT- II: FERROUS ALLOYS** **9**

The iron-carbon equilibrium diagram - phases, invariant reactions - microstructure of slowly cooled steels - eutectoid steel, hypo and hypereutectoid steels - effect of alloying elements on the Fe-C system - diffusion in solids - Fick's laws - phase transformations - T-T-T-diagram for eutectoid steel – pearlitic, baintic and martensitic transformations - tempering of martensite – steels – stainless steels – cast irons.

**UNIT- III: MECHANICAL PROPERTIES** **9**

Tensile test - plastic deformation mechanisms - slip and twinning - role of dislocations in slip - strengthening methods - strain hardening - refinement of the grain size - solid solution strengthening - precipitation hardening - creep resistance - creep curves - mechanisms of creep - fracture - the Griffith criterion - critical stress intensity factor and its determination - fatigue failure - fatigue tests - methods of increasing fatigue life - hardness - Rockwell and Brinell hardness - Knoop and Vickers microhardness.

**UNIT –IV: MAGNETIC AND DIELECTRIC MATERIALS** **9**

Introduction - Classification of magnetic materials - Ferromagnetism – domain theory – types of energy – hysteresis – hard and soft magnetic materials – ferrites - dielectric materials – types of polarization – Langevin-Debye equation – frequency effects on polarization - dielectric breakdown – insulating materials – Ferroelectric materials.

**UNIT –V: NEW MATERIALS 9**

Ceramics – types and applications – composites: classification, role of matrix and reinforcement, processing of fibre reinforced plastics – metallic glasses: types , glass forming ability of alloys, melt spinning process, applications - shape memory alloys:phases, shape memory effect, pseudoelastic effect, Ni-Ti alloy, applications – nanomaterials: preparation (bottom up and top down approaches), properties and applications.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of this course,

- The students will have knowledge on the various phase diagrams and their applications
- The students will acquire knowledge on $Fe-Fe_3C$ phase diagram, various microstructures and alloys
- The students will get knowledge on mechanical properties of materials and their measurement
- The students will gain knowledge on magnetic and dielectric properties of materials.
- The students will understand the basics of ceramics, composites and nanomaterials.

**TEXT BOOKS:**


1. Balasubramaniam, R. - Callister's Materials Science and Engineering‖. Wiley India Pvt. Ltd., 2014.
2. Raghavan, V. - Physical Metallurgy: Principles and Practice‖. PHI Learning, 2015
3. Raghavan, V. - Materials Science and Engineering: A First course‖. PHI Learning, 2015.


**REFERENCE BOOKS:**


1. Askeland, D. - Materials Science and Engineering‖. Brooks/Cole, 2010.
2. Smith, W.F., Hashemi, J. & Prakash, R. - Materials Science and Engineering- ‖. Tata McGraw Hill Education Pvt. Ltd., 2014.
3. Wahab, M.A. -Solid State Physics: Structure and Properties of Materials‖ Narosa Publishing House, 2009.

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**1921203 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To study the nature and facts about environment.
- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth's interior and surface.

**UNIT-I: ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 14**

Definition, scope and importance of environment – need for public awareness – concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the grassland ecosystem, aquatic ecosystems (lakes, oceans) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of an ecosystems.

**UNIT-II: ENVIRONMENTAL POLLUTION 8**

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial /Agricultural.

**UNIT-III: NATURAL RESOURCES 10**

Forest resources: Use and over-exploitation, deforestation, soil erosion and desertification, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over- utilization of surface and ground water, floods, drought, conflicts over water– Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity– role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

**UNIT-IV: SOCIAL ISSUES AND THE ENVIRONMENT 7**

From unsustainable to sustainable development – urban problems related to energy –water conservation, rain water harvesting and watershed management – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife protection Act – Forest conservation Act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

**UNIT-V: HUMAN POPULATION AND THE ENVIRONMENT 6**

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health – Case studies.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

At the end of the course, the student should be able to:

- Gain knowledge on ecosystem, environment and biodiversity.
- Understand the process and disadvantages of environmental pollution.
- Analyze the ill effects of over exploitation of natural resources.
- Explain the social issues from unsustainable to sustainable development.
- Outline the need for decrease in population growth and its measures.

**TEXT BOOKS:**

1. Benny Joseph, ‘Environmental Science and Engineering’, Tata McGraw-Hill, New Delhi, 2006.
2. Gilbert M. Masters, ‘Introduction to Environmental Engineering and Science’, 2nd edition, Pearson Education, 2004.

**REFERENCE BOOKS:**

1. Dharmendra S. Sengar, "Environmental law", Prentice Hall of India PVT LTD, New Delhi, 2007.
2. Erach Bharucha, “Textbook of Environmental Studies”, Universities Press (I) PVT, LTD, Hydrabad, 2015.
3. Rajagopalan, R, "Environmental Studies - From Crisis to Cure"’, Oxford University Press, 2005.
4. G. Tyler Miller and Scott E. Spoolman, “Environmental Science”, Cengage Learning India PVT, LTD, Delhi, 2014.

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**1901006** **PROGRAMMING IN - C** **L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To develop C Programs using basic programming.
- To develop C programs using arrays
- To develop C programs using strings
- To develop applications in C using functions
- To develop C program using structures and union

**UNIT –I: BASICS OF C PROGRAMMING 9**

Introduction to algorithm: Flowchart-Pseudo code- Introduction to programming paradigms- C programming: Data Types -Keywords-Variables and Constants– Operators and Expressions: Expressions -precedence,-associativity-Input/Output statements-Decision making and looping: Branching statement, Iterative statement - Compilation process.

**UNIT –II: ARRAYS AND STRINGS 9**

Introduction to Arrays: One dimensional array: Assigning an array to another array –Equating an array with another array-Two dimensional Arrays: Declaration-usage of two dimensional array-reading, storing and accessing elements in two dimensional array-memory representation-String operations: String library functions- list of strings-command line arguments.

**UNIT –III: FUNCTIONS** **9**

Introduction to functions: Classification of functions- function definition-function call-function with inputs and outputs-recursive function-library functions-scope of variables.

**UNIT –IV: STRUCTURES AND UNIONS** **9**

Introduction to Structures: Array of structures – Nested structure-functions and Structures-Introduction to union-: practical applications of union —type def. and structures-enumerated data type.

**UNIT-V: STORAGE CLASS AND PREPROCESSOR DIRECTIVE** **9**

Introduction to storage classes: Types of storage classes- C preprocessor Directives: Types of preprocessor directives-Pragma Directive-conditional directive. **TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

- Develop simple applications in C using basic constructs.
- Design and implement applications using arrays and strings
- Develop and implement applications in C using functions
- Develop applications in C using structures and unions
- Design applications using preprocessor to stimulate functions

**TEXT BOOKS:**

1. Anita Goel and Ajay Mittal, ―Computer Fundamentals and Programming in C, Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011.
2. ReemaThareja, ―Programming in C, Oxford University Press, Second Edition, 2016.

**REFERENCE BOOKS:**

1. Paul Deitel and Harvey Deitel, ―C How to Program, Seventh edition, Pearson Publication.

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| 1901007 | ENGINEERING GRAPHICS | L T P C |
|---|---|---|
| | (Common to all branches of B.E. / B.Tech. Programmes) | 2 0 4 4 |

**OBJECTIVES:**

The main learning objective of this course is to impart knowledge

- To draw the conics curves and special curves.
- To draw the orthographic projection of lines and plane surfaces.
- To draw the projections and solids and Isometric projection of simple solids.
- To draw projections of Section of Solids and development of surfaces.
- To draw free hand sketching of basic geometrical constructions, multiple views of objects and Perspective Projection of simple solids.

**CONCEPTS AND CONVENTIONS (Not for Examination) 1**

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

**UNIT- I: PLANE CURVES AND SPECIAL CURVES 10**

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid (Rolling Circle rolls on flat surface only). Construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

**UNIT- II: PROJECTION OF POINTS, LINES AND PLANE SURFACES 16**

Orthographic projection- Principles-Principal planes - First angle projection-projection of points at First Quadrant only. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method. Projection of planes (polygonal and circular surfaces) which inclined to both the principal planes by rotating object method.

**UNIT- III: PROJECTION OF SOLIDS AND ISOMETRIC PROJECTION 16**

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is Inclined to one of the principal planes by rotating object method. Principles of isometric projection – isometric scale – Isometric projections of simple solids - Prisms, pyramids, cylinders, cones.

**UNIT- IV: PROJECTION OF SECTIONED SOLIDS & DEVELOPMENT OF SURFACES 16**

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

**UNIT- V: FREE HAND SKETCHING AND PERSPECTIVE PROJECTIONS 16**

Free Hand sketching: Visualization principles – Representation of Three Dimensional objects – Layout of views- Free hand sketching of multiple views from pictorial views of objects. Perspective projection of simple solids-Prisms and pyramids by visual ray method.

**TOTAL: 75 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of this course, the students will be able:

- To construct the conics curves and special curves.
- To construct the orthographic projection of lines and plane surfaces.
- To construct the projections and solids and Isometric projection of simple solids.
- To construct projections of Section of Solids and development of surfaces.
- To construct free hand sketching of basic geometrical constructions, multiple views of objects and Perspective Projection of simple solids.

**TEXT BOOKS:**


1. N.D.BHATT, "Engineering Drawing (Plane and Solid Geometry)", Charotar Publishing House PVT. LTD. 53$^{rd}$ Edition : 2018 (Reprint)
2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2018.


**REFERENCE BOOKS:**


1. T. Jeyapoovan, "Engineering Graphics Using Auto CAD", Vikas Publishing House Pvt. LTD, seventh Edition, 2015.
2. Luzzader, Warren.J. and Duff, John M., "Fundamentals of Engineering Drawing with an

introduction to Interactive Computer Graphics for Design and Production", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.

3. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson, 2nd Edition, 2011.
4. Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2009.
5. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2013.

**Publication of Bureau of Indian Standards**:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

**Special points applicable to University Examinations on Engineering Graphics:**

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day.

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| 3 | 3 | - | 1 | - | 3 | - | - | - | - | 2 | - | 2 | 2 | 2 | 2 | 2 |
| 4 | 3 | - | 2 | - | 3 | - | - | - | - | 2 | - | 2 | 2 | 2 | 1 | 1 |
| 5 | 3 | - | 3 | - | 3 | - | - | - | - | 2 | - | 2 | 2 | 2 | 1 | 1 |

**1901010** **C- PROGRAMMING LABORATORY** **L T P C**

**0 0 4 2**

**COURSE OBJECTIVES:**

- To develop programs in C using basic constructs.
- To develop applications in C using arrays and functions.
- To develop applications in C using Strings and Structures.
- To develop various applications using array concepts
- To develop various application using function concept.

**LIST OF PROGRAMS:**

1. Programs using I/O statements and expressions.
2. Programs using decision-making constructs.
3. Write a program to find whether the given year is leap year or Not? (Hint: not every centurion year is a leap. For example 1700, 1800 and 1900 is not a leap year)
4. Write a program to perform the Calculator operations, namely, addition, subtraction, multiplication, division and square of a number.
5. Check whether a given number is Armstrong number or not?
6. Check whether a given number is odd or even?
7. Write a program to perform factorial of a number.
8. Write a C program to find out the average of 4 integers.
9. Show how to display array elements using two dimensional array.
10. Write a C program to perform swapping using function.
11. Display all prime numbers between two intervals using functions.
12. Reverse a sentence using recursion.
13. Write a program in C to get the largest element of an array using the function.
14. Write a C program to concatenate two string.
15. Write a C program to find the length of String.
16. Find the frequency of a character in a string.
17. Write a C program to Store Student Information in Structure and Display it.
18. The annual examination is conducted for 10 students for five subjects. Write a program to read the data and determine the following:
    (a) Total marks obtained by each student.
    (b) The highest marks in each subject and the marks of the student who secured it.
    (c) The student who obtained the highest total marks.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

- Develop C programs for simple applications.
- Making use of basic constructs, arrays and strings.
- Develop C programs involving functions,
- Develop program using recursion, pointers, and structures.
- Design applications using sequential and random access file processing.

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**1901208 ENGINEERING PRACTICES LABORATORY** **L T P C**

(Common to all branches of B.E. / B.Tech. Programmes) **0 0 4 2**

**COURSE OBJECTIVES:**

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.
- To provide hands on training for fabrication of components using carpentry, sheet metal and welding equipment / tools
- To gain the skills for making fitting joints and assembling air conditioner
- To develop the skills for making simple electrical wiring connections using suitable tools
- To provide hands on experience for soldering and gain knowledge about the behavior of electronics components

## GROUP A (CIVIL & MECHANICAL)

**I CIVIL ENGINEERING PRACTICE 15**

**Buildings:**

a) Study of plumbing and carpentry components of residential and industrial buildings safety aspects.

**Plumbing Works**:

a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
b) Study of pipe connections requirements for pumps and turbines.
c) Preparation of plumbing line sketches for water supply and sewage works.
d) Hands-on-exercise:
   Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.
e) Demonstration of plumbing requirements of high-rise buildings.

**Carpentry works:**

a) Study of the joints in roofs, doors, windows and furniture.
b) Hands-on-exercise:
   Wood work, joints by sawing, planning and cutting.

**II MECHANICAL ENGINEERING PRACTICE 15**

**Welding:**

a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.
b) Gas welding practice

**Basic Machining:**

a) Simple Turning and Taper turning
b) Drilling Practice

**Sheet Metal Work:**

a) Forming & Bending
b) Model making – Trays and funnels.
c) Different type of joints.

**Fitting:**

a) Preparation of square fitting

b) Preparation of V – fitting models.

**Machine assembly practice:**

a) Assembly of centrifugal pump

b) Assembly of air conditioner

**Demonstration on:**

a) Smithy operations, upsetting, swaging, setting down and bending.
Example – Exercise – Production of hexagonal headed bolt.

b) Foundry operations like mould preparation for gear and step cone pulley.

## <u>GROUP B (ELECTRICAL & ELECTRONICS)</u>

**III ELECTRICAL ENGINEERING PRACTICE** **15**

1. Residential house wiring using Switches, Fuse, Indicator, Lamp and Energy meter.
2. Fluorescent Lamp Wiring.
3. Staircase Wiring.
4. Measurement of Voltage, Current, Power and Power factor in electrical circuit.
5. Measurement of Energy using Analog & Digital Energy meter.
6. Measurement of Earth Resistance.
7. Study of Industrial house wiring.
8. Identification & Study of protective devices: Fuses & Fuse carriers, MCB, ELCB and Isolators with ratings and usage.

**IV ELECTRONICS ENGINEERING PRACTICE** **15**

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, RMS period, frequency) using CR.
2. Study of logic gates AND, OR, EX-OR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components, Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

- Carry out various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering
- Fabricate carpentry components and pipe connections including plumbing works and use welding equipment's to join the structures.
- Carry out the basic machining operations, make the models using sheet metalworks. Illustrate on centrifugal pump, air conditioner, operations of smithy, foundry and fittings
- Carry out basic home electrical works and measure the electrical quantities
- Elaborate on the electronics components, gates and soldering practices.

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:**

**CIVIL**

1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings. 15 Sets
2. Carpentry vice (fitted to work bench) 15 Nos.
3. Standard woodworking tools 15 Sets
4. Models of industrial trusses, door joints, furniture joints 5 each

**MECHANICAL**

1. Arc welding transformer with cables and holders 5 Nos.
2. Welding booth with exhaust facility 5 Nos.
3. Welding accessories like welding shield, chipping hammer, wire brush, etc. 5 Sets
4. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit. 2 Nos.
5. Centre lathe 2 Nos.
6. Hearth furnace, anvil and smithy tools 2 Sets
7. Moulding table, foundry tools 2 Sets
8. Power Tool: Angle Grinder 2 Nos.
9. Study-purpose items: centrifugal pump, air-conditioner One each
10. Fitting tools, Hack saw frame, 12' file, hack saw blade 15 Nos.

## ELECTRICAL

1. Assorted electrical components for house wiring 15 Sets
2. Fluorescent Lamp 15 Sets
3. Electrical measuring instruments 10 Sets
4. Analog & Digital energy meter 5 Sets
5. Megger 2

## ELECTRONICS

1. Soldering guns 10 Nos.
2. Assorted electronic components for making circuits 50 Nos.
3. Small PCBs 10 Nos.
4. Multimeters 10 Nos.
5. Study purpose items: Telephone, FM radio, low-voltage power supply

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| 1901209 | APPLIED PHYSICS AND ENVIRONMENTAL CHEMISTRY LABORATORY | L | T | P | C |
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(Common to all branches of B.E. / B.Tech. Programmes)

(Laboratory classes on alternate weeks for Physics and Environmental Chemistry)

## APPLIED PHYSICS LABORATORY

**COURSE OBJECTIVES:**

- To measure the band gap of given semiconductor.
- To study I-V characteristics of solar cell
- To measure electrical resistivity of metal and alloy
- To calculate the hkl planes
- To measure the paramagnetic susceptibility by Quinke's method

**LIST OF EXPERIMENTS: (Any 5 Experiments)**

1. Determination of band gap of a semiconductor.
2. Study of I-V characteristics of solar cell and determination of its efficiency.
3. Determination of electrical resistivity of metal and alloy –Carey foster Bridge.
4. Calculation of lattice cell parameter – X-ray diffraction method.
5. Measurement of susceptibility of paramagnetic solution by Quinke's method.
6. Study of magnetic Hysteresis-B-H curve.
7. Measurement of Temperature using LM35.

**TOTAL: 30 PERIODS**

**DEMO:**

1. Crystal growth- Low temperature solution growth.
2. Absorption and transmittance measurement of materials – UV visible spectrum.
3. Attenuation losses in optical Fiber.

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to:

- Measure the band gap of semiconductors
- Measure the efficiency of solar cell
- Compare the resistivity of metals and alloys
- Calculate the lattice parameter and interplanar distance.
- Understand the susceptibility values for any paramagnetic substances

**REFERENCE BOOKS:**


1. Wilson J.D. and Hernaandez Hall C.A. – "Physics Laboratory Experiments", Houghton Mifflin Company, New York, 2005.
2. S. Srinivasan, "A Text Book of Practical Physics", S. Sultan Chand publications. 2005.
3. R. Sasikumar, "Practical Physics", PHI Learning Pvt. Ltd, New Delhi, 2011.


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| 4 | 3 | 1 | 2 | 2 | - | 1 | - | 1 | 1 | - | - | - | 1 | - | - | - |
| 5 | 3 | 2 | 2 | 2 | - | 2 | - | 1 | 1 | - | - | - | 2 | - | - | - |

## ENVIRONMENTAL CHEMISTRY LABORATORY

**COURSE OBJECTIVES:**

- To determine the dissolved oxygen and chloride content in water
- To determine calcium and magnesium present in domestic water
- To estimate iron, sodium and chlorine using various techniques
- To determine the chemical oxygen demand in industrial effluent
- To determine the available chlorine in bleaching powder.

**LIST OF EXPERIMENTS: (Any 5 Experiments)**

1. Determination of total, temporary & permanent hardness of water by EDTA method.
2. Determination of DO content of water sample by Winkler's method.
3. Determination of chloride content of water sample by argentometric method.
4. Estimation of iron content of the water sample using spectrophotometer
5. Determination of COD value of industrial effluents
6. Estimation of sodium by flame photometry
7. Estimation of available chlorine in bleaching powder

**TOTAL: 30 PERIODS**

**DEMO:**

1. Pollution abatement by adsorption techniques
2. Scintillation Process

**COURSE OUTCOMES:**

The student should be able to:

- Appreciate the basic requirements for potable water.
- Understand the need of dissolved oxygen in water.
- Explore the quantity of bleaching powder to be added in water.
- Analyze the ill effects caused by the industrial effluents.
- Explore new research areas in the treatment of waste water.

**TEXTBOOKS:**

1. Vogel's Textbook of Quantitative Chemical Analysis (8th Edition, 2014)

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## THIRD SEMESTER

**1918301 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS L T P C**

**3 1 0 4**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students:

- To introduce Fourier series analysis this is central to many applications in Engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations.
- Apply PDE in solving one dimensional Wave and Heat flow equations.
- To model several physical problems to develop Z transform techniques for discrete time systems.

**UNIT-I: PARTIAL DIFFERENTIAL EQUATIONS 9L+3T**

Formation of partial differential equations - Solutions Lagrange's linear equation — linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

**UNIT-II: FOURIER SERIES 9L+3T**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's identity – Harmonic analysis.

**UNIT-III: APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9L+3T**

Classification of PDE – Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction in infinite plates(excluding insulated edges).

**UNIT-IV: FOURIER TRANSFORMS 9L+3T**

Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

**UNIT-V: Z – TRANSFORMS AND DIFFERENCE EQUATIONS 9L+3T**

Z- transforms – Elementary properties – Inverse Z – transform (using partial fraction and residues) – Convolution theorem – Solution of difference equations using Z – transform.

**TOTAL: 45L+15T:60 PERIODS**

**OUTCOMES:**

At the end of the course Learners will be able to:

- Understand the fundamental concepts of Partial differential Equations.
- Understand the basic concepts of mathematical principles on Fourier & Z- transforms.
- Apply the concept of PDE and Solve Wave equation, and Heat flow equations.
- Understand the concept Fourier series and apply the concept of solving PDE.
- Understand the fundamental concepts for the Solution of difference equations.

**TEXT BOOKS:**


1. Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.
2. Grewal. B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, Delhi, 2012.
3. Narayanan.S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematicsfor Engineering Students" Vol. II & III, S.Viswanathan Publishers Pvt. Ltd.1998.


**REFERENCE BOOKS:**


1. Bali.N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd, 2007.
2. Ramana.B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
4. Erwin Kreyszig,"Advanced Engineering Mathematics", 8th Edition, Wiley India, 2007.
5. Ray Wylie. C and Barrett.L.C, "Advanced Engineering Mathematics" Tata McGraw Hill Education Pvt Ltd, 6th Edition, New Delhi, 2012.
6. P.Sivaramakrishna Das, C.Vijayakumari, Transforms and Partial Differential Equations, Pearson India Education Services Pvt. Ltd, 2019.

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**1909301 ENGINEERING MECHANICS L T P C**

**3 1 0 4**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students:

- To understand the basic concepts of statics.
- To learn the concept of equilibrium in rigid bodies.
- To familiarize the properties of plane surfaces and solids.
- To understand the theory of friction.
- To learn the importance of dynamics in rigid bodies.

**UNIT- I: BASICS AND STATICS OF PARTICLES 9L+3T**

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectorial representation of forces –Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility .

**UNIT- II: EQUILIBRIUM OF RIGID BODIES 9L+3T**

Free body diagram – Types of supports – Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions.

**UNIT- III: PROPERTIES OF SURFACES AND SOLIDS 9L+3T**

Centroids of areas, composite areas, determination of moment of inertia of plane figures by integration, polar moment of inertia-radius of gyration - Parallel axis theorem and perpendicular axis theorem – Centre of mass - mass moment of inertia of simple solids.

**UNIT- IV: FRICTION** **9L+3T**

Frictional Force - Laws of Coulomb friction - Cone of friction - Angle of repose - relation between cone of friction and angle of repose - limiting friction - Rolling resistance - Simple contact friction - Screw – Wedge – Ladder - Belt friction.

**UNIT- V: KINEMATICS AND KINETICS OF RIGID BODIES** **9L+3T**

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

**TOTAL(45L+15T) : 60 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Apply the various methods to determine the resultant forces and its equilibrium acting on a particle in 2D and 3D.
- Apply the concept of reaction forces (non-concurrent coplanar and non -coplanar forces) and moment of various support systems with rigid bodies in 2D and 3D in equilibrium. Reducing the force, moment, and couple to an equivalent force - couple system acting on rigid bodies in 2D and 3D.
- Apply the concepts of locating centroids / center of gravity of various sections / volumes and to find out area moments of inertia for the sections and mass moment of inertia of solids.
- Apply the concepts of frictional forces at the contact surfaces of various engineering systems.
- Apply the various methods of evaluating kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

**TEXTBOOKS:**

1. Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, Sanjeev Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 11$^{th}$ Edition, 2017.
2. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13$^{th}$ edition, Prentice Hall, 2013.

**REFERENCE BOOKS:**

1. Irving H. Shames and Krishna Mohana Rao. G., “Engineering Mechanics – Statics and Dynamics”, 4th Edition, Pearson Education, 2005.
2. Meriam J L and Kraige L G, Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
3. Timoshenko S, Young D H, Rao J V and SukumarPati, Engineering Mechanics, 5th Edition, McGraw Hill Higher Education, 2013.
4. Boresi P and Schmidt J, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
5. Kumar, K.L., “Engineering Mechanics”, 3rd Revised Edition, Tata McGraw-Hill Publishing company, New Delhi, 2008.

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| 1909302 | ENGINEERING THERMODYNAMICS | L | T | P | C |
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**(Use of steam tables and psychrometric chart is permitted)**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students:

- To understand the basic concepts of Engineering thermodynamics and application to the first law of thermodynamics.
- To understand the second law of thermodynamics and its application to the thermodynamic systems and concepts of entropy and exergy.

- To know the various thermodynamic properties and to understand the concept of steam power cycles and its application in the steam power plants.
- To know the various properties of the ideal and real gas and the significance of compressibility factor in real gas.
- To illustrate the Gas Mixtures and the various property relations involved in thermodynamics.

**UNIT-I: BASIC CONCEPTS AND FIRST LAW 9**

Basic concepts - concept of continuum, comparison of microscopic and macroscopic approach. Path and point functions. Intensive and extensive. System and their types. Thermodynamic Equilibrium State, path and process. Quasi-static, reversible and irreversible processes. Heat and work transfer-V diagram. Zeroth law of thermodynamics – concept of temperature and thermal equilibrium– relationship between temperature scales –First law of thermodynamics –application to closed and open systems – steady and unsteady flow processes.

**UNIT-II: SECOND LAW AND ENTROPY 9**

Heat Reservoir, source and sink. Heat Engine, Refrigerator, and Heat pump. Statements of second law and its corollaries. Carnot cycle Reversed Carnot cycle, Performance. Clausius inequality. Concept of entropy, T-s diagram, Tds Equations, entropy change for - pure substance, ideal gases - different processes, principle of increase in entropy. Applications of II Law. High and low grade energy. Irreversibility. I and II law Efficiency.

**UNIT-III: PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE 9**

Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams. p-v-T surface. Use of Steam Table and Mollier Chart. Determination of dryness fraction. Application of I and II law for pure substances. Ideal and actual Rankine cycles, Cycle Improvement Methods - Reheat and Regenerative cycles, Economizer, preheater, Binary and Combined cycles.

**UNIT-IV: IDEAL AND REAL GASES 9**

Properties of Ideal gas- Ideal and real gas comparison- Equations of state for ideal and real gases- Reduced properties. Compressibility factor-.Principle of Corresponding states. -Generalized Compressibility Chart and its use.

**UNIT-V: GAS MIXTURES AND THERMODYNAMIC RELATIONS 9**

Mole and Mass fraction, Dalton's and Amagat's Law. Properties of gas mixture Molar mass, gas constant, density, and change in internal energy, enthalpy, entropy and Gibbs function. Maxwell relations, Tds Equations, Difference and ratio of heat capacities, Energy equation, Joule-Thomson Coefficient, Clausius Clapeyron equation, Phase Change Processes. Simple Calculations.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On successful completion of this course, the students will be able to:

- Apply the basic concepts of thermodynamic system, heat and work interaction and also can plot the PV and TS diagrams for all the processes.
- Apply second law of thermodynamics to open and closed systems and the energy and exergy transfer.
- Explain the concepts of steam formation and properties of pure substance to solve the problems related to steam power plants.
- Differentiate the properties of ideal and real gases to apply the thermodynamic relations to the thermodynamic systems.
- Solve the problems related to Gas Mixtures and the various property relations involved in thermodynamics.

**TEXTBOOKS:**


1. R.K.Rajput, "A Text Book Of Engineering Thermodynamics", 5$^{th}$ Edition, 2017.
2. Yunus A Cengel, Michael A Boles & Mehmet Kanoglu "Thermodynamics, An Engineering Approach", 9$^{th}$ edition 2019.


**REFERENCE BOOKS:**


1. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, July 2017
2. Borgnakke & Sonntag, "Fundamental of Thermodynamics", Wiley 9$^{th}$ Edition, 2016.
3. Chattopadhyay, P, "Engineering Thermodynamics", Oxford University Press 2$^{nd}$ Edition, 2016.

4. Michael J. Moran, Howard N. Shapiro, “Fundamentals of Engineering Thermodynamics”, 9th Edition, 2018.
5. Nag.P.K. “Engineering Thermodynamics”, Tata McGraw-Hill, New Delhi, 6th Edition 2017.

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| **2** | 3 | 3 | 2 | 2 | | | 1 | 1 | | 1 | | 2 | 2 | 1 | | |
| **3** | 3 | 3 | 2 | 2 | | | 1 | 1 | | 1 | | 2 | 2 | 1 | | |
| **4** | 3 | 3 | 2 | 2 | | | 1 | 1 | | 1 | | 2 | 2 | 1 | | |
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| **1909303** | **MANUFACTURING PROCESSES** | **L** | **T** | **P** | **C** |
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**OBJECTIVES:**

The main learning objective of this course is to prepare the students:

- To understand different manufacturing process and select the best one out of the available methods.
- To expose the concepts to the students in various metal casting, metal joining processes.
- To learn and understand the working principle of bulk deformation processes.
- To understand the working principles of sheet metal forming process
- Applying the working principles of plastics moulding.

**UNIT-I: METAL CASTING PROCESSES 9**

Sand Casting : Sand Mould – Type of patterns - Pattern Materials – Pattern allowances –Moulding sand Properties and testing – Cores –Types and applications – Moulding machines– Types and applications; Melting furnaces : Blast and Cupola Furnaces; Principle of special casting processes : Shell - investment – Ceramic mould – Pressure die casting - Centrifugal Casting - CO2 process – Stir casting; Defects in Sand casting.

**UNIT-II: JOINING PROCESSES 9**

Operating principle, basic equipment, merits and applications of: Fusion welding processes: Gas welding - Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding-Gas metal arc welding – Submerged arc welding – Electro slag welding; Operating principle and applications of: Resistance welding - Plasma arc welding – Thermit welding – Electron beam welding – Friction welding and Friction Stir Welding; laser beam welding and under water welding -Brazing and soldering; Weld defects: types, causes and cure.

**UNIT-III: BULK DEFORMATION PROCESSES 9**

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals– Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts. Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion.

**UNIT-IV: SHEET METAL PROCESSES 9**

Sheet metal characteristics – shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes-Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning– Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming.

**UNIT-V: MANUFACTURE OF PLASTIC COMPONENTS 9**

Types and characteristics of plastics – Moulding of thermoplastics – working principles and typical applications – injection moulding – Plunger and screw machines – Compression moulding, Transfer moulding – Typical industrial applications – introduction to blow moulding –Rotational moulding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Apply the working principles of various metal casting processes.
- Explain the working principles of various metal joining processes and applications.
- Analyze the working principles of bulk deformation of metals.

- Apply the working principles of sheet metal forming process.
- Explain the working principles of plastics moulding and its types.

**TEXTBOOKS:**


1. P.C. Sharma, "A Text Book of Production Engineering", S.Chand and Co.Ltd, Eighth Revised edition, 2014
2. Hajra Choudhury SK "Elements of Workshop Technology", Vol. I & II, Media Promoters Pvt. Ltd., 2014
3. Kalpakjian. Manufacturing Engineering and Technology, Pearson Education India Edition, 2013.


**REFERENCE BOOKS:**


1. Rao,P.N. Manufacturing Technology Foundry, Forming and Welding, 4th Edition, TM 2013.
2. Gowri P. Hariharan, A.Suresh Babu, Manufacturing Technology I, Pearson Education, 2008.
3. Roy. A. Lindberg, Processes and Materials of Manufacture, PHI / Pearson education, 2006.
4. Magendran Parashar BS and Mittal R K, "Elements of Manufacturing Processes "Prentice Hall of India, 2003.


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**1909304** **FLUID MECHANICS AND MACHINERY**

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**OBJECTIVES:**

To impart knowledge to the students on the following topics of:

- Mathematical concepts used to predict the properties and characteristics of a fluid.
- Analysis and calculations of major and minor losses associated with pipe flow in piping networks.
- Prediction of physical quantities
- Analysis of the performance of pumps and types.
- Analysis of the performance of turbines and its classifications.

**UNIT-I: FLUID PROPERTIES AND FLOW CHARACTERISTICS 9**

Units and dimensions- Properties of fluids- mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, surface tension and capillarity. Flow characteristics – concept of control volume - application of continuity equation, energy equation and momentum equation.

**UNIT-II: FLOW THROUGH CIRCULAR CONDUITS 9**

Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli- Boundary layer concepts – types of boundary layer thickness – Darcy Weisbach equation – friction factor- Moody diagram- commercial pipes- minor losses – Flow through pipes in series and parallel.

**UNIT-III: DIMENSIONAL ANALYSIS 9**

Need for dimensional analysis – methods of dimensional analysis – Similitude –types of similitude - Dimensionless parameters- application of dimensionless parameters – Model analysis.

**UNIT-IV: PUMPS 9**

Impact of jets - Euler's equation - Theory of roto-dynamic machines – various efficiencies– velocity components at entry and exit of the rotor- velocity triangles - Centrifugal pumps– working principle - work done by the impeller - performance curves - Reciprocating pump-working principle – Rotary pumps –classification-pumps in series-parallel -Head Vs Discharge-cavitation.

**UNIT-V: TURBINES 9**

Classification of turbines – heads and efficiencies – velocity triangles. Axial, radial and mixed flow turbines. Tangential flow turbines -Pelton wheel, Francis turbine and Kaplan turbines-working principles - work done by water on the runner – draft tube. Specific speed - unit quantities – performance curves for turbines– governing of turbines.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will have the:

- Ability to apply mathematical knowledge to predict the properties and characteristics of a fluid.
- Ability to analyse and calculate major and minor losses associated with pipe flow in piping networks.
- Ability to predict the nature of physical quantities mathematically.
- Ability to analyse the performance of pumps.
- Ability to analyse the performance of turbines.

**TEXTBOOKS:**

1. Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi 2017.
2. Bansal R.K “A Text Book Fluid Mechanics and Hydraulic Machines”, Laxmi Publications (p) Ltd, 10th Edition, 2018.

**REFERENCE BOOKS:**

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| 1909305 | MANUFACTURING TECHNOLOGY LABORATORY | L | T | P | C |
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**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Selecting appropriate tools, equipment and machines to complete a given job.
- Performing various welding process using GMAW.
- Performing various machining process such as rolling, drawing, turning, shaping, drilling, milling.
- Fabricating gears using gear making machines.
- Analyzing the defects in the cast and machined components.

**LIST OF EXPERIMENTS:**

1. Taper Turning – Compound rest swiveling method, Tailstock offset method.
2. External and Internal Thread cutting
3. Eccentric Turning.
4. Square Head Shaping.
5. Hexagonal Head Shaping.
6. Fabrication of simple structural shapes using Gas Metal Arc Welding
7. Joining of plates and pipes using Gas Metal Arc Welding/ Submerged arc welding
8. Preparation of green sand moulds
9. Manufacturing of simple sheet metal components using shearing and bending operations.
10. Contour milling using vertical milling machine
11. Spur gear cutting in milling machine
12. Helical Gear Cutting in milling machine
13. Gear generation in hobbing machine.
14. Gear generation in gear shaping machine
15. Plain Surface grinding
16. Cylindrical grinding
17. Tool angle grinding with tool and Cutter Grinder
18. Measurement of cutting forces in Milling / Turning Process
19. CNC Part Programming

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Demonstrate the safety precautions exercised in the mechanical workshop.
- Make the work piece as per given shape and size using Lathe.
- Join two metals using arc welding.
- Use sheet metal fabrication tools and make simple tray and funnel.
- Use different moulding tools, patterns and prepare sand moulds.

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS**

| Sl. No. | LIST OF THE EQUIPMENTS | No. |
|---|---|---|
| 1 | Centre Lathes | 7 Nos. |
| 2 | Horizontal Milling Machine | 2 Nos |
| 3 | Vertical Milling Machine | 1 No |
| 4 | Shaper | 1 No. |
| 5 | Arc welding transformer with cables and holders | 2 Nos |
| 6 | Oxygen and acetylene gas cylinders and blow pipe | 1 No |
| 7 | Moulding table, Moulding equipment | 2 Nos |
| 8 | Sheet metal forming tools and equipment | 2 Nos. |
| 9 | Turret and Capstan Lathes | 1 No each |
| 10 | Surface Grinding Machine | 1 No |
| 11 | Cylindrical Grinding Machine | 1 No |
| 12 | Radial Drilling Machine | 1 No. |
| 13 | Lathe Tool Dynamometer | 1 No |
| 14 | Milling Tool Dynamometer | 1 No |
| 15 | Gear Hobbing Machine | 1 No |
| 16 | Tool Makers Microscope | 1 No |
| 17 | CNC Lathe | 1 No |
| 18 | CNC Milling machine | 1 No |
| 19 | Gear Shaping machine | 1 No |
| 20 | Centreless grinding machine | 1 No |
| 21 | Tool and cutter grinder | 1 No |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** | **4** |
| **1** | 1 | | | | | | 3 | | | | | 2 | 1 | 1 | 1 | |
| **2** | 2 | | | | | | 2 | | | | | 2 | 3 | 2 | 1 | 1 |
| **3** | 2 | | | | | | 1 | | | | | 1 | 1 | 2 | 2 | |
| **4** | 3 | | | | | | 3 | | | | | 1 | 2 | 1 | 2 | 2 |
| **5** | 3 | | | | | | 2 | | | | | 1 | 2 | 1 | 2 | |

| 1909306 | FLUID MECHANICS AND MACHINERY LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
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**OBJECTIVES:**

Upon Completion of this subject, the students can able to:

- Understand hands on experience in flow measurements using different devices.
- Understand the working principle and performance of centrifugal and submergible pumps.
- Know, how to calculate and draw characteristics curves for various experiments related to fluid mechanics.
- Understand the energy flow pattern through the hydraulic turbines and pumps.
- Explain his/her competency towards preventive maintenance of hydraulic turbines.

**LIST OF EXPERIMENTS:**

1. Determination of the Coefficient of discharge of given Orifice-meter.
2. Determination of the Coefficient of discharge of given Venturi-meter.
3. Calculation of the rate of flow using Rotameter.
4. Determination of friction factor for a given set of pipes.
5. Conducting experiments and drawing the characteristic curves of centrifugal pump/ submergible pump
6. Conducting experiments and drawing the characteristic curves of reciprocating pump.

7. Conducting experiments and drawing the characteristic curves of Gear pump.
8. Conducting experiments and drawing the characteristic curves of Pelton wheel.
9. Conducting experiments and drawing the characteristics curves of Francis turbine.
10. Conducting experiments and drawing the characteristic curves of Kaplan turbine.

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able:

- Ability to use the measurement equipment for flow measurement
- Ability to do performance trust on different fluid machinery
- Conduct experiments on hydraulic turbines and pumps to draw characteristics
- Determine the energy flow pattern through the hydraulic turbines and pumps
- Exhibit his/her competency towards preventive maintenance of hydraulic turbines.

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:**

| S. NO. | NAME OF THE EQUIPMENT | Qty. |
|---|---|---|
| 1 | Orifice meter setup | 1 |
| 2 | Venturi meter setup | 1 |
| 3 | Rotameter setup | 1 |
| 4 | Pipe Flow analysis setup | 1 |
| 5 | Centrifugal pump/submergible pump setup | 1 |
| 6 | Reciprocating pump setup | 1 |
| 7 | Gear pump setup | 1 |
| 8 | Pelton wheel setup | 1 |
| 9 | Francis turbine setup | 1 |
| 10 | Kaplan turbine setup | 1 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | - | - | 1 | 2 | 2 | 2 |
| 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | - | - | - | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | - | - | - | 2 | 2 | 2 |
| 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | - | - | 2 | 2 | 2 | 2 |
| 5 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | - | 2 | 2 | - | - | 2 | 2 | 2 | 2 |

**1919001 COMMUNICATION SKILLS LABORATORY - PROJECT BASED L T P C**

**0 0 2 0**

**OBJECTIVES:**

This Course will enable learners to:

- Equip themselves with the English language skills required for the successful undertaking of academic studies with primary emphasis on academic speaking and listening skills.
- Provide guidance and practice in basic general and classroom conversation and to engage in specific academic speaking activities and make effective presentations.
- Improve general and academic listening skills and technical writing skills.
- Strengthen the reading skills of students of engineering.
- Provide more opportunities to develop their project and proposal writing skills.

**UNIT- I: INFORMAL COMMUNICATION – AN INTRODUCTION 6**

Listening - Listening as a key skill- its importance- Speaking - give personal information - ask for personal information - express ability - enquire about ability – rephrase for clarification or emphasis - Improving pronunciation – Articulation of speaking –vowel sounds. Reading – Strategies for effective reading- Read and recognize different text types in a newspaper - Writing-Plan before writing- Develop a paragraph: topic sentence, supporting sentences, concluding sentence.

**UNIT- II: MECHANICS OF BASIC COMMUNICATION 6**

Listening - Listen to a process information- Speaking - asking for details formal/informal – give views, opinions and justification of a news- consonant sounds –diphthongs -.Reading-Read for vocabulary through scientific invention summarize the same into a paragraph- . Writing- compares and contrast ideas using adjectives from multiple sources stating reasons and examples to support ideas. Write a paragraph with reasons and examples- Write a rejoint to a newspaper expressing opinions on particular news.

**UNIT- III: NUANCES OF LSRW 6**

Listening - Lexical chunking for accuracy and fluency- factors that influence fluency- listen for and follow the gist- listen for detail Speaking - deliver a five-minute informal talk - invite and offer - accept - decline - take leave - word stress – stress rules-ability to recognize RP sound- . Reading–

Skimming / Scanning a text to apply both the concepts – to search – to analyze. Writing–Use of dictionary and usage of synonyms- editing and proof reading.

**UNIT- IV: TECHNICAL COMMUNICATION – BASIC PRESENTATION SKILLS 6**

Listening - Being an active listener: giving verbal and non-verbal feedback- listening to a podcast of a native speaker and reciprocating Speaking - participating in a group discussion - conversational speech listening to and participating in conversations - persuade.– Sentence stress – intonations types-features of connected speech Reading– Genre and Organization of Ideas- note taking and summarizing Writing–Email writing- Job application- Blog writing.

**UNIT- V: COMMUNICATION SKILLS FOR FORMAL OCCASION 6**

Listening to documentaries and make notes (TED talks) Speaking -Power point presentation - strategies for presentations and interactive communication - group/pair presentations –use stress and intonation to convey meaning and nuances of meaning clearly- Reading– Technical passages for comprehension- understanding how the text positions the reader- Writing– Statement of Purpose - analyse the situation in a picture / photo and write a suitable description with a proper title

**TOTAL : 30 PERIODS**

**The lab course is offered as an Employability Enhancement Course.**
**The Course will have an Internal End semester exam includes a project work. The Students need to have 75% attendance for the completion of the course.**

**OUTCOMES:**

At the end of the course Learners will be able to:

- Read and evaluate texts critically
- Make effective presentations
- Participate confidently and appropriately in conversations both formal and informal
- Write winning job applications.
- Display critical thinking in various professional contexts.

**REFERENCE BOOKS:**


1. Gramer F.Margot and Colin S.Ward ‘Reading and Writing’ (Level 3) Oxford University Press: Oxford, 2011.

2. Debra Daise, CharlNorloff, and Paul ‘Reading and Writing’ (Level 4) Oxford University Press: Oxford, 2011
3. Brooks, Margret. ‘Skills for Success. Listening and Speaking.’ (Level 4 )Oxford University Press, Oxford: 2011.
4. Richards,C. Jack. & David Bholke. ‘Speak Now’ (Level 3.) Oxford University Press, Oxford: 2010.
5. Davis,Jason and Rhonda LIss. ‘Effective Academic Writing’ (Level 3) Oxford University Press: Oxford, 2006
6. E.Suresh Kumar. ‘Enriching Speaking and Writing Skills. Second Edition. Orient Black swan: Hyderabad, 2012
7. Petelin, Roslyn and Marsh Durham. ‘The Professional Writing Guide: Knowing Well and Knowing Why’. Business & Professional Publishing: Australia, 2004.
8. Bhatnagar, Nitin and Mamta Bhatnagar. ‘Communicative English for Engineers and Professionals’. Pearson: New Delhi, 2010.
9. Hughes, Glyn and Josephine Moate. Practical English Classroom. Oxford University Press: Oxford, 2014.
10. Vargo, Mari. Speak Now (Level 4). Oxford University Press: Oxford, 2013.
11. Richards C. Jack. Person to Person (Starter). Oxford University Press: Oxford, 2006.
12. Ladousse, Gillian Porter. Role Play. Oxford University Press: Oxford, 2014
13. IELTS, TOFEL testing series
14. Jack c. Richards. Tactics for Listening: Developing. Oxford University Press: Oxford,.2004
15. New Oxford Dictionary for writers and editors: The essential A-Z Guide to the Written Word 2005.


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| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** | **4** |
| **1** | 3 | 3 | 2 | 3 | 3 | - | - | - | - | 3 | - | 1 | 2 | 1 | 2 | 2 |
| **2** | 3 | 2 | 3 | 2 | 2 | - | 2 | - | - | 3 | - | 1 | 2 | 2 | 1 | 1 |
| **3** | 3 | 3 | - | 2 | - | - | - | - | - | 3 | - | 1 | 1 | 1 | 1 | 1 |
| **4** | 3 | 3 | - | - | - | - | 3 | - | - | 2 | - | 1 | 2 | 2 | 1 | 1 |
| **5** | 3 | 2 | 2 | - | - | - | - | - | - | 3 | - | 1 | 1 | 2 | 2 | 2 |

## FOURTH SEMESTER

**1918405 STATISTICS AND NUMERICAL METHODS L T P C**

**3 1 0 4**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- This course aims at providing the necessary basic concepts of statistical and numerical Methods for solving numerically different problems of engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples this plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

**UNIT-I: TESTING OF HYPOTHESIS 9L+3T**

Sampling distributions - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness off it.

**UNIT-II: DESIGN OF EXPERIMENTS 9L+3T**

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design.

**UNIT-III: SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS 9L+3T**

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method - Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative method of Gauss Seidel –Dominant Eigen value of a matrix by Power method.

**UNIT-IV: INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION 9L+3T**

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's rules.

**UNIT-V: NUMERICAL SOLUTION OF ORDINARYDIFFERENTIAL EQUATIONS 9L+3T**

Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order equations - Multi step methods: Milne's and Adams -Bash forth predictor corrector methods for solving first order equations.

**TOTAL: 45L+15T PERIODS**

**COURSE OUTCOMES:**

At the end of the course Learners will be able to:

- Apply the concept of testing of hypothesis for small and large samples in real life problems.
- Apply the basic concepts of classifications design of experiments in the field of agriculture.
- Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.
- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering application.

**TEXT BOOKS:**

1. Grewal. B.S. and Grewal. J.S., "Numerical Methods in Engineering and Science ", 10th Edition, Khanna Publishers, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

**REFERENCE BOOKS:**

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning,2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3. Gerald.C.F., Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi,2006.

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | | | | | | | | | | | 1 | | | |
| **2** | 3 | 3 | | | | | | | | | | | 1 | | | |
| **3** | 3 | 3 | | | | | | | | | | | 1 | | | |
| **4** | 3 | 3 | | | | | | | | | | | 1 | | | |
| **5** | 3 | 3 | | | | | | | | | | | 1 | | | |

**1909401** **KINEMATICS OF MACHINERY** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Applying the basic components of mechanisms.
- Analysing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism
- Designing cam mechanisms for specified output motions.
- Applying the basic concepts of toothed gearing and kinematics of gear trains
- Analysing the effects of friction in machine elements

**UNIT- I: BASICS OF MECHANISMS 9**

Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, Mobility – Kutzbach criterion, Gruebler's criterion – Grashof's Law – Kinematic inversions of four-bar chain and slider crank chains – Limit positions – Mechanical advantage – Transmission Angle – Description of some common mechanisms – Quick return mechanisms, Straight line generators, Universal Joint – rocker mechanisms.

**UNIT- II: KINEMATICS OF LINKAGE MECHANISMS 9**

Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method– Velocity and acceleration polygons – Velocity analysis using instantaneous centres – kinematic analysis of simple mechanisms – Coincident points – Coriolis component of Acceleration – Introduction to linkage synthesis problem.

**UNIT- III: KINEMATICS OF CAM MECHANISMS 9**

Classification of cams and followers – Terminology and definitions – Displacement diagrams – Uniform velocity, parabolic, simple harmonic and cycloidal motions – Derivatives of follower motions – Layout of plate cam profiles – Specified contour cams – Circular arc and tangent cams – Pressure angle and undercutting – sizing of cams.

**UNIT- IV: GEARS AND GEARTRAINS 9**

Law of toothed gearing – Involutes and cycloidal tooth profiles –Spur Gear terminology and definitions –Gear tooth action – contact ratio – Interference and undercutting. Gear trains – Speed ratio, train value – Parallel axis gear trains – Epicyclic Gear Trains- Compound gear trains- reverted gear trains-cyclometer- differential gear.

**UNIT- V: FRICTION IN MACHINE ELEMENTS 9**

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Bearings and lubrication – Friction clutches – Belt and rope drives – Friction in brakes- Band and Block brakes-disc brakes

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to:

- Become familiar with the basic components of mechanisms and implement it.
- Identify the assembly in detail with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism and interpret required solutions.
- Create customized cam mechanisms for required particular output motions.
- Understand the basic concepts of toothed gearing and kinematics of gear trains and bring into practicable form of the concepts learned.
- Examine in detail the effects of friction in machine elements and infer the required results.

**TEXT BOOKS:**

1. Dr.F.B. Sayyad, “Kinematics &Theory of Machines”, Tech knowledge publications, 2019.
2. Rattan, S.S, “Theory of Machines”, 5$^{th}$ Edition, Tata McGraw-Hill, 2019.

**REFERENCE BOOKS:**


1. Allen S. Hall Jr., "Kinematics and Linkage Design", Prentice Hall, 1961
2. Cleghorn. W. L, "Mechanisms of Machines", Oxford University Press, 2014
3. Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines", 3rd Edition Affiliated East-West Pvt. Ltd., New Delhi, 2006.
4. John Hannah and Stephens R.C., "Mechanics of Machines", Viva Low-Prices Student Edition, 1999.
5. Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, 2005.
6. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", 5th Edition, Oxford University Press, 2017.


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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 2 | 2 | | 2 | | | 1 | | | | 1 | 3 | | 1 | |
| **2** | 3 | 2 | 2 | | 2 | | | 1 | | | | 1 | 3 | | 1 | |
| **3** | 3 | 2 | 2 | | 2 | | | 1 | | | | 1 | 3 | | 1 | |
| **4** | 3 | 2 | 2 | | 2 | | | 1 | | | | 1 | 3 | | 1 | |
| **5** | 3 | 2 | 2 | | 2 | | | 1 | | | | 1 | 3 | | 1 | |

| **1909402** | **METAL CUTTING AND MACHINE TOOLS** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **0** | **3** |

**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understand the fundamental knowledge in material removal processes
- Study about the different turning machines and automatic machine tools.
- Know about the principles of reciprocating, milling and gear cutting machines.
- Describe the principles of abrasive processes and broaching processes.
- Illustrate the CNC machine tools, micro and wafer machining

**UNIT-I: THEORY OF METAL CUTTING 9**

Mechanics of chip formation, single point cutting tool, forces in machining, Types of chip, cutting tools– nomenclature, orthogonal metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

**UNIT-II: TURNING MACHINES 9**

Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes- tool layout – automatic lathes: semi-automatic – single spindle : Swiss type, automatic screw type – multi spindle.

**UNIT-III: SHAPER, MILLING AND GEAR CUTTING MACHINE 9**

Shaper - Types of operations. Drilling, reaming, boring, Tapping. Milling operations-types of milling cutter- pocket milling, surface contouring – mill turn centers- High speed machining -Gear cutting – forming and generation principle and construction of gear milling, hobbing and gear shaping processes –finishing of gears.

**UNIT-IV: ABRASIVE PROCESS AND BROACHING 9**

Abrasive processes: grinding wheel – specifications and selection, types of grinding process– cylindrical grinding, surface grinding, centreless grinding and internal grinding- Typical applications– concepts of surface integrity, broaching machines: broach construction – push, pull, surface and continuous broaching machines.

**UNIT-V: CNC MACHINING 9**

Numerical Control (NC) machine tools – CNC types, constructional details, special features, machining Centre, part programming fundamentals CNC – manual part programming – micromachining – wafer machining.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Apply fundamental knowledge in material removing processes and analyse metal cutting parameters.

- Articulate the construction and mechanism of turning and automatic machine tools.
- Establish the working principles and operations of shaper, milling and gear cutting machines.
- Summarize the working principle and specification of abrasive processes and broaching processes.
- Evaluate the CNC machine tools, construction and programming fundamentals.

**TEXTBOOKS:**

1. Kalpakjian.S,“ Manufacturing Engineering and Technology”, Pearson Education India Edition, 2009.
2. Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.

**REFERENCE BOOKS:**

1. Geofrey Boothroyd, “Fundamentals of Metal Machining and Machine Tools”, McGraw Hill,1984.
2. Hajra Choudhury. “Elements of Workshop Technology – Vol.II”. Media Publishers & Promoters, India, 2010.
3. HMT – “Production Technology”, Tata McGraw Hill, 1998.
4. Richerd R Kibbe, John E. Neely, Roland O.Merges and Warren J.White “Machine Tool Practices”, Prentice Hall of India, 1998.
5. Rao. P.N “Manufacturing Technology,” Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi, 2003.

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** | **4** |
| **1** | 1 | 1 | 3 | 2 | 1 | | 2 | 1 | | | | 1 | 1 | 2 | 3 | 2 |
| **2** | 2 | 3 | | 1 | 2 | | | | | | | | | 2 | 3 | |
| **3** | 2 | 3 | | 2 | 1 | | | | | | | | 3 | 1 | 2 | |
| **4** | 2 | 2 | 1 | 2 | 3 | 2 | | | | | | | 2 | 3 | | |
| **5** | 2 | | 1 | 2 | 3 | | | | | | | 1 | | 2 | 1 | |

**1909403 STRENGTH OF MATERIALS L T P C**

**3 0 0 3**

**OBJECTIVES:**

To impart knowledge on the following Topics:

- To understand and analyze the stresses developed in bars, compounds bars, beams, shafts, cylinders and spheres.
- To analyze the transverse loading on beams and stresses in beam for various engineering applications.
- To analyze the torsion principles for shafts and springs for various engineering applications.
- To analyze the deflection of beams using various methods.
- To analyze thick and thin shells.

**UNIT – I: STRESS, STRAIN AND DEFORMATION OF SOLIDS 9**

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains –Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress.

**UNIT –II : TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9**

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending– bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

**UNIT- III: TORSION 9**

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

**UNIT-IV: DEFLECTION OF BEAMS 9**

Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell's reciprocal theorems.

**UNIT-V: THIN CYLINDERS, SPHERES AND THICK CYLINDERS 9**

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lame's theorem.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Develop an understanding of the concepts of stress and strain and their use in analysis of machine members
- Explain the concept and procedures used in the analysis of loaded beams and shafts with various support conditions
- Develop an understanding of material behaviour under condition of pure torsion (twisting moment) on circular shafts.
- Compute slopes and deflections in determinate beams subjected to loading using various methods
- Analyze the stresses and deformations induced in thick and thin Shells.

**TEXTBOOKS:**

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016.
2. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2009.
3. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2007.

**REFERENCE BOOKS:**

1. Egor. P.Popov "Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2002
2. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2007.

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 2 | | | | | | | | | | | 2 | 1 | | |
| **2** | 2 | 2 | 2 | 2 | | | | | | | | | 2 | | | |
| **3** | 2 | 2 | 3 | | | | | | | | | | 2 | | | |
| **4** | 2 | | 2 | | | | | | | | | | 2 | | | |
| **5** | 2 | | 1 | | 2 | | | | | | | | 3 | | | |

| **1909404** | **APPLIED THERMODYNAMICS** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **0** | **3** |

**(Use of standard refrigerant property data book, Steam Tables, Mollier diagram and Psychrometric chart permitted)**

**OBJECTIVES:**

The main learning objective of this course is to impart knowledge on:

- To apply thermodynamic concepts to different air standard cycles and solve problems.
- To describe the functioning and features of IC engines, components and auxiliaries.
- To calculate the performance parameters of IC Engines.
- To solve problems in single-stage and multi-stage air compressors
- To translate the flow in Gas turbines and solve problems.

**UNIT-I: GAS POWER CYCLES 9**

Air Standard Cycles - Otto, Diesel and Dual – Calculation of mean effective pressure, and air standard efficiency Comparison of cycles

**UNIT-II: INTERNAL COMBUSTION ENGINES AND COMBUSTION 9**

IC engine – Classification and application IC engine - Different components and their functions of IC engines. Theoretical and actual Valve timing diagrams - Port time diagram - Theoretical and actual p-V diagrams of a four stroke Otto and Diesel cycle engine. Geometric, operating, and performance comparison of SI and CI engines. Combustion in SI– Pre-ignition – Detonation - octane number. Combustion in CI Engines -Delay period- Diesel Knock- Cetane number.

**UNIT-III: INTERNAL COMBUSTION ENGINE PERFORMANCE AND SYSTEMS 9**

Performance parameters and calculations - Morse and Heat Balance tests. Ignition systems – Magneto and Battery - Fuel Injection system - Electronic fuel injection - Cooling systems - Lubrication systems - Supercharging - Dissociation.

**UNIT-IV: RECIPROCATING AIR COMPRESSOR 9**

Classification of Air compressor - Reciprocating compressor - construction and working. Equation of work with and without clearance - Free air delivered - Volumetric efficiency, Isothermal efficiency, mechanical efficiency and overall isothermal efficiency - Multistage air compressor with Inter-cooling.

**UNIT-V: GAS TURBINES 9**

Brayton Cycle - Classification of Gas turbine, Merits of gas turbine- Constant pressure combustion gas turbine – open cycle gas turbine - Methods for improvement of thermal efficiency of open cycle turbine plant- Effect of operating variables on thermal efficiency - Closed cycle gas turbine - Constant volume Combustion turbines - Performance of gas turbine - Power developed, Thermal efficiency and work ratio.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Execute thermodynamic concepts to different air standard cycles and solve problems.
- Report the functioning and features of IC engines, components and auxiliaries.
- Appraise the performance parameters of IC Engines.
- Solve problems in single-stage and multi-stage air compressors
- Explain the flow in Gas turbines and solve problems.

**TEXTBOOKS:**

1. Kothandaraman, C.P., “A Course in Thermal Engineering", Fifth Edition,” Dhanpat Rai and Co, 2004.

2. Rajput, R.K., “Thermal Engineering” Tenth Edition, Laxmi Publication (P) LTD, 2017.

**REFERENCE BOOKS:**

1. Ganesan, V. "Internal Combustion Engines", Third Edition, Tata Mcgraw-Hill 2012.
2. Ballaney, P.L. "Thermal Engineering", Khanna publishers, 24th Edition 2012.
3. Ganesan, V. "Gas Turbines" Third Edition, Tata McGraw -Hill 2017.
4. Rudramoorthy, R. "Thermal Engineering", “Tata McGraw-Hill, New Delhi, 2003.
5. Sarkar, B.K, "Thermal Engineering", Tata McGraw-Hill Publishers, 2007.

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**1915001 PROFESSIONAL ETHICS L T P C**

**3 0 0 3**

**OBJECTIVES:**

The main learning objective of this course to prepare the students:

- To introduce and educate the students on the concept of Human Values.
- To enable the students to have awareness on Engineering Ethics theories and models.
- To make students understand the code of ethics and fundamental principles in social experiments in engineering.
- To educate on safety and risk aspects in engineering and to appreciate the rights of others.
- To create awareness about international issues related to ethics.

**UNIT – I: HUMAN VALUES** **9**

Moral values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Introduction to Yoga and Meditation for professional excellence and stress management - Simple Living and High Thinking, Science and Spirituality.

**UNIT – II: ENGINEERING ETHICS** **9**

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of Professional roles – Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

**UNIT – III: ENGINEERING AS SOCIAL EXPERIMENTATION** **9**

Engineering as Experimentation – Engineers as responsible Experimenters - Engineer's Responsibilities to Economically Deprived People and Environment, Corruption – Codes of Ethics-Fundamental Principles – A Balanced Outlook on Law – Challenger Case Study.

**UNIT – IV: SAFETY, RESPONSIBILITIES AND RIGHTS** **9**

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – Government Regulator's approach to risks - The Three Mile Island, Chernobyl & Bhopal Case Studies, Greenery Effects - Collegiality and Loyalty - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Unethical Behaviour at Work Place – Reporting Unethical Behaviour- Professional Rights – Employee Rights – Intellectual Property Rights (IPR).

**UNIT – V: INTERNATIONAL ISSUES** **9**

Multinational corporations - Business ethics - Environmental ethics - Internet ethics - Role in Technological Development - Weapons development-engineers as managers - Consulting Engineers - Engineers as expert witnesses and advisors - Honesty - leadership - Sample code of conduct ethics - ASME, ASCE, IEEE, Institution of Engineers (India),Indian Institute of Materials Management Institution of electronics and telecommunication engineers (IETE), India – Corporate Social Responsibility, Indian and Western Culture – Cyber Crime.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of this course, the students will be able to:

- Understand human values and apply ethics in societal issues.
- Explain and get understanding of nuances of engineering ethics.
- Impart the knowledge of Engineer's responsibility to society and code of ethics
- Analyse and handle the risk and safety issues related to engineering.
- Apply ethical principles in international context.

**TEXT BOOKS:**

1. World Community Service Centre, "Value Education", Vethathiri publications, Erode, 2011.
2. R. Subramanian, 'Professional Ethics' Oxford University Press, $2^{nd}$ Edition 2017
3. R. S. Nagarazan, 'A Textbook on Professional Ethics and Human Values' New Age International Publishers, 2015
4. Sekhar, R.C., Ethical Choices in Business Response Books, New Delhi, Sage Publications, 1997.

**REFERENCE BOOKS:**

1. Langford, Duncan (EDT): Internet Ethics, London, Macmillan Press Ltd., 2000.
2. Erwann, M. David, Michele S. Shauf, Computers, Ethics and Society, Oxford University Press,2003
3. Alan Kitson and Robert Campbell:" The Ethical Organisation", Red Globe Press, 2008.
4. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Professional Ethics and Human Values", Prentice Hall of India, New Delhi, 2013.
5. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York, $3^{rd}$ edition, 2017.

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**1909405 COMPUTER AIDED MACHINE DRAWING PRACTICES LABORATORY**

| | L | T | P | C |
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**COURSE OBJECTIVES:**

The main learning objective of this course is to provide hands on training to the students in:

- Applying standard drawing practices using fits and tolerances.
- Modelling orthogonal views of machine components.
- Modelling orthogonal views of assembled components.
- Preparing standard drawing layout for modelled parts.
- Preparing standard drawing layout for assemblies with BoM.

**PART- I: DRAWING STANDARDS & FITS AND TOLERANCES 4**

Code of practice for Engineering Drawing, BIS specifications – Welding symbols, riveted joints, keys, fasteners – Reference to hand book for the selection of standard components like bolts, nuts, screws, keys etc. - Limits, Fits – Tolerancing of individual dimensions – Specification of Fits – Preparation of production drawings and reading of part and assembly drawings, basic principles of Geometric Dimensioning & Tolerancing.

**PART- II: 2D DRAFTING 56**

Drawing, Editing, Dimensioning, Layering, Hatching, Block, Array, Detailing, Detailed Drawing.

1. Bearings – Bush Bearing
2. Valves – Safety and Non-return Valves.
3. Couplings – Flange, Oldham's, Muff, Gear couplings.
4. Joints – Universal, Knuckle, Gib & Cotter, Strap, Sleeve & Cotter joints.
5. Engine parts – Piston, Connecting Rod, Crosshead (vertical and horizontal), Stuffing box, Multi-plate clutch.
6. Machine Components – Screw Jack, Machine Vice, Lathe Tail Stock, Plummer Block, Vane and Gear pumps.

(Total: 20% of classes for theory classes and 80% of classes for practice)

Note: 25% of assembly drawings must be done manually and remaining 75% of assembly drawings must be done by using any CAD software. The above tasks can be performed manually and using standard commercial 2D CAD software.

**TOTAL (L: 4 + P: 56) = 60 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Recognize standard drawing practices using fits and tolerances & implement the same.
- Create the orthogonal views of machine components using cad software.
- Create using cad software the orthogonal views of assembled components.
- Make the drawing layout for modelled parts as per the standards.
- Develop the standard drawing layout with BoM for assemblies.

**TEXT BOOKS:**


1. Narayana K.L., "Machine Drawing", 6th Edition, New Age International Publishers, 2019.
2. N. D. Bhatt and V.M. Panchal, "Machine Drawing", 48th Edition, Charotar Publishers, 2013.


**REFERENCE BOOKS:**


1. Junnarkar, N.D., "Machine Drawing", 1st Edition, Pearson Education, 2004
2. N. Siddeshwar, P. Kanniah, V.V.S. Sastri, "Machine Drawing" , published by Tata Mc GrawHill,2006
3. Gopalakrishna K.R., "Machine Drawing", 22nd Edition, Subhas Stores Books Corner, Bangalore, 2013.


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**1909406 STRENGTH OF MATERIALS LABORATORY**

| L | T | P | C |
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**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Performing various destructive testing on metal samples.
- Analysing the effect of torsion on metal rods.
- Performing various hardness tests.
- Understanding the effects of hardening on metal specimens.
- Analysing the effects of tempering on metal specimens.

**LIST OF EXPERIMENTS:**

1. Tension test on a mild steel rod.
2. Double sheer test on mild steel and aluminum rods
3. Torsion test on mild steel rod.
4. Impact test on metal specimen.
5. Hardness test on metals - Brinell and Rockwell Hardness Number.
6. Deflection test on beams.
7. Compression test on helical springs.
8. Strain measurement using Rosette strain gauge.
9. Effect of hardening - Improvement in hardness and impact resistance of steels..
10. Tempering- Improvement in Mechanical properties Comparison.
    (i) Unhardened specimen.
    (ii) Quenched specimen.
    (iii) Quenched and tempered specimen.
11. Microscopic examination of
    (i) Hardened sample.
    (ii) Hardened and tempered sample.

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Ability to perform various destructive testing on metal samples.

- Analyze the effect of torsion on metal rods.
- Ability to perform various hardness tests.
- Ability to understand the effects of hardening on metal specimens.
- Analyze the effects of tempering on metal specimens.

## LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

| Sl. No. | NAME OF THE EQUIPMENT | Qty. |
|---|---|---|
| 1 | Universal Tensile Testing machine with double 1 shear attachment – 40 Ton Capacity | 1 |
| 2 | Torsion Testing Machine (60 NM Capacity) | 1 |
| 3 | Impact Testing Machine (300 J Capacity) | 1 |
| 4 | Brinell Hardness Testing Machine | 1 |
| 5 | Rockwell Hardness Testing Machine | 1 |
| 6 | Spring Testing Machine for tensile and compressive loads(2500N) | 1 |
| 7 | Metallurgical Microscopes | 3 |
| 8 | Muffle Furnace (800 C) | 1 |

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## FIFTH SEMESTER

**1909501** **THERMAL ENGINEERING** **L T P C**

**3 0 0 3**

**(Use of standard refrigerant property data book, Steam Tables, Mollier diagram and Psychrometric chart permitted)**

**OBJECTIVES:**

- To impart knowledge on working principles and performance of Boilers.
- To apply the thermodynamic concepts for Steam Nozzles.
- To study the components, systems and improve the performance of steam Turbines.
- To understand the concept of psychrometric properties and its process.
- To apply the thermodynamic concepts into refrigeration and air conditioning systems.

**UNIT -I: BOILERS** **9**

Types and comparison. Mountings and Accessories. Fuels - Solid, Liquid and Gas. Performance calculations, Boiler trial.

**UNIT -II: STEAM NOZZLE** **9**

Types and Shapes of nozzles, Flow of steam through nozzles, Critical pressure ratio, Variation of mass flow rate with pressure ratio, Effect of friction, Metastable flow.

**UNIT -III: STEAM TURBINES** **9**

Types, Impulse and reaction principles, Velocity diagrams, Work done and efficiency – optimal operating conditions. Multi-staging, compounding and governing.

**UNIT -IV: PSYCHROMETRY** **9**

Psychrometry and psychrometric charts, property calculations of air vapour mixtures. Psychrometric process – Sensible heat exchange processes. Latent heat exchange processes. Adiabatic mixing, evaporative cooling

**UNIT -V: REFRIGERATION AND AIR – CONDITIONING** **9**

Vapour compression refrigeration cycle- super heat, sub cooling – Performance calculations - working principle of vapour absorption system- Alternate refrigerants - Air conditioning system: Types, Working Principles Cooling Load calculations -Concept of RSHF, GSHF, ESHF -(Use of standard thermodynamic tables, Mollier diagram, Psychrometric chart and refrigerant property tables are permitted in the examination)

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to:

- Use the functioning and features of different types of Boilers and auxiliaries and calculate performance parameters.
- Solve problems in Steam Nozzle by using mollier charts
- Analyse the flow in steam turbines, draw velocity diagrams for steam turbines and solve problems.
- Summarize the concept of air properties, psychrometric charts and process.
- Analyse the problems in refrigeration and air conditioning system using charts.

**TEXT BOOKS:**

1. Rajput. R. K., "Thermal Engineering" Laxmi Publishers, 2018.
2. Mahesh. M. Rathore, "Thermal Engineering", 1st Edition, Tata Mc Graw Hill Publications, 2010.

**REFERENCE BOOKS:**

1. Nag P.K. " Power Plant Engineering " Tata McGraw Hill , 4th Edition, 2019
2. Ballaney. P.L ." Thermal Engineering", Khanna publishers, 24th Edition 2012
3. Kothandaraman, C.P., Domkundwar .S and Domkundwar A.V.,"A course in Thermal Engineering", Dhanpat Rai & Sons, 2016.
4. Arora .C.P., "Refrigeration and Air Conditioning", Third edition, Tata Mc Graw hill, 2017
5. Andrew D. Althouse, Carl H. Turnquist,"Modern Refrigeration and Air Conditioning" Goodheart-Willcox, 2016.

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**1909502** **DESIGN OF MACHINE ELEMENTS** **L T P C**

**3 0 0 3**

**(Use of P S G Design Data Book is permitted)**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students :

- To Design machine members subjected to static and variable loads.
- To implements shafts and couplings for various applications.
- To analyze bolted and welded joints for various kinds of loads.
- To impart knowledge of helical, leaf springs and flywheels for various applications.
- To design and select sliding and rolling contact bearings.

**UNIT-I: STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS 12**

Design process- buckling- factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and 'C' frame- Factor of safety - theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading.

**UNIT-II: SHAFTS AND COUPLINGS 7**

Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys, keyways and splines - Rigid and flexible couplings

**UNIT-III: TEMPORARY AND PERMANENT JOINTS 10**

Threaded fastners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints, riveted joints for structures - theory of bonded joints- riveted joints.

**UNIT-IV: ENERGY STORING ELEMENTS AND ENGINE COMPONENTS 9**

Various types of springs, optimization of helical springs - rubber springs - Flywheels considering stresses in rims and arms for engines and punching machines- Connecting Rods and crank shafts.

**UNIT-V: BEARINGS** **7**

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs, - Selection of Rolling Contact bearings.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Analyze the stresses and strains induced in machine elements.
- Understand the basic concept of shaft, coupling, key, open-crossed belt pulley and gears drives.
- Design threaded fasteners, knuckle joints, cotter joints riveted and welded joints
- Design and helical, leaf springs and flywheels for automotive applications.
- Design and select sliding and rolling contact bearings for various applications.

**TEXT BOOKS:**

1. Bhandari V B, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, 2016
2. Joseph Shigley, Richard G. Budynas and J. Keith Nisbett "Mechanical Engineering Design", 10th Edition, Tata McGraw-Hill, 2015.

**REFERENCE BOOKS:**

1. Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill BookCo.(Schaum's Outline), 2010
2. P.C.Gope, "Machine Design – Fundamental and Application", PHI learning private ltd, New Delhi, 2012.
3. R.B. Patel, "Design of Machine Elements", MacMillan Publishers India P Ltd., Tech-Max Educational resources, 2011.

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**1909503** **METROLOGY AND MEASUREMENTS** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students able:

- To impart knowledge on various Metrological equipment's available to measure the dimension of the components.
- To learn the correct procedure to be adopted to measure the dimension of the components.
- To gain knowledge for conduct computer aided inspection.
- To learn about form measurement used for industrial components.
- To understand knowledge about measuring techniques of mechanical properties in industrial applications.

**UNIT -I: BASICS OF METROLOGY 9**

Introduction to Metrology – Need – Elements – Work piece, Instruments – Persons – Environment – their effect on Precision and Accuracy – Errors – Errors in Measurements – Types – Control – Types of standards.

**UNIT -II: LINEAR AND ANGULAR MEASUREMENTS 9**

Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchangeability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications.

**UNIT -III: ADVANCES IN METROLOGY 9**

Basic concept of lasers Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM– Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications.

**UNIT -IV: FORM MEASUREMENT 9**

Principles and Methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications.

**UNIT -V: MEASUREMENT OF POWER, FLOW AND TEMPERATURE 9**

Force, torque, power - mechanical, Pneumatic, Hydraulic and Electrical type. Flow measurement: Venturimeter, Orifice meter, rotameter, pitot tube – Temperature: bimetallic strip, thermocouples, electrical resistance thermometer – Reliability and Calibration – Readability and Reliability.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to:

- Apply the concepts of measurements to apply in various metrological instruments.
- Analyze the principles of linear and angular measurement tools used for industrial applications.
- Apply the procedure for conducting computer aided inspection.
- Demonstrate the techniques of form measurement used for industrial components.
- Apply various measuring techniques of mechanical properties in industrial applications.

**TEXT BOOKS:**

1. Gupta. I.C., "Engineering Metrology", Dhanpatrai Publications, 2018.
2. Jain R.K. "Engineering Metrology", Khanna Publishers, 2009.

**REFERENCE BOOKS:**

1. Alan S. Morris, "The essence of Measurement", Prentice Hall of India 2010.
2. Beckwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education, 2014.
3. Raghavendra, Krishnamurthy "Engineering Metrology & Measurements", Oxford Univ. Press,2013.
4. Venkateshan, S. P., "Mechanical Measurements", Second edition, John Wiley &Sons, 2015.

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**1909504** **DYNAMICS OF MACHINES** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students:

- To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
- To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- To understand the effect of dynamics of undesirable vibrations.
- To understand the principles in mechanisms used for speed control and stability control.
- To understand the principles of gyroscopic effects.

**UNIT -I: FORCE ANALYSIS 9**

Dynamic force analysis – Inertia force and Inertia torque– D Alembert's principle –Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams –Fly Wheels – Flywheels of punching presses- Dynamics of Cam- follower mechanism.

**UNIT -II: BALANCING 9**

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder engine – Balancing of Multi-cylinder inline, V-engines – Partial balancing in engines – Balancing of linkages –Balancing machines-Field balancing of discs and rotors.

**UNIT -III: FREE VIBRATION 9**

Basic features of vibratory systems – Degrees of freedom – single degree of freedom – Free vibration– Equations of motion – Natural frequency – Types of Damping – Damped vibration– Torsional vibration of shaft – Critical speeds of shafts – Torsional vibration – Two and three rotor torsional systems.

**UNIT -IV: FORCED VIBRATION 9**

Response of one degree freedom systems to periodic forcing – Harmonic disturbances – Disturbance caused by unbalance – Support motion –transmissibility – Vibration isolation vibration measurement.

**UNIT -V: MECHANISM FOR CONTROL** **9**

Governors – Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling force curves. Gyroscopes – Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to:

- Calculate static and dynamic forces of mechanisms.
- Work out the amount of balancing masses required and their locations of reciprocating and rotating masses.
- Compute the frequency of free vibration.
- Compute the frequency of forced vibration and damping coefficient.
- Analyse the speed and lift of the governor and find the gyroscopic effect on automobiles, ships and airplanes.

**TEXT BOOKS:**


1. F. B. Sayyad, “Dynamics of Machinery”, McMillan Publishers India Ltd., Tech-Max Educational resources, 2019.
2. Rattan, S.S, “Theory of Machines”, 5th Edition, Tata McGraw-Hill, 2019.
3. Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, 5$^{th}$ Edition, Oxford University Press, 2016.


**REFERENCE BOOKS:**


1. Cleghorn. W. L, “Mechanisms of Machines”, Oxford University Press, 2014.
2. Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines", 3$^{rd}$ Edition Affiliated East-West Pvt. Ltd., New Delhi, 2006.
3. Khurmi, R.S., ”Theory of Machines”, 14$^{th}$ Edition, S Chand Publications, 2005.
4. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.

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**1909513 DYNAMICS AND METROLOGY LABORATORY**

| L | T | P | C |
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| 0 | 0 | 4 | 2 |

**OBJECTIVES:**

The main learning objective of this course is to prepare the students able to:

- Apply the principles of kinematics involved in various mechanisms.
- Apply the principles of dynamics involved in various experiments
- Demonstrate the calibration of simple linear measuring instruments used in manufacturing industries.
- Demonstrate the important linear and angular measurements carried out in manufacturing industries.
- Demonstrate the measurement of prismatic components using contact and non-contact methods and surface metrology.

**Part-I: DYNAMICS LABORATORY (30)**

**LIST OF EXPERIMENTS:**

1. Study of gear parameter.
2. Kinematic models to study various mechanisms.
3. Determination of moment of inertia of flywheel and axle system.
4. Determination of Mass Moment of Inertia of axis symmetric bodies using Turn Table apparatus
5. Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.
6. Transverse vibration of Free-Free beam – with and without concentrated masses.

7. Determination of torsional natural frequency of single and Double Rotor systems.- Undamped and Damped Natural frequencies.
8. Dynamic analysis of cam mechanism.
9. Experiment of Watt Governor.
10. Experiment of Porter Governor.
11. Experiment of motorized gyroscope.
12. Determination of critical speed of shaft.

**Part-II: METROLOGY LABORATORY (30)**

**LIST OF EXPERIMENTS:**

1. Calibration of vernier calliper using gauge blocks and measurement of given samples.
2. Calibration of micrometer using gauge blocks and measurement of given samples using micrometer.
3. Calibration of dial gauge using given gauge blocks.
4. Calibration of vernier height gauge using gauge blocks and measurement of given sample using vernier height gauge.
5. Calibration of vernier depth gauge using gauge blocks and measurement of given sample using vernier depth gauge.
6. Measurement of bore diameter of given samples using Bore gauge.
7. Measurement of bore diameter of given samples using telescopic gauge
8. Measurement of linear dimensions of given sample using Comparator.
9. Measurement of angles using sine bar.
10. Measurement of gear parameters using gear tooth vernier.
11. Non-contact (Optical) measurement using Profile projector.
12. Measurement of Surface finish in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus based instruments.

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to:

- Determine the measurement of various kinematic parameters.
- Found the vibration parameters in various experiments.
- Select a suitable measuring instrument for measurement of linear and angular dimensions

and use the same for carrying out measurements.

- Calibrate simple linear measuring instruments like Vernier caliper, micrometer, Vernier height gauge, etc. using gauge blocks.
- Use advanced measuring equipment, surface finish measuring equipment to carryout measurements.

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS**

**DYNAMICS LABORATORY**

| SL.NO. | NAME OF EQUIPMENTS | QUANTITY |
|---|---|---|
| 1 | Cam follower setup. | 1No. |
| 2 | Motorized gyroscope. | 1 No. |
| 3 | Governor apparatus - Watt, Porter, Proell and Hartnell governors. | 1 No. |
| 4 | Whirling of shaft apparatus. | 1 No. |
| 5 | Two rotor vibration setup. | 1 No. |
| 6 | Spring mass vibration system. | 1 No. |
| 7 | Torsional Vibration of single rotor system setup | 1 No. |
| 8 | Gear Models | 1 No. |
| 9. | Turntable apparatus | 1 No. |

**METROLOGY LABORATORY**

| SL. NO. | NAME OF EQUIPMENTS | QUANTITY |
|---|---|---|
| 1 | Micrometer | 5 Nos. |
| 2 | Vernier Caliper | 5 Nos. |
| 3 | Vernier Height Gauge | 2 Nos. |
| 4 | Vernier depth Gauge | 2 Nos. |
| 5 | Slip Gauge Set | 1 No. |
| 6 | Gear Tooth Vernier | 1 No. |

| | | |
|---|---|---|
| 7 | Sine Bar | 1 No. |
| 8 | Profile Projector | 1 No. |
| 9 | Mechanical Comparator | 1 No. |
| 10 | Dial Gauge | 2 Nos. |
| 11 | Bore Gauge | 1 No. |
| 12 | Telescopic Gauge | 1 No. |

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| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** | **4** |
| **1** | 1 | 2 | 2 | 3 | | | | | | | | | 2 | | 2 | |
| **2** | 1 | 2 | 2 | 3 | | | | | | | | | 2 | | 2 | |
| **3** | 1 | 1 | 1 | 2 | | | | | | | | | 1 | | 1 | |
| **4** | 1 | 1 | 1 | 2 | | | | | | | | | 1 | | 1 | |
| **5** | 1 | 1 | 1 | 2 | | | | | | | | | 1 | | 1 | |

**1909514 THERMAL ENGINEERING LABORATORY L T P C**

**0 0 4 2**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Gain a detailed knowledge in Engine components.
- Study the components, systems and performance of internal combustion engines.
- Ability to learn the value timing-V diagram and performance of IC Engines.
- Understand the characteristics of fuels/Lubricants used in IC Engines.
- Study the Performance of steam generator/ turbine.

**LIST OF EXPERIMENTS:**

**I.C. ENGINE LAB:**

1. Valve Timing and Port Timing diagrams.

2. Actual p-v diagrams of IC engines.
3. Performance Test on 4 – stroke Diesel Engine.
4. Heat Balance Test on 4 – stroke Diesel Engine.
5. Morse Test on Multi-cylinder Petrol Engine.
6. Retardation Test on a Diesel Engine.
7. Determination of Flash Point and Fire Point of various fuels / lubricants.
8. Determination of Viscosity using Red Wood Viscometer

**STEAM LAB:**

1. Study and demo on Steam Generators and Turbines.

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to:

- Recognize the components and conduct the performance test on internal combustion engines.
- Analysis the performance test on steam power cycles in boiler and formulate its efficiency.
- Resolve the problems involving steam nozzles and steam turbines.
- Compare the working and performance of petrol and diesel engines.
- Estimate the various properties of lubrication oils.

**TOTAL: 60 PERIODS**

**LIST OF EQUIPMENT**

**(For a batch of 30 students)**

1. I.C Engine – 2 stroke and 4 stroke model 1 set
2. Red Wood Viscometer 1 No.
3. Apparatus for Flash and Fire Point 1 No.
4. 4-stroke Diesel Engine with mechanical loading. 1 No.
5. 4-stroke Diesel Engine with hydraulic loading. 1 No.
6. 4-stroke Diesel Engine with electrical loading with data Acquisition 1 No.
7. Multi-cylinder Petrol Engine 1 No.
8. Data Acquisition system with any one of the above engines 1 No.
9. Steam Boiler with turbine setup 1 No.

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 3 | | 3 | | 2 | 2 | 1 | | | | | 3 | 3 | | |
| 2 | 3 | 3 | | 3 | | 2 | 2 | 1 | | | | | 3 | 3 | | |
| 3 | 3 | 3 | | 3 | | 2 | 2 | 1 | | | | | 3 | 3 | | |
| 4 | 3 | 3 | | 3 | | 2 | 2 | 1 | | | | | 3 | 3 | | |
| 5 | 3 | 3 | | 3 | | 2 | 2 | 1 | | | | | 3 | 3 | | |

**1919002 PROFESSIONAL COMMUNICATION L T P C**

**0 0 2 1**

**OBJECTIVES:**

This course aims to

- Enhance the Employability and Career Skills of students.
- Orient the students towards grooming as a professional.
- Learn how to speak in Group discussions
- Make them employable Graduates and help them attend interviews successfully.
- Develop their confidence and help those express views clearly.

**UNIT- I: GENERAL ENGLISH FOR COMPETITIVE EXAMS 6**

English for competitive exams —General awareness of Current Affairs – multiple choice – Cloze – Vocabulary Structure.

**UNIT- II: MECHANICS OF INTERPERSONAL COMMUNICATION 6**

Introduction to soft skills - Interpersonal communication - Introducing oneself to the audience — answering questions – writing a message – memo –mail – asking for comments – giving information – agreeing to requests – apologizing – Complaining – Business proposal – short report – summarizing.

**UNIT- III: BASICS OF GROUP DISCUSSION 6**

Introduction to Group Discussion— participating in group discussions – questioning and clarifying –GD strategies –monologues – dialogues – discussions.

**UNIT- IV: FUNDAMENTALS OF INTERVIEW SKILLS 6**

Interview etiquette –Portfolio development- attending job interviews–FAQs related to job interviews- Interview types –expressing opinions – present circumstances - past experiences – future plans

**UNIT- V: SPECIFIC SKILLS FOR CAREER ADVANCEMENT 6**

Recognizing differences between groups and teams - networking professionally- respecting social protocols- understanding career management- developing a long- term career plan- making career changes. – organizing a larger unit of discourse – expressing and justifying opinions – negotiating – collaborating – disagreeing – speculating – decision taking.

**TOTAL: 30 PERIODS**

The lab course is offered as an Employability Enhancement Course

The course is offered as a one credit paper with an End Semester Examination.

**OUTCOMES:**

At the end of the course learners will be able to:

- Make effective presentations.
- Participate confidently in Group Discussions
- Attend job interviews and interacting in different situations.
- Write business reports, proposals and related correspondence.
- Develop adequate Soft Skills required for the workplace.

**REFERENCE BOOKS:**


1. Butterfield, “Jeff Soft Skills for Everyone”, Cengage Learning: New Delhi, 2015
2. “Interact English Lab Manual for Undergraduate Students”, Orient Blackswan: Hyderabad, 2016.
3. E.Suresh Kumar, “Communication for Professional Success”, Orient Blackswan: Hyderabad, 2015
4. Raman, Meenakshi and Sangeeta Sharma, “Professional Communication”. Oxford University Press: Oxford, 2014
5. S. Hariharan. “Soft Skills”. MJP Publishers: Chennai, 2010.
6. Successful Presentations: DVD and Student’s Book. “A video series teaching business

communication skills for adult professionals" by John Huges and Andrew Mallett- OUP 2012.

7. Goodheart-Willcox, "Professional Communication", First Edition, 2017. Online test book
8. "Training in Interpersonal Skills: Tips for Managing People at Work", Pearson Education, India, 6 edition, 2015
9. "English for success in Competitive exams". Philip Sunil Solomon – OUP 2009.

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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | 2 | 3 | 3 | - | - | - | - | 3 | - | 1 | 1 | 1 | 2 | 1 |
| **2** | 3 | 2 | 2 | 2 | 2 | - | 3 | - | - | 2 | - | 1 | 1 | 1 | 2 | 1 |
| **3** | 3 | 2 | - | 3 | - | - | - | - | - | 3 | - | 1 | 1 | - | - | - |
| **4** | 3 | 3 | - | - | - | - | 3 | - | - | 3 | - | 1 | 1 | 1 | 1 | 1 |
| **5** | 3 | 2 | 3 | - | - | - | - | - | - | 3 | - | 1 | 1 | 1 | 1 | 1 |

## SIXTH SEMESTER

| | | | | | |
|---|---|---|---|---|---|
| **1909601** | **DESIGN OF TRANSMISSION SYSTEMS** | **L** | **T** | **P** | **C** |
| | | **3** | **0** | **0** | **3** |

**(Use of P S G Design Data Book permitted)**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students:

- To impart knowledge on the principles and procedure for the design of Mechanical power Transmission components.
- To understand the standard procedure available for Design of Transmission of Mechanical elements.
- To develop and design worm and bevel gears.
- To learn about design of gear boxes.
- Ability to learn about design of cams, breaks and clutches.

**UNIT-I: DESIGN OF FLEXIBLE ELEMENTS 9**

Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

**UNIT -II: SPUR GEARS AND PARALLEL AXIS HELICAL GEARS 9**

Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane-Equivalent number of teeth-forces for helical gears.

**UNIT -III: BEVEL, WORM AND CROSS HELICAL GEARS 9**

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits-terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

**UNIT -IV: GEAR BOXES** **9**

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

**UNIT -V: CAMS, CLUTCHES AND BRAKES** **9**

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches-Electromagnetic clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to:

- Design different types of belts, chains and rope drives.
- Compute the design calculations for spur and helical gears.
- Design worm and bevel gears for automotive applications.
- Design different types of gear boxes in automobiles.
- Design different types of cams, brakes and clutches

**TEXT BOOKS:**


1. Bhandari V, “Design of Machine Elements”, 4$^{th}$ Edition, Tata McGraw-Hill Book Co, 2016.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, 8$^{th}$ Edition, Tata McGraw-Hill, 2008.


**REFERENCE BOOKS:**


1. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, “Design of Machine Elements” 8$^{th}$ Edition, Printice Hall, 2010.
2. Orthwein W, “Machine Component Design”, Jaico Publishing Co, 2012.
3. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine Design”, 4$^{th}$ Edition, Wiley, 2010.

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| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** | **4** |
| **1** | 2 | 2 | 3 | | | | | 1 | | | | 2 | 3 | 3 | | |
| **2** | 2 | 2 | 3 | | | | | 1 | | | | 2 | 3 | 3 | | |
| **3** | 2 | 2 | 3 | | | | | 1 | | | | 2 | 3 | 3 | | |
| **4** | 2 | 2 | 3 | | | | | 1 | | | | 2 | 3 | 3 | | |
| **5** | 2 | 2 | 3 | | | | | 1 | | | | 2 | 3 | 3 | | |

**1909602 HEAT AND MASS TRANSFER L T P C**

**3 1 0 4**

**(Use of Heat and Mass Transfer Data Book permitted)**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Applying the principle mechanism of heat transfer under steady state and transient conditions.
- Applying the fundamental concept and principles in convective heat transfer.
- Applying the theory of phase change heat transfer and design of heat exchangers.
- Applying the fundamental concept and principles in radiation heat transfer.
- Analysing the relation between heat and mass transfer and to solve simple mass transfer problems.

**UNIT -I: CONDUCTION 9L+3T**

General Differential equation – Cartesian, Cylindrical and Spherical Coordinates – One Dimensional Steady State Heat Conduction — plane and Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite Solids –Use of Heisler's charts.

**UNIT -II: CONVECTION 9L+3T**

Conservation Equations - Hydrodynamics and Thermal Boundary layer - Forced Convection: External Flow – Flow over Plates, Cylinders and Bank of tubes and Internal Flow through tubes. Free Convection: – Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and internal flow through tubes.

**UNIT -III: PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 9L+3T**

Nusselt's theory of condensation- Regimes of Pool boiling and Flow boiling, correlations in boiling and condensation. Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors- Analysis - LMTD and NTU methods.

**UNIT-IV: RADIATION 9L+3T**

Radiation laws - Black Body and Gray body Radiation - Shape Factor - Electrical Analogy. Radiation Shields- Radiation through gases.

**UNIT -V: MASS TRANSFER 9L+3T**

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion - Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

**TOTAL (45 L+15T) : 60 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Evaluate the principle mechanism of heat transfer under steady state and transient conditions.
- Examine and analyze the fundamental concept and principles in convective heat transfer.
- Calculate the amount of heat transfer in heat exchangers.
- Apply the fundamental concept and principles in radiation heat transfer.
- Compute the relation between heat and mass transfer and to solve simple mass transfer problems.

**TEXT BOOKS:**


1. R.C. Sachdeva, "Fundamentals of Engineering Heat & Mass transfer", New Age International Publishers, 2009
2. Yunus A. Cengel, "Heat Transfer A Practical Approach" – Tata McGraw Hill, 5$^{th}$ Edition – 2013

**REFERENCE BOOKS:**

1. Frank P. Incropera and David P. Dewitt, “Fundamentals of Heat and Mass Transfer”, John Wiley & Sons, 7th Edition, 2014.
2. Holman, J.P., “Heat and Mass Transfer”, Tata McGraw Hill, 2010
3. Kothandaraman, C.P., “Fundamentals of Heat and Mass Transfer”, New Age International, New Delhi, 2012
4. S.P. Venkateshan, “Heat Transfer”, Ane Books, New Delhi, 2014

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 1 | 1 | | | | | | 1 | | 1 | | 1 | | 1 | | |
| **2** | 3 | 2 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | |
| **3** | 1 | 1 | | | | 1 | | 1 | | 1 | | 1 | | 1 | | |
| **4** | 3 | 3 | 2 | 1 | 3 | 2 | | 1 | | 1 | | 1 | | 1 | | |
| **5** | 1 | 2 | 2 | 2 | | 1 | | 1 | | 1 | | 1 | | 2 | | |

| 1909603 | FINITE ELEMENT ANALYSIS | L | T | P | C |
|---|---|---|---|---|---|
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**OBJECTIVES:**

The main learning objective of this course is to prepare the students :

- To understand the concepts of mathematical modeling of engineering problems.
- To understand the concept of finite element formulation for solving one Dimensional problems in Engineering.
- To understand the concepts of finite element formulations to solve the two dimensional scalar variable problems.
- To understand the two dimensional vector variable problems and to apply finite element formulation for solving the axisymmetric problems and temperature effects using plate and shell elements.
- To understand the concept of isoparametric elements to solve the problems oriented with complex structures and exposure to various analysis softwares.

**UNIT -I: INTRODUCTION 9L + 3T**

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

**UNIT -II: ONE-DIMENSIONAL PROBLEMS 9L + 3T**

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation –Transverse deflections and Natural frequencies of beams.

**UNIT-III: TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS 9L + 3T**

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.

**UNIT-IV: TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS 9L + 3T**

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.

**UNIT- V: ISOPARAMETRIC FORMULATION 9L + 3T**

Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements– One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

**TOTAL (45L+15T) : 60 PERIODS**

**COURSE OUTCOMES :**

Upon completion of this course, the students can able to:

- Apply the concepts of types of numerical analysis and able to apply the functional approximation techniques to solve field variable problems in mechanical engineering.

- Solve the various one dimensional problems (structural, thermal and dynamic) by the finite element formulations.
- Apply the concepts of finite element formulations to solve the two dimensional scalar variable problems.
- Analyze the two dimensional vector variable problems and to apply finite element formulation for solving the axisymmetric problems and temperature effects using plate and shell elements.
- Apply the concept of isoparametric elements to solve the problems oriented with complex structures and exposure to various analysis softwares.

**TEXT BOOKS :**

1. Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw-Hill, 2005 (Reprint 2015)
2. P.Seshu, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd. New Delhi, 2007. (Reprint 2019)

**REFERENCE BOOKS:**

1. Rao, S.S., "The Finite Element Method in Engineering", 6th Edition, Butterworth Heinemann, 2017.
2. Logan, D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2017.
3. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2007.
4. Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering", 4th Edition, Prentice Hall College Div, 2012
5. Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons, (Indian Reprint 2013)

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | 2 | 1 | 1 | 1 | | | 2 | 2 | | 1 | 3 | 3 | | |
| **2** | 3 | 3 | 2 | 2 | 1 | 1 | | | 1 | 2 | | 2 | 3 | 3 | | |
| **3** | 3 | 3 | 2 | 2 | 1 | 1 | | | 1 | 2 | | 2 | 3 | 3 | | |
| **4** | 3 | 3 | 2 | 2 | 1 | 1 | | | 1 | 2 | | 2 | 3 | 3 | | |
| **5** | 3 | 3 | 2 | 3 | 2 | 2 | 2 | | 2 | 2 | | 3 | 3 | 3 | | |

**1909609 CAD /CAM AND ANALYSIS LABORATORY**

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**OBJECTIVES:**

The main learning objective of this course is to provide hands on training to the students in to:

- Design three dimensional (3D) geometric model of parts, sub-assemblies, assemblies and exporting it to drawing.
- Analyze the force, stress, deflection in mechanical components.
- Analyze thermal stress and heat transfer in mechanical components.
- Analyze the vibration of mechanical components.
- Apply the fundamental working principle of CNC machine tool, Programming G & M Code programming and simulate the CNC program.

**LIST OF EXPERIMENTS:**

**1. 3D GEOMETRIC MODELLING 20**

1. CAD Introduction – Sketcher
2. Solid modelling: Extrude, Revolve, Sweep, Variational sweep and Loft.
3. Surface modelling: Extrude, Sweep, Trim, Mesh of curves and Free form.
4. Feature manipulation: Copy, Edit, Pattern, Suppress, History operations.
5. Assembly: Constraints, Exploded Views, Interference check
6. Drafting: Layouts, Standard & Sectional Views, Detailing & Plotting.
7. Exercises in Modelling and drafting of Mechanical Components
8. Assembly using Parametric and Feature based Packages

**2. SIMULATION AND ANALYSIS 20**

1. Force and Stress analysis using link elements in Trusses.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates.
4. Stress analysis of axis–symmetric components.
5. Thermal stress and heat transfer analysis of plates.
6. Thermal stress analysis of cylindrical shells.
7. Vibration analysis of spring-mass systems.

**3. MANUAL PART PROGRAMMING: - CNC Machining and Turning Centre 20**

1. Linear Cutting.
2. Circular cutting.

3. Cutter Radius Compensation.
4. Canned Cycle Operations.
5. Straight, Taper and Radial Turning.
6. Thread Cutting.
7. Rough and Finish Turning Cycle.
8. Drilling and Tapping Cycle

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Create and export 3 Dimensional geometric models of parts, sub-assemblies, assemblies as a drawing file.
- Examine methodically in detail the force, stress, deflection in mechanical components and understand it.
- Study, understand and interpret about thermal stress and heat transfer in mechanical components.
- Identify and measure the parameters in detail related to the vibration of mechanical components.
- Recognize the fundamental working principle of CNC machine tool, create G & M code program based on application required and simulate the CNC program.

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS**

| Sl. No. | DESCRIPTION EQUIPMENT | QUANTITY |
|---|---|---|
| **HARDWARE** | | |
| 1. | Computer server | 1 |
| 2. | Computer nodes or systems (High end CPU with atleast 1 GB main memory) networked to the server | 30 |
| 3. | A3 size plotter / Laser Printer | 1 |
| 4. | CNC Lathe | 1 |
| 5. | CNC Milling Machine | 1 |
| **SOFTWARE** | | |

| | | |
|---|---|---|
| 6. | Any High end integrated modelling and manufacturing CAD / CAM software | 15 licenses |
| 7. | CAM Software for machining centre and turning centre - (CNC Programming and tool path simulation for FANUC / Sinumeric and Heidenhain controller) | 15 licenses |
| 8. | Licensed operating system | Adequate |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 2 | 2 | | | 3 | | | 1 | | | | 1 | | | | |
| 2 | 2 | 2 | | | 3 | | | 1 | | | | 1 | | | | |
| 3 | 2 | 2 | | | 3 | | | 1 | | | | 1 | | | | |
| 4 | 2 | 2 | | | 3 | | | 1 | | | | 1 | | | | |
| 5 | 2 | 3 | 3 | | 3 | | 2 | | | | | 1 | 3 | 2 | 3 | 2 |

**1909610 DESIGN AND FABRICATION PROJECT**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Make breakthrough on potential research areas of Mechanical Engineering
- Evaluate the several existing solutions for the problems identified.
- Create a solution for the research plan identified.
- Comprehend the experiments as a team and interpret the results.
- Make clear documentation of the findings of the work conducted.

**GUIDELINE FOR REVIEW AND EVALUATION:**

The students may be grouped into 2 to 4 and work under a project supervisor. The device/ system/component(s) to be fabricated may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the group and the fabricated model, which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to:

- Discover potential research areas in the field of Mechanical Engineering.
- Compare and contrast the several existing solutions for the problems identified.
- Formulate and propose a plan for creating a solution for the research plan identified.
- Conduct the experiments as a team and interpret the results.
- Report and present the findings of the work conducted.

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| 1 | 3 | 2 | | | | | | | | | 2 | 2 | 2 | | 1 | 3 |
| 2 | 2 | 3 | | | | | | | | | | 1 | 2 | | 2 | 2 |
| 3 | 2 | 2 | 3 | 1 | | | | | | | | 1 | 3 | 2 | 3 | 2 |
| 4 | 2 | | 1 | 3 | 2 | | | | 2 | | 2 | 1 | 1 | 2 | 2 | 2 |
| 5 | | | 1 | | 2 | | | | | | 2 | 1 | | 2 | | |

## 1909611 HEAT TRANSFER LABORATORY

**L T P C**
**0 0 4 2**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students:

- To study the heat transfer phenomena to predict the relevant coefficient using implementation
- To expose the mechanisms of free and forced convection
- To demonstrate the phase change heat transfer and calculate the performance of heat exchanging devices

- To explain diffusion and convective mass transfer
- To study the performance of refrigeration cycle / components

**HEAT TRANSFER LAB: 45**

1. Thermal conductivity measurement using guarded plate apparatus.
2. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
3. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
4. Determination of heat transfer coefficient under forced convection from a tube.
5. Determination of Thermal conductivity of composite wall.
6. Determination of Thermal conductivity of insulating powder.
7. Heat transfer from pin-fin apparatus (forced convection modes)
8. Determination of Stefan – Boltzmann constant.
9. Determination of emissivity of a grey surface.
10. Effectiveness of Parallel / counter flow heat exchanger.

**REFRIGERATION AND AIR CONDITIONING LAB 15**

1. Determination of COP of a refrigeration system
2. Experiments on Psychometric processes
3. Performance test on a reciprocating air compressor
4. Performance test in a fluidized Bed Cooling Tower

**TOTAL: 60 PERIODS**

**LIST OF EQUIPMENTS**

**(For a batch of 30 students)**

| SL. No. | LIST OF EQUIPMENTS | QUANTITY |
|---|---|---|
| 1 | Guarded plate apparatus | 1 No. |
| 2 | Lagged pipe apparatus | 1 No. |
| 3 | Natural convection-vertical cylinder apparatus | 1 No. |
| 4 | Forced convection inside tube apparatus | 1 No. |

| | | |
|---|---|---|
| 5 | Composite wall apparatus | 1 No. |
| 6 | Thermal conductivity of insulating powder apparatus | 1 No. |
| 7 | Pin-fin apparatus | 1 No. |
| 8 | Stefan-Boltzmann apparatus | 1 No. |
| 9 | Emissivity measurement apparatus | 1 No. |
| 10 | Parallel/counter flow heat exchanger apparatus | 1 No. |
| 11 | Single/two stage reciprocating air compressor | 1 No. |
| 12 | Fluidized bed cooling tower apparatus | 1 No. |
| 13 | Refrigeration test rig | 1 No. |
| 14 | Air-conditioning test rig | 1 No. |

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to,

- Conduct tests on heat conduction apparatus and evaluate thermal conductivity of materials.
- Identify the correlation to find the heat transfer rate in free and forced convection.
- Analyze the performance of parallel/counter flow heat exchanger apparatus and reciprocating air compressor.
- Integrate the concepts of radiative heat transfer apparatus and evaluate Stefan Boltzmann constant and emissivity.
- Conduct tests to evaluate the performance of refrigeration and air conditioning test rigs.

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| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** | **4** |
| **1** | 3 | 3 | | 3 | | 2 | 2 | 1 | | | | | 3 | 3 | | |
| **2** | 3 | 3 | | 3 | | 2 | 2 | 1 | | | | | 3 | 3 | | |
| **3** | 3 | 3 | | 3 | | 2 | 2 | 1 | | | | | 3 | 3 | | |
| **4** | 3 | 3 | | 3 | | 2 | 2 | 1 | | | | | 3 | 3 | | |
| **5** | 3 | 3 | | 3 | | 2 | 2 | 1 | | | | | 3 | 3 | | |

## SEVENTH SEMESTER

| 1909701 | ELECTRIC VEHICLES | L | T | P | C |
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**OBJECTIVE:**

The main learning objective of this course is to prepare the students:

- To discuss about the need for alternate system:
- To understand the concept of storage devices and fuel cells
- To comprehend knowledge about propulsion motors and controllers
- To impart knowledge on understanding concept of vehicle layout
- To improvise the conception on hybrid vehicles

**UNIT - I: NEED FOR ALTERNATIVE SYSTEM 9**

History of electric and hybrid vehicles. Need of electric and hybrid vehicles – comparative study of diesel, petrol, electric and hybrid vehicles. Limitations of electric vehicles. Specification of different electric and hybrid vehicles.

**UNIT- II: ENERGY STORAGE DEVICES AND FUEL CELLS 9**

Electromechanical batteries- types of batteries –lead acid batteries, nickel-based batteries, lithium-based batteries, Electro-chemical reactions, Thermodynamic voltage, specific energy, specific power, energy efficiency and Ultra-Capacitors. Fuel Cell- Fuel cell characteristics- Fuel cell types – Applications- Connecting cell in series-water management in the Polymer Exchange Membrane PEM fuel cell- Thermal Management of the PEM fuel cell.

**UNIT- III: PROPULSION MOTORS AND CONTROLLERS 9**

Types of electric motors – working principle of AC and DC motors. Characteristic of shunt, series and compound type of DC motors- permanent magnet and separately exited DC motors. AC single phase and 3-phase motor – inverters – DC and AC motor speed controllers

**UNIT - IV: VEHICLE LAYOUT 9**

Electric vehicle layout, specifications, system components, electronic control system, performance of electric vehicles – traction motor characteristics, tractive effort, transmission requirements, energy consumption, safety and challenges in electric vehicles.

**UNIT - V: HYBRID VEHICLES 9**

Concepts of hybrid electric drive train, types, architecture of series and parallel hybrid electric drive train, merits and demerits, hybrid electric drive train design, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On successful completion of this course, the student will be able to:

- Understand and describe the importance of electric vehicle
- Discuss the method of storage devices
- Analysis the different motors and controllers
- Design the concept of electric vehicles components
- Explain hybrid vehicles and its related components

**TEXT BOOKS:**

1. James Larminie and John Lowry, Electric Vehicle Technology Explained, John Wiley & Sons, 2003.
2. Iqbal Husain, Electric and Hybrid Vehicles-Design Fundamentals, CRC Press, 2003.

**REFERENCE BOOKS:**

1. Ron HodKinson, Light Weight Electric/ Hybrid Vehicle Design, Butterworth Heinemann Publication, 2005
2. Lino Guzzella, Vehicle Propulsion System, Springer Publications, 2005.
3. Mehrdad Ehsani, Modern Electric, Hybrid Electric and Fuel Cell Vehicles, CRC Press, 2009.
4. Jack Erjavec and Jeff Arias, Hybrid, Electric and Fuel Cell Vehicles, Cengage Learning, 2012.
5. Seref Soylu, Electric Vehicles - The Benefits and Barriers, In-Tech Publishers, Croatia, 2011.

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| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** | **4** |
| **1** | 2 | 2 | | | | 2 | | | | | | | 1 | | 2 | |
| **2** | | | | | 2 | | | | 2 | 2 | | | | 1 | | 1 |
| **3** | 2 | | 3 | | 2 | | | | | | 2 | | | | 3 | |
| **4** | | | | 3 | | 1 | | | 2 | | | | | | | 3 |
| **5** | 1 | | 2 | | 3 | | 2 | | | | | 2 | 1 | | | 3 |

**1909702 PROCESS PLANNING AND COST ESTIMATION**

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**OBJECTIVE:**

The main learning objective of this course is to prepare the students:

- To introduce the process planning concepts to make cost estimation for various products after process planning.
- To understand the concept of process planning activities and preparation of set of documents.
- To study the concept of cost estimation methods.
- To understand the concept of production cost estimation.
- To comprehend machine time calculations.

**UNIT- I: INTRODUCTION TO PROCESS PLANNING 9**

Introduction- methods of process planning-Drawing interpretation-Material evaluation – steps in process selection-.Production equipment and tooling selection

**UNIT- II: PROCESS PLANNING ACTIVITIES 9**

Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods - Set of documents for process planning-Economics of process planning- case studies

**UNIT- III: INTRODUCTION TO COST ESTIMATION 9**

Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure- Estimation labor cost, material cost- allocation of overhead charges- Calculation of depreciation cost

**UNIT- IV: PRODUCTION COST ESTIMATION 9**

Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop

**UNIT - V: MACHINING TIME CALCULATION 9**

Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining

Time for Different Lathe Operations ,Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon the completion of this course the students will be able to

- Select the process, equipment and tools for various industrial products.
- Prepare process planning activity chart.
- Explain the concept of cost estimation.
- Compute the job order cost for different type of shop floor.
- Calculate the machining time for various machining operations.

**TEXT BOOKS:**


1. Peter scalon, “Process planning, Design/Manufacture Interface”, Elsevier science technology Books, Dec 2003.
2. Sinha B.P, “Mechanical estimating and Costing”, Tata-McGraw Hill publishing co, 1995.


**REFERENCE BOOKS:**


1. Chitale A.V. and Gupta R.C., “Product Design and Manufacturing”, $2^{nd}$ Edition, PHI, 2002.
2. Ostwalal P.F. and Munez J., “Manufacturing Processes and systems”, $9^{th}$ Edition, John Wiley, 1998.
3. Russell R.S and Tailor B.W, “Operations Management”, $4^{th}$ Edition, PHI, 2003.
4. Mikell P. Groover, “Automation, Production, Systems and Computer Integrated Manufacturing”, Pearson Education 2001.
5. K.C. Jain & L.N. Aggarwal, “Production Planning Control and Industrial Management”, Khanna Publishers 1990.


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| **2** | | 1 | | 1 | | | | | 1 | | 2 | | | 3 | | |
| **3** | | | 2 | | | | 2 | | | | | | 2 | | 2 | |
| **4** | 3 | | | | 2 | | | | | 2 | | | | 3 | | 1 |
| **5** | | | 1 | | | 2 | | | 2 | | | | 1 | | | 2 |

| 1909703 | MECHATRONICS AND AUTOMATION | L | T | P | C |
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**OBJECTIVE:**

The main learning objective of this course is to prepare the students:

- To impart knowledge about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation.
- To make the students describe Mechatronics components and systems using the basic building blocks of various systems mathematically, along with different modes of controller.
- To utilize the architectures of Microprocessor, Microcontroller and Programmable Peripheral Interface 8255, Pin Diagram, Addressing Modes, Programming and interfacing circuits of Microprocessor.
- To learn how to apply the architecture, programming and application of programmable logic controllers to problems and challenges in the areas of Mechatronics engineering.
- To design and develop a Mechatronics system using the knowledge and skills acquired through the course and also from the given case studies.

**UNIT- I: INTRODUCTION 9**

Introduction to Mechatronics – Concepts of Mechatronics approach – Need for Mechatronics- Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors – Actuators – Classification – Stepper motor – Servo motor

**UNIT- II: SYSTEM MODELS AND CONTROLLERS 9**

Systems – Classification - Building blocks of Mechanical, Electrical, Fluid and Thermal Systems, Rotational – Translational Systems, Continuous and discrete process Controllers – Control Mode – Two – Step mode – Proportional Mode – Derivative Mode – Integral Mode – PID Controllers – Digital Controllers – Velocity Control – Adaptive Control – Digital Logic Control.

**UNIT - III: MICROPROCESSOR AND MICROCONTROLLER 9**

Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes –Instruction set of

8085 – Concepts of 8051 microcontroller – Block diagram –Architecture of 8255 - Stepper Motor Control – Traffic Control interface, Introduction to Arduino processor.

**UNIT- IV: PROGRAMMABLE LOGIC CONTROLLERS 9**

Programmable Logic Controllers – Basic Structure – Input / Output Processing – Programming – Mnemonics – Timers, Internal relays and counters – Shift Registers – Master and Jump Controls – Data Handling – Selection of a PLC.

**UNIT- V: MECHATRONIC SYSTEM DESIGN 9**

Stages in designing Mechatronics Systems – Traditional and Mechatronic Design - Case studies of Mechatronics systems- Pick and place Robot- Engine Management system- Automatic car park barrier.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon the completion of this course the students will be able to:

- Describe the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical, Electronic Systems, actuators and sensor and technology.
- Describe Mechatronic components and systems using the basic building blocks of various systems mathematically, along with different modes of controller.
- Describe the architecture of Microprocessor, Microcontroller and Programmable Peripheral Interface 8255, Pin Diagram, Addressing Modes, Programming and interfacing circuits of Microprocessor.
- Explain the architecture, programming and application of programmable logic controllers to problems and challenges in the areas of Mechatronics engineering.
- Describe a Mechatronics system using the knowledge and skills acquired through the course and also from the given case studies.

**TEXT BOOKS:**

1. Bolton, “Mechatronics”, Prentice Hall, 2013.
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, 5$^{th}$ Edition, Prentice Hall, 2013.

**REFERENCE BOOKS:**


1. Bradley D.A, Dawson D, Buru N.C and Loader A.J, “Mechatronics”, Chapman and Hall, 1993.
2. Clarence W, de Silva, "Mechatronics" CRC Press, First Indian Re-print,2013
3. Devadas Shetty and Richard A.Kolk, “Mechatronics Systems Design”, PWS publishing company, 2007.
4. Krishna Kant, “Microprocessors & Microcontrollers”, Prentice Hall of India, 2007.
5. Michael B.Histand and Davis G.Alciatore, “Introduction to Mechatronics and Measurement systems”, McGraw Hill International edition, 2007.


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| 2 | 2 | | 2 | | 2 | | | | | | | 2 | | 2 | | |
| 3 | | 2 | | 1 | | 3 | | | 3 | | | | | 2 | | |
| 4 | | | 1 | | | | | | | | 2 | | 2 | | 3 | |
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## 1909714 MECHATRONICS AND AUTOMATION LABORATORY

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**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Measuring of physical quantity such as displacement, force and temperature and also the operation of signal conditioning circuits.
- Applying a suitable sensor and image processing technique for Mechatronics systems.
- Design appropriate circuits to automate and control the hydraulic, pneumatic and electric actuators.
- Apply PLC, PID and 8085 microcontroller as a control unit Mechatronics system.
- Developing a model of pneumatic and hydraulic circuits by using simulation software.

## LIST OF EXPERIMENTS:

1. Assembly language programming of 8085– Addition – Subtraction – Multiplication Division – Sorting – Code Conversion.
2. Stepper motor interface.
3. Traffic light interface.
4. Speed control of DC motor.
5. Study of various types of transducers.
6. Study of hydraulic, pneumatic and electro-pneumatic circuits.
7. Modelling and analysis of basic hydraulic, pneumatic and electrical circuits using Software.
8. Study of PLC and its applications.
9. Study of image processing technique.

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Measuring of physical quantity such as displacement, force and temperature and also the operation of signal conditioning circuits.
- Applying a suitable sensor and image processing technique for Mechatronics systems.
- Design appropriate circuits to automate and control the hydraulic, pneumatic and electric actuators.
- Apply PLC, PID and 8085 microcontroller as a control unit in Mechatronics system.
- Developing a model of pneumatic and hydraulic circuits by using simulation software.

## LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

| Sl. No. | NAME OF THE EQUIPMENT | QUANTITY |
|---|---|---|
| 1 | Basic Pneumatic Trainer Kit with manual and electrical controls/ PLC Control each. | 1 No. |
| 2 | Basic Hydraulic Trainer Kit | 1 No |
| 3 | Hydraulics and Pneumatics Systems Simulation Software | 10 No |
| 4 | 8051 - Microcontroller kit with stepper motor and drive circuit sets | 2 No |
| 5 | Image processing system with hardware & software | 1 No. |

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| **2** | 3 | | | 3 | | | | | | | | | 3 | | | |
| **3** | 3 | | 3 | | | | | | | | | | 3 | | | |
| **4** | 3 | | | | 3 | | | | | | | | | 2 | | 3 |
| **5** | 3 | 2 | | | | | | | 2 | | | | | 2 | | 3 |

| 1909715 | PROJECT WORK - PHASE I | L | T | P | C |
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**OBJECTIVES:**

The main learning objective of this course is to prepare the students:

- To improve the skills in reading conference proceedings and journals.
- To develop the ability to identify a specific Mechanical Engineering problem and familiarize with the tools required to solve the same.
- To get knowledge from brainstorming students.
- To motivate self and group of students working together.
- To identify the materials required for the project with optimal price and its locations.

**GUIDELINES:**

- ➢ A group of 3 or 4 students have to identify the topic of project related to the field of Mechanical Engineering.
- ➢ The candidates have to be in regular contact with their guide and the topic of project must be mutually decided by the guide and students.
- ➢ The topic has to be approved by a review committee constituted by the department.
- ➢ The work has to be presented periodically in front of the review committee.
- ➢ The report consisting of a detailed problem statement and a literature review is to be prepared.
- ➢ The preliminary results (if available) of the problem may also be discussed in the report.

- The project report should be presented in standard format.

**EVALUATION:**

- The progress of the project is evaluated based on a minimum of three reviews.
- The project work is evaluated by carrying out a comprehensive viva, based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

**TOTAL: 60 PERIODS**

**OUTCOME:**

On successful completion of this course, students will be able to:

- Apply the knowledge gained from the theory and practical courses to solve problem in the field of Mechanical Engineering.
- Implement the solution for the Mechanical Engineering problems with suitable modeling and software and analysis.
- Analysis the ideas received from the group of students and choice the best possible solution.
- Develop team work by motivation self and group.
- Choose the best materials to implement the project.

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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 1 | 3 | 3 | 1 | 1 |
| **2** | 3 | 3 | 2 | 3 | 3 | 1 | 3 | 1 | 3 | 3 | 3 | 1 | 3 | 3 | 1 | - |
| **3** | 3 | 3 | 2 | 2 | 3 | - | 3 | - | 3 | 3 | 3 | - | 3 | - | 1 | 1 |
| **4** | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 1 | 3 | 3 | 3 | 1 | 3 | - | 1 | 1 |
| **5** | 3 | 3 | 3 | 1 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 1 | 2 | 3 | 1 | 1 |

**1909716** **INTERNSHIP** **L T P C**

**0 0 0 1**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students:

- To improve the practical knowledge.
- To get hands on experience in an industry.

**GUIDELINES:**

- A Student has to undergo an internship in a reputed industry for a period of 15 days minimum.
- He can attend such internship in any of summer vacations in his previous semesters and submit the relevant certificate in the seventh semester for getting one credit.

## EIGHT SEMESTER

**1909801** **GREEN MANUFACTURING**

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**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Acquire a broad understanding of sustainable manufacturing, green product and process.
- Understand the analytical tools, techniques in green manufacturing.
- Understand the structures of sustainable manufacturing, environmental and management practice.
- Understand the Industrial Ecology, Eco design and Pollution prevention.
- Understand the Solar energy devices and Selection of natural friendly materials.

**UNIT-I: INTRODUCTION 9**

Environmental effects of design – Environmental damage – In efficient energy use – Design for recycling.

**UNIT-II: ENVIRONMENTAL LIFE CYCLE ASSESSMENT 9**

Material flow and cycles – Material recycling – Emission less manufacturing.

**UNIT-III: GREEN DESIGN METHODS 9**

Mass balance analysis – Green indicate – Design for disassembly design for recycle – Rist analysis – Material selection.

**UNIT-IV: DESIGN FOR ENVIRONMENT 9**

Eco design – Industrial Ecology – Pollution prevention – Reduction of toxic emission.

**UNIT-V: SUSTAINABLE ECONOMIC ENVIRONMENT 9**

Solar energy devices – wind energy resources – Full cost accounting methodology – Selection of natural friendly materials.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Explain the concepts of Green Manufacturing Design.
- It will impart green design methods and to assess the life cycle of the product.
- Structures of sustainable manufacturing, environmental and management practice.
- Apply the knowledge of Industrial Ecology, Eco design and Pollution prevention.
- . Develop solar energy devices and Selection of natural friendly materials.

**TEXTBOOKS:**


1. Dornfield David, Green Manufacturing, Springer, 2012.
2. Davim.J.Pauls, Green Manufacturing Processes and Systems, Springer, 2013.


**REFERENCE BOOKS:**


1. Cairncrss and Francis – Costing the earth – Harvard Business School Press - 2009.
2. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
3. World commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.


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| 1 | 2 | 2 | 2 | | | | | | | | | | 3 | | | 3 |
| 2 | | 2 | 2 | | | | | | | | | | 3 | | | 3 |
| 3 | | 2 | 2 | 2 | | | | | | | | | 3 | | 2 | 3 |
| 4 | | 2 | 2 | | | 1 | | | | | | | 3 | | | 3 |
| 5 | 2 | 2 | 2 | | | | | | | | | | 3 | | | 3 |

**1909807** **PROJECT WORK- PHASE - II**

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**OBJECTIVES:**

The main learning objective of this course is to prepare the students able:

- To develop the ability to identify a specific Mechanical Engineering problem and find a solution of the same.
- To develop the students to learn the new technologies in various domains to carry out the project activities.
- To explore the research avenues in the mechanical engineering field.
- To train them in different machine available in the industries to complete its project work.
- To train the students in preparing power point presentation for its detailed project work to face reviews.

**GUIDELINES:**

- ➢ The group of students have to complete project (phase II) under the guidance of a faculty member, as specified in Phase - I.
- ➢ The students have to be in regular contact with their guide and the topic of project must be mutually decided by the guide and students.
- ➢ The topic has to be approved by a review committee constituted by the department.
- ➢ The work has to be presented periodically in front of the review committee.
- ➢ The students have to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.
- ➢ The report must bring out the conclusions of the work and future scope for the study.
- ➢ The project report should be presented in standard format.

**EVALUATION:**

- ➢ The progress of the project is evaluated based on a minimum of three reviews.
- ➢ The project work is evaluated by carrying out a comprehensive viva, based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

**TOTAL PERIODS: 180**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Identify the problem associated with manufacturing related works.
- Design and modify the components by using of the new technologies in various domains.
- Analysis the new component to replace the existing one with ease of working and maintenance of the components.
- Explain different types of machine associated in its project work.
- Prepared detailed project work as in power point presentation with working model to face the reviews.

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## PROFESSIONAL ELECTIVES FOR B.E. MECHANICAL ENGINEERING

## SEMESTER- V, ELECTIVE- I, [Manufacturing - Domain]

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| **1909505** | **WELDING TECHNOLOGY** | **L T P C** |
| | | **3 0 0 3** |

**OBJECTIVES:**

The main learning objective of this course is to prepare the students able to:

- Describe the basics of welding and to know about the various types of welding processes.
- Develop the knowledge in resistance welding processes.
- Learn the solid state welding processes.
- Impart the knowledge in special welding processes.
- Design the weld joint and describe the testing of welding.

**UNIT -I: GAS AND ARC WELDING PROCESSES 9**

Fundamental principles – Air Acetylene welding, Oxyacetylene welding, Carbon arc welding, Shielded metal arc welding, Submerged arc welding, TIG & MIG welding, Plasma arc welding and Electro slag welding processes - advantages, limitations and applications.

**UNIT -II: RESISTANCE WELDING PROCESSES 9**

Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding, Percussion welding and High frequency resistance welding processes - advantages, limitations and applications.

**UNIT -III: SOLID STATE WELDING PROCESSES 9**

Cold welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forge welding, Roll welding and Hot pressure welding processes - advantages, limitations and applications.

**UNIT -IV: OTHER WELDING PROCESSES 9**

Thermit welding, Atomic hydrogen welding, Electron beam welding, Laser Beam welding, Friction stir welding, Under Water welding, welding automation in aerospace, nuclear and surface transport vehicles.

**UNIT -V: DESIGN OF WELD JOINTS, WELDABILITY AND TESTING OF WELDMENTS** **9**

Various weld joint designs – Welding defects – causes and remedies - Weldability of Aluminium, Copper, and Stainless steels. Destructive and non-destructive testing of weldments.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students can be able to:

- Understood the principles of gas and arc welding process and its types.
- Explain the concept of resistance welding process.
- Analyze the principles of various solid states welding process.
- Integrate the special welding processes.
- Analyze the concepts on weld joint design, Weldability and testing of weldments in various materials.

**TEXT BOOKS**


1. Little R.L., "Welding and welding Technology", Tata McGraw Hill Publishing Co., Ltd., New Delhi, 34th reprint, 2008.
2. Parmer R.S., "Welding Engineering and Technology", 1st Edition, Khanna Publishers, New Delhi, 2008.


**REFERENCES**


1. AWS- Welding Hand Book. 8th Edition. Vol- 2. "Welding Process" 2012.
2. Christopher Davis. "Laser Welding- Practical Guide". Jaico Publishing House. 2010
3. Nadkarni S.V. "Modern Arc Welding Technology", Oxford IBH Publishers, 1st Edition, 2005.


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**1909506 UNCONVENTIONAL MACHINING PROCESSES**

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**OBJECTIVE:**

The main learning objective of this course is to prepare the students to:

- Classify the unconventional machining processes and to describe the mechanical processes.
- Describe the thermal and electrical based process.
- Identify the chemical and electro chemical based process parameters and their influence on performance and their applications.
- Learn the advanced Nano finishing process.
- Know the latest trends in unconventional machining processes.

**UNIT -I: INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES 9**

Unconventional machining Process – Need – classification – merits, demerits and applications. Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining - Ultrasonic Machining. (AJM, WJM, AWJM and USM). Working Principles – equipment used – Process parameters – MRR- Applications.

**UNIT -II: THERMAL AND ELECTRICAL ENERGY BASED PROCESSES 9**

Electric Discharge Machining (EDM) – Wire cut EDM – Working Principle-equipments-Process Parameters-Surface Finish and MRR- electrode / Tool – Power and control Circuits-Tool Wear – Dielectric – Flushing –– Applications. Laser Beam machining and drilling, (LBM), plasma, Arc machining (PAM) and Electron Beam Machining (EBM). Principles – Equipment –Types - Beam control techniques – Applications.

**UNIT -III: CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES 9**

Chemical machining and Electro-Chemical machining (CHM and ECM)- Etchants – Maskant - techniques of applying maskants - Process Parameters – Surface finish and MRR-Applications. Principles of ECM- Equipments-Surface Roughness and MRR Electrical circuit-Process Parameters ECG and ECH - Applications.

**UNIT -IV: ADVANCED NANO FINISHING PROCESSES 9**

Abrasive flow machining, chemo-mechanical polishing, magnetic abrasive finishing, magneto rheological finishing, magneto rheological abrasive flow finishing their working principles, equipment's, effect of process parameters, applications, advantages and limitations.

**UNIT-V: RECENT TRENDS IN NON-TRADITIONAL MACHINING PROCESSES 9**

Recent developments in non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Comparison of non-traditional machining processes.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students can be able to:

- Apply the different UCMP for real time applications.
- Analyze the various thermal energy and electrical energy based UCMP.
- Integrate the chemical and electro-chemical energy based UCMP.
- Apply the various nano abrasives based UCMP in industries.
- Analyze the recent trend based unconventional machining processes.

**TEXT BOOKS:**


1. Adithan. M., "Unconventional Machining Processes", Atlantic, New Delhi, India, 2009. ISBN 13: 9788126910458.
2. Anand Pandey, "Modern Machining Processes", Ane Books Pvt. Ltd., New Delhi, India, 2019.


**REFERENCE BOOKS:**


1. Benedict. G.F. "Non traditional Manufacturing Processes", Marcel Dekker Inc., New York, 2010.
2. PaulDeGarmo, J.T.Black, and Ronald.A.Kohser, "Material and Processes in Manufacturing" Prentice Hall of India Pvt. Ltd., 8thEdition, New Delhi , 2012. agadeesha T., "Non-Traditional Machining Processes", I.K. International Publishing House Pvt. Ltd., New Delhi, India, 2017, ISBN-13: 978-9385909122.
3. Kapil Gupta, Neelesh K. Jain and Laubscher R.F., "Hybrid Machining Processes: Perspectives on Machining and Finishing", 1st edition, Springer International Publishing., Switzerland, 2016

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**1909507 ADDITIVE MANUFACTURING L T P C**

**3 0 0 3**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students to:

- Describe the additive manufacturing processes.
- Design the additive manufacturing processes.
- Learn the principle of photo polymerization and powder bed fusion processes.
- Obtain the knowledge in Extrusion and sheet based manufacturing.
- Identify the characteristics of the different materials those are used in additive manufacturing technologies.

**UNIT -I: INTRODUCTION 9**

Overview – Need - Development of Additive Manufacturing Technology -Principle – AM Process Chain- Classification –Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Applications- Industry 4.0.

**UNIT -II: DESIGN FOR ADDITIVE MANUFACTURING 9**

Design tools: Data processing - CAD model preparation – Part orientation and support structure generation – Model slicing –Tool path generation- Design for Additive Manufacturing: Concepts and objectives- AM unique capabilities – DFAM for part quality improvement- Customised design and fabrication for medical applications.

**UNIT -III: PHOTO POLYMERIZATION AND POWDER BED FUSION PROCESSES 9**

Photo polymerization: SLA-Photo curable materials – Process - Advantages and Applications. Powder Bed Fusion: SLS-Process description – powder fusion mechanism – Process Parameters– Typical Materials and Application. Electron Beam Melting.

**UNIT -IV: EXTRUSION BASED AND SHEET LAMINATION PROCESSES 9**

Extrusion Based System: FDM-Introduction – Basic Principle – Materials – Applications and Limitations – Bioextrusion. Sheet Lamination Process:LOM- Gluing or Adhesive bonding – Thermal bonding.

**UNIT -V: MATERIALS, MANUFACTURING AND BEAM DEPOSITION PROCESS 9**

Composite materials – Reinforcing materials – Matrix materials – Advanced heat treatment of metals modern manufacturing methods – Three dimensional printing – Advantages – Bioplotter - Beam deposition process: LENS - Process description – Material delivery – Process parameters – Materials – Benefits – Applications- Digital manufacturing.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Analyze the capability of different additive manufacturing processes.
- Apply the design for additive manufacturing processes in industry.
- Implement the principle of photo polymerization and powder bed fusion processes.
- Analyze the extrusion and sheet based manufacturing.
- Apply the different materials in AM technology to manufacturing sector.

**TEXT BOOKS:**


1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", 3rd edition, World Scientific Publishers, 2010.
2. Ian Gibson, David W.Rosen, Brent Stucker "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" Springer, 2010.


**REFERENCE BOOKS:**


1. Andreas Gebhardt "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing" Hanser Gardner Publication 2011.
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.

3. Liou L.W. and Liou F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press, 2007.
4. Tom Page “Design for Additive Manufacturing” LAP Lambert Academic Publishing, 2012.

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**1909508** **MICRO ELECTRO MECHANICAL SYSTEMS** **L T P C**
**3 0 0 3**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students able:

- To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
- To educate on the rudiments of Micro fabrication techniques.
- To introduce various sensors and actuators
- To introduce different materials used for MEMS
- To educate on the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

**UNIT – I: INTRODUCTION** **9**

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection

**UNIT- II: SENSORS AND ACTUATORS - I** **9**

Electrostatic sensors – Parallel plate capacitors – Applications – Inter digitized Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation– Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications – Magnetic Actuators – Micro magnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys

**UNIT- III: SENSORS AND ACTUATORS - II** **9**

Piezoresistive sensors – Piezoresistive sensor materials - Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators– piezoelectric effects – piezoelectric materials – Applications to Inertia , Acoustic, Tactile and Flow sensors.

**UNIT -1V: MICROMACHINING** **9**

Silicon Anisotropic Etching – Anisotropic Wet Etching – Dry Etching of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies- Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process.

**UNIT- V: POLYMER AND OPTICAL MEMS** **9**

Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene–Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS – Lenses and Mirrors – Actuators for Active Optical MEMS.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of this course, the students will be able to:

- Apply the basic science, circuit theory, Electro-magnetic field theory and apply them to electrical engineering problems
- Ability to understand and analyse, linear and digital electronic circuits.
- Ability to understand the concept of sensors and actuators.
- Apply the knowledge different micromachining process and different types of etchants used in the MEMS.

- Identification of different polymer used in the optical MEMS.

**TEXT BOOKS:**

1. Chang Liu, "Foundations of MEMS", Pearson Education Inc., 2006.
2. Stephen D Senturia, "Microsystem Design", Springer Publication, 2000.
3. Tai Ran Hsu, “MEMS & Micro systems Design and Manufacture” Tata McGraw Hill, New Delhi, 2002.

**REFERENCE BOOKS:**

1. James J.Allen, "Micro Electro Mechanical System Design", CRC Press Publisher, 2010
2. Julian w. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, "Micro Sensors MEMS and Smart Devices", John Wiley & Son LTD,2002
3. Mohamed Gad-el-Hak, editor, “ The MEMS Handbook”, CRC press Baco Raton, 2000.
4. Nadim Maluf,“ An Introduction to Micro Electro Mechanical System Design”, Artech House, 2000.
5. Thomas M.Adams and Richard A.Layton, “Introduction MEMS, Fabrication and Application,” Springer 2012.

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**1909509 QUALITY CONTROL AND RELIABILITY ENGINEERING L T P C**

**3 0 0 3**

**OBJECTIVES**:

The main learning objective of this course is to prepare the students to:

- Apply the 7 QC tools in problem solving for continuous improvement.
- Design online sampling plan for quality control using control charts and performs process capability studies.
- Apply the strategies of acceptance sampling plan to perform quality audit in the customer site.
- Evaluate the different reliability measurements applying the reliability concepts
- Select the suitable method of improving the reliability and integrate reliability concepts in new product design and development.

**UNIT -I: INTRODUCTION AND STATISTICAL PROCESS CONTROL 9**

Introduction:-definitions of quality, Evolution of Quality: Inspection, Quality Control, Quality assurance Customer-Orientation: Internal & External Customer Concept, Life cycle approach to quality costs- Prevention; Appraisal and Failure costs. Seven SPC tools -Histogram, Check sheets, Ishikawa diagrams, Pareto, Scatter diagrams, Control charts and flow chart.

**UNIT -II: ONLINE QUALITY CONTROL 9**

Control chart for attributes –control chart for non-conforming– p chart and np chart – control chart for nonconformities– C and U charts, Control chart for variables – X chart, R chart and$\sigma$chart -State of control and process out of control identification in charts, pattern study and process capability studies.

**UNIT -III: OFFLINE QUALITY CONTROL 9**

Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling techniques – O.C. curves – producers Risk and consumers Risk. AQL, LTPD, AOQL concepts standard sampling plans for AQL and LTPD- uses of standard sampling plans.

**UNIT -IV: RELIABILITY CONCEPTS 9**

Reliability engineering - fundamentals – failure data analysis, Mean failure rate, Mortality curves concept of burn –in period, useful life and wear out phase of a system, mean time to failure, meantime between failure, hazard rate – failure density and conditional reliability-Maintainability and availability – simple problems.

**UNIT -V: RELIABLITY ESTIMATION 9**

System reliability: Series, Parallel and Mixed configurations, Reliability improvement techniques, use of Pareto analysis – design for reliability – redundancy unit and standby redundancy- fault tree analysis – Optimization in reliability – Product design – Product analysis – Product development – Product life cycles.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Apply the 7 QC tools in problem solving for continuous improvement.
- Design online sampling plan for quality control using control charts and perform process capability studies.
- Apply the strategies of acceptance sampling plan to perform quality audit in the customer site.
- Evaluate the different reliability measurements applying the reliability concepts
- Apply the suitable method of improving the reliability and integrate reliability concepts in new product design and development.

**TEXT BOOKS:**

1. Douglas.C. Montgomery, “Introduction to Statistical quality control”, 7$^{th}$ edition, John Wiley 2012.
2. Srinath. L.S., “Reliability Engineering”, 4$^{th}$ edition Affiliated East west press, 2011.

**REFERENCE BOOKS:**

1. Besterfield D.H., “Quality Control”, 8th edition, Prentice Hall, 2009..
2. Connor, P.D.T.O., “Practical Reliability Engineering”, 5 theditionWiley India, 2012
3. John.S. Oakland. “Statistical process control”, Elsevier Butterworth-Heinemann, 2008.
4. Monohar Mahajan, “Statistical Quality Control”, DhanpatRa i& Sons 2016.

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**SEMESTER- VI, ELECTIVE –II, [Humanities and Management – Domain]**

**1915002 PRINCIPLES OF MANAGEMENT L T P C**

**3 0 0 3**

**OBJECTIVES:**

- Study the principles of management, functions and its application an organization.
- Educate the students on the concept of planning and decision making.
- Understand the dynamics of human relations in organizations.
- Learn about motivation, communication and leadership aspects.
- Study the process controlling and the various techniques involved to control the processes.

**UNIT – I: INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9**

Definition of Management – Science or Art – Manager Vs Entrepreneur - types of managers managerial roles and skills –Evolution of Management – Scientific, human relations, system and contingency approaches – Types of Business organization - Sole proprietorship, partnership, company-public and private sector enterprises - Organization culture and Environment – Multinational Corporations - Current trends and issues in Management.

**UNIT – II: PLANNING 9**

Nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies – Planning premises – Strategic Management –types of strategies – Planning Tools and Techniques – Decision making steps and process.

**UNIT – III: ORGANISING 9**

Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority – departmentalization – delegation of authority – centralization and decentralization – Job Design - Human Resource Management – HR Planning, Talent Acquisition, Training and Development, Performance Management, Career planning and management.

**UNIT – IV: DIRECTING 9**

Motivation – motivation theories – motivational techniques – job satisfaction – job enrichment – leadership – types and theories of leadership – communication – process of communication – barrier in communication – effective communication – communication and IT.

**UNIT – V: CONTROLLING** **9**

System and process of controlling – budgetary and non-budgetary control techniques – use of computers and IT in Management control – Quality control and Inventory Control - Productivity problems and management – control and performance – direct and preventive control – Maintenance control and purchase control– reporting.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Students will be able to have a clear understanding of managerial functions.
- Students would have knowledge to apply planning techniques and decision making.
- Understand concept of Human Resource Management.
- Students would be able to understand motivation, leadership and communication principles.
- Students would be able to apply control techniques in the organization.

**TEXTBOOKS:**

1. Stephen P. Robbins & Mary Coulter, “Management”, 14th Edition, Pearson, 2017
2. JAF Stoner, Freeman R.E and Daniel R Gilbert “Management”, 6th Edition, Pearson, 2004.

**REFERENCE BOOKS:**

1. Stephen A. Robbins & David A. Decenzo & Mary Coulter, “Fundamentals of Management” 10th Edition, Pearson Education, 2016.
2. Robert Kreitner & Mamata Mohapatra, “Management”, Biztantra, 2008.
3. Harold Koontz & Heinz Weihrich “Essentials of management” Tata Mc Graw Hill, 2006.
4. Tripathy PC & Reddy PN, “Principles of Management”, Tata McGraw Hill, 6th edition 2017.

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**1915003** **TOTAL QUALITY MANAGEMENT** **LT P C**

**3 0 0 3**

**OBJECTIVES:**

- To understand the need and evolution of quality concepts related to TQM
- To understand the TQM Principles and Models.
- To learn and apply the traditional tools and techniques of TQM.
- To educate students to apply the modern tools and techniques in TQM.
- To understand and apply QMS and EMS in any organization.

**UNIT – I: INTRODUCTION** **9**

Introduction - Definition of quality - Need for quality - Evolution of quality - Dimensions of product and service quality - Definition of TQM - Basic concepts of TQM – Principles of TQM - TQM Framework- Barriers to TQM – Benefits of TQM – Cost of Quality.

**UNIT – II: TQM PRINCIPLES** **9**

Leadership--The Deming Philosophy, Quality council, Quality statements and Strategic planning-Hoshin Planning - Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward - Continuous process improvement –Juran Trilogy, PDSA cycle, 5S and Kaizen - Supplier partnership – Partnering, Sourcing, Supplier selection, Supplier Rating and Relationship development.

**UNIT – III: TQM TOOLS &TECHNIQUES - I** **9**

The seven traditional tools of quality – New management tools – Six-sigma Process Capability– Bench marking – Reasons to bench mark, Bench marking process, Criticisms of Bench Marking – FMEA –FMEA Documentation, Stages.

**UNIT – IV: TQM TOOLS & TECHNIQUES - II** **9**

Quality Circles – Quality Function Deployment (QFD) – House of Quality – QFD Process, Benefits – Total Productive Maintenance – Concepts, Benefits – Business Process Reengineering – Concepts, Process and Applications – Business Process Improvement.

**UNIT – V: QUALITY MANAGEMENT SYSTEM** **9**

Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards-AS 9100, TS16949 and TL 9000-ISO 9001 Requirements – Implementation- Documentation-Internal Audits-Registration-Environmental Management System: Introduction -ISO 14000 Series Standards-Concepts of ISO 14001 -Requirements of ISO 14001-Benefits of EMS - National and International Awards.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Understand the basic concepts, contribution of quality guru's and TQM framework.
- Imparting the knowledge of TQM Principles.
- Apply the tools and techniques of quality management.
- Apply Quality philosophy in business processes with an understanding on customer Requirements.
- Create and develop the details requirements for ISO audit of the organizations.

**TEXT BOOKS:**


1. Dale Besterfield, Carol B. Michna, Glen H. Besterfield, Mary B. Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.


**REFERENCE BOOKS:**


1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Janakiraman. B and Gopal.R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd.,7 th Print 2011.
4. Itay Abuhav, ISO 9001: 2015 - A Complete Guide to Quality Management Systems, CRC Press; 1st edition (2017)
5. ISO 9001-2015 standard.

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**1915004 HUMAN RIGHTS L T P C**

**3 0 0 3**

**OBJECTIVES:**

- Sensitize the Engineering students to various aspects of Human Rights.
- Educate on the evolution of human rights movement.
- Create awareness and understanding on the international deliberations towards human rights.
- Educate on constitutional rights and provisions related to human rights in India.
- Create awareness on support organizations in Human Rights in India.

**UNIT – I: INTRODUCTION 9**

Human Rights - Meaning, Origin and Development. Notion and classification of Rights – Natural, Moral and Legal Rights. Civil, Political Rights, Economic, Social and Cultural Rights, Educational Rights, Collective and Solidarity Rights - Societal problems and human rights

**UNIT – II: EVOLUTION OF HUMAN RIGHTS MOVEMENT 9**

Evolution of the concept of Human Rights Magana carta – Geneva Convention1864. Universal Declaration of Human Rights, 1948. Principles of Human Rights - Theories of Human Rights – Feminist Perspectives of Human Rights – Human Rights Problems - Violence against Women and Children, Communal Violence.

**UNIT – III: INTERNATIONAL PRESPECTIVES** **9**

Theories and Perspectives of United Nation Laws – United Nations Agencies to monitor and compliance – United National Commission of Human Rights (UNCHR) – United Nations Children Fund (UNICEF) – United Nations Commission for Refugee (UNHCR) – United Nations Education, scientific and cultural Organisation (UNESCO) – International Labour Organisation and Labour Rights.

**UNIT – IV: HUMAN RIGHTS IN INDIA** **9**

Human Rights in India – Constitutional Provisions / Guarantees. – Fundamental rights, Directive Principles of State, Policies, Fundamental Duties - International Human Rights and the Indian Constitution – Human Rights violation in Private and Public Domain - Within the Family, by Dominant Castes and Religious Groups, Riots and Violence

**UNIT – V: HUMAN RIGHTS SUPPORT ORGANISATION** **9**

Human Rights of Disadvantaged People, Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People - Implementation of Human Rights – National and State Human Rights Commission – Judiciary – Role of NGO's, Media, Educational Institutions, Social Movements.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Engineering students, acquire the basic knowledge of human rights.
- Understanding on the evolution of human rights movement.
- Ability to understanding on UN laws and agencies related to human rights.
- Advocate on constitutional provisions related to human rights in India.
- Impart the knowledge of various organizations involved in support of human rights in India.

**REFERENCE BOOKS:**


1. Kapoor S.K., "Human Rights under International law and Indian Laws", Central Law Agency, Allahabad, 7th edition 2014.
2. Chandra U., "Human Rights", Allahabad Law Agency, Allahabad, 2014.
3. Upendra Baxi, 'The Future of Human Rights', Oxford University Press, NewDelhi, 3rd edition 2012.

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**1915005 ENTERPRENEURSHIP DEVELOPMENT L T P C**

**3 0 0 3**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students to:

- Develop and strengthen entrepreneurial qualities and entrepreneur’s role in economic growth.
- Impart understanding on Entrepreneurial Training and Development Programs.
- Develop understanding on the business environment and to manage projects.
- Create an understanding on project finance and accounting principles.
- Create awareness on entrepreneurial support offered through government agencies and schemes.

**UNIT – I: INTRODUCTION 9**

Entrepreneur – Types of Entrepreneurs – Entrepreneurship as a Career – Entrepreneurial Personality - Characteristics of Successful, Entrepreneur – Knowledge and Skills of Entrepreneur. Difference between Entrepreneur and Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

**UNIT – II: ENTREPRENEURIAL MOTIVATION 9**

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self-Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

**UNIT – III: BUSINESS ENVIRONMENT AND PROJECT MANAGEMENT 9**

Business Environment - Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

**UNIT – IV: FINANCING AND ACCOUNTING 9**

Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, and Management of working Capital. Accounting – Double Entry system of accounting.

**UNIT – V: SUPPORT TO ENTREPRENEURS 9**

Entrepreneur Support Organizations - Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures - Business Incubators – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of the course, students will be able to:

- Gain knowledge and skills needed to run a business.
- Understanding the concept on entrepreneurial motivation.
- Formulate project proposals based on understanding on business environment.
- Evaluate accounting and financial aspects of business.
- Understanding on project funding and support agencies.

**TEXT BOOKS:**

1. Khanka. S.S., “Entrepreneurial Development” S. Chand& Co. Ltd., Ram Nagar, New Delhi, 2013.
2. Donald F Kuratko, “Entrepreneurship – Theory, Process and Practice”, 10th Edition, Cengage Learning, 2017.

**REFERENCE BOOKS:**

1. Hisrich R D, Peters M P, “Entrepreneurship” 10th Edition, Tata McGraw-Hill, 2017.

2. Mathew J Manimala, "Entrepreneurship theory at cross roads: paradigms and praxis" 2nd Edition Dream tech, 2005.
3. Rajeev Roy, "Entrepreneurship" 2nd Edition, Oxford University Press, 2011.
4. EDII "Faculty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development", Institute of India, Ahmadabad, 1986.


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**1904606 INTELLECTUAL PROPERTY RIGHTS L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To acquaint the students with basics of intellectual property rights with special reference to Indian Laws and its practices.
- To provide an overview of the statutory, procedural, and case law underlining these processes and their interplay with litigation.
- To provide the detailed idea about Agreements and Registration.
- To provide a superior environment to students for commercialization of intellectual property.
- To encourage and protect innovation in the form of intellectual property rights.

**UNIT-I: INTRODUCTION 9**

Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological

Research, Inventions and Innovations – Important examples ofIPR.

**UNIT-II: REGISTRATIONOFIPRs 9**

Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad.

**UNIT-III: AGREEMENTS AND LEGISLATIONS 9**

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

**UNIT-IV: DIGITAL PRODUCTS AND LAW 10**

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

**UNIT-V: ENFORCEMENT OF IPRS 8**

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

**TOTAL: 45 PERIODS**

**OUTCOME:**

Upon completion of the course, the students able to:

- Skill to understand the concept of intellectual property rights.
- Develops procedural knowledge to Legal System and solving the problem relating to Intellectual property rights.
- Skill to pursue the professional programs in Company Secretary Ship, Law. Business (MBA), International Affairs, Public Administration and Other fields.
- Employability as the Compliance Officer, Public Relation Officer and Liaison Officer.
- Establishment of Legal Consultancy and service provider.

**TEXT BOOKS:**

1. V. Scople Vinod, “Managing Intellectual Property”, Prentice Hall of India Pvt Ltd, 2012.
2. S. V. Satakar, “Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi,2002.

**REFERENCE BOOKS:**


1. Deborah E. Bouchoux, “Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets”, Cengage Learning, Third Edition, 2012.
2. Prabuddha Ganguli, "Intellectual Property Rights: Unleashing the Knowledge Economy”, McGraw Hill Education, 2011.


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**1903612** **DISASTER MANAGEMENT** **L T P C**

**( Common to EEE, Medical Electronics, Mechanical)** **3 0 0 3**

**OBJECTIVES:**

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR).
- To enhance awareness of institutional processes in the country.
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity.

**UNIT- I: INTRODUCTION TO DISASTERS** **9**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

**UNIT- II: APPROACHES TO DISASTER RISK REDUCTION (DRR) 9**

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processes and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.

**UNIT- III: INTER-RELATIONSHIP BETWEEN DISASTERS AND EVELOPMENT 9**

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

**UNIT-IV: DISASTER RISK MANAGEMENT IN INDIA 9**

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, and Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

**UNIT- V: DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS 9**

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management. **TOTAL: 45 PERIODS**

**OUTCOMES:**

The students will be able to:

- Differentiate the types of disasters, causes and their impact on environment and society.
- Assess factors of vulnerability and its impacts.
- Knowledge of various methods of risk reduction measures as well as mitigation.
- Draw the hazard and vulnerability profile of India and Scenarious in the Indian context.
- Assess Disaster damage assessment and management.

**TEXT BOOKS:**

1. Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13:978-9380386423.
2. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012. ISBN-10: 1259007367, ISBN-13:978-1259007361.
3. Gupta Anil K, Sreeja S. Nair. "Environmental Knowledge for Disaster Risk Management", NIDM, New Delhi, 2011.
4. Kapur Anu Vulnerable India "A Geographical Study of Disasters, IIAS and Sage Publishers", New Delhi, 2010.

**REFERENCE BOOKS:**

1. Govt. of India, Disaster Management Act , Government of India, New Delhi, 2005.
2. Government of India, National Disaster Management Policy, 2009.

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**SEMESTER- VI, ELECTIVE –III, [Fluid &Thermal Power Engineering - Domain]**

| **1909604** | **TURBO MACHINERY** | **L** | **T** | **P** | **C** |
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**OBJECTIVES:**

- To make students to understand the concept of energy equations.
- To understand the concept of h-s diagram and velocity diagram of fans, blowers and wind tunnels.
- To improvise knowledge on configuration and working, h-s diagram, velocity triangles, blade of compressor.
- To impart knowledge in constructing velocity triangles and analyzing the performance of turbo machines.
- To know the concept of hydraulic pumps and turbines.

**UNIT- I: ENERGY EQUATIONS 7**

Definition and classification of Turbo machines, Application of I and II law of thermodynamics, Specific work – Representation of specific work in T-s and h-s diagram –Euler's equation of turbo machines - Losses - Various efficiencies – Degree of reaction.

**UNIT- II: FANS, BLOWERS, WIND TUNNELS 11**

Centrifugal fans and blowers– configuration and working, h-s diagram, velocity triangles, stage work, stage pressure rise, stage pressure coefficient, stage efficiency, degree of reaction, slip factor. Axial flow fans – configuration and working, h-s diagram, velocity triangles, blade loading and flow coefficient, static pressure rise, degree of reaction, Wind tunnels.

**UNIT –III: COMPRESSORS 9**

Centrifugal compressors – configuration and working, h-s diagram, velocity triangles, stage work, stage pressure rise, stage pressure coefficient, stage efficiency, degree of reaction, slip factor. Axial flow compressors – configuration and working, h-s diagram, velocity triangles, blade loading and flow coefficient, static pressure rise, degree of reaction, stalling and surging.

**UNIT- IV: STEAM AND GAS TURBINES 9**

Axial and radial flow gas turbines – configuration and working, h-s diagram, velocity triangles, stage work, pressure ratio, stage loading and flow coefficient, degree of reaction. Steam turbines – impulse and reaction turbines, velocity and pressure compounding, stage efficiency, governing.

**UNIT- V: HYDRAULIC PUMPS AND TURBINES 9**

Classification, Pelton wheel, Francis turbine, Kaplan turbine, velocity triangles, work done, various efficiencies, specific speed, characteristics, draft tube, governing, Centrifugal and axial flow pumps – construction details, characteristics, velocity triangles, work done, head developed, various efficiencies, specific speed. Priming – cavitation.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On successful completion of this course, the student will be able to:

- Apply the basic concepts and principle of operation of turbo machines
- Evaluate the performance of fans and blowers, draw velocity triangles and solve Problems.
- Impart the knowledge on performance of various types of compressors, draw velocity triangles and solve problems.
- Explain performance of steam and gas turbines, draw velocity triangles and solve problems.
- Explain performance of hydraulic turbines and pumps, draw velocity triangles and solve problems.

**TEXT BOOKS:**

1. S.M. Yahya,Turbine, Compressors and Fans, Tata McGraw-Hill Education Pvt. Ltd., Fourth edition, 2011.
2. Venkanna B.K., Fundamentals of Turbo machinery, PHI learning Pvt. Ltd., 2009.

**REFERENCE BOOKS:**

1. P.R. Khajuria, S.P. Dubey,Gas Turbines and Propulsive Systems, Dhanpat Rai Publications, 2012.
2. R.K. Bansal,A text book of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, revised 9th edition, 2010.
3. S. L. Dixon and C. A. Hall,Fluid Mechanics and Thermodynamics of Turbomachinery, Butterworth-Heinemann, Elsevier, Seventh edition 2014.
4. V. Kadambi, Mahohar Prasad, An introduction to Energy Conversion:Turbo machinery,

Volume III, New Age International, Second edition, 2011.

5. V. Ganesan, Gas Turbines, McGraw Hill, Third edition, 2010.
6. Austin H Church and Jagdish Lal, Centrifugal Pumps and Blowers, Metropolitan Book Co. Pvt. Ltd., 2000.

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| **1909605** | **COMPUTATIONAL FLUID DYNAMICS** | **L** | **T** | **P** | **C** |
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**OBJECTIVES:**

- To introduce Governing Equations of viscous fluid flows.
- To introduce numerical modelling and its role in the field of fluid flow and heat transfer.
- To enable the students to understand the various discretization methods, solution procedures and turbulence modelling.
- To create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speed computers.
- To know the concept of solving the Turbulence models and Mesh generation techniques

**UNIT-I: GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 9**

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

**UNIT- II: FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION 9**

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three - dimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.

**UNIT- III: FINITE VOLUME METHOD FOR CONVECTION DIFFUSION 9**

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.

**UNIT-IV: FLOW FIELD ANALYSIS 9**

Finite volume methods -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms.

**UNIT- V: TURBULENCE MODELS AND MESH GENERATION 9**

Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon the completion of this course the students will be able to:

- Derive the governing equations and boundary conditions for Fluid dynamics
- Analyze Finite difference and Finite volume methods for Diffusion
- Analyze Finite volume method for Convective diffusion
- Analyze Flow field problems.
- Explain and solve the Turbulence models and Mesh generation techniques

**TEXT BOOKS:**

1. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 2017.

2. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Pearson Education Ltd.Second Edition, 2007.

**REFERENCE BOOKS:**

1. Anil W. Date "Introduction to Computational Fluid Dynamics" Cambridge University Press, 2005.
2. Chung, T.J. "Computational Fluid Dynamics", Cambridge University, Press, 2002.
3. Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005
4. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2014.
5. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 2004.

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**1909606 GAS DYNAMICS AND SPACE PROPULSION**

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**(Use of Gas tables and psychrometric chart is permitted)**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students:

- To understand the fundamental concepts of compressible flow and the use of gas tables.
- To know the concepts of compressible flow behaviour in constant area ducts.
- To gain knowledge in the development of shock waves and its effects.
- To understand the types of jet engines and their performance parameters.
- To understand the types of rocket engines and their performance parameters.

**UNIT-I: BASIC CONCEPTS AND ISENTROPIC FLOWS 9**

Energy and momentum equations of compressible fluid flows, Concepts of compressible flow – Mach waves and Mach cone. Flow regimes, effect of Mach number on compressibility. Stagnation, static, critical properties and their interrelationship. Isentropic flow and its relations. Isentropic flow through variable area ducts – nozzles and diffusers. Use of Gas tables.

**UNIT-II: COMPRESSIBLE FLOW THROUGH DUCTS 9**

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties. Choking. Isothermal flow with friction. Use of Gas tables

**UNIT-III: NORMAL AND OBLIQUE SHOCKS 9**

Governing equations - Rankine-Hugoniot Relation. Variation of flow parameters across the normal and oblique shocks. Prandtl – Meyer expansion and relation. Use of Gas tables.

**UNIT-IV: JET PROPULSION 9**

Theory of jet propulsion – thrust equation – Performance parameters - thrust, power and efficiency. Operation, cycle analysis and performance of ram jet, turbojet, turbofan, turboprop and pulse jet engines.

**UNIT-V: SPACE PROPULSION 9**

Types of rocket engines and propellants. Characteristic velocity – thrust equation. Theory of single and multistage rocket propulsion. Liquid fuel feeding systems. Solid propellant geometries. Orbital and escape velocity. Rocket performance calculations.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Explain the fundamentals of compressible flow concepts to the nozzle and diffuser making use of gas tables.
- Illustrate the compressible flow behaviour in constant area ducts involving with friction and heat transfer.
- Analyze the development of shock waves and its effects on the properties of the fluids.

- Differentiate the types of jet engines and their performance parameters were calculated.
- Explain type of rocket engines and their performance parameters are studied.

**TEXTBOOKS:**

1. V. Ganesan, “GasTurbines” 3rd Edition, McGraw Hill, 2017
2. S.M. Yahya, “Fundamentals of Compressible Flow with Aircraft and Rocket propulsion”, New Age International (P) Limited, 3rd Edition, 2017.

**REFERENCE BOOKS:**

1. R. D. Zucker and O Biblarz, “Fundamentals of Gas Dynamics”, 3rd Edition, Wiley, 2019.
2. Balachandran, P., “Fundamentals of Compressible Fluid Dynamics”, Prentice-Hall of India, 2007.
3. Radhakrishnan, E., “Gas Dynamics”, 6th Edition, Printice Hall of India, 2017.
4. Babu, V., “Fundamentals of Compressible Flow”, CRC Press, 2nd Edition, 2014.
5. Anderson, J.D., “Modern Compressible flow”, 3rd Edition, McGraw Hill, 2017.

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**1909607 REFRIGERATION AND AIR CONDITIONING L P T C**

**3 0 0 3**

**(Steam and Refrigeration table with Psychrometric Chart is permitted in University Examination)**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students:

- To understand the underlying principles of operations in different Refrigeration & Air conditioning systems and components.
- To provide knowledge on Vapour compression Refrigeration systems and to solve problems
- To understand the concept of various refrigeration system
- To improvise knowledge on use of Psychrometric properties and its use in psychrometric processes
- To understand the thought on load calculation on air conditioning.

**UNIT –I: INTRODUCTION 9**

Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification - Nomenclature - ODP & GWP.

**UNIT- II: VAPOUR COMPRESSION REFRIGERATION SYSTEM 9**

Vapour compression cycle: p-h and T-s diagrams - deviations from theoretical cycle – sub cooling and super heating- effects of condenser and evaporator pressure on COP- multipressure system - low temperature refrigeration - Cascade systems – problems. Equipment’s: Type of Compressors, Condensers, Expansion devices, Evaporators.

**UNIT- III: OTHER REFRIGERATION SYSTEMS 9**

Working principles of Vapour absorption systems and adsorption cooling systems – Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration - Magnetic - Vortex and Pulse tube refrigeration systems.

**UNIT- IV: PSYCHROMETRIC PROPERTIES AND PROCESSES 9**

Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature

Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.

**UNIT- V: AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION 9**

Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system; Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators & Safety controls.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon the completion of this course the students will be able to:

- Explain the basic concepts of Refrigeration
- Explain the Vapour compression Refrigeration systems and to solve problems
- Discuss the various types of Refrigeration systems
- Calculate the Psychrometric properties and its use in psychrometric processes
- Explain the concept of air conditioning and to solve problems.

**TEXT BOOKS:**

1. Arora, C.P, “Refrigeration and Air Conditioning”, 3rd edition, McGraw Hill, New Delhi, 2010.
2. R.S.Khurmi and J.K.Gupta, “A text of Refrigeration and Air conditioning”, S. Chand Publisher, 1987.

**REFERENCE BOOKS:**

1. ASHRAE Hand book, Fundamentals, 2010.
2. Jones W.P., “Air conditioning engineering”, 5th edition, Elsevier Butterworth-Heinemann, 2007.
3. Roy J.Dossat, “Principles of Refrigeration”, 4th Edition, Pearson Education Asia, 2009.
4. Stpecler. W.F. and Jones J. W., “Refrigeration and Air conditioning”, McGraw Hill, New Delhi, 1986.

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| 1909608 | POWER PLANT ENGINEERING | L | T | P | C |
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**OBJECTIVE:**

The main learning objective of this course is to prepare the students:

- To understand the construction and working of the components inside a thermal power plant.
- To improvise knowledge on working of the components inside a Diesel, Gas and Combined cycle power plants.
- To study about the construction and working of the components of nuclear power plants.
- To comprehend about the working of the components inside Renewable energy power plants.
- To be familiar with the applications of power plants while extend their knowledge to power plant economics and environmental hazards and estimate the costs of electrical energy production.

**UNIT- I: COAL BASED THERMAL POWER PLANTS 9**

Rankine cycle - improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.

**UNIT- II: DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS 9**

Otto, Diesel, Dual & Brayton Cycle - Analysis & Optimisation. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

**UNIT –III: NUCLEAR POWER PLANTS 9**

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

**UNIT- IV: POWER FROM RENEWABLE ENERGY 9**

Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.

**UNIT- V: ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS 9**

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon the completion of this course the students will be able to:

- Explain the layout, construction and working of the components inside a thermal power plant.
- Explain the layout, construction and working of the components inside a Diesel, Gas and Combined cycle power plants.
- Explain the layout, construction and working of the components inside nuclear power plants.
- Explain the layout, construction and working of the components inside Renewable energy power plants.
- Explain the applications of power plants while extend their knowledge to power plant economics and environmental hazards and estimate the costs of electrical energy production.

**TEXT BOOKS:**

1. Nag. P.K., "Power Plant Engineering", Third Edition, Tata McGraw – Hill Publishing Company Ltd., 2008.

2. Er.R.K. RaJput, “A Text Book of Power Plant Engineering”, 5th Edition, Laxmi Publications Pvt. Ltd., 2014.

**REFERENCE BOOKS:**

1. El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.
2. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.
3. Thomas C. Elliott, Kao Chen and Robert C. Swanekam.P, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw – Hill, 1998.

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**SEMESTER- VII, ELECTIVE- IV, [Automotive & Design Engineering - Domain]**

**1909704 GEOMETRIC DIMENSIONING AND TOLERANCING**

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**OBJECTIVES:**

The main learning objective of this course is to prepare the students to:

- Impart the knowledge on geometric dimensioning and run out tolerance symbols.
- Understand the application of datum's to appropriate surfaces.
- Gaining knowledge on form tolerances and limits.
- Learn about the orientation and profile tolerances.
- Gaining knowledge on location and run out tolerances.

**UNIT -I: INTRODUCTION 9**

Introduction to GD&T, Terminology & Basic Rules, Features and Rules of GD&T- Introduction to Features and Material Conditions- Maximum Material Condition- Least Material Condition, Basics of Functional Gauging, Introduction-Concept of production drawing

**UNIT -II: DATUMS CONTROL 9**

Introduction to Datums- The Datum Reference Frame- Primary Datum Controls, Introduction to MMB, Adding GD&T to a Drawing/Design: The Feature Control Frame, SLOF for Drawings (Size, Location, Orientation & Form)

**UNIT -III: FORM TOLERANCES 9**

Straightness (Surface), Straightness (Median Line/MMC) – Flatness (Surface), Flatness (Median Plane/MMC) – Circularity- Cylindricity

**UNIT -IV: ORIENTATION AND PROFILE TOLERANCES 9**

Orientation Tolerance: Parallelism (Surface), Parallelism (Axis), Perpendicularity (Surface), Perpendicularity (Axis), Angularity (Surface and Axis) Profile Tolerances: Profile of a Surface – Basics, Profile (Modifiers and More Examples), Profile of a Line

**UNIT –V: LOCATION AND RUNOUT TOLERANCES 9**

Location Tolerance: True Position –Basics, True Position vs Coordinate Dimensions, Concentricity, Symmetry Runout Tolerances: Runout/Circular Runout, Total Runout.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to:

- Apply Geometric Dimensioning and Tolerancing symbols on drawings.
- Summarize the similarities and differences between coordinate and geometric dimensioning and tolerancing.
- Analysis the three-plane concept and application of datum to appropriate surfaces.
- Apply tolerances of orientation and profile in required modules.
- Find out the location tolerances and tolerances of run out.

**TEXT BOOKS:**


1. Alex Krulikowski, Fundamentals of Geometric Dimensioning and Tolerancing, as per ANSI/ASME Y14.5M-2009, Author: Publisher: Delmar Learning, Third edition, 2012.
2. James D Meadows, Geometric Dimensioning and Tolerancing: Applications and Techniques for Use in Design Manufacturing and Inspection, T&F India, ISBN-10: 9781138049277, 2017.


**REFERENCE BOOKS:**


1. Ashok Kumar, Simplified GD&T: Based on ASME-Y 14.5, Kindle Edition, 2009
2. P.S. Gill, Geometric Dimensioning and Tolerancing, K. Kataria & Sons; 2013 edition, ISBN-10: 935014378X, ISBN-13: 978-9350143780, 2013.
3. Dimensioning and Tolerancing ASME Y14.5, Publisher: ASME, ISBN: 9780791831922, Publish Date: 2009.
4. Alex Krulikowski, Fundamentals of Geometric Dimensioning and Tolerancing Using Critical Thinking Skills, 2012.


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**1909705 DESIGN OF JIGS, FIXTURES AND PRESS TOOLS**

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**OBJECTIVES:**

The main learning objective of this course is to prepare the students:

- To understand the functions and design principles of Jigs, fixtures and press tools
- To gain proficiency in the development of design of jigs and fixtures
- To improvise knowledge on press working terminologies and elements of cutting dies
- To understand the concept of bending and drawing dies
- To learn the design concept of various types of forming techniques

**UNIT- I: LOCATING AND CLAMPING PRINCIPLES 9**

Objectives of tool design- Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Redundant Location – Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used.

**UNIT- II: JIGS AND FIXTURES 9**

Design and development of jigs and fixtures for given component- Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems- Quick change fixtures.

**UNIT- III: PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES 9**

Press Working Terminologies - operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Center of pressure- Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts – Design and preparation of four standard views of simple blanking, piercing, compound and progressive dies.

**UNIT- IV: BENDING AND DRAWING DIES 9**

Difference between bending and drawing – Blank development for above operations – Types of

Bending dies – Press capacity – Spring back – knockouts – direct and indirect – pressure pads – Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads-ironing – Design and development of bending, forming, drawing, reverse redrawing and combination dies – Blank development for axisymmetric, rectangular and elliptic parts – Single and double action dies.

**UNIT- V: FORMING TECHNIQUES AND EVALUATION 9**

Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies – recent trends in tool design- computer Aids for sheet metal forming Analysis – basic introduction - tooling for numerically controlled machines- setup reduction for work holding – Single minute exchange of dies – Poka Yoke

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon the completion of this course the students will be able to:

- Summarize the different methods of Locating Jigs and Fixtures and Clamping principles
- Design and develop jigs and fixtures for given component
- Develop the press working terminologies and elements of cutting dies
- Distinguish between Bending and Drawing dies.
- Impart the ideas and identify the different types of forming techniques.

**TEXT BOOKS:**

1. Joshi, P.H. “Jigs and Fixtures”, Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2010.
2. Joshi P.H “Press tools - Design and Construction”, S.Chand Publisher, 2010..

**REFERENCE BOOKS:**

1. ASTME Fundamentals of Tool Design Prentice Hall of India.
2. Design Data Hand Book, PSG College of Technology, Coimbatore.
3. Donaldson, Lecain and Goold “Tool Design”, 5$^{th}$ Edition, Tata McGraw Hill, 2017.
4. Hoffman “Jigs and Fixture Design”, Thomson Delmar Learning, Singapore, 2004.
5. Kempster, “Jigs and Fixture Design”, Third Edition, Hoddes and Stoughton, 1974.
6. Venkataraman. K., “Design of Jigs Fixtures & Press Tools”, Tata McGraw Hill, New Delhi, 2005.

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| 1909706 | HYDRAULICS AND PNEUMATICS | L | T | P | C |
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**OBJECTIVES:**

- To impart knowledge about the elements and techniques involved in fluid power principles and hydraulic pumps which are very much essential to understand the hydraulics.
- To gather adequate knowledge of hydraulic actuators and control components from the mechanical engineering context.
- To know the architecture and application of hydraulic circuits and systems.
- To handle the construction and function of pneumatic and electro pneumatic systems
- To learn how to trouble shoot the hydraulic and pneumatic components and apply them in practice.

**UNIT-I: FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS 9**

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

**UNIT-II: HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9**

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

**UNIT-III: HYDRAULIC CIRCUITS AND SYSTEMS 9**

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double-Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

**UNIT-IV: PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9**

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

**UNIT-V: TROUBLE SHOOTING AND APPLICATIONS 9**

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of Pneumatic and Hydraulic circuits for Industrial Machine Tools – Low cost Automation – Hydraulic and Pneumatic power packs. Case Studies of industrial applications.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Apply the real life applications of fluid power and operation of different types of hydraulic pumps.
- Discuss the of hydraulic actuators and control components from the mechanical engineering context.
- Handle the architecture and application of hydraulic circuits and systems.
- Narrate the construction and function of Pneumatic and electro pneumatic systems.
- Comfortably trouble shoot the hydraulic and pneumatic components and apply them in practice

**TEXT BOOKS:**

1. Anthony Esposito, “Fluid Power with Applications”, Pearson Education 2012.
2. Majumdar S.R., “Oil Hydraulics Systems- Principles and Maintenance”, Tata McGraw-Hill, 2010.

**REFERENCE BOOKS:**

1. Anthony Lal, “Oil hydraulics in the service of industry”, Allied publishers, 2010.
2. Dudelyt, A. Pease and John T. Pippenger, “Basic Fluid Power”, Prentice Hall, 2015.
3. Shanmugasundaram.K, “Hydraulic and Pneumatic controls”, Chand & Co, 2006.

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**1909707** **AUTOMOBILE ENGINEERING** **L T P C**

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**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Explaining various types of automobiles, their power packs and types of vehicle bodies.
- Analysing the various fuel supply and management systems.
- Analysing the various types of transmission systems for a vehicle.
- Analysing the working parameters of various braking and suspension system in a vehicle.
- Analysing the working parameters of various electrical and electronic devices in a vehicle

**UNIT -I: VEHICLE STRUCTURE AND ENGINES 9**

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines –components-functions and materials, variable valve timing (VVT).

**UNIT -II: ENGINE AUXILIARY SYSTEMS 9**

Electronically controlled gasoline injection system for SI engines, electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system, Emission norms (Euro and BS).

**UNIT -III: TRANSMISSION SYSTEMS 9**

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

**UNIT -IV: STEERING, BRAKES AND SUSPENSION SYSTEMS 9**

Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction Control.

**UNIT -V: ELECTRICAL AND ELECTRONIC SYSTEMS 9**

Introduction to Battery, Alternator, and Starter Motor systems, working principle, and circuitry, Safety systems - seat belts, air-bag, ABS, Modern electronic features in vehicles like tyre pressure monitoring, ESP, EBD, Automatic headlamp ON, Rain sensing wipers, speed sensing auto locking, OBD. HVAC system.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to:

- Analyze the various types of automobiles, their power packs and types of vehicle bodies.
- Apply the various types of power train and fuel supply and management systems in real time automotive.

- Analyze the various types of transmission systems for a vehicle.
- Compute the working parameters of various braking and suspension system in a vehicle.
- Analyze the working parameters of various electrical and electronic devices in a vehicle.

**TEXT BOOKS:**

1. Jack Erjavek, “Automotive Technology – A Systems Approach”, Thomson Learning, 3rd Edition, 2012.
2. William H. Crouse and Donald L. Anglin, “Automotive Mechanics”, Tata McGraw Hill, 10th Edition, 2004.

**REFERENCE BOOKS:**

1. Gill P.S., “A Textbook of Automobile Engineering – Vol. I , II and III”, S.K.Kataria and Sons, 2nd Edition, 2012.
2. Kirpal Singh, Automobile Engineering Volume I and II, Standard Publishers &Distributors, 14th Edition, 2017.
3. Kumar D.S., “Automobile Engineering”, S.K.Kataria and Sons, 2nd Edition, 2017.
4. Robert Bosch Gmbh, “Automotive Handbook”, Robert Bosch, 2004.

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| 1909708 | ALTERNATIVE FUELS & EMISSION CONTROL FOR AUTOMOBILE | L | T | P | C |
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**OBJECTIVE:**

The main learning objective of this course is to prepare the students:

- To understand the concept of various emissions from SI engine and control techniques
- To improvise knowledge on various emissions from CI engine and control techniques
- To impart knowledge on use of emission measuring instruments and test procedures
- To study about the concept of various alcohol and gaseous fuels and their use in SI and CI engines
- To understand the concept of using various vegetable oils (Biodiesel) and their use in CI engines

**.UNIT- I: EMISSIONS FROM SI ENGINES AND THEIR CONTROL 9**

Introduction to SI Engine Combustion, Pollutants – sources – formation (CO, HC, NOx and lead) – Effect of design and operating variables on emission formation, Effects of pollution on environment, human – Regulated & Unregulated emissions - Emission Standards -controlling of emission formation in engines, thermal reactors, catalytic converters, charcoal canister control for evaporative emission, positive crankcase ventilation system, nanoparticles - Introduction to noise pollution.

**UNIT - II: EMISSIONS FROM CI ENGINES AND THEIR CONTROL 9**

Introduction to CI Engine Combustion, Emission formation in CI Engines (HC, CO, NOx, aldehydes, smoke and particulates) - Physical and Chemical delay - Effects of design and operating variables on emission formation – Control techniques, Fumigation, EGR, HCCI,RCCI, NOx SCR, diesel oxidation catalytic converter, DPF, NOx versus particulates trade off, Secondary air injection, thermal reactor, Cetane number effect, NOx Adsorber, Laser Assisted Combustion.

**UNIT - III: EMISSION MEASUREMENT AND TEST PROCEDURES 9**

Principle of operation of emission measuring instruments used in SI and CI engines, Non Dispersive Infra-Red, Flame Ionization Detector , Chemiluminescent analyzer, Liquid and Gas Chromatography, Spot sampling and continuous indication type smoke meters (Bosch,AVL and Hartridge smoke meters), Emission norms - EPA, CARB, Euro and Bharat norms, Emission Test Procedures - FTP, Steady State, Constant volume sampling (CVS 1 & 3),Chassis dyno - seven mode and thirteen mode cycles for emission sampling, Dilution tunnel, Sealed Housing for

Evaporative Determination (SHED) test, Sound level meters.

**UNIT - IV: ALCOHOL FUELS AND GASEOUS FUELS 9**

Properties of alcohols, alcohol - gasoline blends, flexible fuel vehicle, methanol reformed gas engine, dual fuel system, spark assisted diesel engine, surface ignition engine, ignition accelerators, oxygenated additives, Engine modifications, Performance, Combustion and Emission characteristics in SI and CI engines. Properties of hydrogen, production and storage methods, safety precautions, biogas production and its properties, CO2 and H2S scrubbing in Biogas, Properties of LPG and CNG, use, Performance, Combustion and Emission characteristics of H2, LPG, CNG and biogas in SI and CI engines.

**UNIT - V: VEGETABLE OILS 9**

Various vegetable oils for diesel engines, structure and properties, Problems in using vegetable oils in diesel engines, Methods to improve the engine performance using vegetable oils - Preheating, Transesterification, Emulsification, Blending with good secondary fuels, Production technologies for biofuels for internal combustion engines - pyrolysis, gasification, liquefaction - Semi-adiabatic engine, surface ignition engine, ignition accelerators, dual fueling with gaseous and liquid fuels, Performance in engines – Performance, Emission and Combustion characteristics in diesel engines. Role of Nanofluids, additives and cetane improvers for performance improvement of vegetable oils as fuel.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to:

- Analyse the formation of various emissions from SI engine and control techniques
- Analyse the formation of various emissions from CI engine and control techniques.
- Develop the test procedures and use of emission measuring instruments.
- Explain about various alcohol and gaseous fuels and their use in SI and CI engines
- Formulate and identify the various vegetable oils (Biodiesel) and their use in CI engines.

**TEXT BOOKS:**

1. B.P.Pundir, IC Engines Combustion and Emissions, Narosa Publishers, 2010.
2. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers, 1997 ISBN 0-76-80-0052-1.

**REFERENCE BOOKS:**


1. Ganesan, V., Internal Combustion Engines, Tata McGraw Hill Co., 2013.
2. Ayhan Demirbas, Biodiesel A Realistic Fuel Alternative for Diesel Engines, Springer-Verlag London Limited 2008,ISBN-13: 9781846289941.
3. Heywood,J.B., Internal Combustion Engine Fundamentals, McGraw Hill Book Co., 1995.
4. Crouse.W.M. and Anglin.A.L., Automotive Emission Control, McGraw Hill, 1995.
5. Dr. S.S Thipse, Alternative Fuels, Jaico Publications, 2010.


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**SEMESTER -VII, ELECTIVE- V, [Materials and Automation Engineering - Domain]**

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| **1909709** | **NON DESTRUCTIVE TESTING AND EVALUATION** | **L** | **T** | **P** | **C** |
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**OBJECTIVES:**

The main learning objective of this course is to prepare the students:

- To study and understand the various Non Destructive Evaluation and Testing methods, theory and their industrial applications.
- To understand the concept of different methods of NDE such as liquid penetrant testing and Magnetic particle testing methods
- To improvise knowledge of Thermography and eddy current testing methods.
- To study about the concept of ultrasonic testing and acoustic emission techniques.
- To study about the testing methods of Radiography

**UNIT - I: OVERVIEW OF NDT** **9**

NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT. Visual inspection – Unaided and aided.

**UNIT - II: SURFACE NDE METHODS** **9**

Liquid penetrant Testing-Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

**UNIT- III: THERMOGRAPHY AND EDDY CURRENT TESTING (ET)** **9**

Thermography- Principles, Contact and non-contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

**UNIT- IV: ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE) 9**

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique – Principle, AE parameters, Applications

**UNIT - V: RADIOGRAPHY (RT) 9**

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to:

- Explain the fundamental concepts of NDT and its applications
- Discuss the different methods of NDE.
- Explain the concept of Thermography and Eddy current testing.
- Illustrate the concept of Ultrasonic Testing and Acoustic Emission
- Analysis the concept of Radiography.

**TEXT BOOKS:**

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2014.
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010.

**REFERENCE BOOKS:**

1. ASM Metals Handbook,"Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing
3. Charles, J. Hellier," Handbook of Non-destructive evaluation", McGraw Hill, New York 2001.

4. Paul E Mix, “Introduction to Non-destructive testing: a training guide”, Wiley, 2nd Edition New Jersey, 2005.

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**1909710** **COMPOSITE MATERIALS AND MECHANICS** **L T P C**

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**OBJECTIVES:**

The main learning objective of this course is to prepare the students:

- To understand the fundamentals of composite material strength and its mechanical behavior.
- To understand the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
- To Thermo-mechanical behavior and study of residual stresses in Laminates during processing.
- To Implement of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.
- To study the concept of thermal analysis in laminates.

**UNIT- I: INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS & MANUFACTURING** **9**

Definition –Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic and

Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina –Transformation Matrix, Transformed Stiffness. Manufacturing: Bag Moulding Compression Moulding – Pultrusion – Filament Winding – Low density materials-Automobile, Aerospace and Marine applications

**UNIT- II: FLAT PLATE LAMINATE CONSTITUTE EQUATIONS 9**

Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates

**UNIT- III: LAMINA STRENGTH ANALYSIS 9**

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure.

**UNIT- IV: THERMAL ANALYSIS 9**

Assumption of Constant C.T.E's. Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E's. C.T.E's for special Laminate Configurations – Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates.

**UNIT - V: ANALYSIS OF LAMINATED FLAT PLATES 9**

Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to:

- Summarize the various types of Fibers - Equations and manufacturing methods for Composite materials

- Derivation of Flat plate Laminate equations and determination of lamina stresses within laminates.
- Analysis the thermo- mechanical behaviour and residual stresses.
- Explain the types of failure in Composite laminates.
- Analyze Thermal analysis of Laminates.

**TEXT BOOKS:**

1. Gibson, R.F., "Principles of Composite Material Mechanics", 4th Edition, McGraw-Hill, CRC press in progress, 2016.
2. Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw Hill, 2009.

**REFERENCE BOOKS:**

1. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1998.
2. Halpin, J.C., "Primer on Composite Materials, Analysis", Technomic Publishing Co., 1984.
3. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press-2006, First Indian Edition - 2007
4. Mallick, P.K., Fiber, "Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc, 1993.

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| **2** | 2 | | 2 | | | 2 | | 2 | | 2 | | 1 | | 1 | | 2 |
| **3** | 3 | 1 | | 2 | | 2 | | | 1 | | 1 | | | 2 | | |
| **4** | 2 | 1 | | | 3 | | 2 | | 2 | | 1 | | 1 | | 2 | |
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| 1909711 | SURFACE ENGINEERING | L | T | P | C |
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**OBJECTIVES:**

The main learning objective of this course is to prepare the students:

- To understand the concept of various welding processes in surface finishing.
- To study about the techniques used for thermal spray processes in surface finishing.
- To comprehend the various plating processes in surface finishing.
- To improvise knowledge on various diffusion processes in surface finishing.
- To understand the concept of various recent processes in surface finishing.

**UNIT- I: WELDING ASSISTED PROCESSES 9**

Hard facing, Cladding, Overlaying by Shielded metal arc welding, flux cored arc welding, submerged arc welding, gas tungsten arc welding, plasma transferred arc welding, laser beam welding techniques, consumables for weld surfacing, dilution measurement, microstructural features, Friction surfacing processes.

**UNIT - II: THERMAL SPRAY TECHNIQUES 9**

Principles, Process Parameters, Coating Properties and Applications of: Flame Spraying (FS) - Spray and Fuse Coating (S&F) - Detonation-Gun Spraying (D-GUN) - High-Velocity Oxy-Fuel (HVOF) Spraying, High Velocity Air Fuel Spraying (HVAF), Arc Spraying (AS) -Atmospheric Plasma Spraying (APS) - Vacuum Plasma Spraying (VPS) - Cold-Gas Spraying Method (CGSM) - Electro Spark Coating (ESC).

**UNIT - III: PLATING PROCESSES 9**

Fundamentals of Electro deposition, plating of nickel, chromium, tin and copper – pulsed plating – electroless plating - electrochemical conversion coating, metallizing, selective plating for repair, Hard anodizing.

**UNIT- IV: DIFFUSION PROCESSES 9**

Principle of diffusion processes - Boriding, Aluminising, Siliconizing, Chromising, Sursulf - Selection of diffusion processes - Characteristics of diffused layer - micro structure and micro hardness evaluation - properties and applications.

**UNIT - V: ALLIED PROCESSES** **9**

Laser beam hardening, glazing, Laser Surface Melting, Laser Surface alloying, Laser Cladding, Electron beam hardening, Physical vapor deposition, Thermal evaporation, Arc vaporization, Sputtering, Ion plating - Chemical vapor deposition – Properties and applications of thin coatings.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On successful completion of the course the student will be able to:

- Explain the various welding processes in surface finishing.
- Understood the various thermal spraying processes in surface finishing.
- Explain the various plating processes in surface finishing
- Illustrate the various diffusion processes in surface finishing
- Explain the various recent processes in surface finishing

**TEXT BOOKS:**

1. Kenneth G.Budinski, Prentice Hall, Englewood Cliff, Surface Engineering for Wear Resistance,2000.
2. Ohio, Surface Engineering, ASM Metals Handbook", 2004.

**REFERENCE BOOKS:**

1. Emest Rabinowicz, Friction and Wear of Materials, John Wiley & Sons, New York,2004.
2. R.S. Parmar, Welding technology and processes, Khanna publishers, New Delhi,2006.
3. Lech Pawlowski, Science and Engineering of Thermal Spray Coatings, Springer Verlag Publications, Berlin, 2005.

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**1909712 MECHANICAL BEHAVIOUR OF MATERIALS**

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**OBJECTIVES:**

The main learning objective of this course is to prepare the students to:

- Understand the concept of concepts of stress, strain and mechanical properties of materials
- Improvise knowledge on various types of defects, slips and dislocations in crystal structures
- Comprehend knowledge on various strengthening mechanisms of materials
- Study about different types of fractures and application of facture mechanics in the design of ceramics, polymers and metals
- Understand the concept of fatigue in ceramics, polymers, metals, creep and stress rupture in materials

**UNIT- I: CONCEPT OF STRESSES AND STRAINS 9**

Concept of stresses and strains, Engineering stresses and strains, Different types of loading and temperature encountered in applications, Tensile Test- stress-strain response for metal, Ceramic and polymer, Elastic region, Yield criteria, Yield point, Plastic deformation, Necking and fracture, Bonding and Material Behaviour; Theoretical estimates of yield strength in metals and ceramics, Mechanical properties of materials in small dimensions-Nano indentation.

**UNIT- II: CRYSTALS AND DEFECTS 9**

Crystals and defects, Classification of defects, thermodynamics of defects, Geometry of dislocations, Concepts of plastic deformation by slip and twinning, Slip systems in FCC, BCC and HCP lattices, Critical resolved shear stress for slip, Theoretical shear strength of solids, Stacking faults and deformation bands; Observation of dislocations, Climb and cross slip, Dislocations in FCC and HCP lattice, Partial dislocations, Stress fields and energies of dislocations, Forces between dislocations, Interaction of dislocations, Dislocation sources and their multiplications, Frank Reed and grain boundary sources, dislocations in ceramics and glasses.

**UNIT- III: STRENGTHENING** **9**

Strengthening from grain boundaries, Grain size measurements, Yield point phenomenon, Strain aging, Solid solution strengthening, strengthening from fine particles, Fiber strengthening, Cold working and strain hardening, Annealing of cold worked metal.

**UNIT- IV: FRACTURE** **9**

Fracture in ceramics, Polymers and metals, Different types of fractures in metals, Fracture mechanics - linear fracture mechanics- KIC, elasto-plastic fracture mechanics- JIC, Measurement and ASTM standards, Design based on fracture mechanics, Effect of environment, Effect of microstructure on KIC and JIC, Application of fracture mechanics in the design of metals, ceramics and polymers.

**UNIT - V: FATIGUE AND CREEP CURVE** **9**

S-N curves, Low and high cycle fatigue, Life cycle prediction, Fatigue in metals, ceramics
And polymers; Effect of stress concentration on fatigue, Size effect, Surface effects and fatigue, Creep and stress rupture, Creep curve, Stress rupture test, Mechanism of creep deformation, Activation energy for steady state creep, Super plasticity, Fracture at elevated temperature, Creep resistant alloys, Creep under combined stresses.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to:

- Explain basic concepts of stress, strain and mechanical properties of materials
- Describe various types of defects, slips and dislocations in crystal structures
- Explain various strengthening mechanisms of materials
- Explain different types of fractures and application of facture mechanics in the design of ceramics, polymers and metals
- Explain fatigue in ceramics, polymers, metals, creep and stress rupture in materials

**TEXT BOOKS:**


1. G.E. Dieter, Mechanical Metallurgy, 2nd edition., McGraw-Hill, 1989.
2. R.W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, John Wiley & Sons, 1989.
3. J. Roesler, H. Harders, M. Baeker, Mechanical Behavior of Engineering Materials: Metals, Ceramics, Polymers, and Composites, Springer-Verlag, 2007.

**REFERENCE BOOKS:**


1. T. H. Courtney, Mechanical Behavior of Materials, McGraw-Hill, 1990.
2. R. Hill, E. Robert, Physical Metallurgy Principles, 2nd ed., East West Press, 1972.
3. W.M. Hyden, W.G.Moffatt, Structure and Properties of Materials, Vol. 3, McGraw Hill
4. M.A. Meyers, K.K. Chawla, Mechanical Behavior of Materials, 2nd ed., Cambridge University Press, 2009.
5. W.F. Hosford, Mechanical Behavior of Materials, Cambridge University Press, 2005.
6. R.W.K. Honeycombe, Plastic deformation of Metals, 2nd ed., Edward Arnold Press,1984.


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| **3** | 1 | | | | 1 | | 1 | | | 2 | | | | 2 | | 2 |
| **4** | 3 | 1 | | 2 | | | 2 | | 2 | | 1 | | 2 | | | 1 |
| **5** | 2 | | 1 | | | 1 | | 2 | | 2 | | 1 | | 1 | | 2 |

**1909713** **INDUSTRIAL ROBOTICS TECHNOLOGY** **L T P C**

**3 0 0 3**

**OBJECTIVES**:

The main learning objective of this course is to prepare the students for:

- Explaining the concepts of industrial robots with respect to its classification, specifications and coordinate systems. Reviewing the need and application of robots in different engineering fields.
- Exemplifying the different types of robot drive systems as well as robot end effectors.
- Applying the different sensors and image processing techniques in robotics to improve the ability of robots.
- Developing robotic programs for different tasks and analyzing the kinematics motions of robot.
- Implementing robots in various industrial sectors and interpolating the economic analysis of robots.

**UNIT- I: FUNDAMENTALS OF ROBOT** **9**

Robot - Definition - Robot Anatomy – Co-ordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions-Need for Robots-Different Applications.

**UNIT- II: ROBOT DRIVE SYSTEMS AND END EFFECTORS** **9**

Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

**UNIT- III: SENSORS AND MACHINE VISION** **9**

Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors ,binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications, Inspection, Identification, Visual Serving and Navigation.

**UNIT - IV: ROBOT KINEMATICS AND ROBOT PROGRAMMING** **9**

Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Expert system, Manipulator Mechanism Design-Derivations and problems. Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effector commands and simple Programs.

**UNIT - V: IMPLEMENTATION AND ROBOT ECONOMICS** **9**

RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots. **TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Explain the concepts of industrial robots with respect to its classification, specifications and coordinate systems. Review the need and application of robots in different engineering fields.
- Exemplify the different types of robot drive systems as well as robot end effectors.
- Apply the different sensors and image processing techniques in robotics to improve the ability of robots.
- Develop robotic programs for different tasks and analyze the kinematics motions of robot.
- Implement robots in various industrial sectors and interpolate the economic analysis of robots.

**TEXT BOOKS:**

1. Fu. K.S, Gonzalez. R.C, Lee. C.S.G "Robotics – Control, Sensing, Vision, and Intelligence", McGraw Hill, 2015.

2. Groover Mikell .P, "Industrial Robotics -Technology Programming and Applications", McGraw Hill, 2014.

**REFERENCES BOOKS:**

1. Craig J.J., "Introduction to Robotics Mechanics and Control", Pearson Education, 2009.

2. Deb S.R., "Robotics Technology and Flexible Automation" Tata McGraw Hill Book Co., 2013.

3. Koren Y., "Robotics for Engineers", McGraw Hill Book Co., 1992

4. Maja J Mataric, "The Robotics Primer "Universities Press. 2013.

5. Robin R. Murphy "Introduction to AI Robotics" PHI Learning Private Limited, 2000.

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| **2** | 3 | - | 2 | 2 | - | - | - | - | - | - | - | - | 3 | - | 2 | 1 |
| **3** | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 3 | 2 | 3 | 1 |
| **4** | 3 | - | 2 | 3 | - | - | - | - | - | - | - | - | 3 | 3 | 3 | 1 |
| **5** | 3 | - | 3 | 3 | - | - | - | - | - | - | - | - | 3 | 3 | 3 | 1 |

**1920001 FUNDAMENTALS OF NANOSCIENCE L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To learn about basis of nanomaterials and their properties.
- To learn the general preparation techniques of nanomaterials.
- To make the students learn the different synthesis techniques of nanomaterials.
- To explore various characterization techniques.
- To elucidate the different applications of nanomaterials.

**UNIT- I: INTRODUCTION 9**

Nano scale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering- Classifications of nano structured materials- nano particles- quantum dots, nano wires-ultra-thinfilms- multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

**UNIT- II: GENERAL METHODSOF PREPARATION 9**

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

**UNIT- III: NANOMATERIALS 9**

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO,$TiO_2$,MgO, $ZrO_2$, NiO, nano alumina, Ferrites, Quantum wires, Quantum dots-preparation, properties and applications.

**UNIT- IV: CHARACTERIZATION TECHNIQUES 9**

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA,SIMS-Nano indentation.

**UNIT - V: APPLICATION 9**

Nano InfoTech: Information storage- nano computer, molecular switch, super chip, nano crystal, Nano biotechnology: nano probes in medical diagnostics and biotechnology, Nano medicines, Targeted drug delivery, Bio imaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nano sensors, nano crystalline silver for bacterial inhibition, Nano particles for sun barrier products - In Photostat, printing, solar cell, battery.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to:

- Familiarize about the science of nanomaterials.
- Demonstrate the preparation of nanomaterials.
- Knowledge on different materials and their synthesize technique.
- Develop knowledge in characteristic nanomaterials.
- Learn where and how to apply the various properties of nanomaterials.

**TEXT BOOKS:**

1. A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia,1996.
2. N John Dinardo, "Nanoscale Characterization of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.

**REFERENCE BOOKS:**

1. G Timp, "Nanotechnology", AIP press/Springer, 1999.
2. AkhleshLakhtakia, "The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations". Prentice-Hall of India (P) Ltd, New Delhi, 2007.

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| 2 | 2 | - | 3 | 3 | 3 | - | - | - | - | - | - | 1 | - | - | 2 | - |
| 3 | 2 | - | 3 | 3 | 3 | - | - | - | - | - | - | 1 | - | - | 2 | - |
| 4 | 2 | - | 3 | 3 | 3 | 1 | 1 | - | - | - | - | 1 | - | - | 2 | - |
| 5 | 2 | - | 3 | 3 | 3 | 1 | - | - | - | - | - | 1 | - | - | 2 | - |

**SEMESTER-VIII, ELECTIVE-VI, [Industrial Engineering - Domain]**

**1909802 COMPUTER INTEGRATED MANUFACTURING SYSTEMS L T P C**

**3 0 0 3**

**OBJECTIVES**:

The main objective of this course is to prepare the students:

- To impart the knowledge about CIM & Automation and analyse the Manufacturing process to manufacture the component.
- To understand the application of computers in the production plans and process planning in the shop floor.
- To develop the knowledge to identifying the part families, machine cell design and layout in the manufacturing systems.
- Ability to understand the application of automated guided vehicles in the flexible manufacturing systems.
- To design and develop the Industrial Robots for Industry application in various aspect of manufacturing & Material handling systems.

**UNIT- I: INTRODUCTION 9**

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control-Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerised elements of CIM system – Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.

**UNIT- II: PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING 9**

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II(MRP-II) & Enterprise Resource Planning(ERP)- Simple Problems.

**UNIT- III: CELLULAR MANUFACTURING 9**

Group Technology (GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems.

**UNIT - IV: FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS) 9**

Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control – Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.

**UNIT- V: INDUSTRIAL ROBOTICS 9**

Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students can able to:

- Apply the concept of computer integrated manufacturing and the Manufacturing process to manufacture the mechanical component.
- Apply the Manufacturing knowledge and utilization of computers in Process Planning and gain Confidence in controlling of the production in shop floor.
- Analyse and identify the part families in Cellular Manufacturing system and design the machine layout for the production.
- Convert conventional system to FMS by using the automated guided vehicle to increase the productivity of the industries.
- Design and Select the Industrial Robots for Industry application.

**TEXT BOOKS:**

1. Mikell.P. Groover “Automation, Production Systems and Computer Integrated Manufacturing”, PEARSON, 4th Edition 2016.

2. Kant Vajpayee S., “Principles of Computer Integrated Manufacturing”, Prentice Hall India, 2009.

## REFERENCE BOOKS:

1. Gideon Halevi and Roland Weill, “Principles of Process Planning – A Logical Approach” Chapman& Hall, London, 2$^{nd}$ Edition 2002.
2. Mikell P Groover. & ZIMMERS E., “CAD/CAM – Computer Aided Design and Manufacturing”, PEARSON, 2013.
3. Rao. P. N., Tewari. N. and Kundra. T.K., “Computer Aided Manufacturing”, Tata McGraw Hill Publishing Company, 2000.
4. Radhakrishnan P., Subramanyan S. and Raju V., “CAD/CAM/CIM”, 2$^{nd}$ Edition, New Age International (P) Ltd, New Delhi, 2000.

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| 1909803 | PRODUCTION PLANNING AND CONTROL | L | T | P | C |
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## OBJECTIVES:

The main learning objective of this course is to prepare the students to:

- Understand the production methods and analyse the revenue and loss of the firm.
- Prepare production planning and control activities of the production and work measurement strategies.
- Formulate the capacity and balancing of machines and process capability for multi-product system.

- Understand the various components and functions of production planning and control such as work study, product planning, process planning, production scheduling, Inventory Control.
- Know the recent trends like manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

**UNIT - I: INTRODUCTION 9**

Objectives and benefits of planning and control-Functions of production control-Types of production- job- batch and continuous-Product development and design-Marketing aspect - Functional aspects- Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration- Standardization, Simplification & specialization- Break even analysis-Economics of a new design

**UNIT - II: WORK STUDY 9**

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards

**UNIT- III: PRODUCT PLANNING AND PROCESS PLANNING 9**

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi-product system.

**UNIT- IV: PRODUCTION SCHEDULING 9**

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling- Batch production scheduling-Product sequencing – Production Control systems- Periodic batch control-Material requirement planning Kanban – Dispatching-Progress reporting and expediting- Manufacturing lead time-Techniques for aligning completion times and due dates

**UNIT - V: INVENTORY CONTROL AND RECENT TRENDS IN PPC 9**

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems- elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students able to:

- Formulate the revenue and loss of the firm (BEP) and standardization and simplification for profit consideration.
- Understand the motion study and work measurement of the workers during the manufacturing of the product.
- Prepare the process planning and the route sheet for production of components with effective balancing of machines.
- Ability to solve the scheduling problems and prepare production schedule to completion of product in time.
- Develop and plan for manufacturing requirements, manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

**TEXT BOOKS:**


1. James.B. Dilworth, ”Operationsmanagement –Design, Planning and Control for manufacturing and services” McGraw Hill International edition 1992.
2. Martand Telsang, “Industrial Engineering and Production Management”, First editions. Chand and Company, 2000.


**REFERENCE BOOKS:**


1. Chary. S.N., “Theory and Problems in Production & Operations Management”, Tata McGraw Hill, 1995.
2. Elwood S.Buffa, and Rakesh K.Sarin, “Modern Production / Operations Management”, 8th Edition John Wiley and Sons, 2000.
3. Jain. K.C. & Aggarwal. L.N., “Production Planning Control and Industrial Management”, Khanna Publishers, 1990.

4. Kanishka Bedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007.
5. Melynk, Denzler, "Operations management – A value driven approach" Irwin McGraw hill.
6. Norman Gaither, G. Frazier, "Operations Management" 9th Edition, Thomson learning IE, 2007
7. Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn.1984

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**1909804 INDUSTRIAL SAFETY**

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**OBJECTIVES:**

The main learning objective of this course is to prepare the students:

- To understand the basic approaches of the organizations and safety management
- To study the concept of Work design and facility planning
- To comprehend the accident investigation process and accident reports
- To discuss the principles of safety performance monitoring
- To Elaborate the methods of safety education and training (K2: U)

**UNIT- I: BASICS OF SAFETY ENGINEERING & ACTS 9**

Evolution of modern safety concept – Safety audit – Acts: Factories act – 1948 – Statutory authorities – Tamil Nadu factories Rules 1950 under safety and health – Environment act – 1986 – Air act 1981, Water act 1974 – other acts; Safety in industries – General safety concepts, machine guarding, hazards in metal removing process, welding process, cold and hot working process. Introduction to Electrical Acts.

**UNIT- II: SAFETY MANAGEMENT 9**

History of Safety movement –Evolution of modern safety concept - General concepts of management – Planning for safety for optimization of productivity - productivity, quality and safety - line and staff functions for safety - budgeting for safety - safety policy. Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, evaluation of performance of supervisors on safety.

**UNIT- III: ACCIDENT INVESTIGATION AND REPORTING 9**

Concept of an accident, reportable and non-reportable accidents, unsafe act and condition – Principles of accident prevention, Supervisory role - Role of safety committee – Accident causation models - Cost of accident. Overall accident investigation process - Response to accidents, India reporting requirement, Planning document, Planning matrix, Investigators Kit, Functions of investigator, Four types of evidences, Records of accidents, Accident reports - Class exercise with case study.

**UNIT- IV: SAFETY PERFORMANCE MONITORING 9**

Reactive and proactive monitoring techniques - Permanent total disabilities, Permanent partial disabilities, Temporary total disabilities - Calculation of accident indices, Frequency rate, Severity rate, Frequency severity incidence, Incident rate, Accident rate, Safety “t” score, Safety activity rate-problems

**UNIT- V: SAFETY EDUCATION AND TRAINING 9**

Importance of training - identification of training needs-training methods – programme, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

- Explain basic approaches of the organizations and safety management
- Perform Work design and facility planning
- Describe concepts of accident investigation process and accident reports
- Discuss the principles of safety performance monitoring
- Elaborate the methods of safety education and training.

**TEXT BOOKS:**

1. L M Deshmukh, Industrial safety management, TATA McGraw Hill, 2010.
2. Heinrich H.W., Industrial Accident Prevention, McGraw-Hill Company, New York, 2001.

**REFERENCE BOOKS:**

1. The Factories Act 1948, Madras Book Agency, Chennai, 2000.
2. The Environment Act (Protection) 1986, Commercial Law Publishers (India) Pvt. Ltd., New Delhi.
3. Water (Prevention and control of pollution) act 1974, Commercial Law publishers (India) Pvt. Ltd., New Delhi.
4. Air (Prevention and control of pollution) act 1981, Commercial Law Publishers (India) Pvt. Ltd., New Delhi.
5. The Indian boilers act 1923, Commercial Law Publishers (India) Pvt.Ltd., Allahabad.
6. The Mines Act 1952, Commercial Law Publishers (India) Pvt.Ltd., Allahabad.
7. The manufacture, storage and import of hazardous chemical rules 1989, Madras Book Agency, Chennai.

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**1909805** **INDUSTRY 4.0**

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**OBJECTIVES:**

The main learning objective of this course is to prepare the students able to:

- Impart knowledge in Industry 4.0.
- Give students an introduction to an advanced information process techniques.
- Understand basic concepts of learning.
- Acquainted with vat polymerization and material extrusion
- Familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.

**UNIT-I: INTRODUCTION 9**

Industrial Revolutions, Industry 4.0 – Definition, principles, Application of Industry 4.0 in process & discrete industries, Benefits of Industry 4.0, challenges in Industry 4.0, Smart manufacturing, Internet of Things, Industrial Gateways, Basics of Communication requirements.

**UNIT-II: INTELLIGENT MANUFACTURING 9**

Goals of AI in manufacturing- Methods for production equipment selection and layout, Heuristic scheduling of multiple resources, Fuzzy multiple attribute decision making methods- Application of neural networks and fuzzy sets to machining and metal forming.

**UNIT-III: CONCEPT OF MACHINE LEARNING 9**

A Concept Learning Task: Notation, The Inductive Learning Hypothesis, Concept Learning as Search, FIND-S: Algorithm for finding a Maximally Specific Hypothesis: Version Spaces and the CANDIDATE-ELIMINATION Algorithm; Convergence of CANDIDATE-ELIMINATION Algorithm to the correct Hypothesis; Appropriate Training Examples for learning; Applying Partially Learned Concept, Inductive Bias: A Biased Hypothesis Space; An Unbiased Learner; The Futility of BiasFree Learning.

**UNIT-IV: VAT POLYMERIZATION AND MATERIAL EXTRUSION 9**

Photo polymerization: Stereo lithography Apparatus (SLA)- Materials -Process –Advantages Limitations- Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Extrusion Based System: Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations.

**UNIT-V: DESIGN FOR ADDITIVE MANUFACTURING (DFAM) 9**

Concepts and Objectives- AM Unique Capabilities: Part Consolidation-Topology Optimization Light weight Structure - DFAM for Part Quality Improvement. Data Processing - CAD Model Preparation -Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation-Customized Design and Fabrication for Medical Applications- Case Studies.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Operate Industry 4.0 and Smart Manufacturing in Industry
- Apply artificial intelligence (AI) and data mining (DM) techniques to improve the efficiency of manufacturing systems
- Understand basic concepts of learning.
- Elaborate the vat polymerization and material extrusion processes and its applications.
- Acquire knowledge on process of transforming a concept into the final product in AM technology.

**TEXTBOOKS:**

1. Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2017
2. Machine Learning by Tom M. Mitchell, McGraw-Hill International Edition, 1997.
3. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.

**REFERENCE BOOKS:**

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress., United States, 2015.

2. Christoph Jan Bartodziej, "The Concept Industry 4.0 An Empirical Analysis of Technologies and Applications in Production Logistics", Springer Gambler., Germany, 2017.
3. Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.

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| 1909003 | OPERATIONS RESEARCH | L | T | P | C |
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**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Selecting the constraints on the availability of resources and developing a model and render an optimal solution during the given circumstances.
- Appraising the challenges in the transportation and production problems and furnishing a rational solution to maximize the benefits.
- Planning the purchase/manufacturing policies, managing the spares/stock and meeting the customer demands.
- Analyzing the queue discipline and exploring the avenues for better customer service.
- Investigating the nature of the project/failure and offering methodical assistance towards decision making.

**UNIT-I: LINEAR MODELS 15**

The phase of an operation research study – Linear programming – Graphical method – Simplex algorithm – Duality formulation – Sensitivity analysis.

**UNIT-II: TRANSPORTATION MODELS AND NETWORK MODELS 8**

Transportation Assignment Models –Traveling Salesman problem-Networks models – Shortest route – Minimal spanning tree – Maximum flow models –Project network – CPM and PERT networks – Critical path scheduling – Sequencing models.

**UNIT-III: INVENTORY MODELS 6**

Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

**UNIT-IV: QUEUEING MODELS 6**

Queueing models - Queueing systems and structures – Notation parameter – Single server and multi-server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation.

**UNIT-V: DECISION MODELS 10**

Decision models – Game theory – Two person zero sum games – Graphical solution- Algebraic solution– Linear Programming solution – Replacement models – Models based on service life – Economic life– Single / Multi variable search technique – Dynamic Programming – Simple Problem.

**TOTAL :45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Select the constraints on the availability of resources, develop a model and render an optimal solution during the given circumstances.
- Appraise the challenges in the transportation and production problems and furnish a rational solution to maximize the benefits.
- Plan the purchase/ manufacturing policies, manage the spares/ stocks and meet the customer demands.
- Analyze the queue discipline and explore the avenues for better customer service.

- Investigate the nature of the project/ failure and offer methodical assistance towards decision making.

**TEXTBOOKS:**

1. Wayne.L.Winston, “Operations research applications and algorithms”, 4th edition, Cengage learning, 2004.
2. Hamdy ATaha, “Operations research an introduction”, 10th edition, PHI/Pearson education, 2017.

**REFERENCE BOOKS:**

1. Srinivasan G, “Operations research principles and applications”, 3rd edition EEE PHI, 2017.
2. Pannerselvam R, “Operations research”, 2nd edition, PHI, 2009.
3. :Ravindran, Phillips and Solberg, “Operations research principles and practice”, 2nd edition, Wiley India, 2007.
4. Sharma J K, “Operations research theory and applications”, 5th edition, Macmillan India, 2013.
5. Premkumar Gupta and D.S.Hira, “Problems in Operations research”, S.Chand, 2009.

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**DEPARTMENT OF MECHANICAL ENGINEERING COURSE OFFERING TO THE OTHER DEPARTMENT**

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| **1909307** | **APPLIED FLUID DYNAMICS AND THERMODYNAMICS** | **3** | **0** | **0** | **3** |

**(Use Steam tables with Mollier Chart, Psychrometric Chart and Refrigeration tables in End Semester Examination)**

**OBJECTIVES:**

- To make students understand fluids properties and application of orifice and Venturimeter.
- To impart knowledge on the dimensional analyses and its methods.
- To understand the working principle of different types of pumps and its applications
- To understand the thermodynamics laws and basic IC engines functions.
- To understand the properties of steam and application of ranking cycle.

**UNIT-I:- BASIC CONCEPTS OF FLUID MECHANICS & FLOW OF FLUIDS** **9**

Introduction – classification - types of fluids – properties - laws of pressure - atmospheric, gauge, absolute pressure, pressure measurement – manometers - mechanical gauges. Head of a liquid - Bernoulli's theorem - orifice and venturimeter.

**UNIT-II:- DIMENSIONAL ANALYSIS** **9**

Introduction – dimensions - dimensional analyses - Rayleigh's and Buckingham's method.

**UNIT-III:- PUMPS AND TURBINES** **9**

Introduction - types of pumps - reciprocating pump - construction details - co-efficient of discharge – slip - power required - centrifugal pump – classification - working principle - specific speed – turbines – classification – working principle.

**UNIT-IV:- LAWS OF THERMODYNAMICS AND BASIC IC ENGINE CYCLES** **9**

Systems, Zeroth law, first law of thermodynamics - concept of internal energy and enthalpy - applications of closed and open systems - second law of thermodynamics. Basic IC engine, 2 stroke and 4 stroke engine and gas turbine cycle- Brayton cycle.

**UNIT-V:- THERMODYNAMICS OF REFRIGERATORS AND HEAT PUMPS** **9**

Properties of steam - Ranking cycle - Boilers and its accessories - Basic thermodynamics of refrigerators and heat pumps.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of this course, the students will be able to:

- Understand fluids properties and application of orifice and Venturimeter.
- Understand the dimensional analyses.
- Understand the working principle of different types of pumps and its applications.
- Apply first and second law of thermodynamics to open and closed systems under steady and unsteady conditions. Understand the thermodynamics laws and basic IC engines functions.
- Explain the properties of steam and application of ranking cycle.

**TEXTBOOKS:**

1. Bansal.R.K,'Fluid Mechanics and Hydraulic Machines', Laxmi Publications' (P) Ltd, 2018.
2. Nag, P.K., Engineering Thermodynamics, Tata McGraw-Hill Co. Ltd., 2013.

**REFERENCE BOOKS:**

1. Shames, I.H., 'Mechanics of fluids', Kogakusha, Tokyo, 2013
2. Reynolds, Thermodynamics, Int. Student Edition, McGraw-Hill Co. Ltd., 1990.
3. Ramalingam. K.K, "Thermodynamics", Sci-Tech Publications, 2009.
4. Yunus A. Çengel, Michael A. Boles, Thermodynamics: An Engineering Approach, McGraw- Hill Higher Education, 2014.

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| 1909308 | THEORY OF MACHINES | L | T | P | C |
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**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Apply the basic components of mechanisms.
- Apply the basic knowledge on the friction applications.
- Design cam mechanisms for specified output motions.
- Apply the basic concepts of toothed gearing and kinematics of gear trains.
- Analyze the effects of inertia, turning moment and balancing of rotating and reciprocating masses.

**UNIT-I: TERMINOLOGY 9**

Definitions - Kinematic links - Pairs - Chain - Machines and mechanism - Types and uses – Kinematic inversion of four bar chain and slider crank mechanism. Velocity and acceleration in simple mechanisms - Vector polygon and instantaneous centre methods – Coriolis component of acceleration.

**UNIT-II: FRICTION AND APPLICATION 9**

Sliding and rolling friction –friction in screw threads-Bearing and lubrication- Friction clutches-Belt drives- Friction aspects in brakes.

**UNIT-III: MOTION OF CAM AND FOLLOWER 9**

Cam and follower - types - application – displacement diagrams - profile layout for uniform velocity Uniform acceleration and retardation - simple harmonic and cycloidal motion.

**UNIT-IV: GEARS AND GEAR TRAINS 9**

Gears - classification - terminology -law of gearing - tooth profile - interference between rack and pinion. Gear trains - simple - compound reverted. Simple epicyclic gear trains.

**UNIT-V: FLYWHEEL AND BALANCING 9**

Inertia - turning moment - flywheel - fluctuation of speed and energy. Balancing of rotating masses and reciprocating masses. **TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of this course, the students will be able to:

- Apply the basic components of mechanisms.
- Apply the basic knowledge on the friction applications.
- Design cam mechanisms for specified output motions.
- Apply the basic concepts of toothed gearing and kinematics of gear trains.
- Analyze the effects of inertia, turning moment and balancing of rotating and reciprocating masses.

**TEXTBOOKS:**


1. Rattan, S.S, “Theory of Machines”, 3rd Edition, Tata McGraw-Hill, 2009.
2. Khurmi, R.S. and Gupta, J.K., “Theory of machines”, Eurasia Publication House, 1994.


**REFERENCE BOOKS:**


1. Thomas Beven, “Theory of Machines”, CBS Publishers and Distributors, NewDelhi, 1984.

2. Ballaney, P.L., “Theory of machines”, Khanna Publishers, NewDelhi, 1994.


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**1909407** **FARM TRACTORS**

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**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- To understand the construct the tractor engines.
- To analyze the engine construction and various systems involved.
- To analyze various power transmission system and brakes.
- To analyze the tractor hydraulic systems.
- To analyze power tiller and testing of tractors.

**UNIT-I: TRACTORS 9**

Classification of tractors - Tractor engines - Construction of engine blocks, cylinder head and crankcase - Features of cylinder, piston, connecting rod and crankshaft - Firing order combustion chambers.

**UNIT-II: ENGINE SYSTEMS 9**

Valves- inlet and outlet valves - Valve timing diagram - Air cleaner - Exhaust – Silencer - Cooling systems - Lubricating systems - Fuel system - Governor- Electrical system.

**UNIT-III: TRANSMISSION SYSTEMS 9**

Transmission - Clutch - Gear box - Sliding mesh - Constant mesh - Synchro mesh - Differential, final drive and wheels steering geometry - Steering systems - Front axle and wheel alignment - Brake - Types - System.

**UNIT-IV: HYDRAULIC SYSTEMS 9**

Hydraulic system - Working principles, three point linkage - draft control - Weight transfer, theory of traction - Tractive efficiency - Tractor chassis mechanics - Stability - Longitudinal and lateral Controls - Visibility - Operators seat.

**UNIT-V: POWER TILLER, BULLDOZER AND TRACTOR TESTING 9**

Power tiller - Special features - Clutch - Gear box - Steering and brake - Makes of tractors, power tillers and bulldozers. Bulldozer - Salient features - Turning mechanism, track mechanism, components - Operations performed by bulldozers - Types of tests - Test procedure - Need for testing & evaluation of farm tractor - Test code for performance testing of tractors and power tillers.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of this course, the students will be able to:

- Construct the tractor engines.
- Analyze the engine systems.
- Analyze various power transmission system and brakes.
- Analyze the tractor hydraulic systems.
- Analyze power tiller and testing of tractors.

**TEXTBOOKS:**


1. Jain. S.C., and Rai. C.R., "Farm tractor maintenance and repair", Standard publishers and distributors, New Delhi, 1999

2.Jagadeeshwar Sahay, “Elements of Agricultural Engineering”, Standard Publishers Co.,


**REFERENCE BOOKS:**


1. Barger. E.L., Liljedahl. J.B.  And McKibben. E.C., “Tractors and their Power Units”, Wiley Eastern Pvt. Ltd., New Delhi, 1997.
2. Domkundwar. A.V., “A course in internal combustion engines”, Dhanpatrai& Co. (P) Ltd., Educational and Technical Publishers,Delhi, 1999.
3. Black. P.O., “Diesel engine manual”, Taraporevala Sons & Co., Mumbai, 1996.
4. Grouse. W.H. and Anglin. D.L., “Automative mechanics”, Macmillan McGraw- Hill, Singapore, Indian Standard Codes for Agricultural Implements Published by ISI, New Delhi, 1993.


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| **1909515** | **DESIGN OF BASIC MACHINE ELEMENTS** | **L** | **T** | **P** | **C** |
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**(Use of PSG Design Data book is permitted in the End Semester Examination)**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Select the materials and design machine members subjected to static and variable loads.
- Design the power transmission systems.
- Design shafts and couplings for various applications.
- Design helical, leaf springs and flywheels for various applications.
- Design and selection of gears and contact bearings.

**UNIT-I: STRESSES IN MACHINE MEMBERS 9**

Introduction to design process- factor influencing the machine design, selection of material based on mechanical properties- Direct, bending and torsional stress equations- calculation of Principal stresses for combined loading. Design of curved beams- factor of safety – theories of failure-stress concentration- design of variable loading- Soderberg and Goodman relations.

**UNIT-II: DESIGN OF POWER TRANSMISSION SYSTEMS 9**

Selection of V-Belts and pulleys- selection of flat belts and pulleys- wire ropes and pulleys-selection of transmission chains and sprockets. Design of pulleys and sprockets.

**UNIT-III: DESIGN OF SHAFTS AND COUPLINGS 9**

Design of solid and hollow shafts based on strength and rigidity- Design of keys, keyways and splines- Design of rigid and flexible couplings. Design of bolts and nuts - knuckle and cotter joints.

**UNIT-IV: DESIGN OF ENERGY STORING ELEMENTS 9**

Design of helical, leaf, disc and torsional springs under constant loads and varying loads - Concentric torsion springs.

**UNIT-V: DESIGN OF GEARS AND BEARINGS 9**

Gears - spur gear and helical gear - terminology - strength of gear teeth - Lewis equation - Buckingham equation.- Failure of gear teeth.- Applications of different types of Gears - Types of bearings – sliding contact and rolling contact types. – Bearing selection based on application - Lubrication in journal bearings – calculation of bearing dimensions. **TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Select the materials and design machine members subjected to static and variable loads.
- Design the power transmission systems.
- Design shafts and couplings for various applications.
- Design helical, leaf springs and flywheels for various applications.
- Design and selection of gears and contact bearings.

**TEXTBOOKS:**


1. Khurmi R.S and Gupta J.K., "A Textbook of Machine Design", Euarsia publication house, 2005
2. Bhandari V.B., "Design of Machine Elements", Tata McGraw-Hill Book Co, 2003.


**REFERENCE BOOKS:**


1. Norton R.L., "Machine Design – An Integrated Approach", Pearson Publications, 3rd Edition, 2006.
2. Srivastava A.K., Goering.C E and Rohrbach R.P. "Engineering Principles of Agricultural Machines", Revised Printing by American Society of Agricultural Engineers.1993.
3. Gary Krutz, Lester Thompson and Paul Clear, "Design of Agricultural Machinery", John Wiley and Sons, New York, 1984.


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**1909612 REFRIGERATION AND AIR CONDITIONING FOR AGRICULTURAL ENGINEERS**

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**(Steam and Refrigeration table with Psychrometric Chart is permitted in the End Semester Examination)**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Review the thermodynamic principles of refrigeration.
- Understand the operation of the system components and refrigerants.
- Analyze the psychrometric processes.
- Analyze the load calculation of air conditioning systems.
- Apply the refrigeration cycles in various plants

**UNIT-I: REFRIGERATION CYCLE 8**

Review of thermodynamic principles of refrigeration. Concept of Air refrigeration system. Vapour compression refrigeration cycle–use of P.H charts–multistage and multiple evaporator systems-cascade system – COP comparison.

**UNIT-II: REFRIGERANTS, SYSTEM COMPONENTS AND BALANCING 9**

Compressors – reciprocating & rotary (elementary treatment) – condensers – evaporators cooling towers. Refrigerants – Properties – selection of refrigerants, Alternative refrigerants, cycle controls.

**UNIT-III: PSYCHROMETRY 10**

Psychrometric processes use of psychrometric charts – grand and room sensible heat factors – bypass factors – air washers, requirements of comfort air conditioning, summer and winter air conditioning.

**UNIT-IV: AIR CONDITIONING SYSTEMS 9**

Cooling load calculation working principles of – centralized Air conditioning systems, split, ductable split, packaged air conditioning, VAV & VRV systems. Duct design by equal friction method, indoor air quality concepts.

**UNIT-V: UNCONVENTIONAL REFRIGERATION CYCLES 9**

Vapor absorption systems – Ejector jet, steam jet refrigeration, thermo electric refrigeration. Applications: ice – plant – food storage plants – milk chilling plants.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of this course, the students will be able to:

- Review the thermodynamic principles of refrigeration.
- Understand the operation of the system components and refrigerants.
- Analyze the psychrometric processes.
- Analyze the load calculation of air conditioning systems.
- Apply the refrigeration cycles in various plants

**TEXTBOOKS:**


1. Manohar Prasad, "Refrigeration and Air Conditioning", Wiley Eastern Ltd., New Delhi, 1983.
2. Arora, C.P., "Refrigeration and Air Conditioning", Tata McGraw Hill, New Delhi,1988.


**REFERENCE BOOKS:**


1. Dossat, R.J., "Principles of Refrigeration and Air Conditioning", Pearson Education Pvt. Ltd., New Delhi, 1997.
2. Jordon and Priester, "Refrigeration and Air Conditioning", Prentice Hall of India Pvt. Ltd., New Delhi,1985.
3. Stoecker, N.F., and Jones, "Refrigeration and Air Conditioning", Tata McGraw Hill, New Delhi, 1981.


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| 1909717 | HEAT AND MASS TRANSFER FOR AGRICULTURAL ENGINEERS | L | T | P | C |
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**(Heat and Mass Transfer Data Book Permitted in the End Semester Examination)**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Apply the principle mechanism of heat transfer under steady state and transient conditions.
- Apply the fundamental concept and principles in convective heat transfer
- Apply the theory of phase change heat transfer and design of heat exchangers.
- Apply the fundamental concept and principles in radiation heat transfer.
- Analyze the relation between heat and mass transfer and to solve simple mass transfer problems.

**UNIT-I: CONDUCTION 9**

Basic concepts – Mechanism of heat transfer – Conduction, convection and radiation – General differential equation of heat conduction – Fourier law of conduction – Cartesian and cylindrical coordinates – one dimensional steady state heat conduction – Conduction through plane walls, cylinders and spherical systems – Composite systems – Conduction with internal heat generation-Extended surfaces – Unsteady heat conduction – Lumped analysis – Use of Heislerschart.

**UNIT-II: CONVECTION 9**

Basic concepts – Convective heat transfer coefficients – Boundary Layer concept – Types of convection – Forced convection – Dimensional analysis – External flow – Flow over plates, Cylinders and spheres – Internal flow – Laminar and turbulent flow – Combined Laminar and turbulent flow – Flow over bank of tubes – Free convection – Dimensional analysis – Flow over vertical plates, horizontal plate, inclined plate, cylinders and spheres.

**UNIT-III: PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 9**

Nussels theory of condensation – Pool boiling, flow boiling, correlations in boiling and condensation, types of heat exchangers – LMTD method of heat exchanger analysis – Overall heat transfer coefficient – Fouling Factors.

**UNIT-IV: RADIATION 9**

Basic concepts, law of radiation – Stefan Boltsmann law, Kirchoff law – Block body radiation – Grey body radiation shape factor algebra – Electrical analogy – Radiation shields – introduction to gas radiation.

**UNIT-V: MASS TRANSFER 9**

Basic concepts – Diffusion mass transfer – Fick's Law of diffusion – Steady state molecular diffusion – Convective mass transfer – Momentum, heat and mass transfer analogy – Convective mass transfer correlations.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of this course, the students will be able to:

- Apply the principle mechanism of heat transfer under steady state and transient conditions.
- Apply the fundamental concept and principles in convective heat transfer
- Apply the theory of phase change heat transfer and design of heat exchangers.
- Apply the fundamental concept and principles in radiation heat transfer.
- Analyze the relation between heat and mass transfer and to solve simple mass transfer problems.

**TEXTBOOKS:**


1. Sachdeva, R.C., "Fundamentals of Engineering Heat and Mass Transfer", New Age International, New Delhi, 1995.
2. Yadav, R., "Heat and Mass Transfer", Central Publishing House, New Delhi,1995.


**REFERENCE BOOKS:**


1. Nag, P.K., "Heat Transfer", Tata McGraw Hill Book Co., New Delhi, 2002.
2. Holman, J.P., Heat and Mass transfer, Tata McGraw Hill Book Co., New York, 2002.
3. Kothandaraman, C.P., "Fundamentals of Engineering Heat and Mass Transfer", New Age International, New Delhi, 1998.

4. Incropera, F. P., and Dewitt, D. P., “Fundamentals of Engineering Heat and Mass Transfer”, John Wiley and Sons, New York,1998.
5. Ozisik, M.H., “Heat Transfer”, McGraw Hill Book Co., New York,1994.

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| 3 | 2 | 2 | 1 | 1 | | | | | | | | 1 | | 1 | | |
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| 1909003 | OPERATIONS RESEARCH | L | T | P | C |
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**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Selecting the constraints on the availability of resources and developing a model and render an optimal solution during the given circumstances.
- Appraising the challenges in the transportation and production problems and furnishing a rational solution to maximize the benefits.
- Planning the purchase/manufacturing policies, managing the spares/stock and meeting the customer demands.
- Analyzing the queue discipline and exploring the avenues for better customer service.
- Investigating the nature of the project/failure and offering methodical assistance towards decision making.

**UNIT-I: LINEAR MODELS 15**

The phase of an operation research study – Linear programming – Graphical method– Simplex algorithm – Duality formulation – Sensitivity analysis.

**UNIT-II: TRANSPORTATION MODELS AND NETWORK MODELS 8**

Transportation Assignment Models –Traveling Salesman problem-Networks models – Shortest route – Minimal spanning tree – Maximum flow models –Project network – CPM and PERT networks – Critical path scheduling – Sequencing models.

**UNIT-III: INVENTORY MODELS 6**

Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

**UNIT-IV: QUEUEING MODELS 6**

Queueing models - Queueing systems and structures – Notation parameter – Single server and multi-server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation.

**UNIT-V: DECISION MODELS 10**

Decision models – Game theory – Two person zero sum games – Graphical solution- Algebraic solution– Linear Programming solution – Replacement models – Models based on service life – Economic life– Single / Multi variable search technique – Dynamic Programming – Simple Problem

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Select the constraints on the availability of resources, develop a model and render an optimal solution during the given circumstances.
- Appraise the challenges in the transportation and production problems and furnish a rational solution to maximize the benefits.
- Plan the purchase/ manufacturing policies, manage the spares/ stocks and meet the customer demands.
- Analyze the queue discipline and explore the avenues for better customer service.
- Investigate the nature of the project/ failure and offer methodical assistance towards decision making.

**TEXTBOOKS:**


1. Wayne.L.Winston, “Operations research applications and algorithms”, 4th edition, Cengage learning, 2004.
2. HamdyATaha, “Operations research an introduction”, 10th edition, PHI/Pearson education, 2017.


**REFERENCE BOOKS:**


1. Srinivasan G, “Operations research principles and applications”, 3rd edition EEE PHI, 2017.
2. Pannerselvam R, “Operations research”, 2nd edition, PHI, 2009.
3. :Ravindran, Phillips and Solberg, “Operations research principles and practice”, 2nd edition, Wiley India, 2007.
4. Sharma J K, “Operations research theory and applications”,5th edition, Macmillan India, 2013.
5. Premkumar Gupta and D.S.Hira, “Problems in Operations research”, S.Chand, 2009.


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**SEMESTER –V: OPEN ELECTIVE- I**

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| **1909510** | **PRODUCT DESIGN AND DEVELOPMENT** | **L T P C** |
| | | **3 0 0 3** |

**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Product design and development
- Apply the concept of prototyping in a real-life problem.
- Reduce the waste by using product architecture**.**
- Understand the concepts of industrial design.
- Understand the concepts of DFM

**UNIT-I: INTRODUCTION 9**

Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behaviour analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements.

**UNIT-II: CONCEPT GENERATION AND SELECTION 9**

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits.

**UNIT-III: PRODUCT ARCHITECTURE 9**

Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions

**UNIT-IV: INDUSTRIAL DESIGN 9**

Need for industrial design – impact – design process – investigation of for industrial design – impact – design process – investigation of customer needs – conceptualization – refinement –

management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

**UNIT-V: DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT** **9**

Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes – Economic Analysis.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of this course, the students will be able to:

- Product design and development
- Apply the concept of prototyping in a real life problem.
- Reduce the waste by using product architecture**.**
- Understand the concepts of industrial design.
- Understand the concepts of DFM

**TEXTBOOKS:**

1. Kari T.Ulrich and Steven D.Eppinger, "Product Design and Development", McGraw-Hill International Edn.2017.

**REFERENCE BOOKS:**

1. Kemnneth Crow, "Concurrent Engg./Integrated Product Development", DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
2. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.

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**1909511 VIBRATION AND NOISE CONTROL** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Apply the fundamental concepts of vibration.
- Apply the fundamentals of noise.
- Describe the various sources of noise for automotive applications.
- Determine the natural frequencies and mode shapes of the two degree freedom systems.
- Describe the different types of noise and its control measures

**UNIT-I: BASICS OF VIBRATION 9**

Introduction, classification of vibration: free and forced vibration, undamped and damped vibration, linear and nonlinear vibration, response of damped and undamped systems under harmonic force, analysis of single degree and two degree of freedom systems, torsional vibration, determination of natural frequencies

**UNIT-II: BASICS OF NOISE 9**

Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise dose level, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis, tracking analysis, sound quality analysis.

**UNIT-III: AUTOMOTIVE NOISE SOURCES 9**

Noise Characteristics of engines, engine overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiated noise, intake and exhaust noise, engine necessary contributed noise, transmission noise, aerodynamic noise, tire noise, brake noise.

**UNIT-IV: CONTROLTECHNIQUES 9**

Vibration isolation, tuned absorbers, un-tuned viscous dampers, damping treatments, application dynamic forces generated by IC engines, engine isolation, crank shaft damping, modal analysis of the mass elastic model shock absorbers.

**UNIT-V: SOURCE OF NOISE AND CONTROL 9**

Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of this course, the students will be able to:

- Apply the fundamental concepts of vibration.
- Apply the fundamentals of noise.
- Describe the various sources of noise for automotive applications.
- Determine the natural frequencies and mode shapes of the two degree freedom systems.
- Describe the different types of noise and its control measures

**TEXTBOOKS:**

1. Singiresu S.Rao, “Mechanical Vibrations”, 6th Edition, Pearson Education, 2016

**REFERENCE BOOKS:**

1. Balakumar Balachandran and Edward B. Magrab, “Fundamentals of Vibrations”, 1st Edition, Cengage Learning, 2009
2. Benson H. Tongue, “Principles of Vibrations”, 2nd Edition, Oxford University, 2007

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| **2** | 3 | 2 | 2 | 2 | | | 1 | | | | | 1 | 2 | 2 | | |
| **3** | 3 | 2 | 2 | 2 | | | 1 | | | | | 1 | 2 | 2 | | |
| **4** | 3 | 2 | 2 | 2 | | | 1 | | | | | 1 | 2 | 2 | | |
| **5** | 3 | 2 | 2 | 2 | | | 1 | | | | | 1 | 2 | 2 | | |

**1909512 INDUSTRIAL SAFETY ENGINEERING L T P C**

**3 0 0 3**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Identify unsafe conditions and recognize unsafe alerts.
- Interpret the rules and regulations for safety operations.
- Capable of solving problem of accidents.
- Capable of solving the present for criticizing the present for improved safety.
- Collaborate and modify processes / procedures for safety.

**UNIT-I: INTRODUCTION 9**

Evolution of modern safety concepts – Fire prevention – Mechanical hazards – Boilers, Pressure vessels, Electrical Exposure.

**UNIT-II: CHEMICAL HAZARDS 9**

Chemical exposure – Toxic materials – Radiation Ionizing and Non-ionizing Radiation - Industrial Hygiene – Industrial Toxicology.

**UNIT-III: ENVIRONMENTAL CONTROL 9**

Industrial Health Hazards – Environmental Control – Industrial Noise - Noise measuring instruments, Control of Noise, Vibration, - Personal Protection.

**UNIT-IV: HAZARD ANALYSIS** **9**

System Safety Analysis –Techniques – Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), HAZOP analysis and Risk Assessment.

**UNIT-V: SAFETY REGULATIONS** **9**

Explosions – Disaster management – catastrophe control, hazard control, Factories Act, Safety regulations Product safety – case studies.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of this course, the students will be able to:

- Identify and prevent chemical, environmental mechanical, fire hazard.
- Collect, analyze and interpret the accidents data based on various safety techniques.
- Apply proper safety techniques on safety engineering and management.
- Able to perform hazard analysis.
- Aid to design the system with environmental consciousness by implementing safety regulation.

**TEXTBOOKS:**


1. John V.Grimaldi, "Safety Management", AITB S Publishers, 2003.


**REFERENCE BOOKS:**


1. David L.Goetsch, "Occupational Safety and Health for Technologists", Engineers and Managers, Pearson Education Ltd. 5th Edition, 2005.
2. Deshmukh L M, "Industrial Safety Management", Tata McGraw-Hill Publishing Company Ltd.,2005
3. Safety Manual, "EDEL Engineering Consultancy", 2000.

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**SEMESTER –VII: - OPEN ELECTIVE- II**

**1909718** **ROBOTICS** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understand the functions of robots and review the need and application of robots in different engineering fields.
- Exemplify the different types of robot drive systems as well as robot end effectors.
- Apply the different sensors and image processing techniques in robotics to improve the ability of robots.
- Develop robotic programs for different tasks and analyze the kinematics motions of robot.
- Implement robots in various industrial sectors and interpolate the economic analysis of robots.

**UNIT-I: FUNDAMENTALS OF ROBOT 9**

Robot - Definition - Robot Anatomy - Coordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions-Need for Robots-Different Applications.

**UNIT-II: ROBOT DRIVE SYSTEMS AND END EFFECTORS 9**

Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations

**UNIT-III: SENSORS AND MACHINE VISION 9**

Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors ,binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data- Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data

Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications-Inspection, Identification, Visual Serving and Navigation.

**UNIT-IV: ROBOT KINEMATICS AND ROBOT PROGRAMMING 9**

Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems. Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effector commands and simple Programs.

**UNIT-V: IMPLEMENTATION AND ROBOT ECONOMICS 9**

RGV, AGV; Implementation of Robots in Industries -Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of this course, the students will be able to:

- Understand the functions of robots and review the need and application of robots in different engineering fields.
- Exemplify the different types of robot drive systems as well as robot end effectors.
- Apply the different sensors and image processing techniques in robotics to improve the ability of robots.
- Develop robotic programs for different tasks and analyze the kinematics motions of robot.
- Implement robots in various industrial sectors and interpolate the economic analysis of robots.

**TEXTBOOKS:**


1. Klafter R.D., Chmielewski T.A and Negin M., "Robotic Engineering - An Integrated Approach", Prentice Hall, 2003.
2. Groover M.P., "Industrial Robotics -Technology Programming and Applications", McGraw Hill, 2001.

**REFERENCE BOOKS:**


1. Craig J.J., "Introduction to Robotics Mechanics and Control", Pearson Education, 2008.
2. Deb.S.R., "Robotics Technology and Flexible Automation", Tata McGraw Hill Book Co., 1994.
3. Koren Y., "Robotics for Engineers", McGraw Hill Book Co., 1992.
4. Fu.K.S.,Gonzalz R.C. and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence",McGraw Hill Book Co., 1987.
5. Rajput R.K., "Robotics and Industrial Automation", S.Chand and Company, 2008.


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**1909719 TESTING OF MATERIALS L T P C**

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**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Apply the concept of testing to various materials and result analysis.
- Apply various mechanical testing procedures to different materials.
- Apply different nondestructive testing procedures to different materials.
- Apply material characterization testing for analysis.
- Apply advanced testing techniques for thermal and chemical fields.

**UNIT-I: INTRODUCTION TO MATERIALS TESTING 9**

Overview of materials, Classification of material testing, Purpose of testing, Selection of material, Development of testing, Testing organizations and its committee, Testing standards, Result Analysis, Advantages of testing

**UNIT-II: MECHANICAL TESTING 9**

Introduction to mechanical testing, Hardness test (Vickers, Brinell, Rockwell), Tensile test, Impact test (Izod, Charpy) - Principles, Techniques, Methods, Advantages and Limitations, Applications. Bend test, Shear test, Creep and Fatigue test - Principles, Techniques, Methods, Advantages and Limitations, Applications.

**UNIT-III: NON DESTRUCTIVE TESTING 9**

Visual inspection, Liquid penetrant test, Magnetic particle test, Thermography test – Principles, Techniques, Advantages and Limitations, Applications. Radiographic test, Eddy current test, Ultrasonic test, Acoustic emission- Principles, Techniques, Methods, Advantages and Limitations, Applications.

**UNIT-IV: MATERIAL CHARACTERIZATION TESTING 9**

Macroscopic and Microscopic observations, Optical and Electron microscopy (SEM and TEM) - Principles, Types, Advantages and Limitations, Applications. Diffraction techniques, Spectroscopic Techniques, Electrical and Magnetic Techniques- Principles, Types, Advantages and Limitations, Applications.

**UNIT-V: OTHER TESTING 9**

Thermal Testing: Differential scanning calorimetry, Differential thermal analysis. Thermo-mechanical and Dynamic mechanical analysis: Principles, Advantages, Applications. Chemical Testing: X-Ray Fluorescence, Elemental Analysis by Inductively Coupled Plasma-Optical Emission Spectroscopy and Plasma-Mass Spectrometry.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of this course, the students will be able to:

- Apply the concept of testing to various materials and result analysis.
- Apply various mechanical testing procedures to different materials.
- Apply different nondestructive testing procedures to different materials.
- Apply material characterization testing for analysis.
- Apply advanced testing techniques for thermal and chemical fields.

**TEXT BOOKS:**


1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.
2. Cullity, B. D., "Elements of X-ray diffraction", 3rd Edition, Addison-Wesley Company Inc., Nēw York, 2000.


**REFERENCE BOOKS:**


1. P. Field Foster, "The Mechanical Testing of Metals and Alloys" 7th Edition, Cousens Press, 2007.
2. Metals Handbook: Mechanical testing, (Volume 8) ASM Handbook Committee, 9th Edition, American Society for Metals, 1978.
3. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA.
4. Brandon D.G., "Modern Techniques in Metallography", Von Nostrand Inc. NJ, USA, 1986.


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**1909720** **DESIGN OF ELECTRIC VEHICLES**

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**OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understand about electric vehicle technology.
- Understand the load distribution and stability of vehicles.
- Analyze the handling characteristics of road vehicles.
- Analyze the steering, suspension and designing of breaks.
- Understand hybrid vehicles, power electronics and fuel cell vehicles.

**UNIT-I: INTRODUCTION TO ELECTRIC VEHICLES 9**

Electric Vehicle – Need - Types – Cost and Emissions – End of life. Electric Vehicle Technology – layouts, cables, components, Controls. Batteries – overview and its types. Battery plug-in and life. Ultra-capacitor, Charging – Methods and Standards. Alternate charging sources – Wireless & Solar.

**UNIT-II: STABILITY OF VEHICLES 9**

Load distribution for three wheeler and four wheeler-Stability of vehicle running on slope, banked road and during turn-calculation of Tractive effort, maximum acceleration and reaction forces for different drives.

**UNIT-III: HANDLING CHARACTERISTICS OF ROAD VEHICLES 9**

Steering geometry-Steady state handling characteristics- Steady state response to steering input-Testing of handling characteristics-Transient response characteristics- Directional stability.

**UNIT-IV: STEERING, SUSPENSION AND BRAKE 9**

Steering System - Ackerman Principle of Steering - Front End Geometry - Steering Gearbox-Types-Recirculating Ball - Rack and Pinion - Power Steering. Suspension - Front and Rear Forks - Springs for Suspension - Telescopic Suspension - Monoshock Suspension - Hydraulic Shock Absorber - Dampers. Design Consideration – Brake - Drum Brakes - Disc Brakes – ABS.

**UNIT-V: POWER ELECTRONICS AND CONTROL FOR HYBRID AND FUEL CELL VEHICLES** **9**

Series Hybrid Vehicle Propulsion System, Parallel Hybrid Vehicle Propulsion System, Fuel Cell Vehicles, Power Electronics Requirements, Propulsion Motor Control Strategies, APU Control System in Series Hybrid Vehicles, Fuel Cell for APU Applications.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of this course, the students will be able to:

- Understand about electric vehicle technology.
- Understand the load distribution and stability of vehicles.
- Analyze the handling characteristics of road vehicles.
- Analyze the steering, suspension and designing of breaks.
- Understand hybrid vehicles, power electronics and fuel cell vehicles.

**TEXTBOOKS:**


1. Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.
2. Rajesh Rajamani, "Vehicle Dynamics and Control", 1st edition, Springer, 2005


**REFERENCE BOOKS:**


1. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", Society of Automotive Engineers Inc, 1992.
2. Dr.Kirpal Singh, 'Automobile Engineering'- Vol. I and II, Standard Publishers, New Delhi, 2011
3. V. Ganesan, 'Internal Combustion Engines', Tata McGraw Hill Book Co, Eighth Reprint, 2010.
4. Ali Emadi, "Handbook of Automotive Power Electronics and Drives", Taylor & Francis Group, First Edition, USA, 2005.

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**OPEN ELECTIVE – I (V SEMESTER) OFFERED BY ALL DEPARTMENT EXCEPT MECHANICAL ENGINEERING**

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| **1902512** | **ENVIRONMENT AND AGRICULTURE** | **L T P C** |
| | | **3 0 0 3** |

**OBJECTIVES:**

- To emphasize on the importance of environment and agriculture on changing global scenario and the emerging issues connected to it.
- To understand the ecological context of agriculture and its concerns.
- To study the context of climate change and emerging global issues.
- To gain knowledge on water balance.
- To understand the importance of virtual water.

**UNIT-I: ENVIRONMENTAL CONCERNS 9**

Environmental basis for agriculture and food – Land use and landscape changes – Water quality issues – Changing social structure and economic focus – Globalization and its impacts – Agro ecosystems.

**UNIT-II: ENVIRONMENTAL IMPACTS 9**

Irrigation development and watersheds – mechanized agriculture and soil cover impacts – Erosion and problems of deposition in irrigation systems – Agricultural drainage and downstream impacts – Agriculture versus urban impacts.

**UNIT- III: CLIMATE CHANGE 9**

Global warming and changing environment – Ecosystem changes – Changing blue-green-grey water cycles – Water scarcity and water shortages – Desertification.

**UNIT-IV: ECOLOGICAL DIVERSITY AND AGRICULTURE 9**

Ecological diversity, wild life and agriculture – GM crops and their impacts on the environment – Insets and agriculture – Pollination crisis – Ecological farming principles – Forest fragmentation and agriculture – Agricultural biotechnology concerns.

**UNIT-V: EMERGING ISSUES** **9**

Global environmental governance – alternate culture systems – Mega farms and vertical farms – Virtual water trade and its impacts on local environment – Agricultural environment policies and its impacts – Sustainable agriculture.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Students may be able to know how the environment and agriculture are related and the changes in the environmental due to agriculture.
- Students will be able to gather idea on about how the mechanization helps and impacts of soil erosion due to agricultural activities.
- Students will have a wide knowledge of changing environment due to global warming and climate change and its impact on water.
- Students are exposed to the ecological diversity in agriculture and different technologies used in farming activities.
- Students are able to understand the global governance system and agricultural policies involved in the sustainable agricultural systems.

**TEXT BOOKS:**


1. M.Lakshmi Narasaiah, Environment and Agriculture, Discovery Pub. House, 2006.
2. Arvind Kumar, Environment and Agriculture, ABH Publications, New Delhi, 2005


**REFERENCE BOOKS:**


1. T.C. Byerly, Environment and Agriculture, United States Dept. of Agriculture, Economic Research Service, 2006.
2. Robert D. Havener, Steven A. Breth, Environment and agriculture: rethinking development issues for the 21st century: proceedings of a symposium, Winrock International Institute for Agricultural Development, 1994.
3. Environment and agriculture: environmental problems affecting agriculture in the Asia and Pacific region; World Food Day Symposium, Bangkok, Thailand. 1989.

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| **3** | 1 | 3 | - | - | - | 1 | 2 | - | - | - | - | 2 | 2 | 2 | 2 | 1 |
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**1902513 PRODUCTION TECHNOLOGY OF AGRICULTURAL MACHINERY** **L T P C 3 0 0 3**

**OBJECTIVES:**

- To understand the mechanical properties of engineering materials and their classifications
- To understand the basic principles of lathe and the corresponding machines.
- To gain knowledge on various welding techniques available.
- To understand the importance of advanced manufacturing process.
- To emphasize on the importance of accuracy on machine operation.

**UNIT- I: ENGINEERING MATERIALS** **9**

Engineering materials - their classification - Mechanical properties of materials, strength, elasticity, plasticity, stiffness, malleability, ductility, brittleness, toughness, hardness, resilience, machinability, formability, weldability. Steels and cast irons: Carbon steels, their classification based on percentage of carbon as low, mild, medium & high carbon steel, their properties & applications. Wrought iron, cast iron. Alloy steels: Stainless steel, tool steel.

**UNIT- II: MACHINING** **9**

Basic principles of lathe - machine and operations performed on it. Basic description of machines and operations of Shaper-Planner, Drilling, Milling & Grinding.

**UNIT- III: WELDING** **9**

Introduction, classification of welding processes. Gas welding, types of flames and their applications. Electric Arc welding. Resistance welding, Soldering & Brazing processes and their uses.

**UNIT-IV: ADVANCED MANUFACTURING PROCESS** **9**

Abrasive flow machining - abrasive jet machining - water jet machining - Electro Discharge Machining (EDM) - Wire cut EDM - Electro Chemical Machining (ECM) - Ultrasonic Machining / Drilling (USM / USD) - Electron Beam Machining (EBM) - Laser Beam Machining (LBM).

**UNIT- V: CNC MACHINE** **9**

Numerical control (NC) machine tools - CNC: types, constitutional details, special features - design considerations of CNC machines for improving machining accuracy - structural members - slide ways - linear bearings - ball screws - spindle drives and feed drives. Part programming fundamentals - manual programming.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of this course,

- Students can able to apply the different manufacturing process and use this in industry for component production.
- Students will be able to understand the working principle of lathe and various operations done on it.
- Students will be able to gather idea on welding and soldering process.
- Students will gain wide knowledge on various advance manufacturing process.
- Students will gain knowledge in CNC machine and improving the machining accuracy.

**TEXTBOOKS:**


1. "Manufacturing Engineering and Technology", Kalpakjian and Schmid, Pearson, 2010.
2. Hajra Choudry, "Elements of workshop technology - Vol II", Media promoters, 2002.


**REFERENCE BOOKS:**


1. Gupta. K.N., and Kaushik, J.P., 1998, Workshop Technology Vol I and II, New Heights, Daryaganj, New Delhi.
2. Arthur. D., et. al. 1998, General Engineering Workshop Practice, Asia Publishing House, Bombay.
3. Chapman W.A.J., Workshop Technology, 1992, Part I, II, III, E.L.B.S. and Edward Amold Publishers Ltd, London.


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| **3** | 3 | 2 | - | 2 | 2 | - | - | 2 | - | - | - | - | 1 | - | 3 | 2 |
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**1903514 AIR POLLUTION AND CONTROL ENGINEERING L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To impart knowledge on the principle and design of control of Indoor/ particulate/ gaseous air pollutant and its emerging trends.
- To gain knowledge of characteristics of air pollution and noise pollution.
- To create awareness among the sources and effects of air pollution.
- To gain knowledge on air pollution control Equipments.
- To develop a knowledge on air quality standards.

**UNIT- I: INTRODUCTION 9**

Structure and composition of Atmosphere – Definition, Scope and Scales of Air Pollution – Sources and classification of air pollutants and their effect on human health, vegetation, animals, property, aesthetic value and visibility- Ambient Air Quality and Emission standards – Ambient and stack sampling and Analysis of Particulate and Gaseous Pollutants.

**UNIT- II: METEOROLOGY 9**

Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Atmospheric Diffusion Theories – Dispersion models, Plume rise.

**UNIT- III: CONTROL OF PARTICULATE CONTAMINANTS 9**

Factors affecting Selection of Control Equipment – Gas Particle Interaction – Working principle, Design and performance equations of Gravity Separators, Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators – Operational Considerations.

**UNIT- IV: CONTROL OF GASEOUS CONTAMINANTS 9**

Factors affecting Selection of Control Equipment – Working principle, Design and performance equations of absorption, Adsorption, condensation, Incineration, Bio scrubbers, Bio filters – Process control and Monitoring - Operational Considerations.

**UNIT- V: INDOOR AIR QUALITY MANAGEMENT 9**

Air quality standards - Sources, types and control of indoor air pollutants, sick building syndrome and Building related illness - Town planning regulations of industries-Sources and Effects of Noise Pollution – Measurement – Standards –Control and Preventive measures.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The students completing the course will have

- An understanding of the nature and characteristics of air pollutants, noise pollution and basic concepts of air quality management.
- Ability to identify, formulate and solve air and noise pollution problems.
- Ability to design stacks and particulate air pollution control devices to meet applicable standards.
- Ability to select control equipment’s.
- Ability to control effects of noise pollution and indoor air pollution.

**TEXT BOOKS:**


1. Lawrence K. Wang, Norman C. Pareira, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo, springer science , science media LLC,2004.
2. Noel de Nevers, "Air Pollution Control Engineering", Waveland press,Inc 2017.
3. Anjaneyulu. Y, "Air Pollution and Control Technologies", Allied Publishers (P) Ltd., India 2002.


**REFERENCE BOOKS:**


1. David H.F. Liu, Bela G. Liptak, "Air Pollution", Lweis Publishers, 2000.
2. Arthur C. Stern, "Air Pollution (Vol.I – Vol.VIII)", Academic Press, 2006.
3. Wayne T.Davis, "Air Pollution Engineering Manual", John Wiley & Sons, Inc, 2000.
4. M.N Rao and HVN Rao, "Air Pollution", Tata Mcgraw Hill Publishing Company limited, 2007.


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**1903515 PARTICIPATORY WATER RESOURCES MANAGEMENT `** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To gain an insight on local and global perceptions and approaches on participatory water resource management
- To know the role of farmers in socio economic issues and challenges.
- To bring the knowledge of water conservation.
- To gain knowledge on issues of water management.
- To develop knowledge on global challenges and solutions.
-

**UNIT- I: FUNDAMENTALS: SOCIOLOGY AND PARTICIPATORY APPROACH 9**

Sociology – Basic concepts – Perspectives- Social Stratification – Irrigation as a Socio technical Process - Participatory concepts– Needs for participatory -Objectives of participatory approach.

**UNIT- II: UNDERSTANDING FARMERS PARTICIPATION 9**

Farmers participation - Need and Benefits - Comparisons of cost and benefit -Sustained system performance - Kinds of participation - Context of participation, factors in the environment - WUA - Constraints in organizing FA - Role of Community Organizer – socio economic - Case Studies.

**UNIT- III: ISSUES IN WATER MANAGEMENT 9**

Multiple use of water – Issues in Inter-sectoral Water Allocation - domestic, irrigation, industrial sectors - Modernization techniques and its challenges – Command Area Development - Water delivery systems – Advantages and disadvantages.

**UNIT-IV: PARTICIPATORY WATER CONSERVATION 9**

Global Challenges -Social – Economic – Environmental - Solutions –Political - Water Marketing – Water Rights -Consumer education – Success Stories Case Studies.

**UNIT- V: PARTICIPATORY WATERSHED DEVELOPMENT 9**

Concept and significance of watershed - Basic factors influencing watershed development – Principles of watershed management - Definition of watershed management – Identification of problems - Watershed approach in Government programmes –- People's participation – Entry point activities - Evaluation of watershed management measures.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The students will be able to

- Gain knowledge on various processes involved in participatory water resource management.
- Understand farmer's participation in water resources management.
- Aware of the issues related to water conservation and watershed Development.
- Get knowledge in participatory water conservation.
- Understand concept, principle and approach of watershed management.

**TEXT BOOKS:**

1. Sivasubramaniyan, K. "Water Management", SIMRES Publication, Chennai, 2011.
2. Uphoff.N, "Improving International Irrigation management with Farmer Participation – Getting the process Right – Studies in water Policy and Management", No.11, West view press, Boulder, CO, 1986.
3. Tideman E.M., "Watershed Management", Omega Scientific Publishers, New Delhi, 1996.

**REFERENCE BOOKS:**

1. Chambers Robert, "Managing canal irrigation", Cambridge University Press, 1989.

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**1904007** **DATA STRUCTURES** **L T P C**
**3 0 0 3**

**OBJECTIVE**

- To understand Linear Data structures programs
- To understand the Non-linear data structures program
- To have an idea about implementing search techniques
- To have a better understanding in sorting techniques
- To understand the various Indexing algorithms

**UNIT- I: LINEAR DATA STRUCTURES - LIST** **9**

Introduction to structure-Abstract Data Types (ADTs) - List ADT - array-based implementation - linked list implementation - singly linked lists- circularly linked lists - applications of lists – Polynomial Manipulation.

**UNIT- II: LINEAR DATA STRUCTURES - STACKS, QUEUES** **9**

Stack ADT – Operations – Applications – Evaluating arithmetic expressions- Conversion of Infix to postfix expression – Queue ADT – Operations – Circular Queue – Priority Queue – deQueue – applications of queues.

**UNIT- III: NON LINEAR DATA STRUCTURES TREES- GRAPHS** **9**

.– Binary Trees – Binary tree representation and traversals – Application of trees: – Graph and its representations – Graph Traversals – Connected components.

**UNIT –IV: SORTING** **9**

Selection sort-Insertion sort – Merge sort – Quick sort – Heap sort – Bubble sort- Shell sort – Radix sort.

**UNIT-V: SEARCHING AND INDEXING** **9**

Linear Search – Binary Search - Hash tables – Overflow handling – Hash Index – B-Tree Indexing.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

- To learn about Linear Data structures
- Ability to describe stack queue and linked list operation
- Ability to analyze algorithms

- To understand about the tree concepts.
- Ability to summarize searching and sorting techniques.

**TEXT BOOKS:**

1. Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures, Galgotia Book Source, Gurgaon, 1976.
2. Gregory L. Heilman, Data Structures, Algorithms and Object Oriented Programming, Tata Mcgraw-Hill, New Delhi, 2002.

**REFERENCE BOOKS:**

1. Jean-Paul Tremblay and Paul G. Sorenson, An Introduction to Data Structures with Applications, Second Edition, Tata McGraw-Hill, New Delhi, 1991.
2. Alfred V. Aho, John E. Hopcroft and Jeffry D. Ullman, Data Structures and Algorithms, Pearson Education, New Delhi, 2006.

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**1904504 GEOGRAPHIC INFORMATION SYSTEM L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To introduce the fundamentals and components of Geographic Information System.
- To provide details of spatial data structures and input, management and output processes.
- To provide details about raster input data structures.
- To be familiar with network topologies.
- To analyze data analytics and various applications of GIS.

**UNIT - I: FUNDAMENTALS OF GIS 9**

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - geographical data types - Spatial, Attribute data- types of attributes – scales/ levels of measurements.

**UNIT – II: SPATIAL DATA MODELS 9**

Database Structures – Relational, Object Oriented – ER diagram - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models TIN and GRID data models - OGC standards - Data Quality.

**UNIT - III: DATA INPUT AND TOPOLOGY 9**

Scanner - Raster Data Input – Raster Data File Formats – Vector Data Input –Digitiser – Topology - Adjacency, connectivity and containment – Topological Consistency rules – Attribute Data linking – ODBC – GPS - Concept GPS based mapping.

**UNIT - IV: DATA ANALYSIS 9**

Vector Data Analysis tools - Data Analysis tools - Network Analysis - Digital Education models - 3D data collection and utilisation.

**UNIT - V: APPLICATIONS 9**

GIS Applicant - Natural Resource Management - Engineering - Navigation - Vehicle tracking and fleet management - Marketing and Business applications - Case studies.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

This course equips the student to

- Have basic idea about the fundamentals of GIS.
- Understand the types of data models.
- Get knowledge about data input and topology.
- Gain knowledge on data quality and standards.
- Understand data management functions and data output.

**TEXT BOOKS:**

1. Kang - Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.

2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, “An Introduction Geographical Information Systems, Pearson Education, 2nd Edition, 2007.

**REFERENCE BOOKS:**

1. Lo.C.P., Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall India Publishers, 2006.

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**1904508** **DATABASE MANAGEMENT SYSTEM** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To learn the fundamentals of data models and to represent a database system using ER diagrams.
- To study SQL and relational database design.
- To understand the fundamental concepts of transaction processing- concurrency control techniques recovery procedures
- To have an introductory knowledge about Query Processing.
- To analyze the different DB storage like XML,ODMG etc. in distributed environment

**UNIT- I: INTRODUCTION TO DATABASE 9**

Purpose of Database System – Views of data – Data Models – Database System Architecture – Introduction to relational databases – Relational Model – Keys – Entity-Relationship model – E-R Diagrams – Enhanced-ER Model – ER-to-Relational Mapping.

**UNIT-II: RELATIONAL DATABASE 9**

Relational Model – Keys – Relational Algebra – SQL fundamentals – Advanced SQL features – Embedded SQL– Dynamic SQL.

**UNIT- III: DATABASE DESIGN 9**

Functional Dependencies – Non-loss Decomposition -First, Second, Third Normal Forms, Dependency Preservation – Boyce Codd Normal Form – Multi-valued Dependencies and Fourth Normal Form – Join Dependencies and Fifth Normal Form.

**UNIT- IV: TRANSACTION PROCESSING AND CONCURRENCY CONTROL 9**

Transaction Concepts – ACID Properties – Schedules – Serializability – Concurrency Control – Need for Concurrency – Locking Protocols – Two Phase Locking – Deadlock – Transaction Recovery - Save Points – Isolation Levels – SQL Facilities for Concurrency and Recovery.

**UNIT - V: IMPLEMENTATION TECHNIQUES 9**

RAID – File Organization – Organization of Records in Files – Indexing and Hashing –Ordered

Indices – B+ tree Index Files – B tree Index Files – Static Hashing – Dynamic Hashing – Query Processing Overview – Query optimization using Heuristics and Cost Estimation.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, students will be able to:

- Classify the modern and futuristic database applications based on size and complexity
- Map ER model to Relational model to perform database design effectively
- Write queries using normalization criteria and optimize queries.
- Compare and contrast various indexing strategies in different database systems
- Appraise how advanced databases differ from traditional databases.

**TEXT BOOKS:**

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, Database System Concepts, Sixth Edition, Tata McGraw Hill, 2011
2. Ramez Elmasri, Shamkant B. Navathe, ―Fundamentals of Database Systems, Sixth Edition, Pearson, 2011.

**REFERENCE BOOKS:**

1. C. J. Date, A.Kannan, S. Swamynathan, ―An Introduction to Database Systems‖, Eighth Edition, Pearson Education, 2006.
2. Raghu Ramakrishnan, ―Database Management Systems‖, Fourth Edition, McGraw-Hill College Publications, 2015.
3. G.K.Gupta, "Database Management Systems‖, Tata McGraw Hill, 2011.

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**1904509** **CLOUD COMPUTING** **L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To understand the concept of cloud computing.
- To appreciate the evolution of cloud from the existing technologies.
- To have knowledge on the various issues in cloud computing.
- To be familiar with the lead players in cloud.
- To appreciate the emergence of cloud as the next generation computing paradigm.

**UNIT–I: INTRODUCTION** **9**

Introduction to Cloud Computing – Definition of Cloud – Evolution of Cloud Computing – Underlying Principles of Parallel and Distributed Computing – Cloud Characteristics.

**UNIT- II: CLOUDENABLING TECHNOLOGIES** **9**

Service Oriented Architecture – REST and Systems of Systems – Web Services – Publish Subscribe Model – Basics of Virtualization – Types of Virtualization – Implementation Levels of Virtualization – Virtualization Structures – Tools and Mechanisms – Virtualization of CPU – Memory – I/O Devices.

**UNIT- III: CLOUD ARCHITECTURE, SERVICES AND STORAGE** **9**

Layered Cloud Architecture Design – NIST Cloud Computing Reference Architecture – ublic, Private and Hybrid Clouds - laaS – PaaS – SaaS – Architectural Design Challenges – Cloud Storage – Storage-as-a-Service – Advantages of Cloud Storage – Cloud Storage Providers – S3.

**UNIT- IV: RESOURCE MANAGEMENT AND SECURITY IN CLOUD** **9**

Inter Cloud Resource Management – Resource Provisioning and Resource Provisioning Methods – Global Exchange of Cloud Resources – Security Overview – Cloud Security Challenges – Software-as-a-Service Security – Security Governance – Virtual Machine Security – IAM – Security Standards.

**UNIT- V: CLOUD TECHNOLOGIES AND ADVANCEMENTS** **9**

Hadoop – Map Reduce –Google App Engine – Programming Environment for Google App Engine –– Amazon Web services-Open Stack – Federation in the Cloud.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On Completion of the course, the students should be able to:

- Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
- Learn the key and enabling technologies that help in the development of cloud.
- Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models.
- Explain the core issues of cloud computing such as resource management and security.
- Be able to install and use current cloud technologies.

**TEXT BOOKS:**

1. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. Rittinghouse, John W., and James F. Ransome, ―Cloud Computing: Implementation, Management and Security, CRC Press, 2017.

**REFERENCE BOOKS:**

1. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, ―Mastering Cloud Computing, Tata McGraw Hill, 2013.
2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing - A Practical Approach, Tata McGraw Hill, 2009.
3. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice), O'Reilly, 2009.

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**1906505** **PHOTONIC NETWORKS** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

The student should be made:

- To enable the students to manifest the components used is the optical system, propagation of signals and their impairments in optical fiber.
- To enable the student to understand the importance of the backbone infrastructure for our present and future communication needs.
- To familiarize the students about the optical network architectures and the protocol stack in use.
- To enable the student to understand the differences in the design of data plane and the control plane and the routing, switching and the resource allocation methods and the network management and protection methods in vogue.
- To expose the student to the advances in networking and switching domains and the future trends.

**UNIT - I: OPTICAL SYSTEM COMPONENTS 9**

Light Propagation in optical fibers – Loss & bandwidth, System limitations, Nonlinear effects; Solitons; Optical Network Components – Couplers, Isolators & Circulators, Multiplexers & Filters, Optical Amplifiers, Switches, Wavelength Converters.

**UNIT - II: OPTICAL NETWORK ARCHITECTURES 9**

Introduction to Optical Networks; Wavelength Division Multiplexing, optical add/drop multiplexer, SONET / SDH, Metropolitan-Area Networks, Layered Architecture; Broadcast and Select Networks – Topologies for Broadcast Networks, Media-Access Control Protocols, Wavelength Routing Architecture.

**UNIT - III: WAVELENGTH ROUTING NETWORKS 9**

The optical layer, Optical Network Nodes, Routing and wavelength assignment, Traffic Grooming in Optical Networks, Architectural variations- Linear Light wave networks, Logically Routed Networks.

**UNIT - IV: PACKET SWITCHING AND ACCESS NETWORKS 9**

Photonic Packet Switching – OTDM, Multiplexing and Demultiplexing, Synchronization, Broadcast OTDM networks, Switch-based networks, Contention Resolution Access Networks – Network Architecture overview, Optical Access Network Architectures and OTDM networks, OTDR.

**UNIT - V: NETWORK DESIGN AND MANAGEMENT 9**

Transmission System Engineering – System model, Power penalty - transmitter, receiver, Optical amplifiers, crosstalk, dispersion, Wavelength stabilization, Overall design considerations, Control and Management – Network management functions, Configuration management, Performance management, Fault management, Optical safety, Service interface.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The student should be able to:

- Elucidate the components in an optical system.
- Use the backbone infrastructure for our present and future communication needs.
- Analyze the architectures and the protocol stack.
- Compare the differences in the design of data plane, control plane, routing, switching and resource allocation methods.
- Annotate the network management and protection methods in vogue.

**TEXT BOOKS:**


1. Rajiv Ramaswami and Kumar N. Sivarajan, "Optical Networks: A Practical Perspective", Second Edition, Harcourt Asia Pte Ltd., 2004.
2. Siva Ram Moorthy and Mohan Gurusamy, "WDM Optical Networks: Concept, Design and Algorithms", 1st Edition, Prentice Hall of India, 2002.


**REFERENCE BOOKS:**


1. John M. Senior, "Optical Fiber Communication", 3rd edition, Prentice Hall,2009.
2. Uyless N. Black, "Optical Networks, Third Generation Transport Systems", 1st Edition, Prentice hall of India, 2002.
3. Biswanath Mukherjee, "Optical WDM Networks", Springer Series, 2006.
4. Govind P. Agrawal, "Fiber Optic Communication Systems", 3rd Edition, Wiley India (P) Ltd, 2002.

5. Gerd Keiser, “Optical Fiber Communication”, 5th Edition, McGraw Hill Education (India) Pvt. Ltd. , 2013.

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**1906506 TELECOMMUNICATION NETWORK MANAGEMENT L T P C**

**3 0 0 3**

**OBJECTIVES:**

The student should be made:

- To understand the concept of network management standards.
- To design the common management information service element model.
- To analyze the various concept of information modeling.
- To examine the concept of SNMPv1 and SNMPv2 protocol.
- To exhibit the examples of network management.

**UNIT-I:BASIC FOUNDATIONS AND NETWORK MANAGEMENT APPLICATIONS 9**

Network management standards–Network management model– Organization model– Information model - Abstract syntax notation One (ASN.1) – Encoding structure– Macros –Functional model. Network management applications functional requirements: Configuration management– Fault management–Performance management–Error correlation technology– Security management– Accounting management– Common management–report management– Policy based management – Service level management – Management service– Community definitions– capturing the requirements– simple and formal approaches–semi formal and formal notations.

**UNIT - II: COMMON MANAGEMENT INFORMATION SERVICE ELEMENT 9**

CMISE model–service definitions–errors–scooping and filtering features– synchronization–functional units– association services– common management information protocol specification.

**UNIT - III: INFORMATION MODELING FOR TMN 9**

Rationale for information modeling–management information model–object oriented modeling paradigm– structure of management information–managed object class definition–management information base.

**UNIT - IV: SIMPLE NETWORK MANAGEMENT PROTOCOL 9**

SNMPv1: Managed networks–SNMP models– organization model– Information model–SNMPv1 communication model–functional model. SNMPv2-major changes in SNMPv2–structure of management information, MIB–SNMPv2 protocol– compatibility with SNMPv1. SNMPv3–architecture–applications–MIB- security, SNMP Management: remote monitoring–SMI and MIB–RMON1 and RMON2.

**UNIT - V: NETWORK MANAGEMENT EXAMPLES 9**

ATM integrated local management interface–ATM MIB–M1– M2–M3–M4–interfaces–ATM digital exchange interface management–digita1 subscriber loop and asymmetric DSL technologies–ADSL configuration management–performance management Network management tools: Network statistics management–network management system–management platform case studies: OPENVIEW–ALMAP.

**TOTAL :45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student should be able to,

- Design and analyze of fault management.
- Analyze the common management information protocol specifications.
- Explain the functioning and design of management information model.
- Describe the simple network management protocol.
- Interpret the various types of network management tools with case studies.

**TEXT BOOKS:**


1. Mani Subramanian, “Network Management: Principles and Practice”, Pearson Education, Second edition, 2010.
2. Lakshmi G Raman, “Fundamentals of Telecommunications Network Management”, Wiley, 1999.


**REFERENCE BOOKS:**


1. Henry Haojin Wang, “Telecommunication Network Management”, Mc- Graw Hill, 1999.
2. Salah Aidarous & Thomas Plevyak, “Telecommunication Network Management: Technologies and Implementations”, Wiley, 1997.
3. Singh B, “Network Security and Management”, Eastern Economy Edition, 2012.


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**1906507** **ENTERTAINTRONICS** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

The student should be made:

- To understand the basics of display devices.
- To enhance the student knowledge in Audio broadcasting systems.
- To enable the student to learn about Television systems.
- To develop the student knowledge in Interactive Gaming Applications.
- To apply the knowledge of Consumer Electronic Applications.

**UNIT - I: DISPLAY DEVICES 9**

Introduction – Underlying technologies of displays -Types of Electronic displays – Segment displays –Two dimensional displays: Liquid Crystal display, Light emitting diode display – Three dimensional displays: Laser display, Holographic display – Applications.

**UNIT - II: AUDIO BROADCASTING SYSTEMS 9**

Loud Speakers: construction, working principles and applications of crystal, condenser and dynamic loudspeakers – Tweeters, Squawkers & Woofers - Public address system - Requirements of Public Addressing system -Microphones: construction, working principles and applications of Carbon, Moving coil and Crystal microphones. Headphones: Principle of operation of crystal and dynamic and Bluetooth based headphones.

**UNIT - III: TELEVISION SYSTEMS 9**

Basics of Television: Television standards, frequency bands, Scanning method, interlacing and synchronization, bandwidth, Advanced TV systems: LCD, LED, HDTV,3DTV, Smart TV. Color concepts, concepts of luminance, Hue and Saturation, Color TV (PAL Systems). Cable TV concepts, Closed Circuit Television.

**UNIT - IV: INTERACTIVE GAMING APPLICATIONS 9**

Fundamental of game design - Gaming scenarios – Interfaces- Multi player interactive gaming – Programming concepts – educational games – Privacy and security in games – Introduction to Android games and its development – Online games.

**UNIT - V: CONSUMER ELECTRONIC APPLICATIONS 9**

Principle of operation of digital clocks, electronic calculator, cellular phones- smart phonesmicrowave ovens, washing machines, air conditioners, ATMs and set-top-boxes – Compact Ultrafast Fiber lasers for Consumer electronics – Virtual reality applications, Alexa.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

The student should be able to:

- Understand the basic applications of display devices.
- Analyze the operation of Audio devices and its applications.
- Know the basic TV Standards and the basics of Television.
- Design the Gaming scenarios and knowing programming concepts.
- Apply the knowledge on the applications of Consumer electronics.

**TEXT BOOKS:**

1. Shoichi Matsumoto, "Electronic display devices", Wiley, 1990.
2. Ajay Sharma, "Audio video and TV Engineering-Consumer Electronics", Dhanpat Rai and co, 2003.
3. R.G. Gupta, "Audio and Video systems", Tata Mc Graw Hill Publishing Co.Ltd, 2010.

**REFERENCE BOOKS:**

1. R. Gulati, "Monochrome and Color Television", New Age International (P) Ltd, New Delhi, 2014.
2. S P Bali, "Consumer Electronics", Pearson, 2007.

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**1907503** **SENSORS AND TRANSDUCERS** **L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To understand the concepts of measurement technology.
- To learn the applications and working of motion and ranging sensors.
- To explore the latest sensor technologies like MEMS & nano sensors, smart sensors
- To learn the various sensors used to measure various physical parameters.
- To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development.

**UNIT - I: INTRODUCTION** **9**

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

**UNIT – II: MOTION, PROXIMITY AND RANGING SENSORS** **9**

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer.,– GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

**UNIT – III: FORCE, MAGNETIC AND HEADING SENSORS** **9**

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

**UNIT-IV: OPTICAL, PRESSURE AND TEMPERATURE SENSORS** **9**

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

**UNIT – V: SIGNAL CONDITIONING and DAQ SYSTEMS** **9**

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring. **TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the students will be able to:

- Explain various calibration techniques and signal types for sensors.
- Understand the basic principles of various sensors.
- Illustrate the basic principles of various smart sensors.
- Apply the various sensors in the Automotive and Mechatronics applications
- Implement the DAQ systems with different sensors for real time applications

**TEXT BOOKS:**


1. Ernest O Doebelin, Dhanesh N.Manik "Measurement Systems – Applications and Design", seventh Edition McGraw-Hill, 2019.
2. 2. Sawney A K and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", 12$^{th}$ edition, Dhanpat Rai & Co, New Delhi, 2013.


**REFERENCE BOOKS:**


1. Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2010.
2. 2. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 1999.
3. 3. Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press, 2015.


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**1907504 INSTRUMENTATION IN BIOMEDICAL ENGINEERING L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To study about the different bio potential and its propagation
- To understand the different types of electrodes and its placement for various recording
- To study the design of bio amplifier for various physiological recording
- To learn the different measurement techniques for non-physiological parameters.
- To familiarize the different biochemical measurements.

**UNIT –I: BIO POTENTIAL GENERATION AND ELECTRODES TYPES 9**

Origin of bio potential and its propagation. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - measurement with two electrodes

**UNIT- II: BIOSIGNAL CHARACTERISTICS AND ELECTRODECONFIGURATIONS 9**

Biosignals characteristics – frequency and amplitude ranges. ECG – Einthoven's triangle, standard 12 lead system. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode.

**UNIT –III: SIGNAL CONDITIONING CIRCUITS 9**

Need for bio-amplifier - differential bio-amplifier, Impedance matching circuit, isolation amplifiers, Power line interference, Right leg driven ECG amplifier, Band pass filtering

**UNIT –IV: MEASUREMENT OF NON-ELECTRICALPARAMETERS 9**

Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - Auscultatory method, direct methods: electronic manometer, Systolic, diastolic pressure, Blood flow and cardiac output measurement: Indicator dilution, and dye dilution method, ultrasound blood flow measurement.

**UNIT –V: BIO-CHEMICAL MEASUREMENT 9**

Blood gas analyzers and Non-Invasive monitoring, colorimeter, Sodium Potassium Analyser, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description).

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student should be able to:

- Understand the different bio potential and its propagation.
- Explain the different electrode placement for various physiological recording
- Design bio amplifier for various physiological recording
- Understand various technique of non-electrical physiological measurements
- Understand the different biochemical measurements

**TEXT BOOKS:**


1. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 2007.
2. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2004. (Units I, II & V)


**REFERENCE BOOKS:**


1. Myer Kutz, "Standard Handbook of Biomedical Engineering and Design", McGraw Hill Publisher, 2003.
2. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 2003.(Units II & IV)
3. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.


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**1908001 3D PRINTING AND DESIGN L T P C**

**3 0 0 3**

**OBJECTIVES:**

- The course is designed to impart knowledge and skills related to 3D printing technologies.
- Selection of material and equipment and develop a product using this technique.
- To understand Industry 4.0 environment.
- To understand CAD and Additive manufacturing
- To understand Additive Equipment.

**UNIT- I: 3D PRINTING AND ADDITIVE MANUFACTURING 9**

Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing Processes, Applications.

**UNIT- II: CAD AND ADDITIVE MANUFACTURING 9**

CAD for Additive Manufacturing-CAD Data formats, Data translation, Data loss, STL format. Additive Manufacturing Techniques - Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology.

**UNIT- III: PROCESS 9**

Process, Process parameter, Process Selection for various applications. Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools

**UNIT –IV: MATERIALS 9**

Polymers, Metals, Non-Metals, Ceramics, Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties. Support Materials.

**UNIT –V: ADDITIVE MANUFACTURING EQUIPMENT 9**

Process Equipment- Design and process parameters-Governing Bonding Mechanism- Common faults and troubleshooting - Process Design- Post Processing: Requirement and Techniques-Product Quality.

**TOTAL: 45 PERIODS**

**OUTCOMES**

At the end of the course, the student should be able to:

- Develop CAD models for 3D printing.
- Import and Export CAD data and generate .stl file.
- Select a specific material for the given application.
- Select a 3D printing process for an application.
- Produce a product using 3D Printing or Additive Manufacturing (AM).

**TEXT BOOKS**

1. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.

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**1908002 SCRIPTING LANGUAGES L T P C**

**3 0 0 3**

**OBJECTIVES:**

- The principles of scripting languages.
- Difference between scripting languages and non- scripting languages.
- Types of scripting languages.
- Scripting languages such as PERL, TCL/TK, python and BASH.
- Creation of programs in the Linux environment and usage of scripting languages in IC design flow.

**UNIT- I: LINUX BASICS 9**

Introduction to Linux , File System of the Linux, General usage of Linux kernel & basic commands, Linux users and group, Permissions for file, directory and users, searching a file & directory, zipping and UNZIPPING CONCEPTS.

**UNIT- II: LINUX NETWORKING 9**

Introduction to Networking in Linux, Network basics & Tools, File Transfer Protocol in Linux, Network file system, Domain Naming Services, Dynamic hosting configuration Protocol & Network information Services.

**UNIT- III: PERL SCRIPTING 9**

Introduction to Perl Scripting, working with simple values, Lists and Hashes, Loops and Decisions, Regular Expressions, Files and Data in Perl Scripting, References & Subroutines, Running and Debugging Perl, Modules, Object – Oriented Perl.

**UNIT- IV: TCL / TK SCRIPTING 9**

Tcl Fundamentals, String and Pattern Matching, Tcl Data Structures, Control Flow Commands, Procedures and Scope, Evel, Working with Unix, Reflection and Debugging, Script Libraries, Tk Fundamentals, Tk by examples, The Pack Geometry Manager, Binding Commands to X Events, Buttons and Menus, Simple Tk Widgets, Entry and List box Widgets Focus, Grabs and Dialogs.

**UNIT –V: PYTHON SCRIPTING 9**

Introduction to Python, using the Python Interpreter, More Control Flow Tools, Data Structures, Modules, Input and Output, Errors and Exceptions, Classes, Brief Tour of the Standard Library.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student should be able to:

- Create and run scripts using PERL in IC design flow.
- Create and run scripts using TCl in IC design flow
- Create and run scripts using Python in IC design flow
- Use Linux environment and write programs for automation of scripts in VLSI tool design flow.
- Usage of scripting languages in IC design flow.

**TEXT BOOKS:**

- Python Tutorial by Guido Van Rossum, Fred L. Drake Jr. editor , Release 2.6.4
- Practical Programming in Tcl and Tk by Brent Welch, Updated for Tcl 7.4 and Tk4.0.
- Teach Yorself Perl in 21 days by David Till.
- Red Hat Enterprise Linux 4 : System Administration Guide Copyright, 2005 Red Hat Inc.

**REFERENCE BOOKS:**

1. 1. Learning Python – 2nd Ed., Mark Lutz and David Ascher, 2003, O'Reilly.
2. Perl in 24 Hours – 3rd Ed., Clinton Pierce, 2005, Sams Publishing.
3. Learning Perl – 4th Ed. Randal Schwartz, Tom Phoenix and Brain d foy. 2005.
4. Python Essentials – Samuele Pedroni and Noel Pappin.2002. O'Reilly.
5. Programming Perl – Larry Wall, Tom Christiansen and John Orwant, 3rd Edition, O'Reilly, 2000. (ISBN 0596000278)

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**1905001 ENERGY CONSERVATION AND MANAGEMEN** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

At the end of the course, the student is expected to

1. Understand and analyse the energy data of industries.
2. Carryout energy accounting and balancing.
3. Conduct energy audit and suggest methodologies for energy savings.
4. Utilize the available resources in optimal ways
5. Understand and analyse of Energy Economics.

**UNIT-I: INTRODUCTION 9**

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

**UNIT-II: ELECTRICAL SYSTEMS 9**

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

**UNIT-III: THERMAL SYSTEMS 9**

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters Efficiency Computation and encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization And Insulators & Refractories.

**UNIT-IV: ENERGY CONSERVATION IN MAJOR UTILITIES 9**

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets.

**UNIT-V: ECONOMICS 9**

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept. **TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

- Can able to analyse the energy data.
- Can carry out energy accounting and balancing.
- Can suggest methodologies for energy savings.
- Can carry out Energy Conservation in Major Utilities.
- Can suggest methodologies for Energy Economics.

**TEXTBOOKS:**

1. Energy Manager Training Manual (4 Volumes) available at www.energymanager training.com, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004

**REFERENCE BOOKS:**

1. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
2. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford,1981.
3. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982.
4. Turner. W.C., "Energy Management Hand book", Wiley, New York, 1982.
5. Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987.

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**1905508 RENEWABLE ENERGY SOURCES**

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**OBJECTIVES:**

- To get exposure on solar radiation and its environmental impact to power.
- To know about the various collectors used for storing solar energy.
- To know about the various applications in solar energy.
- To learn about the wind energy and biomass and its economic aspects.
- To know about geothermal energy with other energy sources.

**UNIT-I: PRINCIPLES OF SOLAR RADIATION 10**

Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

**UNIT-II: SOLAR ENERGY COLLECTION 8**

Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

**UNIT-III: SOLAR ENERGY STORAGE AND APPLICATIONS 8**

Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications-solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

**UNIT-IV: WIND ENERGY 10**

Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria BIO-MASS: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C. Engine operation and economic aspects.

**UNIT-V: GEOTHERMAL ENERGY 9**

Resources, types of wells, methods of harnessing the energy, potential in India. OCEAN

ENERGY: OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics. DIRECT ENERGY CONVERSION: Need for DEC, Carnot cycle, limitations, principles of DEC-Magneto Hydro Dynamic power generation

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

- Understanding the physics of solar radiation.
- Ability to classify the solar energy collectors and methodologies of storing solar energy.
- Knowledge in applying solar energy in a useful way.
- Knowledge in wind energy and biomass with its economic aspects.
- Knowledge in capturing and applying other forms of energy sources like wind, biogas and geothermal energies.

**TEXT BOOKS:**

1. Rai G.D., "Non-Conventional Energy Sources", Khanna Publishers, 2011.
2. Twidell & Wier, "Renewable Energy Resources", CRC Press (Taylor & Francis), 2011.

**REFERENCE BOOKS:**

1. Tiwari and Ghosal, "Renewable energy resources", Narosa Publishing House, 2007.
2. Ramesh R & Kumar K.U, "Renewable Energy Technologies", Narosa Publishing House, 2004.
3. Mittal K M, "Non-Conventional Energy Systems", Wheeler Publishing Co. Ltd, New Delhi, 2003.

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**1905509 SCADA SYSTEM MANAGEMENT** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

- 1.To provide knowledge about the SCADA system and its architecture
- To provide knowledge about SCADA system components
- To provide knowledge about SCADA communication protocols
- To provide knowledge about SCADA monitoring and control in power system
- To provide knowledge about SCADA applications in power system

**UNIT- I: INTRODUCTION 9**

Evolution of SCADA, SCADA definitions, SCADA Functional requirements and Components, SCADA Hierarchical concept, SCADA architecture, General features, SCADA Applications, Benefits.

**UNIT- II: SCADA SYSTEM COMPONENTS 9**

Remote Terminal Unit (RTU), Interface units, Human- Machine Interface Units (HMI), Display Monitors/Data Logger Systems, Intelligent Electronic Devices (IED),Communication Network, SCADA Server, SCADA Control systems and Control panels.

**UNIT- III: COMMUNICATION 9**

SCADA Communication requirements, Communication protocols: Past, Present and Future, Structure of a SCADA Communications Protocol, Comparison of various communication protocols, IEC61850 based communication architecture, Communication media like Fiber optic, PLCC etc. Interface provisions and communication extensions, synchronization with NCC, DCC.

**UNIT –IV: MONITORING AND CONTROL 9**

Online monitoring the event and alarm system, trends and reports, Blocking list, Event disturbance recording. Control function: Station control, bay control, breaker control and disconnector control.

**UNIT –V: APPLICATIONS IN POWER SYSTEM 9**

Applications in Generation, Transmission and Distribution sector, Substation SCADA system Functional description, System specification, System selection such as Substation configuration, IEC61850 ring configuration, SAS cubicle concepts, gateway interoperability list signal naming concept, System Installation, Testing and Commissioning. **TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

- This course gives knowledge about SCADA SYSTEM and its architecture
- This course gives knowledge about various system components of SCADA system.
- This course gives knowledge about various communication protocols of SCADA system.
- This course gives knowledge about SCADA monitoring and control in power system.
- This course gives knowledge about SCADA system applications.

**TEXTBOOKS:**

1. Stuart A. Boyer: SCADA-Supervisory Control and Data Acquisition, Instrument Society of America Publications,USA,2004
2. Gordon Clarke, Deon Reynders: Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems, Newnes Publications, Oxford, UK,2004

3 William T. Shaw, Cybersecurity for SCADA systems, PennWell Books, 2006.

**REFERENCE BOOKS:**

1. David Bailey, Edwin Wright, Practical SCADA for industry, Newnes, 2003
2. Michael Wiebe, A guide to utility automation: AMR, SCADA, and IT systems for electric Power, PennWell 1999.
3. Dieter K. Hammer, Lonnie R. Welch, Dieter K. Hammer, "Engineering of Distributed Control Systems", Nova Science Publishers, USA, 1st Edition, 2001.

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**1910504 PRINCIPLES OF FOOD PRESERVATION**

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**OBJECTIVES:**

- To learn about the shelf life of food products.
- To gain knowledge on the storage of food products.
- To know about the thermal processing methods of food products.
- To design different types of Dryers.
- To understand the non-thermal methods of food preservation.

**UNIT – I: FOOD PRESERVATION AND ITS IMPORTANCE 9**

Introduction to food preservation. Wastage of processed foods; Shelf life of food products; Types of food based on its perishability. Traditional methods of preservation.

**UNIT – II: METHODS OF FOOD HANDLING AND STORAGE 9**

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.retort pouch packing, Aseptic packaging.

**UNIT – III: THERMAL METHODS 9**

Newer methods of thermal processing; batch and continuous; In container sterilization- canning; application of infra-red microwaves; ohmic heating; control of water activity; preservation by concentration and dehydration; osmotic methods.

**UNIT – IV: DRYING PROCESS FOR TYPICAL FOODS 9**

Rate of drying for food products; design parameters of different type of dryers; properties of air-water mixtures. Psychrometric chart, freezing and cold storage.freeze concentration, dehydro-freezing, freeze drying, IQF; calculation of refrigeration load, design of freezers and cold storages.

**UNIT – V: NON-THERMAL METHODS 9**

Super Critical Technology for Preservation - Chemical preservatives, preservation by ionizing radiations, ultrasonics, high pressure, fermentation, curing, pickling, smoking, membrane technology. Hurdle technology,

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course the students are expected to

- Be aware of the different thermal processing methods of food products.
- Understand the concept of food storage.
- Be familiarize with shelf life of food products.
- Recognize the different types of dryers.
- Acquire knowledge on non-thermal methods of food preservation.

**TEXT BOOKS:**

1. Karnal, Marcus and D.B. Lund "Physical Principles of Food Preservation". Rutledge, 2003.
2. VanGarde, S.J. and Woodburn. M "Food Preservation and Safety Principles and Practice".Surbhi Publications, 2001.
3. Sivasankar, B. "Food Processing & Preservation", Prentice Hall of India, 2002.
4. Khetarpaul, Neelam, "Food Processing and Preservation", Daya Publications, 2005.

**REFERENCE BOOKS:**

1. Rahman, M. Shafiur. "Handbook of Food Preservation". Marcel & Dekker, 2006.
2. Zeuthen, Peter and Bogh- Sarensen, Leif. "Food Preservation Techniques". CRC / Wood Head Publishing, 2003.
3. Ranganna, S. "Handbook of Canning and Aseptic Packaging". Tata McGraw-Hill, 2000.

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**1920501** **NANOTECHNOLOGY** **L T P C**
**3 0 0 3**

**OBJECTIVES:**

- Make the students to understand the fundamentals of nanomaterials.
- To acquire the knowledge on different classifications in nano materials.
- To educate the different synthesis techniques.
- To provide information on different fabrication and characterization techniques.
- Make the students to understand and apply the techniques to different systems.

**UNIT -I: BASICS OF NANOTECHNOLOGY 9**

Introduction –Scientific revolutions –Time and length scale in structures –Definition of a nanosystem –Dimensionality and size dependent phenomena –Surface to volume ratio -Fraction of surface atoms-Properties at nanoscale (optical, mechanical, electronic and magnetic).

**UNIT- II:DIFFERENT CLASSES OF NANOMATERIALS 9**

Classification based on dimensionality-Quantum Dots, Wells and Wires-Carbon-based nano materials (buckyballs, nanotubes, graphene)–Metal based nano materials (nanogold, nanosilver and metal oxides) –Nanocomposites-Nanopolymers –Nanoglasses –Nano ceramics.

**UNIT-III: SYNTHESIS OF NANOMATERIALS 9**

Classification of synthesis: Top down and bottom up nanofabrication. Chemical Methods: Solvothermal Synthesis-Photochemical Synthesis –Sonochemical Routes-Chemical Vapor Deposition (CVD) –Metal Oxide -Chemical Vapor Deposition (MOCVD). Physical Methods: Ball Milling –Electrodeposition -Spray Pyrolysis -Flame Pyrolysis - DC/RF Magnetron Sputtering -Molecular Beam Epitaxy (MBE).

**UNIT-IV: FABRICATION AND CHARACTERIZATION OF NANOSTRUCTURES 9**

Nanofabrication: Photolithography and its limitation-Electron-beam lithography (EBL)-Nanoimprint –Softlithography patterning. Characterization: Environmental Scanning Electron Microscopy (ESEM) High Resolution Transmission Electron Microscope (HRTEM) –Scanning Tunneling Microscope (STM)-Surface enhanced Raman spectroscopy (SERS)-X-ray Photoelectron Spectroscopy (XPS) -Auger electron spectroscopy (AES).

**UNIT-V:APPLICATIONS** **9**

Solar energy conversion and catalysis -Molecular electronics and printed electronics – Nanoelectronics -Polymers with a special architecture -Liquid crystalline systems -optical properties, Applications in displays and other devices -Photonics, Plasmonics-Chemical and biosensors –Nanomedicine and Nanobiotechnology –Nanotoxicology challenges.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- Able to understand the basics of nanoscience.
- Able to differentiate the materials based on their structures.
- Ability to understand the different synthesis techniques of nanomaterials.
- Ability to identify various fabrication techniques and characterization of nanostructures.
- Able to apply them for suitable applications.

**TEXT BOOKS:**

1. Bhusan, Bharat (Ed), “Springer Handbook of Nanotechnology”, 2nd Edition, 2007.
2. Hari Singh Nalwa, “Nanostructured Materials and Nanotechnology”, Academic Press, 2002.
3. Pradeep T., “A Textbook of Nanoscience and Nanotechnology”, Tata McGraw Hill Education Pvt. Ltd., 2012.

**REFERENCE BOOKS:**

1. Charles P. Poole Jr., Frank J. Ownes, ‘Introduction to Nanotechnology”, Wiley inter science, 2003.

2. Dupas C., Houdy P., Lahmani M., “Nanoscience: Nanotechnologies and Nanophysics”, Springer –Verlag Berlin Heidelberg, 2007.

3. Mark Ratner and Daniel Ratner, “Nano Technology”, Pearson Education, New Delhi, 2003.

4.Nabok A., “Organic and Inorganic Nanostructures”, Artech House, 2005.

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**1920502** **MICROSCOPY** **L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To introduce the basic principles of optical and electron microscopy.
- To elucidate the different microscopic techniques.
- To explore the knowledge on electron microscopy
- Make the students to learn the sample preparation techniques for the micro structural analysis.
- To investigate on different chemical analysis techniques.

**UNIT- I: INTRODUCTION 9**

History of Microscopy, Overview of current microscopy techniques. Light as particles and waves, Fundamental of optics: Diffraction and interference in image formation, real and virtual images, Resolution, Depth of field and focus, Magnification, Numerical aperture, Aberration of lenses. Components of Light Microscopy, Compound light microscopy and its variations**.**

**UNIT- II: MICROSCOPY 9**

Phase contrast microscopy: optical design, theory, image interpretation, Dark-field microscopy: optical design, theory, image interpretation, Polarization Microscopy: Polarized light, optical design, theory, image interpretation, Differential Interference Contrast (DIC): equipment and optics, image interpretation, Modulation contrast microscopy: contrast methods using oblique illumination.

**UNIT- III: ELECTRON MICROSCOPY 9**

Interaction of electrons with matter, elastic and inelastic scattering, secondary effects, Components of electron microscopy: Electron sources, pumps and holders, lenses, apertures, and resolution. Scanning Electron and Transmission Electron Microscopy: Principle, construction, applications and limitations.

**UNIT- IV: SAMPLE PREPARATION FOR MICROSTRUCTURAL ANALYSIS 9**

Optical Microscopy sample preparation: Grinding, polishing and etching, SEM sample preparation: size constrains, TEM sample preparation: Disk preparation, electro polishing, ion milling, lithography, storing specimens.

**UNIT-V: CHEMICAL ANALYSIS** **9**

Surface chemical composition (Principle and applications) - Mass spectroscopy and X-ray emission spectroscopy - Energy Dispersive Spectroscopy- Wave Dispersive Spectroscopy. Electron spectroscopy for chemical analysis (ESCA), X ray Photoelectron Spectroscopy (XPS), Auger Electron Spectroscopy (AES)- Applications.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student should be

- Able to understand the physics behind the microscopy.
- Ability to describe the principle, construction and working of light microscopy.
- Ability to describe electron microscopy.
- Ability to understand about the important of sample preparation technique.
- Ability to identify the appropriate spectroscopy technique for chemical analysis.

**TEXT BOOKS:**

1. Douglas B. Murphy, Fundamentals of light microscopy and electronic imaging, 2001, Wiley- Liss, Inc. USA
2. David B. Williams and C. Barry Carter, Transmission Electron Microscopy-A Textbook for Materials Science, Springer US, 2nd edition, 2009.

**REFERENCE BOOKS:**

1. Brandon D. G, “Modern Techniques in Metallography”, Von Nostrand Inc. NJ, USA,1986.
2. Whan R E (Ed), ASM Handbook, Volume 10, Materials Characterization“, Ninth Edition, ASM international, USA, 1986.
3. Thomas G., “Transmission electron microscopy of metals”, John Wiley, 1996.

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**1921501 ADVANCED ENGINEERING CHEMISTRY L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To make the students conversant with basics of polymer chemistry.
- Principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.
- To acquaint the student with concepts of important photophysical and photochemical processes and spectroscopy.
- To make the student acquire sound knowledge of second law of thermodynamics and second law based derivations of importance in engineering applications in all disciplines.
- To develop and understand the basic concepts of phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys.

**UNIT-I: POLYMERS AND SPECIALITY POLYMER 9**

Polymers – Types of polymerization – Degree of polymerization – Plastics and types – Mechanism of polymerization (free radical mechanism) properties of polymers - $T_g$ and tacticity – Compounding of plastics – Fabrication of plastics – Blow and extrusion mouldings. Speciality polymers-Conducting polymers: Polyacetylene, polyaniline, synthesis, mechanism of conduction – Applications of conducting polymers. Bio-degradable polymers: Requirements, factors affecting degradation – PLA– preparation, properties –applications.

**UNIT-II: ENERGY SOURCES AND STORAGE DEVICES 9**

Solar energy conversion – Solar cells: Types – Wind energy. Batteries: Types of batteries – Primary battery (alkaline battery), secondary battery (lead acid battery, NICAD battery, lithium, lithium-ion & lithium-sulphur battery), fuel cells – $H_2$-$O_2$ fuel cell.

**UNIT-III: PHOTO CHEMISTRY & ANALYTICAL TECHNIQUES 9**

Photochemistry: Laws of photochemistry - Grothuss–Draper law, Stark–Einstein law and Beer-Lambert's Law. Quantum efficiency – determination - Photophysical processes (Jablonski diagram) - photosensitization - Chemiluminescence and bioluminescence. Analytical techniques: IR, UV – principle, Instrumentation and applications. Thermal analysis: TGA & DTA - principle, instrumentation and applications. Chromatography: Basic principles of column & TLC – principles and applications.

**UNIT-IV: THERMODYNAMICS** **9**

Terminology of thermodynamics - Second law: Entropy - entropy change for an ideal gas, reversible and irreversible processes; Entropy of phase transitions; Clausius inequality. Free energy and work function- Helmholtz and Gibbs free energy functions (problems); Criteria of spontaneity; Gibbs-Helmholtz equation (problems); Clausius-Clapeyron equation; Maxwell relations – Van't Hoff isotherm and isochore.

**UNIT-V: PHASE RULE AND ALLOYS** **9**

Phase rule: Introduction, definition of terms with examples, One component system -Water system – Reduced phase rule – Thermal analysis and cooling curves – Two component systems – Lead-silver system – Pattinson process, Zn-Mg System. Alloys: Introduction- Definition- properties of alloys- Significance of alloying, functions and effect of alloying elements- Nichrome and stainless steel (18/8) – heat treatment of steel.

**Total Periods: 45**

**COURSE OUTCOMES:**

At the end of the course, the student should be able to

- Gain knowledge on polymer chemistry and its developments.
- Understand the process of advanced energy storage devices.
- Analyze the materials using spectroscopic techniques.
- Explain the various state of thermodynamics.
- Outline the nature of alloys by drawing phase rule.

**TEXT BOOKS:**

1. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, 2016.
2. S. Vairam, P. Kalyani and Suba Ramesh, "Engineering Chemistry", Wiley India PVT, LTD, New Delhi, 2015.
3. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd., 2012.

**REFERENCE BOOKS:**

1. P. C. Jain and Monika Jain, "Engineering Chemistry" Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2019.

2. S. S. Dara and S. S. Umare, “A Textbook of Engineering Chemistry”, S. Chand & Company LTD, New Delhi, 2015.
3. B. K. Sharma, “Engineering Chemistry”, Krishna Prakashan Media (P) Ltd, Meerut, 2012.

| **Course Outcomes** | **PO** | | | | | | | | | | | | **PSO** | | | |
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| CO1 | 3 | 2 | 2 | 2 | 2 | | 3 | | | | 1 | 1 | 3 | 1 | 2 | 1 |
| CO2 | 2 | 1 | 2 | 1 | 2 | 2 | 2 | | | | | 1 | 3 | 3 | 3 | 3 |
| CO3 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | | | | | 1 | 2 | 1 | 1 | 1 |
| CO4 | 1 | 1 | 1 | 1 | 1 | | 2 | 1 | | | | 1 | 3 | 2 | 3 | 3 |
| CO5 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | | | 1 | | 1 | 2 | 1 | 1 | 1 |

**1921502** **INDUSTRIAL NANOTECHNOLOGY** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To elucidate on advantages of nanotechnology based applications in each industry
- To provide instances of contemporary industrial applications of nanotechnology
- To provide an overview of future technological advancements and increasing role of nanotechnology in each industry
- To provide an awareness on the nanomaterial synthesis for electronic materials
- To make the student conversant with the latest characterization techniques

**UNIT-I: NANO ELECTRONICS** **9**

Micro and Nanoelectromechanical systems – Sensors, Actuators, Data memory –Lighting and Displays – Applications of piezoelectric and ferroelectric materials- Nano for energy systems - Fuel cells and Photo-voltaic cells – Electric double layer capacitors –Nanoparticle coatings for electrical products

**UNIT-II: BIONANOTECHNOLOGY** **9**

Nanoparticles in bone substitutes and dentistry – Implants and Prosthesis – Nanorobotics in Surgery –Nanosensors in Diagnosis– Neuro-electronic Interfaces– Therapeutic applications

**UNIT-III: NANOTECHNOLOGY IN CHEMICAL INDUSTRY** **9**

Nanocatalyts – Smart materials – Heterogenous nanostructures and composites – Nanostructures for Molecular recognition (Quantum dots, Nanorods, Nanotubes) – Molecular Encapsulation and its applications – Nanoporous zeolites – Self-assembled Nanoreactors

**UNIT-IV: NANOTECHNOLOGY IN AGRICULTURE AND FOOD TECHNOLOGY** **9**

Nanotechnology in Agriculture -Precision farming, Smart delivery system – Insecticides using nanotechnology – Potential of nano-fertilizers - Nanotechnology in Food industry

**UNIT-V: CHARACTERIZATION TECHNIQUES** **9**

X-ray Diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including High-resolution imaging, Surface Analysis techniques-AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation.

**TOTAL 45: PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student should be able to

- Analyze the nanoparticle coatings for electrical products.
- Define various therapeutic applications of bio nanotechnology.
- Explain the process of molecular encapsulation and nano reactors.
- Ability to understand the uses of nanotechnology in food industry.
- Outline the nanofiber production and formulation of gels.

**TEXT BOOKS:**


1. V.A. Rai and J.A. Bai, Nanotechnology Applications in the Food Industry, CRC Press, 2018.
2. S. Thomas, Y. Grohens and Y.B. Pottathara, Industrial Applications of Nanomaterials, Elsevier Press, 2019.
3. N John Dinardo, Nanoscale Characterization of surfaces & Interfaces, 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.


**REFERENCE BOOKS:**


1. Neelina H. Malsch, Biomedical Nanotechnology, CRC Press, 2005.
2. Udo H. Brinker, Jean-Luc Mieusset, Molecular Encapsulation: Organic Reactions in Constrained Systems, Wiley Publishers, 2010.
3. Jennifer Kuzma and Peter VerHage, Nanotechnology in Agriculture and Food Production, Woodrow Wilson International Center, 2006.
4. P. J. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead Publishing Limited, Cambridge, 2007.
5. Y-W. Mai, Polymer Nano composites, Woodhead Publishing Limited, 2006.
6. W.N. Chang, Nanofibres fabrication, performance and applications, Nova Science Publishers Inc, 2009.


| **Course Outcomes** | **PO** | | | | | | | | | | | | **PSO** | | | |
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| CO1 | 2 | 2 | 2 | | 2 | 1 | 1 | | 1 | | | 1 | 3 | 3 | 3 | 3 |
| CO2 | 1 | 2 | 3 | | 1 | 3 | 1 | | 1 | | | 1 | 1 | 1 | 1 | 1 |
| CO3 | 2 | 1 | 2 | | 1 | 1 | 1 | | 1 | | | 1 | 2 | 2 | 2 | 2 |
| CO4 | 3 | 2 | 1 | | 2 | 1 | 1 | | 1 | | | 1 | 1 | 1 | 2 | 2 |
| CO5 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | | 1 | | | 1 | 2 | 2 | 2 | 2 |

**OPEN ELECTIVE – II (VII - SEMESTER) OFFERED BY ALL DEPARTMENT EXCEPT MECHANICAL ENGINEERING**

| 1903706 | GREEN BUILDING DESIGN | L T P C |
|---|---|---|
| | | 3 0 0 3 |

**OBJECTIVES:**

- To develop buildings which use the natural resources to the minimal at the time of construction as well as operation.
- To ensure minimum negative impact on the environment by the construction and operation of a building.
- To gain knowledge on natural lighting and temperature control.
- To develop a design to further reduce the carbon footprint as well as reduce cost of operation.
- To preserve the external environment to the building location.

**UNIT- I: ENVIRONMENTAL IMPLICATIONS OF BUILDINGS 9**

Energy use, carbon emissions, water use, waste disposal; Building materials: sources, methods of production and environmental Implications. Embodied Energy in Building Materials: Transportation Energy for Building Materials; Maintenance Energy for Buildings.

**UNIT- II: IMPLICATIONS OF BUILDING TECHNOLOGIES EMBODIED ENERGY OF BUILDINGS** 9

Framed Construction, Masonry Construction. Resources for Building Materials, Alternative concepts. Recycling of Industrial and Buildings Wastes. Biomass Resources for buildings.

**UNIT- III: COMFORTS IN BUILDING 9**

Thermal Comfort in Buildings – Issues; Heat Transfer Characteristic of Building Materials and Building Techniques. Incidence of Solar Heat on Buildings – Implications of Geographical Locations.

**UNIT- IV: UTILITY OF SOLAR ENERGY IN BUILDINGS 9**

Utility of Solar energy in buildings concepts of Solar Passive Cooling and Heating of Buildings. Low Energy Cooling. Case studies of Solar Passive Cooled and Heated Buildings.

**UNIT- V: GREEN COMPOSITES FOR BUILDINGS** **9**

Concepts of Green Composites. Water Utilization in Buildings, Low Energy Approaches to Water Management. Management of Solid Wastes. Management of Sullage Water and Sewage. Urban Environment and Green Buildings. Green Cover and Built Environment.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The students completing the course will have ability to

- Describe the concepts of sustainable design and green building techniques including energy efficiency and indoor environmental quality management.
- Create drawings and models of their own personal green building project.
- Reducing waste, pollution and environmental degradation.
- Efficiently using energy, water, and other resources.
- Protecting occupant health and improving employee productivity.

**TEXT BOOKS:**

1. K.S.Jagadish, B. U. Venkatarama Reddy and K. S. Nanjunda Rao. "Alternative Building Materials and Technologies". New Age International, 2007.
2. "Low Energy Cooling For Sustainable Buildings". John Wiley and Sons Ltd, 2009.
3. Sustainable Building Design Manual. Vol 1 and 2, Teri, New Delhi, 2004.

**REFERENCE BOOKS:**

1. Osman Attmann, Green Architecture Advanced Technologies and Materials, McGraw McGraw Hill, 2010.
2. Jerry Yudelson, Green building Through Integrated Design, McGraw Hill, 2009.
3. Fundamentals of Integrated Design for Sustainable Building by Marian keeler, Bill Burke.

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**1903716 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To impart the knowledge of screening of environmental and social assessment.
- To gain the knowledge of methods for impact assessment.
- To mitigate the environmental and social impacts of developmental projects.
- To develop knowledge on Assessment of Impact on land, water, air, noise and energy, flora and fauna.
- To study on report preparation of EIA.

**UNIT- I: INTRODUCTION 9**

Impacts of Development on Environment – Rio Principles of Sustainable Development Environmental Impact Assessment (EIA) – Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework–Stakeholders and their Role in EIA–Selection & Registration Criteria for EIA Consultants.

**UNIT-II: ENVIRONMENTAL ASSESSMENT 9**

Screening and Scoping in EIA – Drafting of Terms of Reference, Baseline monitoring, Prediction and Assessment of Impact on land, water, air, noise and energy, flora and fauna - Matrices – Networks – Checklist Methods - Mathematical models for Impact prediction – Analysis of alternatives.

**UNIT- III: ENVIRONMENTAL MANAGEMENT PLAN 9**

Plan for mitigation of adverse impact on water, air and land, water, energy, flora and fauna – Environmental Monitoring Plan – EIA Report Preparation – Review of EIA Reports – Addressing the issues related to the Project Affected People -Environmental Clearance Post Project Monitoring.

**UNIT- IV: SOCIO ECONOMIC ASSESSMENT 9**

Baseline monitoring of Socio economic environment – Identification of Project Affected Personal – Rehabilitation and Resettlement Plan- Economic valuation of Environmental impacts – Cost benefit Analysis.

**UNIT- V: CASE STUDIES 9**

EIA case studies pertaining to Infrastructure Projects – Real Estate Development - Roads and Bridges – Multi-storey Buildings Mass Rapid Transport Systems - Ports and Harbor – Airports -

Dams and Irrigation projects - Power plants – Water supply and drainage projects- Waste water treatment plants, STP – Mining Projects.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**:

The students completing the course will have ability to

- Carry out scoping and screening of developmental projects for environmental and social assessments.
- To explain different methodologies for environmental impact prediction and assessment.
- Plan environmental impact assessments and environmental management plans.
- Evaluate environmental impact assessment reports.
- Analyse case studies on various projects.

**TEXTBOOKS:**


1. Canter, R.L, "Environmental impact Assessment", 2nd Edition, McGraw Hill Inc, New Delhi, 1995.
2. Lohani, B., J.W. Evans, H. Ludwig, R.R. Everitt, Richard A. Carpenter, and S.L. Tu, "Environmental Impact Assessment for Developing Countries in Asia", Volume 1 – Overview, Asian Development Bank,1997.
3. Peter Morris, Riki Therivel "Methods of Environmental Impact Assessment", Routledge Publishers, 2009.


**REFERENCE BOOKS:**


1. Becker H. A., Frank Vanclay ,"The International handbook of social impact assessment" conceptual and methodological advances, Edward Elgar Publishing, 2003.
2. Barry Sadler and Mary McCabe, "Environmental Impact Assessment Training Resource Manual", United Nations Environment Programme, 2002.
3. Judith Petts, "Handbook of Environmental Impact Assessment Vol. I and II", Blackwell Science New York, 1998.
4. Ministry of Environment and Forests EIA Notification and Sectoral Guides, Government of India, New Delhi, 2010.

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| **5** | | | | | | | 1 | | | | 2 | 3 | | | | 3 |

**1904010 OBJECT ORIENTED PROGRAMMING L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To understand Object Oriented Programming concepts and basic characteristics of Java
- To know the principles of packages, inheritance and interfaces
- To define exceptions and use I/O streams
- To develop a java application with threads and generics classes
- To design and build simple Graphical User Interfaces

**UNIT I INTRODUCTION TO OOP AND JAVA FUNDAMENTALS 9**

Object Oriented Programming - Abstraction – objects and classes - Encapsulation- Inheritance - Polymorphism- OOP in Java – Characteristics of Java – The Java Environment - Java Source File - Structure – Compilation. Fundamental Programming Structures in Java – Defining classes in Java – constructors, methods -access specifiers - static members -Comments, Data Types, Variables, Operators, Control Flow, Arrays , Packages - JavaDoc comments**.**

**UNIT II INHERITANCE AND INTERFACES 9**

Inheritance – Super classes- sub classes –Protected members – constructors in sub classes- the Object class – abstract classes and methods- final methods and classes – Interfaces – defining an interface, implementing interface, differences between classes and interfaces and extending interfaces - Strings.

**UNIT III EXCEPTION HANDLING AND I/O 9**

Exceptions - exception hierarchy - throwing and catching exceptions – built-in exceptions, creating own exceptions, Stack Trace Elements. Input / Output Basics – Streams – Byte streams and Character streams – Reading and Writing Console – Reading and Writing Files.

**UNIT IV MULTITHREADING 9**

Differences between multi-threading and multitasking, thread life cycle, creating threads, synchronizing threads, Inter-thread communication, daemon threads, thread groups.

**UNIT V EVENT DRIVEN PROGRAMMING** **9**

Graphics programming - Frame – Components - working with 2D shapes - Using color, fonts, and images - Basics of event handling - event handlers - adapter classes - actions - mouse events - AWT event hierarchy.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, students will be able to:

- Develop Java programs using OOP principles
- Develop Java programs with the concepts inheritance and interfaces
- Build Java applications using exceptions and I/O streams
- Develop Java applications with threads and generics classes
- Develop interactive Java programs using swings.

**TEXT BOOKS:**


1. Herbert Schildt, ―Java the complete reference‖, 8th Edition, McGraw Hill Education, 2011.
2. Cay S. Horstmann, Gary cornell, ―Core Java Volume –I Fundamentals‖, 9th Edition, Prentice Hall, 2013.


**REFERENCES:**


1. Paul Deitel, Harvey Deitel, ―Java SE 8 for programmers‖, 3rd Edition, Pearson, 2015.
2. Steven Holzner, ―Java 2 Black book‖, Dreamtech press, 2011.
3. Timothy Budd, ―Understanding Object-oriented programming with Java‖, Updated Edition, Pearson Education, 2000.


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| **CO 2** | | 3 | 3 | 2 | | 1 | | | | | | | 3 | | | |
| **CO 3** | 2 | | | | | 2 | | | 2 | | | | | | 2 | |
| **CO 4** | | | 2 | 1 | | | | | 2 | 2 | | | | 2 | | |
| **CO 5** | 1 | | 3 | 1 | 3 | 2 | | | 3 | 3 | | | 2 | | | |

**1904703** **TAMIL COMPUTING** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To understand the Tamil grammar and programming basics for Tamil computing.
- To understand the various types of Tamil Computing applications.
- To make the students understand the use of Tamil computing tools and Resources.
- To strengthen the students' ability to carry out the Computational Linguistics in Tamil computing.
- To understand the concepts of Tamil text processing using open – Tamil python library.

**UNIT - I: TAMIL GRAMMAR 9**

Alphabets: Classification & Properties - Words: classification and components - Sentences: Structures and word ordering.

**UNIT - II: PROGRAMMING BASICS FOR TAMIL COMPUTING 9**

History of Tamil Computing - Standards & Fonts - UNICODE - Object Oriented Tamil Computing -Tamil text processing using open-tamil python library.

**UNIT - III: COMPUTATIONAL LINGUISTICS 9**

Basic linguistics - Phonology – Phonology computing – Tholkappiar's Morphological pattern– lexicography – syntax – semantics – pragmatics, Languages for specific purpose & disconise computing

**UNIT - IV: TAMIL COMPUTING TOOLS & RESOURCES 9**

POS Tagger - Morphological Analyser - Morphological Generator - Sentence Parser - Named Entity Recognizer - Word Sense Disambiguator - Ontologies – Universal Networking Language & UNL Enconvertor.

**UNIT - V: TAMIL COMPUTING APPLICATIONS 9**

Machine Translation – Speech : Synthesis & Processing - Information : retrieval & Extraction – Question Answering – Text Summarization – Automatic Indexing – Text Mining – Conceptual Search.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- Explain classification of Tamil grammar and properties
- Adopt a suitable process for tamil computing tools.
- Analyze the different types of computational linguistics such as phonology, Morphology, lexicography.
- Perform and analyze the Tamil computing applications.
- Analyze and process the Tamil python library.

**TEXT BOOKS:**

1. The Oxford Handbook of Computational Linguistics, Edited by RuslanMitkov, Oxford University Press, 2014.

**REFERENCES:**

1. Translation - Theory and Application, Valarmathi, International Institute of Tamil Studies, First Edition, 2001.
2. Tholkaappiyam - Thodariyal, Shanmugam, International Institute of Tamil Studies, First Edition, 2004.
3. Tholkaappiyam: Phonology & Morphology, Albert, International Institute of Tamil Studies, First Edition, 1985.
4. Natural language processing and computational linguistics, Bhargav Srinivasa-Desikan Packt Publishing, first edition 2018.
5. The Phonology and morphology of tamil chrisdas Prathima, 2016.
6. Pos Tasser R Morphological Analzser Shodhganga inflibnet.ac.in
7. A tamil Programming language ayxiv.org, muthiah Annamalai.

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| **CO 3** | | 3 | 2 | | | 3 | | | 2 | 2 | | | | | 3 | |
| **CO 4** | 3 | 2 | | | | 3 | | | | 2 | | | | 2 | | |
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**1904712** **SOFTWARE ENGINEERING** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To understand the phases in a software development project
- To understand the concepts of requirements analysis and modeling.
- To understand software design methodologies
- To learn various testing methodologies
- To be familiar with issues related to software maintenance

**UNIT I SOFTWARE PROCESS** **9**

Introduction to Software Engineering, scope – software crisis – principles of software engineering-Software process – Life cycle models – Traditional and Agile Models - Team organization

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**UNIT II PLANNING AND ESTIMATION** **9**

Planning and the software process – cost estimation: LOC, FP Based Estimation, COCOMO I & II Models – Duration estimation and tracking – Gantt chart - Software Project Management – plan – risk analysis and management.

**UNIT III REQUIREMENTS ANALYSIS AND SPECIFICATION** **9**

Software Requirements: Functional and Non-Functional, Software Requirements specification– Structured system Analysis – modeling: UML based tools, DFD - Requirement Engineering Process.

**UNIT IV SOFTWARE DESIGN AND IMPLEMENTATION** **9**

Design process – Design principles and guidelines – design techniques – coupling and cohesion - metrics – tools. Implementation: choice of programming language, programming practices – coding standards – code walkthroughs and inspections.

**UNIT V TESTING AND MAINTENANCE** **9**

Software testing fundamentals- Testing techniques: white box, black box, glass box testing - unit testing – integration testing –system testing – acceptance testing – debugging. Post-delivery maintenance: Types – objectives - metrics - Reverse Engineering.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES:

- At the end of this course, the students will be able to understand different software life cycle models.
- Perform software requirements analysis
- Apply systematic methodologies for software design and deployment.
- Understand various testing approaches and maintenance related issues.
- Plan project schedule, and estimate project cost and effort required.

## TEXT BOOKS:

1. Roger S. Pressman, “Software Engineering – A Practitioner‟ s Approach”, Seventh Edition, Mc Graw-Hill International Edition, 2010.
2. Ian Sommerville, “Software Engineering”, 9th Edition, Pearson Education Asia, 2011.

## REFERENCE BOOKS:

1. Rajib Mall, “Fundamentals of Software Engineering”, Third Edition, PHI Learning PrivateLimited, 2009.
2. Pankaj Jalote, “Software Engineering, A Precise Approach”, Wiley India, 2010.
3. Kelkar S.A., “Software Engineering”, Prentice Hall of India Pvt Ltd, 2007.
4. Stephen R.Schach, “Software Engineering”, Tata McGraw-Hill Publishing CompanyLimited, 2007.
5. http://nptel.ac.in/.

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| **CO 3** | | | 3 | 3 | | | | | | | 3 | | | | 2 | |
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**1906705** **ACOUSTICS** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

The student should be made:

- To learn the origin of sound.
- To understand the knowledge in sound propagation.
- To enhance the concepts in Sound analysis.
- To acquire basic knowledge in Physiological acoustics.
- To enable the student to understand the analysis of acoustics.

**UNIT - I: INTRODUCTION 9**

Origin of sound. Objective and subjective sound. Sound vibrations, Amplitude, form, and period. Sound waves and their wavelength and speed. Sound pressure level. Energy parameters of sound. Dynamical range. Sound envelope, Sound frequency, Relation between frequency and period.

**UNIT - II: PROPAGATION OF SOUND 9**

Sound propagation. Spherical and plane waves. Change of intensity of a propagating sound wave. Sound reflections, echo, absorption, diffraction, refraction. Relation between pitch and frequency. Pitch standard. Sound spectrum. Types of Public Addressing system. Hi.fi speakers. Microphones: types and its applications.

**UNIT - III: SOUND ANALYSIS 9**

Natural scales. Origin of musical scale. Tonal material and modal scale. Pythagorean tuning, Temperaments. Non-equal temperaments. Equal temperaments. Relation of musical scale and kind of music. Sound Pre-Processing and analysis, Audio analysis tools.

**UNIT - IV: PHYSIOLOGICAL ACOUSTICS 9**

Physiological and psychological acoustics. Loudness. Loudness level. Fletcher-Munson diagram. Range of hearing. Masking. Compression of sound information, Pitch, timbre, subjective duration. Absolute pitch. Acoustics instruments. Peripheral auditory system.

**UNIT - V: ACOUSTICAL ANALYSIS 9**

Sound phenomena in rooms. Direct sound. Early reflections. Reverberation and its formation, Criteria for good acoustics of a room and methods of their realization, Reverberation time.

Dependence of reverberation time on room volume and surfaces (area and absorption), Evaluation of reverberation time. Optimal reverberation times for various types of music and room sizes.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The student should be able to:

- Analyze the basic parameters of sound.
- Understand the effects of propagation.
- Know the basic functions of sound analysis.
- Derive the output using Physiological acoustics.
- Acquire the knowledge on the Applications of acoustics.

**TEXT BOOKS:**


1. Rossing T. D., Moore R. F., Wheeler P. A.," The Science of Sound", 3rd edition San Francisco: Addison Wesley, 2002.
2. Hall D. E.," Musical Acoustics", 3rd edition Pacific Grove, CA: Brooks/Cole, 2001.
3. Howard D. M., Angus J. A. S.," Acoustics and psychoacoustics", 5th edition New York, London: Routledge, 2017.


**REFERENCE BOOKS:**


1. Everest F. A., Pohlmann K. C.," Master Handbook of Acoustics", 5th edition New York: McGraw-Hill, 2001.
2. Rossing T. D., ed.," Springer Handbook of Acoustics", 2nd edition Berlin, Heidelberg: SpringerVerlag 2014.
3. Chakrabarti, Pradip Kumar and Chowdhury, Satyabrata, "A Textbook on Waves and Acoustics", New Central book agency, 2010.


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**1906706** **VISUAL COMMUNICATION** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

The student should be made:

- To know about the basics of communication.
- To learn and acquire the art of visual communication.
- To understand and relate the importance of visual communication
- To gain knowledge about the basic of Visual Communication.
- To acquire idea and concepts of various forms of Media

**UNIT - I: INTRODUCTION 9**

Need for and the Importance of Human and Visual Communication. Communication a expression, skill and process, Understanding Communication: SMRC-Model.

**UNIT - II: PROCESS IN COMMUNICATION 9**

Communication as a process. Message, Meaning, Connotation, Denotation Culture/Codes etc Levels of communication: Technical, Semantic, and Pragmatic. The semiotic landscape: language and visual communication, narrative representation

**UNIT - III: METHODOLOGY 9**

Fundamentals of Design: Definition. Approaches to Design, Centrality of Design, EIements/Elements of Design: Line, Shape, Space, Color, Texture. Form Etc. Principles of Design: Symmetry. Rhythm, Contrast, Balance Mass/Scale etc. Design and Designers (Need, role, process, methodologies etc.).

**UNIT - IV: DESIGN PROCESS 9**

Principles of Visual and other Sensory Perceptions. Color psychology and theory (some aspects) Definition, Optical / Visual Illusions Etc., Various stages of design process- problem identification, search for solution refinement, analysis, decision making, Implementation.

**UNIT - V: GRAPHIC DESIGN 9**

Basics of Graphic Design. Definition, Elements of GD, Design process-research, a source of concept, the process of developing ideas-verbal, visual, combination & thematic, visual thinking, associative techniques, materials, tools (precision instruments etc.) design execution, and presentation.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

The student should be able to:

- Learn about the history & evolution of Communication.
- Understand the Nature & functions of Visual Communication.
- Acquire knowledge on different types of perception & illusion.
- Get knowledge on semiotics.
- Remember the world of ideation creating.

**TEXT BOOKS:**

1. Lester, E, "Visual Communications: Images with Messages", Thomson Learning, 2013.
2. Jonathan Baldwin, "Visual Communication: From Theory to Practice", AVA publishing, 2006.

**REFERENCE BOOKS:**

1. Schildgen, T., "Pocket Guide to color with digital applications", Thomsom Learning, 2000.
2. Palmer, Frederic, "Visual Elements of Art and Design", Longman, 1990.
3. Carter, "Typographic Design : Form and Communication", 6/e, John Wiley, 2014.

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| 1906707 | MEMS AND NEMS | L T P C |
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**OBJECTIVES:**

The student should be made:

- To introduce the concepts of micro and nano electromechanical devices.
- To know the fabrication process of microsystems.
- To know the design concepts of micro sensors.
- To understand the design of various micro actuators.
- To introduce the concepts of quantum mechanics and nano systems.

**UNIT – I: INTRODUCTION TO MEMS AND NEMS 9**

Introduction to Design of MEMS and NEMS, Overview of Nano and Microelectromechanical Systems, Applications of Micro and Nanoelectromechanical systems, Materials for MEMS and NEMS: Silicon, silicon compounds, polymers, metals.

**UNIT – II: MEMS FABRICATION TECHNOLOGIES 9**

Photolithography, Ion Implantation, Diffusion, Oxidation, CVD, Sputtering Etching techniques, Micromachining: Bulk Micromachining, Surface Micromachining, LIGA, Micromolding.

**UNIT – III: MICRO SENSORS 9**

MEMS Sensors: Design of Acoustic wave sensors, Vibratory gyroscope, Capacitive Pressure sensors, Case study: Piezoelectric energy harvester.

**UNIT – IV: MICRO ACTUATORS 9**

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces, Case Study: RF Switch.

**UNIT – V: NANO DEVICES 9**

Atomic Structures and Quantum Mechanics, Shrodinger Equation, ZnO nanorods based NEMS device: Gas sensor.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

After studying this course, the student should be able to,

- Interpret the basics of micro/nano electromechanical systems including their applications and advantages.
- Recognize the use of materials in micro fabrication and describe the fabrication processes including surface micromachining, bulk micromachining and LIGA.
- Analyze the key performance aspects of electromechanical sensors.
- Illustrate the design of micro actuators using various actuations.
- Comprehend the theoretical foundations of quantum mechanics and Nano systems.

**TEXT BOOKS:**


1. Marc Madou, "Fundamentals of Microfabrication", CRC press 1997.
2. Stephen D. Senturia, "Micro system Design", Kluwer Academic Publishers, 2001.


**REFERENCES BOOKS:**


1. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata McGraw Hill, 2002.
2. Chang Liu, "Foundations of MEMS", Pearson education India limited, 2006.
3. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures", CRC Press, 2002.


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**1907001** **TRANSDUCERS ENGINEERING** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To make the students to know the methods of measurement, classification of transducers and to analyze error.
- To make the students to understand the behavior of transducers under static and dynamic conditions and hence to model the transducer.
- To expose the students to different types of resistive transducers and their application areas.
- To make the students to acquire knowledge on capacitive and inductive transducers.
- To impart knowledge on variety of transducers and get introduced to MEMS and Smart transducers.

**UNIT – I: SCIENCE OF MEASUREMENTS AND CLASSIFICATION OF TRANSDUCERS 9**

Units and standards – Static calibration – Classification of errors–Error analysis – Statistical methods – Odds and uncertainty – Classification of transducers – Selection of transducers.

**UNIT - II: CHARACTERISTICS OF TRANSDUCERS 9**

Static characteristics: - Accuracy, precision, resolution, sensitivity, linearity. Dynamic characteristics: Mathematical model of transducer, Zero, I and II order transducers, Response to impulse, step, ramp and sinusoidal inputs.

**UNIT - III: VARIABLE RESISTANCE TRANSDUCERS 9**

Principle of operation, construction details, characteristics and applications of potentiometer, strain gauge, resistance thermometer, Thermistor, hot-wire anemometer, piezo-resistive sensor and humidity sensor.

**UNIT – IV: VARIABLE INDUCTANCE AND VARIABLE CAPACITANCE TRANSDUCERS 9**

Inductive transducers: – Principle of operation, construction details, characteristics and applications of LVDT, Induction potentiometer – Variable reluctance transducers – EI pickup-–

Principle of operation, construction details, characteristics of capacitive transducers - Capacitor microphone, Proximity sensor.

**UNIT – V: OTHER TRANSDUCERS** **9**

Piezoelectric transducer – Hall Effect transducer – Magneto elastic sensor – Digital transducers – Smart transducers - Fiber optic sensors – Thick & Thin Film sensors (Bio sensor & Chemical Sensor) – Nano sensors

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

- Apply the mathematical knowledge and science & engineering fundamentals gained to solve problems pertaining to measurement applications.
- Analyze the problems related to sensors & transducers.
- Select the right sensor/transducer for a given application.
- Determine the static and dynamic characteristics of transducers
- Understand fiber optic sensor, smart transducers and their applications.

**TEXT BOOKS**

1. Doebelin E.O. and Manik D.N., "Measurement Systems", 7th Edition, McGraw-Hill Education Pvt. Ltd., 2019.
2. A.K. Sawhney, A Course in Electrical & Electronic Measurements & Instrumentation, Dhanpat Rai and Co, New Delhi, 2015.

**REFERENCES**

1. Bela G.Liptak, Instrument Engineers' Handbook, Process Measurement and Analysis, 4th Edition, Vol. 1, ISA/CRC Press, 2003.
2. D. Patranabis, Sensors and Transducers, 2nd edition, Prentice Hall of India, 2010.
3. E.A. John P. Bentley, Principles of Measurement Systems, 4$^{th}$ Edition, Pearson Education, 2004.
4. W.Bolton, Engineering Science, Elsevier Newnes, Fifth edition, 2006.
5. Murthy, D.V.S., Transducers and Instrumentation, 2$^{nd}$ Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2008.
6. S.Ranganathan,"Transducer Engineering", Allied Publishers Pvt. Ltd. 2003.

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**1907003 PROCESS MODELING AND SIMULATION**

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**OBJECTIVES:**

- To give an overview of various methods of process modeling, different computational techniques for simulation.
- To analyze the simulation for steady state lumped system.
- To analyze the simulation for unsteady state lumped system.
- To analyze the simulation for steady state distributed system.
- To analyze the simulation for unsteady state distributed system.

**UNIT I INTRODUCTION 9**

Introduction to modeling and simulation, classification of mathematical models, conservation equations and auxiliary relations.

**UNIT II STEADY STATE LUMPED SYSTEMS 9**

Degree of freedom analysis, single and network of process units, systems yielding linear and nonlinear algebraic equations, flow sheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.

**UNIT III UNSTEADY STATE LUMPED SYSTEMS 9**

Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash anddistillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems.

**UNIT IV STEADY STATE DISTRIBUTED SYSTEM 9**

Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems.

**UNIT V UNSTEADY STATE DISTRIBUTED SYSTEM & OTHER MODELLING APPROACHES 9**

Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption, plug flow reactor. Empirical modeling, parameter estimation, population balance and stochastic modeling.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

- Develop the process models based on Conservation principles and Process data.
- Understand the characteristics of state lumped systems.
- Understand the characteristics of state distributed lumped systems.
- Carry out the analysis and design empirical modeling of systems.
- Apply computational techniques to solve the process models

**TEXT BOOKS:**

1. Ramirez, W.; " Computational Methods in Process Simulation ", 2nd Edn., Butterworths Publishers, New York, 2000.
2. Luyben, W.L., " Process Modelling Simulation and Control ",2nd Edn, McGraw-Hill Book Co.,1990

**REFERENCE BOOKS:**

1. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes ", John Wiley, 2000.
2. Franks, R. G. E., "Mathematical Modelling in Chemical Engineering ", John Wiley, 1967.
3. Amiya K. Jana, "Process Simulation and Control Using ASPEN", $2^{nd}$ Edn, PHI Learning Ltd (2012).
4. Amiya K. Jana,"ChemicalProcess Modelling and Computer Simulation" $2^{nd}$ Edn,PHI Learning Ltd, (2012).

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**1907708 STATE VARIABLE ANALYSIS AND DESIGN L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To provide knowledge on design in state variable form.
- To study the design of state variable.
- To study the design of state estimator.
- To study the design of optimal controller.
- To study the design of optimal estimator including Kalman Filter.

**UNIT –I: STATE FORMULATION 9**

Formulation of state variable model, non-uniqueness, controllability, observability, stability.

**UNIT – II: STATE VARIABLE DESIGN 9**

Modes, controllability of modes -effect of state and output Feedback- pole placement Design

**UNIT- III: STATE ESTIMATION 9**

Need for state estimation - design of state Observers - full and reduced order - disturbance estimation - separation principle

**UNIT – IV: OPTIMAL CONTROL 9**

Introduction - Time varying optimal control - LQR steady state optimal control - Solution of Ricatti's equation - Application examples.

**UNIT – V: OPTIMAL ESTIMATION 9**

Optimal estimation - Kalman Bucy Filter-Solution by duality principle - Discrete systems - Kalman Filter - Application examples.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

- Apply advanced control theory to practical engineering problems.

- Understand and analyse state variable design.
- Understand and analyse state estimation.
- Understand and analyse optimal controller.
- Understand and analyse optimal estimator.

**TEXT BOOKS:**

1. K. P. Mohandas, “Modern Control Engineering”, 2nd Edition, Sanguine Technical Publishers, 2016.
2. G. J. Thaler, “Automatic Control Systems”, Jaico Publishing House 1993.
3. M.Gopal, “Modern Control System Theory”, 3rd Edition, New Age International Publishers, 2014.

**REFERENCES:**


1. William S Levine, “Control System Fundamentals,” The Control Handbook, CRC Press, Tayler and Francies Group, 2011.
2. Ashish Tewari, “Modern Control Design with Matlab and Simulink”, John Wiley, New Delhi, 2002.
3. K. Ogata, “Modern Control Engineering”, 5th Edition, PHI, New Delhi, 2002.
4. T. Glad and L. Ljung,, “Control Theory –Multivariable and Non-Linear Methods”, Taylor & Francis, 2002.
5. D.S.Naidu, “Optimal Control Systems” First Indian Reprint, CRC Press, 2009.


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**1908003 SOFTWARE QUALITY MANAGEMENT** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To have an introduction to software quality
- To understand software quality assurance.
- To understand about quality control and reliability.
- To understand quality management system.
- To understand about Quality Standards.

**UNIT- I: INTRODUCTION TO SOFTWARE QUALITY** **9**

Software Quality – Hierarchical models of Boehm and McCall – Quality measurement –Metrics measurement and analysis – Gilb's approach – GQM Model

**UNIT- II: SOFTWARE QUALITY ASSURANCE** **9**

Quality tasks – SQA plan – Teams – Characteristics – Implementation – Documentation –Reviews and Audits

**UNIT-III: QUALITY CONTROL AND RELIABILITY** **9**

Tools for Quality – Ishikawa's basic tools – CASE tools – Defect prevention and removal– Reliability models – Rayleigh model – Reliability growth models for quality Assessment

**UNIT -IV: QUALITY MANAGEMENT SYSTEM** **9**

Elements of QMS – Rayleigh model framework – Reliability Growth models for QMS –Complexity metrics and models – Customer satisfaction analysis

**UNIT -V: QUALITY STANDARDS** **9**

Need for standards – ISO 9000 Series – ISO 9000-3 for software development – CMM and

CMMI – Six Sigma concepts.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student should be able :

- To understand introduction about quality measurement.
- To understand SQA plan.
- To understand about Quality assessment.
- To understand about Customer satisfaction analysis.
- To understand Six Sigma Concepts.

**TEXT BOOKS:**

1. Allan C. Gillies, “Software Quality: Theory and Management”, Thomson Learning, 2003. (UI : Ch 1-4 ; UV : Ch 7-8)
2. Stephen H. Kan, “Metrics and Models in Software Quality Engineering”, Pearson Education (Singapore) Pte Ltd., 2002. (UI : Ch 3-4; UIII : Ch 5-8 ; UIV : Ch 9-11)

**REFERNCE BOOKS:**

1. Norman E. Fenton and Shari Lawrence Pfleeger, “Software Metrics” Thomson, 2003
2. Mordechai Ben – Menachem and Garry S.Marliss, “Software Quality”, Thomson Asia Pte Ltd, 2003.
3. Mary Beth Chrissis, Mike Konrad and Sandy Shrum, “CMMI”, Pearson Education (Singapore) Pte Ltd, 2003.
4. ISO 9000-3 “Notes for the application of the ISO 9001 Standard to software development”.

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**1908004** **C# and .NET PROGRAMMING** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To learn basic programming in C# and the object oriented programming concepts.
- To update and enhance skills in writing Windows applications, ADO.NET and ASP .NET.
- To study the advanced concepts in data connectivity, WPF, WCF and WWF with C# and .NET 4.5.
- To implement mobile applications using .Net compact framework
- To understand the working of base class libraries, their operations and manipulation of data using XML.

**UNIT- I: C# LANGUAGE BASICS 9**

.Net Architecture – Core C# – Variables – Data Types – Flow control – Objects and Types- Classes and Struts – Inheritance- Generics – Arrays and Tuples – Operators and Casts – Indexers

**UNIT- II: C# ADVANCED FEATURES 9**

Delegates – Lambdas – Lambda Expressions – Events – Event Publisher – Event Listener – Strings and Regular Expressions – Generics – Collections – Memory Management and Pointers – Errors and Exceptions – Reflection.

**UNIT- III: BASE CLASS LIBRARIES AND DATA MANIPULATION 9**

Diagnostics -Tasks, Threads and Synchronization – .Net Security – Localization – Manipulating XML- SAX and DOM – Manipulating files and the Registry- Transactions – ADO.NET- Peer-to-Peer Networking – PNRP – Building P2P Applications – Windows Presentation Foundation (WPF).

**UNIT- IV: WINDOW BASED APPLICATIONS, WCF AND WWF 9**

Window based applications – Core ASP.NET- ASP.NET Web forms -Windows Communication Foundation (WCF)- Introduction to Web Services – .Net Remoting – Windows Service – Windows Workflow Foundation (WWF) – Activities – Workflows

**UNIT- V: .NET FRAMEWORK AND COMPACT FRAMEWORK 9**

Assemblies – Shared assemblies – Custom Hosting with CLR Objects – App domains – Core XAML – Bubbling and Tunneling Events- Reading and Writing XAML – .Net Compact Framework – Compact Edition Data Stores – Errors, Testing and Debugging – Optimizing performance – Packaging and Deployment – Networking and Mobile Devices

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student should be able to:

- Write various applications using C# Language in the .NET Framework.
- Develop programs using advanced C# concepts on .NET
- Analyse the base class libraries, operations and manipulation of data using XML.
- Develop distributed applications using .NET Framework.
- Create mobile applications using .NET compact Framework.

**TEXT BOOKS:**

1. Christian Nagel, Bill Evjen, Jay Glynn, Karli Watson, Morgan Skinner. ―Professional C# 2012 and .NET 4.5, Wiley, 2012
2. Harsh Bhasin, ―Programming in C#, Oxford University Press, 2014.

**REFERENCES:**

1. Ian Gariffiths, Mathew Adams, Jesse Liberty, ―Programming C# 4.0, OReilly, Fourth Edition, 2010.
2. Andrew Troelsen, Pro C# 5.0 and the .NET 4.5 Framework, Apress publication, 2012.
3. Andy Wigley, Daniel Moth, Peter Foot, ―Mobile Development Handbook, Microsoft Press, 2011.

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**1908005** **VIRTUAL REALITY** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To study about basic concepts of Virtual reality
- To understand Virtual environment
- To understand geometric modelling
- To study about Virtual Hardware and Software
- To develop Virtual Reality applications

**UNIT -I: INTRODUCTION TO VIRTUAL REALITY 9**

Virtual Reality & Virtual Environment : Introduction – Computer graphics – Real time computer graphics–Flight Simulation –Virtual environments–requirement – benefits of virtual reality- Historical development of VR : Introduction – Scientific Landmark -3D Computer Graphics :Introduction – The Virtual world space – positioning the virtual observer – the perspective projection – human vision – stereo perspective projection – 3D clipping – Colour theory – Simple 3D modeling- illumination models – Reflection models – Shading algorithms- Radiosity – Hidden Surface Removal – Realism-Stereographic image.

**UNIT- II: GEOMETRIC MODELLING 9**

Geometric Modeling: Introduction – From 2D to 3D – 3D space curves – 3D boundary representation - Geometrical Transformations: Introduction – Frames of reference – Modeling transformations – Instances –Picking – Flying – Scaling the VE – Collision detection - A Generic VR system: Introduction – The virtual environment – the Computer environment – VR Technology – Model of interaction-VR Systems.

**UNIT- III: VIRTUAL ENVIRONMENT 9**

Animating the Virtual Environment: Introduction – The dynamics of numbers – Linear and Non-linear interpolation - The animation of objects – linear and non- linear translation - shape & object in between ing – free from deformation – particle system- Physical Simulation : Introduction – Objects falling in a gravitational field-Rotating wheels – Elastic collisions – projectiles – simple pendulum – springs – Flight dynamics of an aircraft.

**UNIT- IV: VR HARDWARES & SOFTWARES 9**

Human factors: Introduction – the eye-the ear-the somatic senses-VR Hardware : Introduction – sensor hardware – Head-coupled displays –Acoustic hardware – Integrated VR systems-VR Software: Introduction –Modeling virtual world –Physical simulation- VR toolkits – Introduction to VRML.

**UNIT –V: VR APPLICATION 9**

Virtual Reality Applications: Introduction – Engineering – Entertainment – Science Training – The Future: Introduction – Virtual environments – modes of interaction.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student should be able to:

- Understood the basic concept of virtual reality
- Understood 3D computer Graphics System
- Design object objects using geometric modeling
- Apply study about Virtual Hardwares and Softwares
- Develop Virtual Reality applications and Develop Virtual Reality applications

**TEXT BOOK**

1. John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.

**REFERENCES BOOKS:**

1. Adams, "Visualizations of Virtual Reality", Tata McGraw Hill, 2000.
2. Grigore C. Burdea, Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, 2nd Edition, 2006.
3. William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface, Application, and Design", Morgan Kaufmann, 2008.
4. www.vresources.org.
5. www.vrac.iastate.edu.
6. www.w3.org/MarkUp/VRML.

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**1905711** **ELECTRICAL CIRCUITS** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To introduce electric circuits and its analysis
- To impart knowledge on solving circuit equations using network theorems
- To introduce the phenomenon of resonance in coupled circuits.
- To introduce Phasor diagrams of three phase circuits
- To analysis the three phase circuits

**UNIT-I: BASIC CIRCUITS ANALYSIS 9**

Resistive elements - Ohm's Law Resistors in series and parallel circuits – Kirchhoff's laws – Mesh current and node voltage - methods of analysis.

**UNIT-II: NETWORK REDUCTION AND THEOREMS FOR DC CIRCUITS 9**

Network reduction: voltage and current division, source transformation – star delta conversion. Theremins' and Norton Theorems – Superposition Theorem – Maximum power transfer theorem – Reciprocity Theorem – Millman's theorem.

**UNIT-III: AC CIRCUITS 9**

Introduction to AC circuits, inductance reactance, capacitive reactance, Phasor diagrams, real power, reactive power, apparent power, power factor, R-L R-C, RLC networks, Network reduction: voltage and current division, source transformation –mesh and node analysis, Theremins' and Norton Theorems – Superposition Theorem – Maximum power transfer theorem –Reciprocity Theorem – Millman's theorem.

**UNIT-IV: THREE PHASE CIRCUITS 9**

A.C. circuits – Average and RMS value - Phasor Diagram – Power, Power Factor and Energy.- Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & un balanced – phasor diagram of voltages and currents – power measurement in three phase circuits.

**UNIT–V: RESONANCE AND COUPLED CIRCUITS 9**

Series and parallel resonance – their frequency response – quality factor and bandwidth – Self and mutual inductance – Coefficient of coupling – Tuned circuits – Single tuned circuits – SMPS.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- Ability to introduce electric circuits and its analysis
- Ability to impart knowledge on solving circuit equations using network theorems.
- Ability to introduce the phenomenon of resonance in coupled circuits.
- Ability to introduce Phasor diagrams of three phase circuits.
- Ability to analysis of three phase circuits.

**TEXT BOOKS:**

1.William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, “Engineering Circuits Analysis”, McGraw Hill publishers, edition, New Delhi, 2013.

2. Charles K. Alexander, Mathew N.O. Sadiku, “Fundamentals of Electric Circuits”, Second Edition, McGraw Hill, 2013.

3. Allan H. Robbins, Wilhelm C. Miller, “Circuit Analysis Theory and Practice”, Cengage Learning India, 2013.

**REFERENCE BOOKS:**

1. Chakrabarti A, “Circuits Theory (Analysis and synthesis), Dhanpath Rai & Sons, New Delhi, 1999.
2. Jegatheesan, R., “Analysis of Electric Circuits,” McGraw Hill, 2015.
3. Joseph A. Edminister, Mahmood Nahri, “Electric circuits”, Schaum‟s series, McGraw- Hill, New Delhi, 2010.
4. M E Van Valkenburg, “Network Analysis”,Prentice-Hall of India Pvt Ltd, New Delhi, 2015.
5. Richard C. Dorf and James A. Svoboda, “Introduction to Electric Circuits”, 7th Edition, John Wiley & Sons, Inc. 2015.
6. Sudhakar A and Shyam Mohan SP, “Circuits and Network Analysis and Synthesis”, McGraw Hill, 2015.

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| **2** | 1 | 3 | 2 | 1 | | | | 1 | | | | 1 | 2 | | | |
| **3** | 1 | | | 2 | 1 | 1 | | | 2 | | | 2 | | 1 | | 3 |
| **4** | 1 | | | | 2 | 2 | 1 | 2 | | | 1 | 1 | | | 1 | |
| **5** | 1 | 3 | 2 | 1 | | 1 | 2 | 1 | | | 1 | 1 | 3 | | | |

**1905712 RENEWABLE ENERGY SYSTEMS** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

- About the stand alone and grid connected renewable energy systems. .
- Design of power converters for renewable energy applications.
- Wind electrical generators.
- Solar energy systems.
- Power converters used for renewable energy systems.

**UNIT-I: INTRODUCTION 9**

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.

**UNIT-II: ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION 9**

Reference theory fundamentals-principle of operation and analysis: IG and PMSG.

**UNIT-III: POWER CONVERTERS 9**

Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing Wind: Three phase AC voltage controllers

**UNIT-IV: ANALYSIS OF WIND AND PV SYSTEMS 9**

Stand-alone operation of fixed and variability speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG, SCIG Based WECS, grid Integrated solar system.

**UNIT-V: HYBRID RENEWABLE ENERGY SYSTEMS 9**

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV Maximum Power Point Tracking (MPPT).

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- Ability to understand and analyze power system operation, stability, control and protection.
- Ability to handle the engineering aspects of electrical energy generation and utilization.
- Ability to understand the stand alone and grid connected renewable energy systems.
- Ability to design of power converters for renewable energy applications.
- Ability to acquire knowledge on wind electrical generators and solar energy systems.

**TEXT BOOKS:**

1. S. N. Bhadra, D.Kastha, S.Banerjee, “Wind Electrical Systems”, Oxford University Press, 2005.

2. B.H.Khan Non-conventional Energy sources Tata McGraw-hill Publishing Company New Delhi, 2009.

**REFERENCE BOOKS:**

1. Rashid .M. H “power electronics Hand book”, Academic press, 2001.

2. Ion Boldea, “Variability speed generators”, Taylor & Francis group, 2006.

3. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.

4. Gray, L. Johnson, “Wind energy system”, prentice hall linc, 1995.

5. Andrzej M. Trzynnadlowski, „Introduction to Modern Power Electronics‟, Second edition, wiley India Pvt. Ltd, 2012.

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| **1** | 3 | 3 | 1 | 2 | 2 | 1 | | | 1 | | | | | 3 | | |
| **2** | 3 | 2 | 2 | 1 | | 1 | | | 2 | | 3 | 1 | 1 | 2 | | |
| **3** | 3 | 2 | 1 | 2 | 2 | 2 | 1 | | 1 | | | | | 1 | | 1 |
| **4** | 3 | 3 | 3 | 2 | 2 | 1 | | | 2 | | 2 | 1 | | | 2 | |
| **5** | 3 | 2 | 1 | 1 | 1 | 2 | 2 | | 1 | | | 2 | 3 | | | |

**1905713 ELECTRIC VEHICLES AND POWER MANAGEMENT L T P C**

**3 0 0 3**

**OBJECTIVES:**

To impart knowledge on the following Topics:

- To understand the concept of electrical vehicles and its operations.
- To provide knowledge about Power train components.
- To understand the various Control strategies in AC and DC drives.
- To understand the need for energy storage in hybrid vehicles.
- To provide knowledge about alternative energy storage technologies that can be used in electric vehicles.

**UNIT-I: ELECTRIC VEHICLES AND VEHICLE MECHANICS 9**

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings, Comparisons of EV with internal combustion Engine vehicles, Fundamentals of vehicle mechanics – EV Testing.

**UNIT-II: ARCHITECTURE OF EV's AND POWER TRAIN COMPONENTS 9**

Architecture of EV's and HEV's – Plug-n Hybrid Electric Vehicles (PHEV) – Standards - Power train components and sizing, Gears, Clutches, Transmission and Brakes.

**UNIT-III: CONTROL OF DC AND AC DRIVES 9**

DC/DC chopper based four quadrant operations of DC drives – Inverter based V/f Operation (motoring and braking) of induction motor drive system – Induction motor and permanent motor-based vector control operation – Switched reluctance motor (SRM) drives.

**UNIT-IV: BATTERY ENERGY STORAGE SYSTEM 9**

Battery Basics, Different types, Battery Parameters, Battery modeling, Traction Batteries, Energy management system in Electric vehicle – Battery Management Systems.

**UNIT-V: ALTERNATIVE ENERGY STORAGE SYSTEMS 9**

Fuel cell – Characteristics- Types – hydrogen Storage Systems and Fuel cell EV – Ultra Capacitors

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- Learners will understand the operation of Electric vehicles and Hybrid Electric vehicles.
- Learners will gain knowledge on Power train components.

- Learners can analyze the control strategies in AC and DC drives.
- Learners will gain knowledge on various energy storage technologies for electrical vehicles.
- Learners know about alternative energy storage technologies for electric vehicles.

**TEXT BOOKS:**

1. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals, Second Edition” CRC Press, Taylor & Francis Group, Second Edition (2011).
2. Ali Emadi, Mehrdad Ehsani, John M.Miller, “Vehicular Electric Power Systems” , Special Indian Edition, Marcel dekker, Inc 2010.
3. James Larminie and John Loury, “Electric Vehicle Technology – Explained”, John Wiley & Sons Ltd, 2003.

**REFERENCE BOOKS:**

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, “Modern Electric, Hybrid Electric and Fuel cell Vehicles” CRC Press, Taylor & Francis Group, Second Edition (2010).
2. Emanuele Crisostomi, Robert Shorten, SonjaStudli & Fabian Wirth “Electric and Plug-in Hybrid Vehicle Networks” Taylor & Francis group 2018.
3. Ronald K Jurgen, “Electric and Hybrid – Electric Vehicles”, SAE, 2002.

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| **2** | 2 | | 2 | | 1 | | 1 | | 2 | | 2 | | 2 | 2 | | |
| **3** | 3 | 2 | 1 | | 2 | | | | 2 | | | | | 3 | | 1 |
| **4** | 3 | 2 | 2 | | 1 | | 2 | | | | 2 | | | | 2 | |
| **5** | 3 | 2 | 1 | | 1 | | | | 1 | | 2 | 2 | 2 | | | |

**1910703** **CLINICAL TRIALS** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To highlight the epidemiologic methods, study design, protocol preparation.
- To learn about the crossover and factorial trial designs.
- To gain knowledge in the basic bio-statistical techniques involved in clinical research.
- To describe the principles involved in ethical, legal and regulatory issues in clinical trials.
- To gain knowledge on the reporting of trials.

**UNIT – I: ROLE OF CLINICAL TRIALS IN NEW DRUG DEVELOPMENT 9**

Drug Discovery, regulatory guidance and governance, pharmaceutical manufacturing, nonclinical research, clinical trials, post-marketing surveillance, ethical conduct during clinical trials.

**UNIT – II: FUNDAMENTALS OF TRIAL DESIGN 9**

Randomised clinical trials, uncontrolled trials. Protocol development, endpoints, patient selection, source and control of bias, randomization, blinding, sample size and power.

**UNIT – III: ALTERNATE TRIAL DESIGNS 9**

Crossover design, factorial design, equivalence trials, bioequivalence trials, non-inferiority trials, cluster randomized trials, multi-center trials.

**UNIT – IV: BASICS OF STATISTICAL ANALYSIS 9**

Types of data and normal distribution, significance tests and confidence intervals, comparison of means, comparison of proportions, analysis of survival data, subgroup analysis, regression analysis, missing data.

**UNIT – V: REPORTING OF TRIALS 9**

Overview of reporting, trial profile, presenting baseline data, use of tables, figures, critical appraisal of report, meta-analysis.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

The student will be able to

- Explain key concepts in the design of clinical trials.

- Describe study designs used in data management for clinical trials.
- Identify key issues and determine alternate trial designs.
- Recognize the roles of regulatory affairs in clinical trials.
- Provide the overview of reporting trials to the students.

**TEXT BOOKS:**

1. Fundamentals of Clinical Trials, Lawrence M. Friedman, Springer Science & Business Media, 2010
2. Textbook of Clinical Trials, David Machin, Simon Day, Sylvan Green, John Wiley & Sons, 2007
3. Clinical Trials: A Practical Approach, Stuart J. Pocock, John Wiley & Sons, 17-Jul-2013.

**REFERENCEBOOKS:**

1. Clinical trials, A practical guide to design, analysis and reporting. Duolao Wang and AmeetBakhai. Remedica. 2006.
2. Introduction to statistics in pharmaceutical clinical trials. T.A. Durham and J Rick Turner. Pharmaceutical Press.
3. Clinical Trials: Study Design, Endpoints and Biomarkers, Drug Safety, and FDA and ICH Guidelines, Tom Brody, Academic Press, 2016

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| **2** | 3 | 2 | 2 | - | - | - | - | 2 | - | - | - | 2 | 2 | 3 | - | - |
| **3** | 3 | 3 | 2 | 2 | - | - | - | 2 | - | - | - | 2 | 2 | 3 | - | - |
| **4** | 3 | 3 | - | - | - | - | 2 | 3 | - | - | - | 2 | 2 | 2 | - | - |
| **5** | 3 | - | - | - | - | - | - | 3 | - | - | - | 2 | 2 | 2 | - | - |

**1910704** **REGULATORY REQUIREMENTS IN PHARAMACEUTICAL INDUSTRIES** **L T P C 3 0 0 3**

**OBJECTIVES:**

- To acquire the knowledge of pharmaceutical industry regulations.
- To learn about the packaging and labeling of drugs.
- To learn about the patent filling process.
- To gain knowledge about the quality guidelines in drug products.
- To gain knowledge on documentation.

**UNIT-I: REGULATORY CONCEPTS** **9**

Quality assurance – Quality control – Practice of cGMP – Schedule M – USFDA.

**UNIT – II: REGULATORY ASPECTS** **9**

Pharmaceuticals: Bulk drug manufacture; Personnel, Buildings and Facilities, Process Equipment, Documentation and Records, Materials Management, Production and In-Process Controls, Packaging and Identification Labelling of API‟s and Intermediates, Storage and distribution, – Biotechnology derived products; Principles, Personnel, Premises and equipments, Animal quarters and care, production, labelling, Lot processing records and distribution records, quality assurance and quality control..

**UNIT – III: INTELLECTUAL PROPERTY RIGHTS** **9**

Patent system – Different types of patents – Filing process of application for patent – Infringement of patents – The patent rules 2003 as amended by the patents (amendment) rules 2016.

**UNIT – IV: ICH GUIDELINES** **9**

Quality guidelines – Impurities in new drug substances (Q3A(R2)) – Impurities in newdrug products(Q3B(R2)) – Validation of analytical procedures text and methodology (Q2 (R1)).

**UNIT – V: QUALITY AUDIT AND SELF INSPECTIONS** **9**

SOPs – Documentation – Loan license auditing – Common technical documentation (CTD) – Drug master file (DMF).

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On completion of the course, the student will be able

- To be familiarise with the pharmaceutical industry manufacturing practices and regulatory aspects of pharmacy products.
- To know the process of patenting activities.
- To acquire knowledge on filling process.
- To know the quality guidelines followed for pharmaceutical products.
- To understand the aspects involved in document preparation for pharmaceutical product registration.

**TEXT BOOKS:**

1. C.V.S. Subbrahmanyam & J.Thimmasetty, Pharmaceutical regulatory affairs, 1$^{st}$ Edn., vallabhPrakashan, New Delhi, 2012.
2. Willig, H., Tuckeman, M.M. and Hitchings, W.S., “Good Manufacturing Practices for Pharmaceuticals”, 5th Edition, Marcel Dekker Drugs and the Pharmaceutical Sciences, by CRC Press, New York, 2000.
3. N Udupa, Krishnamurthy Bhat, A Concise Textbook of Drug Regulatory Affairs, Manipal University Press (MUP); First Edition, 2015.

**REFERENCE BOOKS:**

1. Ira R. Berry,The Pharmaceutical Regulatory Process, marcel dekker Series: Drugs and the Pharmaceutical Sciences, by CRC Press, Newyork, 2004.
2. Mindy J. Allport-Settle, Current Good Manufacturing Practices: Pharmaceutical, Biologics, and Medical Device Regulations and Guidance Documents Concise Reference, Pharmalogika Inc., USA, 2009.
3. Sharma, P.P., “How to Practice GMPs”, 3rd Edition, Vandana Publications, 2006.

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| **2** | 2 | 3 | - | - | - | 2 | 3 | 3 | - | - | - | 2 | 2 | - | - | - |
| **3** | 2 | 2 | 3 | 2 | - | 2 | 3 | 3 | - | - | - | 2 | 2 | - | - | - |
| **4** | 2 | - | - | - | - | 2 | 3 | 3 | - | - | - | 2 | 2 | - | - | - |
| **5** | 2 | - | - | - | - | 2 | 3 | 3 | - | - | - | 2 | 2 | - | - | - |

**1910705 MICROBIOLOGY L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To introduce students to the principles of Microbiology.
- To emphasize the structure and biochemical aspects of various microbes.
- To learn about the Nutritional classification of microorganisms.
- To gain knowledge on the Physical and chemical control of microorganisms.
- To learn about the preservation of food.

**UNIT – I: INTRODUCTION TO MICROBIOLOGY 9**

Classification and nomenclature of microorganisms, microscopic examination of microorganisms: light, fluorescent, dark field, phase contrast, and electron microscopy.

**UNIT – II: MICROBES- STRUCTURE AND REPRODUCTION 9**

Structural organization and multiplication of bacteria, viruses (TMV, Hepatitis B), algae (cyanophyta, rhodophyta) and fungi (Neurospora), life history of actinomycetes (Streptomyces), yeast (Sacharomyces), mycoplasma (M. pneumoniae) and bacteriophages ( T4 phage, ʎ phage)

**UNIT – III: MICROBIAL NUTRITION, GROWTH AND METABOLISM 9**

Nutritional classification of microorganisms based on carbon, energy and electron sources Definition of growth, balanced and unbalanced growth, growth curve and different methods to quantify bacterial growth:(counting chamber, viable count method, counting without equipment, different media used for bacterial culture (defined, complex, selective, differential, enriched) thematematics of growth-generation time, specific growth rate.

**UNIT – IV: CONTROL OF MICROORGANISMS 9**

Physical and chemical control of microorganisms Definition of sterilization, dry and moist heat, pasteurization, tyndalization; radiation, ultrasonication, filtration.Disinfection sanitization, antiseptics sterilants and fumigation.mode of action and resistance to antibiotics; clinically important microorganisms

**UNIT – V: INDUSTRIAL MICROBIOLOGY 9**

Microbes involved in preservation (Lactobacillus, bacteriocins), spoilage of food and food borne pathogens (E.coli, S.aureus, Bacillus, Clostridium). Industrial use of microbes (production of penicillin, alcohol, vitamin B-12); biogas; bioremediation (oil spillage leaching of ores by microorganisms ,pollution control); biofertilizers, biopesticides. Biosensors.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- To provide to the students the fundamentals of Microbiology.
- To Describe the scope of microbiology
- To solve the problems in microbial infection and their control**.**
- To understand the concept of food preservation.
- To be familiarize with the industrial use of microbes.

**TEXT BOOKS:**


1. Pelczar, M.J. “Microbiology”, 5th Edition, Tata McGraw-Hill, 1993.
2. Prescot. Harley, Klein. “Microbiology “: McGraw-Hill Higher Education, 2008.
3. Ananthanarayanan, R. and C.K. Jayaram Paniker, “Textbook of Microbiology”,4th Edition, Orient Longman, 1990.


**REFERENCE BOOKS:**


1. Pelczar, M.J. “Microbiology”, Fifth Edition, Tata McGraw-Hill, 1993.
2. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.
3. Schlegel, H.G. “General Microbiology”, Seventh Edition, Cambridge University Press, 1993


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| **2** | 3 | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 | - | - | - |
| **3** | 3 | 2 | 2 | 2 | - | 2 | 1 | 2 | - | - | - | 2 | 2 | 2 | 2 | - |
| **4** | 3 | - | - | 2 | - | 1 | 2 | 2 | - | - | - | 2 | 2 | 2 | - | - |
| **5** | 3 | - | - | - | - | 3 | 2 | - | - | - | - | 2 | 2 | - | - | - |

**1920701 ANALYTICAL METHODS AND INSTRUMENTATION L T P C**

**3 0 0 3**

**OBJECTIVES**

- Make the students understand the basics of spectrometry
- To explore the knowledge on molecular spectroscopy.
- To introduce the NMR and MASS spectrometry.
- To elucidate the various separation methods in chromatography.
- To gain knowledge on potentiometry and surface microscope.

**UNIT- I: SPECTROMETRY 9**

Properties of electromagnetic radiation- wave properties – components of optical instruments– Sources of radiation – wavelength selectors – sample containers – radiation transducers – Signal process and read outs – signal to noise ratio - sources of noise – Enhancement of signal to noise - types of optical instruments – Applications.

**UNIT –II: MOLECULAR SPECTROSCOPY 9**

Molecular absorption spectrometry – Measurement of Transmittance and Absorbance – Beer's law – Instrumentation - Applications -Theory of fluorescence and Phosphorescence –Theory of Infrared absorption spectrometry – IR instrumentation – Applications – Theory of Raman spectroscopy – Instrumentation – applications.

**UNIT- III: NMR AND MASS SPECTROMETRY 9**

Theory of NMR – chemical shift- NMR-spectrometers – applications of 1H and 13C NMR- Molecular mass spectra – ion sources. Mass Spectrometer. Applications of molecular mass - Electron paramagnetic resonance- g values – instrumentation.

**UNIT- IV: SEPARATION METHODS 9**

General description of chromatography – Band broadening and optimization of column performance-Liquid chromatography – Partition chromatography – Adsorption chromatography – Ion exchange chromatography -size exclusion chromatography- Affinity chromatography- principles of GC and applications – HPLC- Capillary electrophoresis – Applications.

**UNIT-V: ELECTRO ANALYSIS AND SURFACE MICROSCOPY 9**

**Electrochemical cells-** Electrode potential cell potentials – potentiometry- reference electrode – ionselective and molecular selective electrodes – Instrument for potentiometric studies – Voltametry – Cyclic and pulse voltametry- Applications of voltametry . Study of surfaces – Scanning probe microscopes – AFM and STM.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Ability to understand the concept of spectrometry
- Ability to know the operations of various instruments.
- Able to apply molecular spectroscopy concepts in NMR and MASS spectrometry.
- Ability to understand surface microscopy and its applications.
- Ability to acquire knowledge on surface microscopic techniques and voltametric applications.

**TEXT BOOKS:**


1. Skoog, D.A. F. James Holler, and Stanky, R.Crouch "Instrumental Methods of Analysis".CengageLearning , 2007.
2. Willard, Hobart, etal., "Instrumental Methods of Analysis". VII$^{th}$ Edition, CBS, 1986.
3. Braun, Robert D. "Introduction to Instrumental Analysis". Pharma Book Syndicate, 1987.
4. Ewing,G.W. "Instrumental Methods of Chemical Analysis", Vth Edition, McGraw-Hill, 1985


**REFERENCE BOOKS:**


1. Sharma, B.K. "Instrumental Methods of Chemical Analysis : Analytical Chemistry" GoelPublishing House, 1972.
2. Haven, Mary C., e*tal*., "Laboratory Instrumentation ". IV$^{th}$ Edition, John Wiley, 1995.


| Course Outcomes | PROGRAM OUTCOMES | | | | | | | | | | | | Program Specific Outcomes | | | |
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| **CO1** | 3 | - | 3 | 2 | 2 | - | - | 3 | - | 3 | 2 | 1 | 2 | - | - | - |
| **CO2** | 2 | 2 | 3 | 2 | 2 | - | - | 2 | 2 | 3 | 2 | 1 | 2 | - | - | - |
| **CO3** | 2 | 2 | 3 | 3 | 3 | - | 2 | 2 | 2 | 3 | 3 | 1 | 2 | - | - | - |
| **CO4** | 3 | 2 | 3 | 3 | 3 | - | - | 3 | 2 | 3 | 3 | 1 | 2 | - | - | - |
| **CO5** | 3 | - | 3 | 2 | 2 | - | - | 3 | - | 3 | 2 | 1 | 2 | - | - | - |

**1920702** **MEDICAL PHYSICS** **L T P C**

**3 0 0 3**

**COURSE OBJECTIVES**

- To study the complete non-ionizing radiations including light and its effect in human body.
- To understand the principles of ultrasound radiation and its applications in medicine.
- To learn about radioactive nuclides.
- To know the interactions of radiation with matters and how isotopes are produced.
- To study the harmful effects of radiation and radiation protection regulations.

**UNIT-I: NON-IONIZING RADIATION AND ITSMEDICALAPPLICATION 9**

Introduction to EM waves - Tissue as a leaky dielectric - Relaxation processes: Debye model, Cole–Cole model- Overview of non-ionizing radiation effects-Low Frequency Effects- Higher frequency effects. Physics of light-Measurement of light and its unit- limits of vision and color vision an overview - Applications of ultraviolet in medicine, Thermography.

**UNIT-II: ULTRASOUND IN MEDICINE 9**

Ultrasound fundamentals – Generation of ultrasound (Ultrasound Transducer) - Interaction of Ultrasound with matter: Cavitation, Reflection, Transmission- Scanning systems – Artefacts- Ultrasound- Doppler-Double Doppler shift-Clinical Applications- Ultrasonography.

**UNIT-III: PRINCIPLES OF RADIOACTIVE NUCLIDESANDDECAY 9**

Introduction to Radioisotopes - Radioactive decay : Spontaneous Fission, Isomeric Transition, Alpha Decay, Beta Decay, Positron Decay, Electron Capture- Radioactive decay equations – Half life- Mean Life- Effective half-life - Natural and Artificial radioactivity, - Production of radionuclide – Cyclotron produced Radionuclide - Reactor produced Radionuclide: fission and electron Capture reaction, Target and Its Processing Equation for Production of Radionuclide - Radionuclide Generator-Technetium generator.

**UNIT-IV: INTERACTION OF RADIATIONWITH MATTER 9**

Interaction of charged particles with matter –Specific ionization, Linear energy transfer, range, Bremsstrahlung, Annihilation - Interaction of X and Gamma radiation with matter: Photoelectric effect, Compton Scattering, Pair production- Attenuation of Gamma Radiation - Interaction of neutron with matter and their clinical significance- Radionuclide used in Medicine and Technology.

**UNIT-V: RADIATION EFFECTSAND REGULATIONS 9**

Classification of Radiation Damage, Stochastic and Deterministic Effects, Acute Effects of Total Body Irradiation, Long-Term Effects of Radiation, Risk Versus Benefit in Diagnostic Radiology and Nuclear Medicine, Risk of Pregnant Women, Nuclear Regulatory Commission, ALARA Program, Medical Uses of Radioactive Materials, Survey for Contamination and Exposure Rate, Dose Calibrators and Survey Meters, Bioassay, Radioactive Waste Disposal.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- Analyze the low frequency and high frequency effects of non-ionizing radiation and physics of light.
- Define various clinical applications based on ultrasound wave.
- Explain the process of radioactive nuclide production using different techniques
- Analyze radiation mechanics involved with various physiological systems
- Outline the detrimental effects of radiation and regulations for radiation safety.

**TEXT BOOKS:**


1. B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, Medical Physics and Biomedical Engineering, 2nd Edition, IOP Publishers.2001. (Unit I &II)
2. Gopal B. Saha, Physics and Radiobiology of Nuclear Medicine, 4th Edition, Springer, 2013. (Unit III &IV)
3. R.Hendee and Russell Ritenour "Medical Imaging Physics", Fourth Edition William, Wiley-Liss, 2002. (Unit V).


**REFERENCE BOOKS:**


1. S.Webb " The Physics of Medical Imaging", Taylor and Francis,1988
2. HyltonB.Meire and Pat Farrant "Basic Ultrasound" John Wiley & Sons,1995

   John R Cameran , James G Skofronick "Medical Physics" John-Wiley & Sons.1978.


| CO | PO | | | | | | | | | | | | PSO | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **CO1** | 3 | 1 | 1 | - | - | 2 | 1 | - | - | - | - | 3 | 2 | - | - | - |
| **CO2** | 3 | 1 | 2 | 2 | 1 | - | 1 | - | - | - | - | 3 | 2 | - | - | - |
| **CO3** | 3 | 1 | 2 | - | - | 2 | 2 | - | - | - | - | 2 | 1 | - | - | - |
| **CO4** | 2 | 1 | 1 | - | 1 | 1 | 1 | - | - | - | - | 1 | 2 | - | - | - |
| **CO5** | 3 | 2 | 3 | - | 2 | 1 | 3 | - | - | - | - | 3 | 2 | - | - | - |

**1920703** **ELECTRONIC MATERIALS** **L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To Understand the various materials and its properties towards electrical and electronics field.
- To cover the properties of conducting materials.
- Make the students to understand various semiconducting and magnetic materials and their properties.
- To give an idea on dielectric and insulating materials.
- To explore the knowledge on optoelectronic and nano materials.

**UNIT- I: INTRODUCTION 7**

Structure: atomic structures and bonding, types of bonding, band formation. Defects and imperfections in solids: Point, Line and Planar defects; Interfacial defects and volume defects. Classification of materials based on bonding: conductors, semiconductors and insulators.

**UNIT- II: CONDUCTING MATERIALS 9**

Introduction, factors affecting the conductivity of materials, classification based on conductivity of materials, temperature dependence of resistivity, Low resistivity materials (graphite, Al, Cu and steel) and its applications, high resistivity materials (manganin, constantan, nichrome, tungsten) and their applications. Superconductors: Meissner effect, classification and applications.

**UNIT- III: SEMICONDUCTING AND MAGNETIC MATERIALS 10**

Semiconductors: Introduction, types of semiconductors, temperature dependence of semiconductors, compound semiconductors, basic ideas of amorphous and organic semiconductors. Magnetic Materials: classification of magnetic materials, ferromagnetism-B-H curve (Qualitative), hard and soft magnetic materials, magneto materials applications.

**UNIT- IV: DIELECTRIC AND INSULATING MATERIALS 9**

Dielectric Materials: Introduction, classification, temperature dependence on polarization, properties, dielectric loss, factors influencing dielectric strength and capacitor materials, applications. Insulators: Introduction, thermal and mechanical properties required for insulators, Inorganic materials, organic materials, liquid insulators, gaseous insulators and ageing of insulators, applications.

**UNIT –V: OPTOELECTRONIC ANDNANO ELECTRONIC MATERIALS 10**

Optoelectronic materials. Introduction, properties, factor affecting optical properties, role of optoelectronic materials in LEDs, LASERs, photo detectors, solar cells. Nano electronic Materials: Introduction, advantage of nano electronic devices, materials, fabrication, challenges in Nano electronic materials.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- Ability to understand the fundamentals of conducting materials
- Able to define various applications of semiconducting and magnetic materials
- Able to explain the concepts of dielectrics and insulating materials
- Ability to explain various optoelectronic devices and nano electronic materials
- With the basis, students will be able to have clear concepts on electronic behaviours of materials.

**TEXT BOOKS:**

**1.** S.O. Kasap "Principles of Electronic Materials and Devices", 3rd edition, McGraw-Hill Education (India) Pvt. Ltd., 2007.

**2.** W D Callister, "Materials Science & Engineering – An Introduction", Jr., John Willey & Sons, Inc, New York, 7th edition, 2007.

**REFERENCE BOOKS:**

1. B.G. Streetman and S. Banerjee, Solid State Electronic Devices, 6th edition, PHI Learning, 2009.
2. Eugene A. Irene, Electronic Materials Science, Wiley, 2005
3. Wei Gao, Zhengwei Li, Nigel Sammes, An Introduction to Electronic Materials for Engineers, 2nd Edition, World Scientific Publishing Co. Pvt. Ltd., 2011.

| CO | PO | | | | | | | | | | | | PSO | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| CO1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | - | - | - | - | - | 1 | - | - | - |
| CO2 | 2 | 2 | 2 | 1 | 2 | - | - | - | - | - | - | - | 3 | - | - | - |
| CO3 | 3 | 3 | 3 | - | 3 | 2 | - | - | - | - | - | - | 3 | - | - | - |
| CO4 | 2 | 3 | 3 | 1 | 3 | 3 | - | - | - | - | - | - | 3 | - | - | - |
| CO5 | 2 | 3 | 2 | 1 | 3 | 3 | - | - | - | - | - | - | 3 | - | - | - |

**1921701** **WASTE WATER TREATMENT** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To make the student conversant with the water treatment methods including adsorption and oxidation process.
- To provide basic under standings about the requirements of water and its preliminary treatment.
- To study the dynamic processes and understand the features of corrosion and its effects
- To develop and understand the waste water treatment process
- To provide a broad view about the water quality and its standards

**UNIT-I: WATER QUALITY AND PRELIMINARY TREATMENT 9**

Water Quality-physical-chemical and biological parameters of water-Water quality requirement - potable water standards-Wastewater effluent standards-water quality indices. Water purification systems in natural systems- physical processes-chemical processes and biological processes- Primary, secondary and tertiary treatment-Unit operations-unit processes. Mixing, clarification- sedimentation; Types-aeration and gas transfer-coagulation and flocculation, coagulation processes.

**UNIT-II: INDUSTRIAL WATER TREATMENT 9**

Filtration-size and shape characteristics of filtering media-sand filters hydraulics of filtration-design considerations-radial, upflow, highrate and multimedia filters, pressure filter. Water softening-lime soda, zeolite and demineralization processes – Boiler troubles-scale, sludge, priming, foaming, caustic embrittlement and boiler corrosion.

**UNIT-III: CONVENTIONAL TREATMENT METHODS 9**

Taste and odour control-Adsorption-activated carbon treatment-removal of color-iron and manganese removal-aeration, oxidation, ion exchange and other methods-effects of fluorides- fluoridation and defluoridation-desalination-Corrosion prevention and control-factors influencing corrosion-Langelier index-Corrosion control measures.

**UNIT-IV: WASTEWATER TREATMENT 9**

Wastewater treatment-pre and primary treatment-equalization neutralization-screening and grid removal-sedimentation-oil separation gas stripping of volatile organics-biological oxidation-lagoons and stabilization basins-aerated lagoons-activated sludge process-trickling filtration-anaerobic decomposition-Break point chlorination.

**UNIT-V: ADSORPTION AND OXIDATION PROCESSES 9**

Chemical process-Adsorption-theory of adsorption-Ion exchange process-chemical oxidation-advanced oxidation process-sludge handling and disposal-Miscellaneous treatment processes.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student should be able to:

- Gain idea about various methods available for water treatment.
- Appreciate the necessity of water and acquire knowledge of preliminary treatment.
- Interpret the nature of corrosion and its harmful effects.
- Value the various waste water treatment methods.
- Understand about adsorption and oxidation process.

**TEXT BOOKS:**


1. Metcalf and Eddy, "Wastewater Engineering", 4th ed., McGraw Hill Higher Edu., 2002.
2. G.L.Karia and R.A. Christian, Waste Water Treatment, Concepts and Design Approach, Prentice Hall, 2013.
3. Joanne E. Drinon and Frank Spellman, Water and Waste Water Treatment, CRC Press, 2012.


**REFERENCE BOOKS:**


1. S.P. Mahajan, "Pollution control in process industries", 27th Ed. Tata McGraw Hill Publishing Company Ltd., 2012.
2. M. Lancaster, "Green Chemistry: An Introductory Text", 2nd edition, RSC publishing, 2010.
3. C.S. Rao, "Environmental Pollution Control Engineering", New Age International, 2007.
4. M.J. Hammer and M.J. Hammer (Jr.), Water and Waste Water Technology, Pearson, 2011.


| CO | PO | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| **CO 1** | 2 | 1 | 2 | | | | 1 | | 2 | | | 1 |
| **CO 2** | 1 | 2 | 2 | 2 | | | 3 | | 1 | | | 1 |
| **CO 3** | 3 | 1 | | 1 | 3 | 1 | 3 | | | | | 1 |
| **CO 4** | 2 | | 2 | 2 | 1 | | 3 | | | | | 1 |
| **CO 5** | 3 | 2 | | | 1 | | | | | | | 1 |