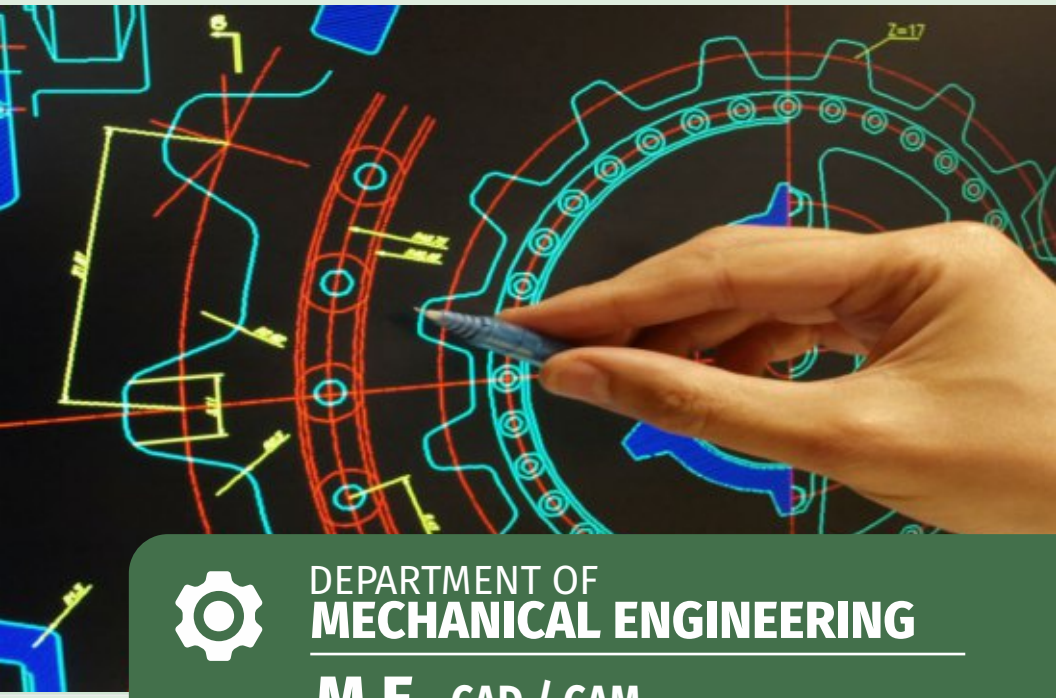
Sri
# SAI RAM
## ENGINEERING COLLEGE
*An Autonomous Institution*

West Tambaram, Chennai - 44

www.sairam.edu.in

*Approved by AICTE, New Delhi*
*Affiliated to Anna University*



## DEPARTMENT OF
# MECHANICAL ENGINEERING

# M.E. CAD / CAM

**AUTONOMOUS**

**REGULATIONS**
**2020**

**PG CURRICULUM AND**
# SYLLABUS
# I - IV
**SEMESTERS**

*Academic Year 2020-21 onwards*

## SRI SAIRAM ENGINEERING COLLEGE

### VISION

To emerge as a "Centre of excellence " offering Technical Education and Research opportunities of very high standards to students, develop the total personality of the individual and instil high levels of discipline and strive to set global standards, making our students technologically superior and ethically stronger, who in turn shall contribute to the advancement of society and humankind.

### MISSION

We dedicate and commit ourselves to achieve, sustain and foster unmatched excellence in Technical Education. To this end, we will pursue continuous development of infra-structure and enhance state-of-the-art equipment to provide our students a technologically up-to date and intellectually inspiring environment of learning, research, creativity, innovation and professional activity and inculcate in them ethical and moral values.

### QUALITY POLICY

We at Sri Sai Ram Engineering College are committed to build a better Nation through Quality Education with team spirit. Our students are enabled to excel in all values of Life and become Good Citizens. We continually improve the System, Infrastructure and Service to satisfy the Students, Parents, Industry and Society.

## DEPARTMENT OF MECHANICAL ENGINEERING

### VISION

To develop a department that commands respect for its technological and engineering depth while maintaining Indian Individuality and assimilating global diversity and meeting eternal challenges.

### MISSION

Department of Mechanical Engineering, SRI SAIRAM ENGINEERING COLLEGE is committed to

**M1** Inculcate students for a successful career in engineering and technology.

**M2** Promote excellence in engineering and technology by motivating students for higher studies.

**M3** Motivate self-employment thereby reducing migration to urban areas.

**M4** Maintain ethical values while assimilating diverse culture without compromising with Indian value system.

**M5** Motivate for lifelong learning.

# AUTONOMOUS CURRICULA AND SYLLABI
# Regulations 2020

## SEMESTER I

| S. NO | COURSE CODE | COURSE TITLE | TOTAL CONTACT HOURS | WEEK HOURS | | | CREDITS |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| **THEORY** | | | | | | | |
| 1. | 20PCDMA101 | Optimization Techniques in Design | 3 | 3 | 0 | 0 | 3 |
| 2. | 20PCDPC101 | Competitive Manufacturing Systems | 3 | 3 | 0 | 0 | 3 |
| 3. | 20PCDPC102 | Computer Aided Tools for Manufacturing | 3 | 3 | 0 | 0 | 3 |
| 4. | 20PCDPC103 | Computer Graphics | 3 | 3 | 0 | 0 | 3 |
| 5. | 20PCDPC104 | Mechanical Vibrations | 3 | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | | |
| 6. | 20PCDPL101 | CAD/CAM Laboratory | 3 | 0 | 0 | 3 | 1.5 |
| **VALUE ADDITIONS - I** | | | | | | | |
| 7. | 20PCDTE101 | Innovative Design Project - I | 4 | 0 | 0 | 4 | 2 |
| | | **TOTAL** | **22** | **15** | **0** | **7** | **18.5** |

## SEMESTER II

| S. NO | COURSE CODE | COURSE TITLE | TOTAL CONTACT HOURS | WEEK HOURS | | | CREDITS |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| **THEORY** | | | | | | | |
| 1. | 20PCDPC201 | Design for Manufacture, Assembly and Environments | 3 | 3 | 0 | 0 | 3 |
| 2. | 20PCDPC202 | Advanced Finite Element Analysis | 3 | 3 | 0 | 0 | 3 |
| 3. | 20PCDPC203 | Integrated Product Design And Process Development | 3 | 3 | 0 | 0 | 3 |
| 4. | 20PCDELXXX | Professional Elective - I | 3 | 3 | 0 | 0 | 3 |
| 5. | 20PCDELXXX | Professional Elective - II | 3 | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | | |
| 7. | 20PCDPL201 | Advanced Analysis and Simulation Laboratory | 3 | 0 | 0 | 3 | 1.5 |
| **VALUE ADDITIONS - I** | | | | | | | |
| 8. | 20PCDTE201 | Innovative Design Project - II | 4 | 0 | 0 | 4 | 2 |
| | | **TOTAL** | **22** | **15** | **0** | **7** | **18.5** |

## SEMESTER III

| S. NO | COURSE CODE | COURSE TITLE | TOTAL CONTACT HOURS | WEEK HOURS | | | CREDITS |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| **THEORY** | | | | | | | |
| 1. | 20PCDPC301 | Research Methodology | 3 | 3 | 0 | 0 | 3 |
| 2. | 20PCDELXXX | Professional Elective III | 3 | 3 | 0 | 0 | 3 |
| 3. | 20PCDELXXX | Professional Elective IV | 3 | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | | |
| 4. | 20PCDPJ301 | Project Work Phase - I | 12 | 0 | 0 | 12 | 6 |
| | | **TOTAL** | **21** | **9** | **0** | **12** | **15** |

## SEMESTER IV

| S. NO | COURSE CODE | COURSE TITLE | TOTAL CONTACT HOURS | WEEK HOURS | | | CREDITS |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| **PRACTICAL** | | | | | | | |
| 1. | 20PCDPJ401 | Project Work Phase - II | 24 | 0 | 0 | 24 | 12 |
| | | **TOTAL** | **24** | **0** | **0** | **24** | **12** |

## PROFESSIONAL ELECTIVES - I

| S. NO | COURSE CODE | COURSE TITLE | TOTAL CONTACT HOURS | WEEK HOURS | | | CREDITS |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| 1. | 20PCDEL201 | Industrial Safety Management | 3 | 3 | 0 | 0 | 3 |
| 2. | 20PCDEL202 | Reliability in Engineering Systems | 3 | 3 | 0 | 0 | 3 |
| 3. | 20PCDEL203 | Advanced Mechanisms Design and Simulation | 3 | 3 | 0 | 0 | 3 |
| 4. | 20PCDEL204 | Lean Manufacturing and Implementation | 3 | 3 | 0 | 0 | 3 |
| 5. | 20PCDEL205 | Mechatronics Applications in Manufacturing | 3 | 3 | 0 | 0 | 3 |
| 6. | 20PCDEL206 | Artificial Intelligence and its Industrial Applications | 3 | 3 | 0 | 0 | 3 |
| 7. | 20PCDEL207 | Design of Plastic Parts | 3 | 3 | 0 | 0 | 3 |

## PROFESSIONAL ELECTIVES - II

| S. NO | COURSE CODE | COURSE TITLE | TOTAL CONTACT HOURS | WEEK HOURS | | | CREDITS |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| 1. | 20PCDEL208 | Advanced Computer Aided Design | 3 | 3 | 0 | 0 | 3 |
| 2. | 20PCDEL209 | Supply Chain Management | 3 | 3 | 0 | 0 | 3 |
| 3. | 20PCDEL210 | Metrology and Non Destructive Testing | 3 | 3 | 0 | 0 | 3 |
| 4. | 20PCDEL211 | Quality Management Techniques | 3 | 3 | 0 | 0 | 3 |
| 5. | 20PCDEL212 | Design for Cellular Manufacturing Systems | 3 | 3 | 0 | 0 | 3 |
| 6. | 20PCDEL213 | Computer Control in Process Planning | 3 | 3 | 0 | 0 | 3 |
| 7. | 20PCDEL214 | Advanced Tool Design | 3 | 3 | 0 | 0 | 3 |

## PROFESSIONAL ELECTIVES - III

| S. NO | COURSE CODE | COURSE TITLE | TOTAL CONTACT HOURS | WEEK HOURS | | | CREDITS |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| 1. | 20PCDEL301 | Tribology In Design | 3 | 3 | 0 | 0 | 3 |
| 2. | 20PCDEL302 | Design of Hydraulic & Pneumatic Systems | 3 | 3 | 0 | 0 | 3 |
| 3. | 20PCDEL303 | Product Life Cycle Management | 3 | 3 | 0 | 0 | 3 |
| 4. | 20PCDEL304 | Data Communications in CAD-CAM | 3 | 3 | 0 | 0 | 3 |
| 5. | 20PCDEL305 | Additive Manufacturing | 3 | 3 | 0 | 0 | 3 |
| 6. | 20PCDEL306 | Design of Material Handling Equipments | 3 | 3 | 0 | 0 | 3 |
| 7. | 20PCDEL307 | Design for Internet of Things | 3 | 3 | 0 | 0 | 3 |

## PROFESSIONAL ELECTIVES - IV

| S. NO | COURSE CODE | COURSE TITLE | TOTAL CONTACT HOURS | WEEK HOURS | | | CREDITS |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| 1. | 20PCDEL308 | Design and Analysis of Experiments | 3 | 3 | 0 | 0 | 3 |
| 2. | 20PCDEL309 | Intelligent Manufacturing Systems | 3 | 3 | 0 | 0 | 3 |
| 3. | 20PCDEL310 | Micro Electro Mechanical Systems Design | 3 | 3 | 0 | 0 | 3 |
| 4. | 20PCDEL311 | Computer Aided Production Planning | 3 | 3 | 0 | 0 | 3 |
| 5. | 20PCDEL312 | Virtual Manufacturing | 3 | 3 | 0 | 0 | 3 |
| 6. | 20PCDEL313 | Engineering Fracture Mechanics | 3 | 3 | 0 | 0 | 3 |
| 7. | 20PCDEL314 | Computer Applications in Design | 3 | 3 | 0 | 0 | 3 |

## PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

To Prepare the graduates to:

**PEO1** To promote successful career in engineering and technological organizations and in other industries with the emphasis in the fields of Design, Engineering, Manufacturing, Service and R&D.

**PEO 2** To prepare students for higher studies and research in institutes of national importance and developed countries by providing strong fundamentals in basic sciences and applying them in engineering.

**PEO 3** Entrepreneurial skill and self-employment in the program adopted.

**PEO 4** Working with ethical values in diverse culture and adherence to Indian culture without compromise in the profession is promoted.

**PEO 5** Institutional program prepares for total development of personality encouraging cultural events, sports, social activities etc.

## PROGRAM SPECIFIC OUTCOMES (PSO)

**PSO 1** To impart sound knowledge on engineering problem analysis, and prepare students for carrying out research in the chosen field.

**PSO2** To devise students for successful career in industry with ethical values, while generating thirst for knowledge and lifelong learning.

## PROGRAMME OUTCOMES(POs)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, research literature, and analyze 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 the public health and safety, and the 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, and modern engineering and IT tools including prediction and modeling 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 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.

# SEMESTER - I

| 20PCDMA101<br>SDG NO. 4 | OPTIMIZATION TECHNIQUES IN DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart knowledge on various categories of existing engineering problems and solutions to such problems through different optimization techniques and approaches.

**UNIT I UNCONSTRAINED OPTIMIZATION TECHNIQUES 10**

Introduction to optimum design - General principles of optimization – Problem formulation & their classifications - Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, Random, pattern and gradient search methods – Interpolation methods.

**UNIT II CONSTRAINED OPTIMIZATION TECHNIQUES 10**

Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - Geometric programming.

**UNIT III ADVANCED OPTIMIZATION TECHNIQUES 10**

Multi stage optimization – dynamic programming; stochastic programming; Multi objective optimization, Genetic algorithms and Simulated Annealing techniques; Neural network & Fuzzy logic principles in optimization.

**UNIT IV STATIC APPLICATIONS 8**

Structural applications – Design of simple truss members - Design applications – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs.

**UNIT V DYNAMIC APPLICATIONS 7**

Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms – Optimum design of simple linkage mechanisms.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Goldberg, D.E., "Genetic algorithms in search, optimization and machine", Barnen, Addison- Wesley, New York, 1989.

2. Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, 1990.
3. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. 1995.
4. Rao, Singaresu, S., "Engineering Optimization – Theory & Practice", New Age International (P) Limited, New Delhi, 2000.

**WEB REFERENCES:**

1. http://web.mit.edu/16.810/www/16.810_L8_Optimization.pdf
2. https://mech.iitm.ac.in/nspch52.pdf

**ONLINE RESOURCES:**

1. https://nptel.ac.in/courses/112/106/112106064/
2. https://nptel.ac.in/courses/111/105/111105039/

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Understand the Concept of optimization and unconstrained optimization techniques.
2. Study constrained optimization techniques particularly equality constraints, inequality constraints
3. Study the Advanced optimization techniques consisting various multistage optimization.
4. Understand the various applications related to statics.
5. Know about Dynamic Applications

**CO- PO &PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | - | - | - | - | - | 1 | 2 | 2 | 2 | 2 |
| CO2 | 3 | 2 | 2 | 1 | - | - | - | - | - | 2 | 1 | 2 | 2 | 2 |
| CO3 | 3 | 2 | 1 | 2 | - | - | - | - | - | 2 | 1 | 2 | 2 | 2 |
| CO4 | 3 | 2 | 1 | 1 | - | - | - | - | - | 1 | 1 | 2 | 2 | 2 |
| CO5 | 3 | 2 | 2 | 1 | 1 | - | - | - | 1 | 1 | 1 | 2 | 2 | 2 |

# SEMESTER - I

| 20PCDPC101<br>SDG NO. 4 | COMPETITIVE MANUFACTURING SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To emphasize the knowledge on the quality improvement, automation, and advanced manufacturing techniques to create the highest-caliber products quickly, efficiently, inexpensively, and in synchronization with the marketing, sales, and customer service of the company.

**UNIT I MANUFACTURING IN A COMPETITIVE ENVIRONMENT 9**

Five areas of competitive manufacturing: cost, quality, delivery, safety/environment, and morale. Automation of manufacturing process - Numerical control - Adaptive control - material handling and movement - Industrial robots - Sensor technology - flexible fixtures - Design for assembly, disassembly and service – PLM – Numerical Problems.

**UNIT II GROUP TECHNOLOGY & FLEXIBLE MANUFACTURING SYSTEMS 9**

Part families - classification and coding - Production flow analysis - Machine cell design - Benefits. Components of FMS - Computer control and functions - Planning, scheduling and control of FMS - Knowledge based scheduling – Quantitative Analysis and FMS.

**UNIT III COMPUTER SOFTWARE, SIMULATION AND DATABASE OF FMS 9**

System issues - Types of software - specification and selection - Trends - Simulation and Applications - Simulation software - Manufacturing data systems - data flow - CAD/CAM considerations - Planning FMS database.

**UNIT IV LEAN MANUFACTURING 9**

Origin of lean production system – Customer focus – Muda (waste) – Standards – 5S system – Total Productive Maintenance – standardized work –Man power reduction – Overall efficiency - Kaizen – Common layouts - Jidoka concept – Poka-Yoke (mistake proofing) - Worker Involvement– Quality circle activity - Suggestion Programmes – Hoshin Planning System (systematic planning methodology) – Lean culture – APQP – SOP – PPAP – Factories of the future.

**UNIT V JUST IN TIME** **9**

Characteristics of JIT - Pull method - quality -small lot sizes - work station loads - close supplier ties – flexible work force - line flow strategy - preventive maintenance for JIT – VSM - Kanban system - strategic implications - implementation issues.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Jha, N.K., "Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.
2. Bhat, S. K., "Total Quality Management", Himalaya Publishing House Pvt. Ltd., 2011.
3. Groover, M.P., "Automation, Production Systems and Computer Integrated Manufacturing ", Third Edition, Prentice-Hall, 2007.
4. Kalpakjian, "Manufacturing Engineering and Technology ", Addison-Wesley Publishing Co., 1995. 5. Ohno, T.T., "Production System Beyond Large-Scale production", Productivity Press (India) Pvt. Ltd. 1992.
6. Dennis, P., "Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System", (Second edition), Productivity Press, New York, 2007.

**WEB REFERENCES:**

1. http://ocw.utm.my/pluginfile.php/3448/mod_resource/content/0/Manufacturing_in_Competitive_Environment_OCW.pdf
2. https://www.revotechnologies.net/uploads/1/6/0/7/16078520/unit_iii-acim.pdf
3. https://searcherp.techtarget.com/definition/lean-production

**ONLINE RESOURCES:**

1. https://www.youtube.com/watch?v=tiarT1YS-lM
2. https://www.youtube.com/watch?v=HkdoR-NNEoI
3. http://www.infocobuild.com/education/audio-video-courses/mechanical-engineering/DesignPractice-IIT-Kanpur/lecture-31.html

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Apply the knowledge to implement and work in competitive manufacturing systems.
2. Practice the principles of flexible manufacturing and Group Technology.
3. Learn computer software and its types regarding simulation and data base of FMS.

4. Understand Lean Manufacturing concepts and its culture.
5. Learn characteristics of Just in Time.

**CO- PO &PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 3 | 2 | - | - | 2 | 2 | 2 | 3 | 1 | 1 |
| CO2 | 3 | 2 | 1 | 2 | 1 | 2 | - | - | 1 | 1 | 1 | 2 | 1 | 2 |
| CO3 | 3 | 2 | 2 | 1 | 3 | 2 | - | - | 2 | 2 | 2 | 3 | 1 | 1 |
| CO4 | 3 | 2 | 2 | 1 | 3 | 2 | - | - | 2 | 2 | 2 | 3 | 1 | 2 |
| CO5 | 1 | 1 | - | - | 1 | 1 | - | - | 1 | 1 | 1 | 1 | - | 2 |

# SEMESTER - I

| 20PCDPC102<br>SDG NO. 4,9&12 | COMPUTER AIDED TOOLS FOR MANUFACTURING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- The purpose of this course is to make the students to get familiarized with various computer aided tools that can be implemented in various industrial applications.

**UNIT I COMPUTER AIDED MANUFACTURING 9**

Manufacturing Processes – Removing, Forming, Deforming and joining – Integration equipments. Integrating CAD, NC and CAM – Machine tools – Point to point and continuous path machining, NC, CNC and DNC – NC Programming – Basics, Languages, G Code, M Code, APT – Tool path generation and verification – CAD/CAM NC Programming – Production Control – Cellular Manufacturing

**UNIT II COMPUTER AIDED PROCESS PLANNING 9**

Role of process planning in CAD/CAM Integration – Computer Aided Process Planning – Development, Benefits, Model and Architecture – CAPP Approaches – Variant, Generative and Hybrid – Process and Planning systems – CAM-I, D-CLASS and CMPP – Criteria in selecting a CAPP System.

**UNIT III COMPUTER AIDED INSPECTION 9**

Engineering Tolerances – Need for Tolerances – Conventional Tolerances –

FITS and LIMITS – Tolerance Accumulation and Surface quality – Geometric Tolerances – Tolerances Practices in design, Drafting and manufacturing – Tolerance Analysis – Tolerance synthesis – Computer Aided Quality control – Contact Inspection Methods – Non Contact Inspection Methods - Non optical.

**UNIT IV REVERSE ENGINEERING 9**

Scope and tasks of Reverse Engineering – Domain Analysis – Process Duplicating – Tools for RE – Developing Technical data – Digitizing techniques – Construction of surface model – Solid part model – Characteristic evaluation – Software's and its application – CMM and its feature capturing - surface and solid modeling.

**UNIT V DATA MANAGEMENT 9**

Strategies for Reverse Engineering Data management – Software application – Finding renewable software components – Recycling real time embedded software – Design experiments to evaluate a RE tools – Rule based detection for RE user interface – RE of assembly programs.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Catherine A. Ingle, "Reverse Engineering", Tata Mc Graw Hill Publication, 1994
2. David D. Bedworth, Mark R. Henderson, Philp M. Wolfe, "Computer Integrated Design and manufacturing", Mc Graw Hill International series, 1991
3. Donald R. Honra, "Co-ordinate measurement and reverse Engineering, American Gear Manufacturers Association.
4. Ibrahim Zeid and R. Sivasubramanian, "CAD/CAM Theory and Practice", Revised First special Indian Edition, Tata Mc Graw Hill Publication, 2007
5. Ibrahim Zeid, "Mastering CAD/CAM", special Indian Edition, Tata Mc Graw Hill Publication, 2007.
6. Linda Wills, "Reverse Engineering" Kluwer Academic Press, 1996.

**WEB REFERENCES:**

1. https://www.inc.com/encyclopedia/computer-aided-design-cad-and-computer-aided-cam.html
2. https://www.brighthubengineering.com/cad-autocad-reviews-tips/62842-computer-aided-process-planning-or-capp/
3. https://physicaldigital.com/what-is-reverse-engineering/

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Apply the concepts of machining and writing programming for CNC milling and turning and also to operate CNC milling and turning equipment.
2. To get familiarized with computer aided tools for various industrial applications in Process planning.
3. Define limits, fits and gauges and know about tolerances, interchangeability, ISO system of limits and fits and to solve its related problems.
4. Acquire basic knowledge about the main opportunities provided by Reverse Engineering, Software used and its applications.
5. Understand data management work related to reverse engineering.

**CO- PO & PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 3 | 2 | - | - | 2 | 2 | 2 | 3 | 1 | 1 |
| CO2 | 3 | 2 | 1 | 2 | 1 | 2 | - | - | 1 | 1 | 1 | 2 | 1 | 2 |
| CO3 | 3 | 2 | 2 | 1 | 3 | 2 | - | - | 2 | 2 | 2 | 3 | 1 | 1 |
| CO4 | 3 | 2 | 2 | 1 | 3 | 2 | - | - | 2 | 2 | 2 | 3 | 1 | 2 |
| CO5 | 1 | 1 | - | - | 1 | 1 | - | - | 1 | 1 | 1 | 1 | - | 2 |

# SEMESTER - I

| 20PCDPC103<br>SDG NO. 4,9&12 | COMPUTER GRAPHICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- Understand the two dimensional graphics and their transformations
- Gain knowledge about graphics hardware devices and software used
- Understand the three dimensional graphics and their transformations

**UNIT I INTRODUCTION** **9**

Survey of computer graphics, Overview of graphics systems – Video display devices, Raster scan systems, Random scan systems, Graphics monitors and Workstations, Input devices, Hard copy Devices, Graphics Software; Output primitives – points and lines, line drawing algorithms, loading the frame

buffer, line function; circle and ellipse generating algorithms; Pixel addressing and object geometry, filled area primitives.

**UNIT II TWO DIMENSIONAL GRAPHICS 9**

Two dimensional geometric transformations – Matrix representations and homogeneous coordinates, composite transformations; Two dimensional viewing – viewing pipeline, viewing coordinate reference frame; widow-to-viewport coordinate transformation, Two dimensional viewing functions; clipping operations – point, line, and polygon clipping algorithms.

**UNIT III THREE DIMENSIONAL GRAPHICS 9**

Three dimensional concepts; Three dimensional object representations – Polygon surfaces- Polygon tables- Plane equations – Polygon meshes; Curved Lines and surfaces, Quadratic surfaces; Blobby objects; Spline representations – Bezier curves and surfaces -B-Spline curves and surfaces. TRANSFORMATION AND VIEWING: Three dimensional geometric and modeling transformations – Translation, Rotation, Scaling, composite transformations; Three dimensional viewing – viewing pipeline, viewing coordinates, Projections, Clipping; Visible surface detection methods.

**UNIT IV ILLUMINATION AND COLOUR MODELS 9**

Light sources – basic illumination models – halftone patterns and dithering techniques; Properties of light – Standard primaries and chromaticity diagram; Intuitive colour concepts – RGB colour model – YIQ colour model – CMY colour model – HSV colour model – HLS colour model; Colour selection.

**UNIT V ANIMATIONS & REALISM 9**

**Animation Graphics:** Design of Animation sequences – animation function – raster animation – key frame systems – motion specification –morphing – tweening.

**Computer Graphics Realism:** Tiling the plane – Recursively defined curves – Koch curves – C curves – Dragons – space filling curves – fractals – Grammar based models – fractals – turtle graphics – ray tracing.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Donald Hearn and M. Pauline Baker, Warren Carithers,"Computer Graphics With Open GL", 4th Edition, Pearson Education, 2010.
2. Jeffrey McConnell, "Computer Graphics: Theory into Practice", Jones and Bartlett Publishers, 2006.
3. Hill F S Jr., "Computer Graphics", Maxwell Macmillan" , 1990.

4. Peter Shirley, Michael Ashikhmin, Michael Gleicher, Stephen R Marschner, Erik Reinhard, KelvinSung, and AK Peters, Fundamental of Computer Graphics, CRC Press, 2010.
5. William M. Newman and Robert F.Sproull, "Principles of Interactive Computer Graphics", Mc GrawHill 1978.
6. http://nptel.ac.in/

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Design two dimensional graphics.
2. Apply two dimensional transformations and to design three dimensional graphics.
3. Apply Illumination and color models.
4. Apply three dimensional transformations.
5. Learn animation Techniques.

**CO- PO & PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 3 | 2 | - | - | 2 | 2 | 2 | 3 | 1 | 1 |
| CO2 | 3 | 2 | 1 | 2 | 1 | 2 | - | - | 1 | 1 | 1 | 2 | 1 | 2 |
| CO3 | 3 | 2 | 2 | 1 | 3 | 2 | - | - | 2 | 2 | 2 | 3 | 1 | 1 |
| CO4 | 3 | 2 | 2 | 1 | 3 | 2 | - | - | 2 | 2 | 2 | 3 | 1 | 2 |
| CO5 | 1 | 1 | - | - | 1 | 1 | - | - | 1 | 1 | 1 | 1 | - | 2 |

# SEMESTER - I

| 20PCDPC104<br>SDG NO. 4,9&11 | MECHANICAL VIBRATIONS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To understand the Fundamentals of Vibration and its practical applications
- To understand the working principle and operations of various vibration measuring instruments
- To understand the various Vibration control strategies

**UNIT I FUNDAMENTALS OF VIBRATION 11**

Review of Single degree freedom systems – Response to arbitrary periodic Excitations –Duhamel's Integral – Impulse Response function – Virtual work –

Lagrange's equation – Single degree freedom forced vibration with elastically coupled viscous dampers – System Identification from frequency response – Transient Vibration – Laplace transformation formulation.

**UNIT II TWO DEGREE FREEDOM SYSTEM 11**

Free vibration of spring-coupled system – mass coupled system – Vibration of two degree freedom system – Forced vibration – Vibration Absorber – Vibration isolation.

**UNIT II MULTI-DEGREE FREEDOM SYSTEM 15**

Normal mode of vibration – Flexibility Matrix and Stiffness matrix – Eigen values and eigenvectors – orthogonal properties – Modal matrix-Modal Analysis – Forced Vibration by matrix inversion – Modal damping in forced vibration – Numerical methods for fundamental frequencies.

**UNIT IV VIBRATION OF CONTINUOUS SYSTEM 11**

Systems governed by wave equations – Vibration of strings – vibration of rods – Euler Equation for Beams – Effect of Rotary inertia and shear deformation – Vibration of plates.

**UNIT V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS 12**

Vibration instruments – Vibration exciters Measuring Devices – Analysis – Vibration Tests –Free and Forced Vibration tests. Examples of Vibration tests – Industrial, case studies.

**TOTAL: 60 PERIODS**

**REFERENCES :**

1. W.T Thomson, Marie Dillon Dahleh, "Theory of Vibrations", Pearson: 5th edition.
2. J.S. Rao, K.Gupta, "Introductory Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd, 1999.
3. SingeresuS.Rao, "Mechanical Vibrations", Pearson: 4th edition, 2003
4. Den Hartog J.P, "Mechanical Vibrations" Dover Publications, 2013.
5. Ramamurti. V, "Mechanical Vibration Practice with Basic Theory", Narosa, New Delhi, 2000.
6. S. Graham Kelly &Shashidar K. Kudari, "Mechanical Vibrations", Tata McGraw–Hill Publishing Com. Ltd New Delhi,2007

**WEB REFERENCES:**

1. http://160592857366.free.fr/joe/ebooks/Mechanical%20Engineering%20Books%20Collection/VIBRATIONS/mechVib%20theory%20and%20applications.pdf

2. http://vdol.mae.ufl.edu/CourseNotes/EML4220/vibrations.pdf
3. https://engineering.purdue.edu/~deadams/ME563/notes_10.pdf

**ONLINE RESOURCES:**

1. https://nptel.ac.in/courses/112103111/
2. https://online.stanford.edu/courses/aa242b-mechanical-vibrations

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Apply equation of motion and energy methods to model basic vibrating mechanical systems and determine the natural frequency of transient vibrations.
2. Analyze the mathematical model of the two degrees of freedom systems and explain about the working principle of vibration absorber.
3. Compute the natural frequencies of a multi degree of freedom system and explain the modal analysis of a forced vibrating system.
4. Determine the natural frequencies of strings, rods and plates.
5. Describe the vibration measurement by using transducers and vibration exciters.
6. Perform and verify computer simulations employing time integration and modal analysis of discrete vibrating systems.

**CO- PO & PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | - | - | - | - | - | 1 | 2 | 2 | 2 | 2 |
| CO2 | 3 | 2 | 2 | 1 | - | - | - | - | - | 2 | 1 | 2 | 2 | 2 |
| CO3 | 3 | 2 | 1 | 2 | - | - | - | - | - | 2 | 1 | 2 | 2 | 2 |
| CO4 | 3 | 2 | 1 | 1 | - | - | - | - | - | 1 | 1 | 2 | 2 | 2 |
| CO5 | 3 | 2 | 2 | 1 | 1 | - | - | - | 1 | 1 | 1 | 2 | 2 | 2 |

# SEMESTER - I

| 20PCDPL101<br>SDG NO. 4 &9 | CAD/CAMLABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 3 | 1.5 |

**OBJECTIVES:**

- To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modeling software's
- To gain knowledge on CNC Machine and its working principle.

**LIST OF EXPERIMENTS**

**CAD LAB** **30**

- CAD Introduction.
- Sketcher
- Solid modeling –Extrude, Revolve, Sweep, etc and Variational sweep, Loft, etc
- Surface modeling –Extrude, Sweep, Trim ..etc and Mesh of curves, Free form etc
- Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc.
- Assembly-Constraints, Exploded Views, Interference check
- Drafting-Layouts, Standard & Sectional Views, Detailing & Plotting.
- CAD data Exchange formats- IGES, PDES, PARASOLID, DXF and STL.

Exercises in Modeling and drafting of Mechanical Components - Assembly using Parametric and feature based Packages like PRO-E / SOLID WORKS/CATIA / NX etc.

**CAM LAB** **15**

Simulation and Machining using CNC / DNC Machine Tools – Use of FEM Packages - Relational Data Base – Networking – Practice on Computer Aided Measuring Instruments – Image Processing – Software Development for Manufacturing – CNC Controllers – Use of advanced CNC Machining Packages – Business Data Processing

**TOTAL: 45 PERIODS**

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

| S.No | NAME OF THE EQUIPMENT | QTY |
|---|---|---|
| 1. | CNC trainer lathe machine with simulation software | 1 |
| 2. | CNC trainer milling machine with simulation software | 1 |

| | | |
|---|---|---|
| 3. | CNC trainer simulation software (Fanuc OT & OM) | 1 |
| 4. | Creo/Elements pro (Formerly pro / Engineer) - University plus lab pack - 30 user licence | 30 |
| 5. | Bench Model CMM | 1 |
| 6. | Vision & image processing software | 2 |
| 7. | Data Processing Software | 2 |
| 8. | A3 Plotter | 1 |
| 9. | Intel Core i5 Processor Computer | 30 |

**OUTCOMES:**

**Upon completion of the course, the students should be able to**

1. Get familiarized with the computer applications in design and preparing drawings for various Mechanical components
2. Familiarize with Assembly Models of Machine Components using 3D modelling Softwares.
3. Knowledge on Create and Evaluate technical drawings using Graphical user interface Tools

**CO- PO & PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 1 | 2 | 1 | - | - | 2 | 2 | 1 | 2 | 2 | 2 |
| CO2 | 3 | 2 | 3 | 1 | 2 | 1 | - | - | 2 | 2 | 1 | 2 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 1 | 2 | 1 | - | - | 2 | 2 | 2 | 2 | 2 | 2 |

# SEMESTER - I

| 20PCDTE101<br>SDG NO. 4 &9 | INNOVATIVE DESIGN PROJECT - I | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**OBJECTIVES:**

- It is proposed to carryout detailed design calculations and analysis of any mechanical component or mechanical system. This helps the students to get familiar with respect to the design methodologies applied to any component or mechanical system subjected to static, dynamic and thermo-mechanical loads.

**GUIDELINES TO BE FOLLOWED:**

Each student must do a innovative Design work under a project supervisor.

Each student is required to select any new component or an integrated mechanical system that involves various sub components which are to be designed as per design standards and further required to be analyzed for optimum dimensions with respect to the strength and stiffness. A project report & fabricated model(if any) to be submitted by the student, 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**

**OUTCOMES:**

**Upon completion of the course, the students should be able to**

1. Conceptualize the societal needs and acquire design ability.
2. Get familiarized with respect to design standards, design calculations and analysis in designing any mechanical component or system.
3. Manufacture the component/equipment to meet the specific needs of the society with appropriate consideration for public health, safety and environmental context for sustainable development.

**CO- PO & PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 1 | 2 | 1 | - | - | 2 | 2 | 1 | 2 | 2 | 2 |
| CO2 | 3 | 2 | 3 | 1 | 2 | 1 | - | - | 2 | 2 | 1 | 2 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 1 | 2 | 1 | - | - | 2 | 2 | 2 | 2 | 2 | 2 |

# SEMESTER - II

| 20PCDPC201<br>SDG NO. 9,11&12 | DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To know the concept of design for manufacturing, assembly and environment.
- To know the computer application in design for manufacturing and assembly.

**UNIT I INTRODUCTION 5**

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric tolerances - Assembly limits -Datum features - Tolerance stacks.

**UNIT II FACTORS INFLUENCING FORM DESIGN 13**

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice – Influence of materials on form design - form design of welded members, forgings and castings.

**UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION 8**

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area-simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability – Design for accessibility - Design for assembly – Product design for manual assembly - Product design for automatic assembly – Robotic assembly

**UNIT IV COMPONENT DESIGN – CASTING CONSIDERATION 10**

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design -Modifying the design - group technology - Computer Applications for DFMA

**UNIT V DESIGN FOR THE ENVIRONMENT 9**

Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T's environmentally responsible

product assessment - Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture – Design for energy efficiency – Design to regulations and standards.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker.
2. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.
3. Bralla, Design for Manufacture handbook, McGraw hill, 1999.
4. Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.
5. Fixel, J. Design for the Environment McGraw Hill., 1996.
6. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
7. Harry Peck , Designing for manufacture, Pitman– 1973
8. Kevin Otto and Kristin Wood, Product Design. Pearson Publication, (Fourth Impression) 2009.

**WEB REFERENCES:**

1. www.nptel.iitm.ac.in,
2. www.ignou.ac.in
3. www.bits-pilani.ac.in

**ONLINE RESOURCES:**

1. https://www.youtube.com
2. https://nptel.ac.in
3. https://www.academia.edu/8472133/Design_For_Manufacturing_Assembly_DFM_DFA_DFMA_
4. https://www.unm.edu/~bgreen/ME101/dfm.pdf
5. https://ocw.mit.edu/courses/mechanical-engineering/2-008-design-and-manufacturing-ii-spring-2004/lecture-notes/

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Learn the design principles for manufacturability.
2. Understand the factors influencing design.

3. Know the design features for machining considerations.
4. Learn the casting considerations for component design.
5. Understand the design considerations for protecting the environmental objectives.

**CO- PO & PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 |

# SEMESTER - II

| 20PCDPC202<br>SDG NO. 4,9 &12 | ADVANCED FINITE ELEMENT ANALYSIS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To develop a thorough understanding of the advanced finite element analysis techniques with an ability to effectively use the tools of the analysis for solving practical problems arising in engineering design

**UNIT I INTRODUCTION 9**

Historical background, Concept of finite element method, boundary, initial and eigen value problems, Finite element formulation starting from governing differential equations – Weighted residual method, Finite element formulation based on stationary of a functional. Review of static analysis using 1D elements.

**UNIT II STATIC ANALYSIS USING 2D AND 3D ELEMENTS 9**

Triangular and quadrilateral elements, Isoparametric formulation, problems using 2D elements, shape functions for axisymmetric and 3D elements, shape functions for higher order elements. Introduction to plates and shells.

**UNIT III DYNAMIC ANALYSIS 9**

Equations of motion for dynamic problems. Consistent and lumped mass matrices. Formulation of element mass matrices. Free vibration problem formulation, Solution of Eigen value problems using 1D elements, Time dependent one-dimensional bar analysis.

**UNIT IV HEAT TRANSFER ANALYSIS 9**

Basic differential equations of heat transfer, one dimensional and two dimensional finite element formulation using variational method and Galerkin's method, one dimensional steady state heat transfer problems involving conduction and convection. Analysis of tapered fin, Formulation of thermal stress problems and examples, transient thermal analysis.

**UNIT V NON-LINEAR ANALYSIS 9**

Introduction, Non-linear differential equation, Solution procedures for non-linear problems, Linearization and directional derivative, Material non-linearity-analysis of axially loaded bars, Geometric non-linearity-Basic continuum mechanics concepts, Governing differential equations and weak forms, Introduction to contact problems.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Chandrupatla T R and Belegundu A D, "Introduction to Finite Elements in Engineering", Pearson Education, New Delhi, 2007.
2. Logan D L, "A First Course in the Finite Element Method", Thomson Learning, 2007.
3. Rao S S, "The Finite Element Method in Engineering", Elsevier, 2005.
4. Rajasekaran S, "Finite Element Analysis in Engineering Design", S Chand, 2008.
5. Seshu P, "A Text book on Finite Element Analysis", Prentice Hall of India, New Delhi, 2003.

**WEB REFERENCES:**

1. http://www.iitg.ac.in/engfac/rtiwari/resume/usdixit.pdf
2. https://enterfea.com/2d-vs-3d-finite-element-analysis/
3. http://www.alberta-fem.de

**ONLINE RESOURCES:**

1. https://enterfea.com
2. http://nptel.ac.in

3. https://www.coursera.org
4. https://www.classcentral.com

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Understand the Finite Element Formulation for various governing differential equations.
2. Gain knowledge to solve finite element methods for 2D and 3D elements.
3. Solve problems under dynamic conditions by applying various techniques.
4. Arrive at the solutions for heat transfer problems.
5. Acquire knowledge in solving non linear problems.

**CO- PO &PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | - | 1 | - | - | - | - | - | 2 | 3 | 2 |
| CO2 | 3 | 2 | 2 | 2 | - | 1 | - | - | - | - | - | 2 | 3 | 2 |
| CO3 | 3 | 2 | 2 | 2 | - | 1 | - | - | - | - | - | 2 | 3 | 2 |
| CO4 | 3 | 2 | 2 | 2 | - | 1 | - | - | - | - | - | 2 | 3 | 2 |
| CO5 | 3 | 2 | 2 | 2 | - | 1 | - | - | - | - | - | 2 | 3 | 2 |

# SEMESTER - II

| 20PCDPC203<br>SDG NO. 4,9 &12 | INTEGRATED PRODUCT DESIGN AND PROCESS DEVELOPMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- The course aims at providing the basic concepts of product design, product features and its architecture so that student can have a basic knowledge in the common features a product has and how to incorporate them suitably in product

**UNIT I INTRODUCTION** **8**

Need for IPPD-Strategic importance of Product development - integration of customer, designer, material supplier and process planner, Competitor and customer - behavior analysis. Understanding customer-promoting customer understanding-involve customer in development and managing requirements - Organization process management and improvement

**UNIT II CONCEPT GENERATION, SELECTION AND TESTING 10**

Plan and establish product specifications. Task - Structured approaches - clarification - search- externally and internally-Explore systematically - reflect on the solutions and processes - concept selection - methodology - benefits. Implications - Product change - variety - component standardization - product performance - manufacturability – Concept Testing Methodologies

**UNIT III PRODUCT ARCHITECTURE 8**

Product development management - establishing the architecture - creation - clustering - geometric layout development - Fundamental and incidental interactions - related system level design issues - secondary systems - architecture of the chunks - creating detailed interface specifications-Portfolio Architecture.

**UNIT IV INDUSTRIAL DESIGN 8**

Integrate process design - Managing costs - Robust design - Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically - Need 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 11**

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 - Understanding and representing tasks-baseline project planning - accelerating the project-project execution.

**a Term Project/Presentation must be given for Assessment – 3 (Compulsory)

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Concurrent Engg./Integrated Product Development. Kemnneth Crow, DRM Associates, 6/3, ViaOlivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book
2. Effective Product Design and Development, Stephen Rosenthal, Business One Orwin, Homewood, 1992,ISBN, 1-55623-603-4
3. Product Design and Development, Karl T.Ulrich and Steven D.Eppinger, McGraw –Hill International Edns.1999

4. Tool Design – Integrated Methods for successful Product Engineering, Stuart Pugh, Addison Wesley Publishing,Neyourk,NY,1991, ISBN 0-202-41639-5

WEB REFERENCES:

1. https://nptel.ac.in/courses/107/104/107104076/
2. www.me.mit/2.7444
3. https://asq.org/quality-resources/design-of-experiments

**ONLINE RESOURCES:**

1. https://nptel.ac.in/courses/107/103/107103082/
2. https://nptel.ac.in/courses/107/101/107101086/
3. https://nptel.ac.in/courses/107/101/107101088/
4. https://nptel.ac.in/courses/112/107/112107258/
5. https://nptel.ac.in/courses/112/106/112106249/

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Understand basic concepts of Product Design, Development and Innovation.
2. Generate concepts and selection for the design of a product.
3. Describe the Product Architecture.
4. Know the Industrial Design procedure.
5. Explain the Design for Manufacturing for Product development in design of Products.

**CO- PO &PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | 2 | 2 | 2 | 3 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 1 | 2 |
| CO2 | 2 | 2 | 1 | 2 | 2 | - | - | 1 | 3 | 3 | 3 | 3 | 1 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 3 |
| CO4 | 2 | 3 | 2 | 3 | 3 | 1 | - | 2 | 3 | 3 | 3 | 3 | 2 | 3 |
| CO5 | - | 2 | 1 | 3 | 2 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 1 | 3 |

# SEMESTER - II

| 20PCDPL201<br>SDG NO. 4 & 9 | ADVANCED ANALYSIS AND SIMULATION LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 3 | 1.5 |

**OBJECTIVES:**

- To give exposure to software tools needed to analyze engineering problems.
- To expose the students to different applications of simulation and analysis tools.

**LIST OF EXPERIMENTS:**

**SIMULATION**

1. MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables
2. Use of Matlab to solve simple problems in vibration
3. Mechanism Simulation using Multibody Dynamic software

**ANALYSIS**

1. Force and Stress analysis using link elements in Trusses, cables etc.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates and simple shells.
4. Stress analysis of axi – 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.
8. Model analysis of Beams.
9. Harmonic, transient and spectrum analysis of simple systems.

**TOTAL: 45 PERIODS**

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

| S.No | NAME OF THE EQUIPMENT | QTY |
|---|---|---|
| 1. | Intel Core i5 Processor Computer | 30 |
| 2. | Color Desk Jet Printer | 01 |
| 3. | Multibody Dynamic Software License Suitable for Mechanism simulation and analysis | 15 |
| 4. | MATLAB licenses | 05 |

**OUTCOMES :**

**Upon completion of the course, the students should be able to**

1. Can model and analyze experiments to meet real world system and evaluate the performance.
2. Aware of software tools needed to analyze and simulate engineering problems.
3. Solve different applications of simulation and analysis tools.

**CO- PO & PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 |

# SEMESTER - II

| 20PCDTE201<br>SDG NO. 4 & 9 | INNOVATIVE DESIGN PROJECT - II | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**OBJECTIVES:**

- It is proposed to carryout detailed design calculations and analysis of any mechanical component or mechanical system. This helps the students to get familiar with respect to the design methodologies applied to any component or mechanical system subjected to static, dynamic and thermo-mechanical loads.

**GUIDELINES TO BE FOLLOWED:**

Each student must do a innovative Design work under a project supervisor. Each student is required to select any new component or an integrated mechanical system that involves various sub components which are to be designed as per design standards and further required to be analyzed for optimum dimensions with respect to the strength and stiffness. A project report & fabricated model(if any) to be submitted by the student, 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**

**OUTCOMES :**

**Upon completion of the course, the students should be able to**

1. Conceptualize the societal needs and acquire design ability.
2. Get familiarized with respect to design standards, design calculations and analysis in designing any mechanical component or system.
3. Manufacture the component/equipment to meet the specific needs of the society with appropriate consideration for public health, safety and environmental context for sustainable development.

**CO- PO & PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO2 | 2 | 2 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO3 | 3 | 1 | - | - | 3 | - | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 3 |

# SEMESTER - III

| 20PCDPC301<br>SDG NO. 4 & 9 | RESEARCH METHODOLOGY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain the details of sampling designs, measurement and scaling techniques and also different methods of data collections.
- To explain several parametric tests of hypotheses and Chi-square test.
- To explain the art of interpretation and the art of writing research reports.

**UNIT I INTRODUCTION** **9**

**Research Methodology:** Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India.

**Defining the Research Problem:** Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.

**UNIT II REVIEWING THE LITERATURE & RESEARCH DESIGN 9**

**Reviewing the literature:** Place of the literature review in research, Bringing clarity and focus to research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, Review of the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

**Research Design:** Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.

**UNIT III DESIGN OF SAMPLE SURVEY & DATA COLLECTION 9**

**Design of Sample Surveys:** Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

**Measurement and Scaling:** Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement, Techniques of Developing Measurement Tools, Scaling, Scale Classification Bases, Scaling Techniques, Multidimensional Scaling, Deciding the Scale.

**Data Collection:** Introduction, Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.

**UNIT IV TESTING OF HYPOTHESES 9**

**Testing of Hypotheses:** Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.

**Chi-square Test:** Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests.

**UNIT V INTERPRETATION AND REPORT WRITING 9**

**Interpretation and Report Writing:** Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

**TOTAL: 45 PERIODS**

**TEXTBOOKS :**

1. Kothari, C.R., "Research Methodology –Methods and techniques", New Age Publications, New Delhi, 2009.
2. Panneerselvam, R., "Research Methodology", Prentice-Hall of India, New Delhi, 2004.
3. D. K. Bhattacharyya, "Research Methodology" Excel Books Publications.
4. Taylor, Sinha & Ghoshal, "Research Methodology: A Guide for Researchers in Management and Social Sciences", PHI Publications

**REFERENCE BOOKS:**

1. Trochim, "Research Methods: the concise knowledge base-Atomic" Dog Publishing, 2005
2. Fink A, "Conducting Research Literature Reviews: From the Internet to Paper", Sage Publications, 2009

**WEB REFERENCES:**

1. https://www.taylorfrancis.com/books/9780203836071
2. https://www.sciencedirect.com/book/9780081022207/research-methods#book-description
3. https://academicguides.waldenu.edu/doctoralcapstoneresources/methodology/libraryresources

**ONLINE RESOURCES:**

1. https://nptel.ac.in/courses/121106007/
2. https://nptel.ac.in/courses/107108011/

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. To develop essential research skills.
2. To develop technical writing skills
3. Understand the various methods used to collect the data to research.

4. Demonstrate the concepts of engineering research and its methodologies.
5. Formulate appropriate research problem and conduct the experiments using systematic methods.

**CO- PO & PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | 3 | - | - | - | - | - | - | 2 | - | 1 | 2 | 2 | 2 |
| CO2 | - | 3 | - | - | - | - | - | - | 2 | 1 | 1 | 2 | 2 | 2 |
| CO3 | - | 3 | - | - | 2 | - | - | - | 1 | - | 1 | 2 | 2 | 2 |
| CO4 | 2 | 3 | 2 | 2 | 2 | - | - | - | 1 | - | 1 | 2 | 2 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 2 | - | - | - | 1 | - | 1 | 2 | 2 | 2 |

# SEMESTER - III

| 20PCDPJ301<br>SDG NO. 4 & 9 | PROJECT WORK PHASE - I | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 12 | 6 |

**OBJECTIVES:**

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.

**SYLLABUS:**

The student individually works on a specific topic approved by the head of the division under the guidance of a faculty member who is familiar in this area of interest. The student can select any topic which is relevant to the area of engineering design. The topic may be theoretical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

**TOTAL: 180 PERIODS**

**OUTCOMES :**

**Upon completion of the course, the students should be able to**

1. Conceptualize the societal needs and acquire exposure to product development.
2. Get familiarized with respect to design standards, design calculations and analysis in designing any mechanical component or system.
3. Get clear idea of their area of work and they will be in a position to carry out the remaining phase II work in a systematic way.

**CO-PO & PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO2 | 2 | 2 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO3 | 3 | 1 | - | - | 3 | - | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 3 |

# SEMESTER - IV

| 20PCDPJ401<br>SDG NO. 4 & 9 | PROJECT WORK PHASE - II | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 24 | 12 |

**OBJECTIVES:**

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions

**SYLLABUS:**

The student should continue the phase I work on the selected topic as per the formulated methodology under the same supervisor. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report submitted and the viva-voce examination by a panel of examiners including one external examiner

**TOTAL: 180 PERIODS**

**OUTCOMES :**

**Upon completion of the course, the students should be able to**

1. Develop project related to societal needs and acquire knowledge regarding product development.

2. Get familiarized with respect to design standards, design calculations and analysis in designing any mechanical component or system.
3. Take up any challenging practical problem in the field of engineering design and find better solutions to it.

**CO-PO & PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO2 | 2 | 2 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO3 | 3 | 1 | - | - | 3 | - | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 3 |

# PROFESSIONAL ELECTIVES - I

| 20PCDEL201<br>SDG NO. 3,8,9,11 | INDUSTRIAL SAFETY MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To achieve an understanding of principles of safety management
- To enable the students to learn about various functions and activities of safety department
- To enable students to conduct safety audit and write audit reports effectively in auditing situations
- To have knowledge about sources of information for safety promotion and training
- To familiarize students with evaluation of safety performance

**UNIT I SAFETY MANAGEMENT** **9**

Evaluation of modern safety concepts - Safety management functions - safety organization, safety department - safety committee, safety audit - performance measurements and motivation - employee participation in safety - safety and productivity.

**UNIT II OPERATIONAL SAFETY** **9**

Hot metal Operation - Boiler, pressure vessels - heat treatment shop - gas furnace operation - electroplating-hot bending pipes - Safety in welding and cutting. Cold-metal Operation - Safety in Machine shop - Cold bending and chamfering of pipes - metal cutting - shot blasting, grinding, painting - power press and other machines.

**UNIT III SAFETY MEASURES** **9**

Layout design and material handling - Use of electricity - Management of toxic gases and chemicals - Industrial fires and prevention - Road safety - highway and urban safety - Safety of sewage disposal and cleaning - Control of environmental pollution - Managing emergencies in Industries - planning, security and risk assessments, on- site and off site. Control of major industrial hazards.

**UNIT IV ACCIDENT PREVENTION** **9**

Human side of safety - personal protective equipment - Causes and cost of accidents. Accident prevention programmes - Specific hazard control strategies - HAZOP - Training and development of employees - First Aid- Fire fighting devices - Accident reporting, investigation.

**UNIT V SAFETY, HEALTH, WELFARE & LAWS 9**

Safety and health standards - Industrial hygiene - occupational diseases prevention - Welfare facilities - History of legislations related to Safety-pressure vessel act-Indian boiler act - The environmental protection act - Electricity act - Explosive act.

**TOTAL: 45 PERIODS**

**REFERENCES :**


1. Industrial safety and the law by P.M.C. Nair Publisher's, Trivandrum.
2. John V. Grimaldi and Rollin H. Simonds, "Safety Management", All India Travellers bookseller, New Delhi-1989.
3. Krishnan N.V., "Safety in Industry", Jaico Publisher House, 1996
4. Managing emergencies in industries, Loss Prevention of India Ltd., Proceedings,1999.
5. Occupational Safety Manual BHEL.
6. Safety security and risk management by U.K. Singh & J.M. Dewan, A.P.H. Publishing company, New Delhi, 1996.
7. Singh, U.K. and Dewan, J.M., "Safety, Security and risk management", APH Publishing Company, New Delhi, 1996.


**WEB REFERENCES:**

1. www.nptel.iitm.ac.in,
2. www.ignou.ac.in
3. www.bits-pilani.ac.in

**ONLINE RESOURCES:**

1. https://www.youtube.com
2. https://nptel.ac.in
3. https://kenanaonline.com/files/0086/86060/IndustrialSafety.pdf
4. https://www.jniosh.johas.go.jp/icpro/jicosh-old/english/publication/gernal_guidebook/2006edition.pdf
5. https://labour.gov.in/industrial-safety-health

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Understand the modern safety concepts
2. Know the operational safety in metal cutting operation
3. Know the emergencies and safety measures in industry
4. Understand the accident prevention, human side of the safety protection
5. Know the safety welfare laws, legislations
6. Able to implement and manage the safety measures in the industry

**CO- PO &PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO4 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO5 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO6 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |

# PROFESSIONAL ELECTIVES - I

| 20PCDEL202<br>SDG NO. 4 & 9 | RELIABILITY IN ENGINEERING SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- Introduce the principles and techniques of Statistical Quality Control and their practical uses in product and/or process design and monitoring Illustrate the basic concepts and techniques of modern reliability engineering tools.

**UNIT I RELIABILITY CONCEPT** **9**

Reliability definition – Quality and Reliability– Reliability mathematics – Reliability functions – Hazard rate – Measures of Reliability – Design life –A priori and posteriori probabilities – Mortality of a component –Bath tub curve – Useful life.

**UNIT II FAILURE DATA ANALYSIS** **11**

Data collection –Empirical methods: Ungrouped/Grouped, Complete/Censored data – Time to failure distributions: Exponential, Weibull – Hazard plotting – Goodness of fit tests.

**UNIT III RELIABILITY ASSESSMENT** **10**

Different configurations – Redundancy – m/n system – Complex systems: RBD – Baye's method – Cut and tie sets – Fault Tree Analysis – Standby system.

**UNIT IV RELIABILITY MONITORING 8**

Life testing methods: Failure terminated – Time terminated – Sequential Testing –Reliability growth monitoring – Reliability allocation – Software reliability.

**UNIT V RELIABILITY IMPROVEMENT 7**

Analysis of downtime – Repair time distribution – System MTTR – Maintainability prediction – Measures of maintainability – System Availability – Replacement theory.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Charles E. Ebeling, "An introduction to Reliability and Maintainability engineering", TMH, 2000.
2. Roy Billington and Ronald N. Allan, "Reliability Evaluation of Engineering Systems", Springer, 2007.

**WEB REFERENCES:**

1. https://www.sebokwiki.org/wiki/Reliability,_Availability,_and_Maintainability
2. http://edcan.org.au/edcan-learning-resources/using-edcan-resources/implementation-resources/assessment/reliability-validity

**ONLINE RESOURCES:**

1. https://nptel.ac.in/courses/105108128/
2. https://www.udemy.com/course/an-introduction-to-reliability-engineering/

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Attain the basic concept of Reliability, fundamental knowledge of measures of reliability.
2. Make failure data Analysis including data collections.
3. Describe reliability assessment and make fault tree analysis.
4. Acquire basic knowledge of life testing methods.
5. Understand the concepts of reliability and maintainability

**CO- PO & PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | - | 1 | - | 1 | - | - | 1 | 2 | 2 | 2 | 2 | 2 |
| CO2 | 2 | 2 | - | 1 | - | 1 | - | - | 1 | 2 | 2 | 2 | 2 | 2 |
| CO3 | 1 | 2 | - | 1 | - | 1 | - | - | 1 | 2 | 2 | 2 | 2 | 2 |
| CO4 | 1 | 2 | - | 1 | - | 1 | - | - | 1 | 2 | 2 | 2 | 2 | 2 |
| CO5 | 1 | 2 | - | 1 | - | 1 | - | - | 1 | 2 | 2 | 2 | 2 | 2 |

# PROFESSIONAL ELECTIVES - I

| 20PCDEL203 SDG NO. 4,9&12 | ADVANCED MECHANISMS DESIGN AND SIMULATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To develop a thorough understanding of the various mechanisms and its design and simulation with an ability to effectively use the various mechanisms in real life problems.

**UNIT I INTRODUCTION** **9**

Review of fundamentals of kinematics-classifications of mechanisms-components of mechanisms – mobility analysis – formation of one D.O.F. multi loop kinematic chains, Network formula – Gross motion concepts-Basic kinematic structures of serial and parallel robot manipulatorscompliant mechanisms-Equivalent mechanisms.

**UNIT II KINEMATIC ANALYSIS** **9**

Position Analysis – Vector loop equations for four bar, slider crank, inverted slider crank, geared five bar and six bar linkages. Analytical methods for velocity and acceleration Analysis– four bar linkage jerk analysis. Plane complex mechanisms-auxiliary point method. Spatial RSSR mechanism - Denavit - Harten berg Parameters – Forward and inverse kinematics of robot manipulators.

**UNIT III PATH CURVATURE THEORY, COUPLER CURVE** **9**

Fixed and moving centrodes, inflection points and inflection circle. Euler Savary equation, graphical constructions – cubic of stationary curvature. Four bar coupler curve-cuspcrunode coupler driven six-bar mechanisms-straight line mechanisms

**UNIT IV SYNTHESIS OF FOUR BAR MECHANISMS 9**

Type synthesis – Number synthesis – Associated Linkage Concept. Dimensional synthesis – function generation, path generation, motion generation. Graphical methods-Pole technique, inversion technique-point position reduction-two, three and four position synthesis of four- bar mechanisms. Analytical methods- Freudenstein's Equation-Bloch's Synthesis.

**UNIT V SYNTHESIS OF COUPLER CURVE BASED MECHANISMS & CAM MECHANISMS 9**

Cognate Lingages-parallel motion Linkages. Design of six bar mechanisms-single dwell-double dwell-double stroke. Geared five bar mechanism-multi-dwell. Cam Mechanisms- determination of optimum size of cams. Mechanism defects. Study and use of Mechanism using Simulation Soft-ware packages. Students should design and fabricate a mechanism model as term project.

**TOTAL:45 PERIODS**

**REFERENCES :**

1. Amitabha Ghosh and Asok Kumar Mallik, "Theory of Mechanism and Machines", EWLP, Delhi, 1999.
2. Kenneth J, Waldron, Gary L. Kinzel, "Kinematics, Dynamics and Design of Machinery", John Wiley-sons, 1999.
3. Ramamurti, V., "Mechanics of Machines", Narosa, 2005.
4. Robert L.Norton., "Design of Machinery",Tata McGraw Hill, 2005.
5. Sandor G.N., and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Prentice Hall, 1984.
6. Uicker, J.J., Pennock, G. R. and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 2005.

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Know basic fundamentals of Kinematic Structures.
2. Do kinematics analysis of mechanism to determine position, velocity, and acceleration of all members
3. Get familiarized with the advanced mechanisms
4. Synthesize four-bar mechanisms using graphical and analytical methods for given motions or functional generation tasks.
5. Understand coupler curve and CAM Mechanisms.

**CO- PO, PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | - | 1 | - | - | - | - | - | 2 | 3 | 2 |
| CO2 | 3 | 2 | 2 | 2 | - | 1 | - | - | - | - | - | 2 | 3 | 2 |
| CO3 | 3 | 2 | 2 | 2 | - | 1 | - | - | - | - | - | 2 | 3 | 2 |
| CO4 | 3 | 2 | 2 | 2 | - | 1 | - | - | - | - | - | 2 | 3 | 2 |
| CO5 | 3 | 2 | 2 | 2 | - | 1 | - | - | - | - | - | 2 | 3 | 2 |

# PROFESSIONAL ELECTIVES - I

| 20PCDEL204<br>SDG NO. 3,8,9&12 | LEAN MANUFACTURING AND IMPLEMENTATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart knowledge on globally competitive manufacturing organisation using lean manufacturing principles
- To understand the key requirements and concepts in lean manufacturing according to industry requirements
- To teach the skills to implement lean manufacturing in industry and manage the productivity

**UNIT I INTRODUCTION TO LEAN MANUFACTURING 8**

Conventional Manufacturing versus Lean Manufacturing, Principles of Lean Manufacturing, Basic elements of lean manufacturing ,Introduction to LM Tools.

**UNIT II CELLULAR MANUFACTURING, JIT, TPM 10**

Cellular Manufacturing, Types of Layout, Principles of Cell layout, Implementation, Just in Time (JIT), Principles of JIT and Implementation of Kanban, Pillars of Total Productive Maintenance (TPM), Principles and implementation of TPM.

**UNIT III SETUP TIME REDUCTION, TQM, 5S, VSM 10**

Set up time reduction, Definition, philosophies and reduction approaches, Total Quality Maintenance Principles and implementation, 5S Principles and implementation, Value stream mapping, Procedure and principles.

**UNIT IV SIX SIGMA – TOOLS & TECHNIQUES 10**

Cost of Quality – Conformance and Non-conformance cost – Basic quality control tools – Seven management tools – Failure mode and effect analysis.

**UNIT V SIX SIGMA METHODOLOGY 7**

Need for Six Sigma - Six Sigma Team – Define, Measure, Analyze, Improve and Control Methodology: Define Measure, Analyze, Improve and control – Lean Six Sigma.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Dennis P. Hobbs, "LEAN Manufacturing Implementation", APICS, 2009.
2. Mikell P. Groover, "Automation, Production Systems and CIM", Pearson International Edition, 2002.
3. Rich Charron, H. James Harrington, Frank Voehl and Hal Wiggin, "The Lean Management Systems Handbook Hardcover", CRC Press, 2004.
4. Ronald G. Askin and Jeffrey B. Goldberg, "Design and Analysis of Lean Production Systems", John Wiley & Sons, 2003.
5. M. Rother and J Shook, "Learning to See: Value Stream Mapping to Add Value and Eliminate Muda", Lean Enterprise Institute, Brookline, 2004..

**WEB REFERENCES:**

1. www.nptel.iitm.ac.in,
2. www.ignou.ac.in
3. www.bits-pilani.ac.in

**ONLINE RESOURCES:**

1. https://www.youtube.com
2. https://nptel.ac.in
3. https://web.wpi.edu/Pubs/E-project/Available/E-project-021813-141730/unrestricted/BodycoteB12.pdf
4. www.lean.org, lean enterprise institute
5. https://leansixsigmainstitute.org/

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Understand the manufacturing systems approach, manufacturing strategy, quality systems, and design for manufacture.
2. Understand the cellular manufacturing concept.

3. Work in teams and professional networks project management, conflict resolution, negotiation, professional networking, persuasion, organization, communication, interpersonal skills.
4. learn the six sigma tools and techniques
5. understand the six sigma methodology
6. implement lean,six sigma, JIT, concepts in an organization.

**CO- PO, PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

# PROFESSIONAL ELECTIVES - I

| 20PCDEL205<br>SDG NO. 4,9&11 | MECHATRONICS APPLICATIONS IN MANUFACTURING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart knowledge about the elements and techniques involved in Mechatronics systems Which are very much essential to understand the emerging field of automation.

**UNIT I INTRODUCTION** **9**

Introduction to Mechatronics - Systems - Mechatronics in Products - Measurement Systems - Control Systems - Traditional design and Mechatronics Design.

**UNIT II SENSORS AND TRANSDUCERS** **9**

Introduction - Performance Terminology - Displacement, Position and Proximity - Velocity and Motion - Fluid pressure - Temperature sensors - Light sensors - Selection of sensors – Signal processing - Servo systems.

**UNIT III MICROPROCESSORS IN MECHATRONICS 9**

Introduction - Architecture - Pin configuration - Instruction set - Programming of Microprocessors using 8085 instructions - Interfacing input and output devices - Interfacing D/A converters and A/D converters –Applications - Temperature control - Stepper motor control - Traffic light controller.

**UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 9**

Introduction - Basic structure - Input / Output processing - Programming - Mnemonics Timers, Internal relays and counters - Data handling - Analog input / output - Selection of PLC.

**UNIT V DESIGN AND MECHATRONICS 9**

Designing - Possible design solutions - Case studies of Mechatronics systems.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Bradley, D.A., Dawson, D, Buru, N.C. and Loader, AJ, "Mechatronics ", Chapman and Hall, 1993
2. Ghosh, P.K. and Sridhar, P.R., 0000 to 8085, “Introduction to Microprocessors for Engineers and Scientists ", Second Edition, Prentice Hall, 1995
3. Lawrence J.Kamm, " Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics ", Prentice-Hall, 2000.
4. Michael B.Histand and David G. Alciatore, " Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 1999.
5. Ramesh.S, Gaonkar, "Microprocessor Architecture, Programming and Applications” Wiley Eastern, 1998.

**WEB REFERENCES:**

1. https://nptel.ac.in/courses/112103174/mechatronics
2. https://mechatronics.colostate.edu/resources/
3. https://www.mechatronicseducation.org/repository

**ONLINE RESOURCES:**

1. https://www.udemy.com/user/rvsingh/mechatronics
2. https://ocw.mit.edu/courses/mechanical-engineering
3. https://nptel.ac.in - Mod-01 Lec-17 Sensors and Transducers
4. https://www.udemy.com/user - Microprocessors & Microcontrollers

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Understand the basic concepts of mechatronics, sensors, their characteristics and their role in various engineering applications.
2. Understand the basic concepts of sensors their role in various engineering applications.
3. Knowledge of microprocessor based on standard architecture and block diagrams
4. Knowledge of Programmable Logic Controllers (PLCs) for different applications and ability to program using Relays, Timers, and Counters.
5. Knowledge on principles of actuators, drives and their design concepts, along with mechatronics design and case studies.

**CO- PO & PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 1 | 1 | 2 | - | 1 | 2 | - | 1 | 1 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 1 | 1 | 2 | - | 1 | 2 | - | 1 | 1 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 1 | 2 | 1 | - | 1 | 2 | - | 1 | 2 | 2 | 2 |
| CO4 | 3 | 2 | 3 | 1 | 2 | 1 | - | 1 | 2 | - | 1 | 3 | 2 | 2 |
| CO5 | 1 | 2 | 2 | 1 | 2 | 2 | - | 1 | 2 | - | 1 | 3 | 2 | 2 |

# PROFESSIONAL ELECTIVES - I

| 20PCDEL206<br>SDG NO. 4,9&12 | ARTIFICIAL INTELLIGENCE AND ITS INDUSTRIAL APPLICATIONS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- The course aims at providing the basic concepts of machine intelligence, knowledge representation and languages used in AI so that student can have a basic knowledge in AI and how to incorporate them suitably in industrial applications and expert systems.

**UNIT I HUMAN AND MACHINE INTELLIGENCE 9**

Concepts of fifth generation computing , Programming in AI environment, Developing artificial intelligence system, natural language processing, neural networks.

**UNIT II KNOWLEDGE REPRESENTATION FOR SMART SYSTEMS 9**

Forward chaining, backward chaining, use of probability and fuzzy logic. Semantic nets, structure and objects, ruled systems for semantic nets; certainty factors, automated learning.

**UNIT III LANGUAGES USED IN AI 9**

Using PROLOG to design expert systems, converting rules to PROLOG, conceptual example, introduction to LISP, function evaluation, lists, predicates, rule creation. Expert System Development: Definition, choice of domain, collection of knowledge base, selection of inference mechanism, case studies of expert system development in design and manufacturing.

**UNIT IV EXPERT SYSTEM TOOLS 9**

Expert systems, controlling reasoning, rule based system, canonical systems, rules and meta rules, associative nets and frame systems, graphs trees and networks, representing uncertainity, probability in expert systems-learning, forms of learning, inductive learning, decision trees, knowledge in learning, heuristic classification, heuristic matching, case studies in expert systems, MYCIN, Meta-Dendral, general structure of an expert system shell, examples of creation of an expert system using an expert system tool, fundamentals of object oriented programming, creating structure and object, object operations, invoking procedures, programming applications, object oriented expert system.

**UNIT V INDUSTRIAL APPLICATION OF AI AND EXPERT SYSTEMS 9**

Robotic vision systems, image processing techniques, application to object recognition and inspection, automatic speech recognition.

**TOTAL : 45 PERIODS**

**REFERENCES:**

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson Education, 2014.
2. David Pool and Alan Mackworth, "Artificial Intelligence: Foundations of Computational agents", Cambridge University, 2011.
3. Daphne Koller and N Friedman, "Probabilistic Graphical Models - Principles and Techniques", MIT, 2009.
4. Tsang and Edward, "Foundations of Constraint Satisfaction: The Classic Text", BoD–Books on Demand, 2014.

**WEB REFERENCES:**

1. http://www.aaai.org/AITopics/
2. http://aima.cs.berkeley.edu/ai.html

3. http://www.aaai.org/AITopics/html/expert.html

**ONLINE RESOURCES:**

1. http://www.aaai.org/AITopics/html/neural.html
2. http://brain.cs.unr.edu/publications/NevPropManual.pdf
3. https://www.coursera.org/specializations/deep-learning
4. https://www.edureka.co/post-graduate/machine-learning-and-ai
5. https://www.sas.com/en_in/whitepapers/making-sense-of-ai-109303.html

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Understand basic concepts of human and machine intelligence as well as neural networking.
2. Generate fuzzy logic, semantic nets and automated learning.
3. Describe the languages used in AI and develop the design of expert system.
4. Know the expert system tools and learning, object oriented programming and object oriented expert system.
5. Explain the Robotic vision systems, image processing techniques, application to object recognition and inspection, automatic speech recognition.

**CO- PO & PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | 2 | 2 | 2 | 3 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 1 | 2 |
| CO2 | 2 | 2 | 1 | 2 | 2 | - | - | 1 | 3 | 3 | 3 | 3 | 1 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 3 |
| CO4 | 2 | 3 | 2 | 3 | 3 | 1 | - | 2 | 3 | 3 | 3 | 3 | 2 | 3 |
| CO5 | - | 2 | 1 | 3 | 2 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 1 | 3 |

# PROFESSIONAL ELECTIVES - I

| 20PCDEL207<br>SDG NO. 4,9&12 | DESIGN OF PLASTIC PARTS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- Get a fundamental overview of plastic part design, Manufacturing considerations, injection molding, Mould Design and Materials selection.

**UNIT I PROPERTIES OF PLASTICS 9**

Mechanical Properties- Material Selection for Strength – Degradation - Wear Resistance and Frictional Properties- Special Properties - Processing - Costs. Mechanical Behavior of Plastics- Short term tests -Long term testing -Design Methods for Plastics using deformation data - Pseudo-Elastic design method for plastics-Thermal stresses and Strains- - Time Temperature Superposition - Fracture behavior - Creep behavior - Impact behavior.

**UNIT II MANUFACTURING CONSIDERATIONS 9**

Manufacturing Considerations -Mold Filling Considerations -Weld line-Shrinkage and War page - Cooling and Solidification-Structural design Considerations-Structural Members- Design for Stiffness - Processing Limitations in Product Design.

**UNIT III TYPES OF MOULDS 9**

Types of moulds and dies for various processing methods - Mould and Die Design Concept and Materials. Injection Mould Design - Basics of mould construction - Methodical Mould Design - Design of Feed System, Ejection System - Venting - Design of Cooling system - Mould alignment concepts and Demoulding Techniques.

**UNIT IV MOULD DESIGN 9**

Basics of mould construction - Mould design -Positive moulds- Positive moulds with Lands- Multi cavity moulds with individual, common Loading Chamber - Moulds with a slide core - Split cavity moulds, Heat losses and energy requirement.

**UNIT V DESIGN CALCULATION 9**

Materials Selection, Mould Cooling, Clamping Force, Venting, Pinch-off, Head die design, Parison Diameter Calculation, Wall Thickness, Vertical-load strength, Blow ratio, Base pushup, Neck and Shoulder Design, Thread and

beads, Bottom Design. Extrusion Die Design - Die geometry, Die Design, Materials and Classification.

**TOTAL: 45 PERIODS**

**REFERENCES:**


1. P.S.Cracknell and R.W Dyson, Handbook of Thermoplastics - Injection Mould Design, Chapman & Hall, 1993.
2. Laszlo Sors and Imre Balazs, Design of Plastics Moulds and Dies, Elsevier, Amsterdam, 1989.
3. R.G.W.Pye, Injection Mould Design, SPE Publication, 2000.
4. R J Crawford, Plastics Engineering, Butterworth-Heinemann, Oxford, 1999
5. Edward Miller(Ed), Plastics Product Design Handbook Part A –Materials and Components, Marcel Dekker, 1981.
6. R.A Malloy, Plastic Part Design for Injection Molding An Introduction, Hanser, 1997
7. N. Rao, K O'Brien, Design Data for Plastics Engineers, Hanser, New York, 1998


**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Select and identify the properties of plastic parts.
2. Understand the considerations to be followed in Manufacturing Plastic parts.
3. Study types of Moulds and Dies, also Mould and Demoulding Techniques.
4. Understand the concepts of Mould considerations.
5. Do design calculations for various design processes.

**CO- PO & PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | 2 | 2 | 2 | 3 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 1 | 2 |
| CO2 | 2 | 2 | 1 | 2 | 2 | - | - | 1 | 3 | 3 | 3 | 3 | 1 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 3 |
| CO4 | 2 | 3 | 2 | 3 | 3 | 1 | - | 2 | 3 | 3 | 3 | 3 | 2 | 3 |
| CO5 | - | 2 | 1 | 3 | 2 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 1 | 3 |

# PROFESSIONAL ELECTIVES - II

| 20PCDEL208<br>SDG NO. 4,9&12 | ADVANCED COMPUTER AIDED DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart knowledge on advanced aspects of enabling computer aided technologies used in design, manufacturing and rapid product development
- To teach degree of competency in the development and application of modern computer aided design and manufacturing system
- To gather knowledge on advances in modern techniques of rapid prototyping and rapid tooling

**UNIT I PRINCIPLES OF COMPUTER GRAPHICS 8**

Introduction,graphicprimitives,pointplotting,lines,Bresenham'scirclealgorithm,ellipse,transformation in graphics, coordinate systems, viewport, 2D and 3D transformation, hidden surface removal, reflection, shading and generation of characters.

**UNIT II CAD TOOLS 9**

Definition of CAD Tools, Types of system, CAD/CAM system evaluation criteria, brief treatment of input and output devices. Graphics standard, functional areas of CAD, Modeling and viewing, software documentation, efficient use of CAD software. Geometric modeling: Types of mathematical representation of curves, wire frame models wire frame entities parametric representation of synthetic curves her mite cubic splines Bezier curves, B-splines, rational curves.

**UNIT III SURFACE MODELING 9**

Mathematical representation surfaces, Surface model, Surface entities surface representation, Parametric representation of surfaces, plane surface, rule surface, surface of revolution, Tabulated Cylinder.

**UNIT IV PARAMETRIC REPRESENTATION OF SYNTHETIC SURFACES9**

Hermite Bicubic surface, Bezier surface, B-Spline surface, COONs surface, Blendingsurface Sculptured surface,Surface manipulation Displaying, Segmentation, Trimming, Intersection, Transformations (both 2D and 3D).

**UNIT V GEOMETRICMODELLING-3D 10**

Solid modeling, Solid Representation, Boundary Representation (13-rep),

Constructive Solid Geometry (CSG). CAD/CAM Exchange: Evaluation of data—exchange format, IGES data representations and structure, STEP Architecture, implementation, ACIS&DXF. Design Applications: Mechanical tolerances, Mass property calculations, Finite Element Modeling and Analysis and Mechanical Assembly.

**TOTAL: 45 PERIODS**

**REFERENCES :**


1. Ibrahim Zeid, "Mastering CAD/CAM (Engineering series)", McGrawHill International, 2004
2. P.N.Rao, "CAD/CAM Principles and Applications", Published by Tata McGraw-Hill Education Pvt. Ltd., 2012
3. M. Groover , E. Zimmers, "CAD/CAM computer aided design and manufacturing", pearsonindia, 1998.
4. Alavala Chennakesava R, "CAD/CAM Concepts and Applications", Pearson India,2008.
5. Radhakrishnan and Subramanian, Raju, "CAD/CAM/CIM", New Age International, 2008.
6. Farid M. Amirouche, "Principles of Computer Aided Design and Manufacturing", Pearson india,2004
7. Warren. Seames, "Computer Numerical Control Concepts and programming", 4th edition, Thomson learning, 2002.


**WEB REFERENCES:**

1. http://math.hws.edu/eck/cs424/downloads/graphicsbook-linked.pdf
2. http://www.cse.iitm.ac.in/~vplab/courses/CG/PDF/Curves&Surfaces.pdf
3. http://www.mweda.com/cst/cst2013/mergedProjects/CST_PARTICLE_STUDIO/common_overview/common_overview_import_export.htm

**ONLINE RESOURCES:**

1. https://www.siggraph.org/free-online-learning-resource-computer-graphics-courses/
2. https://www.tutorialspoint.com/computer_graphics/computer_graphics_curves.htm
3. https://www.autodesk.in/solutions/3d-mechanical-engineering
4. https://www.rs-online.com/designspark/mechanical-software
5. nptel.ac.in

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Understand the fundamentals of computer graphics in 2D and 3D.
2. Apply Geometric modeling representations for various curves.
3. Apply the knowledge of surface modeling and mathematical representations.
4. Discuss the parametric representation of synthetic surfaces.
5. Explain data exchange standards and communication protocols.
6. Apply the concepts of design for manufacturing and assembly.

**CO- PO & PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | 2 | 2 | 3 |
| CO2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | 2 | 2 | 3 |
| CO3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | 2 | 2 | 3 |
| CO4 | 2 | 1 | 1 | - | 1 | - | - | - | - | 1 | - | 2 | 2 | 3 |
| CO5 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | 3 | 2 | 3 |

# PROFESSIONAL ELECTIVES - II

| 20PCDEL209<br>SDG NO. 4,12&17 | SUPPLY CHAIN MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart knowledge on supply chain models and organizational transformations.
- To improve the overall organization performance and customer satisfaction by improving product or service delivery to consumer.

**UNIT I INTRODUCTION** **9**

Logistics- concepts, definitions, approaches, factors affecting logistics. Supply chain - basic tasks of the supply chain - the new corporate model.

**UNIT II SUPPLY CHAIN MANAGEMENT AND INVENTORY** **9**

The new paradigm, the modular company, the network relations, supply process, procurement process - Distribution management, Role of cycle inventory & safety stock in supply chain, Inventory replenishment policies.

**UNIT III EVOLUTION OF SUPPLY CHAIN MODELS 9**

Strategy and structure - factors of supply chain - Manufacturing strategy stages, supply chain progress - model for competing through supply chain management - supply chain redesign - Linking supply chain with customer.

**UNIT IV SUPPLY CHAIN ACTIVITY SYSTEMS 9**

Structuring the supply chain, new products, functional roles, supply chain design framework - Collaborative product commerce.

**UNIT V SUPPLY CHAIN MANAGEMENT ORGANIZATION AND INFORMATION SYSTEM 9**

The management task, logistics organization, the logistics information systems- topology of supply chain application- Resource planning, Enterprise Resource planning, Warehouse management system, product data management- cases.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. S.Chopra, and P. Meindl, "Supply chain Management: Strategy, Planning and Operations", Sixth Edition, Prentice Hall, 2015.
2. M.Christopher., "Logistics Supply Chain Management –Strategies for Reducing Cost and Improving Service", FT Press, Fourth Edition, 2011
3. G.Srinivasan, "Quantitative models in operations and supply chain management", PHI learning pvt. Ltd-New Delhi, 2010.
4. D.K.Agarwal, "A text book of logistics and supply chain management", Macmillan, 2009.
5. Simchi-Levi, D. Kaminsky, P. Simchi-Levi, E. and Ravi Shankar, "Designing & Managing the Supply Chain: Concepts, Strategies & Case Studies", Third Edition, Tata McGraw-Hill, 2007.
6. Yulan Wang, Stein W. Wallace, Bin Shen, Tsan-Ming Choi, "Service supply chain management: A review of operational models", European Journal of Operational Research, pp. 1-14, 2015.
7. XunXu, DoganGursoy, "Influence of sustainable hospitality supply chain management on customers attitudes and behaviors", International Journal of Hospitality Management, Vol.49, pp. 105-116, August 2015

**WEB REFERENCES:**

1. www.nptel.iitm.ac.in,
2. www.ignou.ac.in
3. www.bits-pilani.ac.in

**ONLINE RESOURCES:**

1. https://www.youtube.com
2. https://nptel.ac.in
3. www.udemy.com
4. https://www.tutorialspoint.com/supply_chain_management/ supply_chain_management_tutorial.pdf
5. https://www.researchgate.net/publication/40122004_Supply_Chain_Management_theory_and_practices

**OUTCOMES:**

**Upon completion of the course, the student should be able to:**

1. Understand key theories of supply chain management and logistics in contemporary organizations.
2. Know the initiative and judgment in planning, problem solving, decision making in supply chain management.
3. Distinguish theories; models to interpret transmit responses to sometimes complex supply chain management problems.
4. Understand the supply chain design, its system and activities
5. learn the supply chain management information system

**CO- PO & PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |

# PROFESSIONAL ELECTIVES - II

| 20PCDEL210<br>SDG NO. 4,9&12 | METROLOGY AND NON DESTRUCTIVE TESTING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- Impart the knowledge of quality assurance and inspection techniques.
- Familiarize with the various inspection and measurement techniques like contact and non- contact measurement by adapting Computer Aided Inspection.

- Impart the knowledge of working principles and calibration of various Systems.

**UNIT I MEASURING MACHINES 9**

Tool Maker's microscope - Co-ordinate measuring machines - Universal measuring machine - Laser viewers for production profile checks - Image shearing microscope - Use of computers - Machine vision technology - Microprocessors in metrology.

**UNIT II STATISTICAL QUALITY CONTROL 9**

Data presentation - Statistical measures and tools - Process capability - Confidence and tolerance limits - Control charts for variables and for fraction defectives - Theory of probability - Sampling - ABC standard - Reliability and life testing.

**UNIT III LIQUID PENETRANT AND MAGNETIC PARTICLE TESTS 9**

Characteristics of liquid penetrants - different washable systems - Developers - applications - Methods of production of magnetic fields - Principles of operation of magnetic particle test - Applications - Advantages and limitations.

**UNIT IV RADIOGRAPHY 9**

Sources of ray-x-ray production - properties of d and x rays - film characteristics - exposure charts-contrasts - operational characteristics of x ray equipment - applications.

**UNIT V ULTRASONIC AND ACOUSTIC EMISSION TECHNIQUES 9**

Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method - A, B, C scans - Principles of acoustic emission techniques - Advantages and limitations - Instrumentation - applications.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. American Society for Metals, "Metals Hand Book ", Vol.II, 1976.
2. Barry Hull and Vernon John, " Non Destructive Testing ", MacMillan, 1988.
3. JAIN, R.K. " Engineering Metrology ", Khanna Publishers, 1997.
4. Progress in Acoustic Emission, "Proceedings of 10th International Acoustic Emission Symposium ", Japanese Society for NDI, 1990.

**WEB REFERENCES:**

1. http://www.brainkart.com/article/Co-Ordinate-Measuring-Machines_5841/
2. https://nptel.ac.ac.in/courses/112/106/112106139/
3. https://www.matweb.com
4. https://www.nde-ed.org/index_flash.htm
5. https://ndtlibrary.asnt.org/

**ONLINE RESOURCES:**

1. https://nptel.ac.in/courses/112/106/112106138/
2. https://nptel.ac.in/courses/112/106/112106179/
3. https://nptel.ac.in/courses/112/104/112104250
4. https://nptel.ac.in/courses/112/103/112103261/
5. https://nptel.ac.in/courses/112/106/112106140/
6. https://nptel.ac.in/courses/112/107/112107242/
7. https://nptel.ac.in/courses/112/107/112107259/
8. https://nptel.ac.in/courses/113/106/113106070/
9. https://nptel.ac.in/courses/112/107/112107259/

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Understand the working principle of advanced measuring machines and use of computers in metrology.
2. Analysis the process data using the statistical tools for sampling ,to draw control charts and to find reliability and probability.
3. Learn the applications and principles of liquid penetrant and magnetic particle test.
4. Understand the use ,sources ,properties of X rays ,its equipment and applications.
5. Learn the principle ,types, production ,characteristic , applications and instrumentation of ultrasonic and acoustic emission techniques.

**CO- PO, PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 2 | 1 | - | 1 | - | - | - | 1 | 1 | 2 | 2 | 2 |
| CO2 | 3 | 3 | 2 | 1 | - | 1 | - | - | - | 1 | 1 | 2 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 1 | - | 1 | - | - | - | 1 | 1 | 2 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 1 | - | 1 | - | - | - | 1 | 1 | 2 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 1 | - | 1 | - | - | - | 1 | 1 | 2 | 3 | 2 |

# PROFESSIONAL ELECTIVES - II

| 20PCDEL211<br>SDG NO. 4,9&12 | QUALITY MANAGEMENT TECHNIQUES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To facilitate the understanding of Quality Management principles and process.
- To apply the tools and techniques of quality management to manufacturing and services processes.

**UNIT I INTRODUCTION** **9**

Need for TQM, evolution of quality, Definition of quality, TQM philosophy – Contributions of Deming Juran, Crosby And Ishikawa, TQM Models.

**UNIT II PLANNING** **9**

Vision, Mission, Quality policy and objective Planning and Organization for quality, Quality policy Deployment, Quality function deployment, introduction to BPR and analysis of Quality Costs.

**UNIT III TQM PRINCIPLES** **9**

Customer focus, Leadership and Top management commitment, Employee involvement – Empowerment and Team work, Supplier Quality Management, Continuous process improvement, Training, performance Measurement and customer satisfaction.

**UNIT IV TQM TOOLS AND TECHNIQUES** **9**

PDSA, The Seven Tools of Quality, New Seven management tools, Concept of six sigma, FMEA, Bench Marking, JIT, POKA YOKE, 5S, KAIZEN, Quality circles.

**UNIT V QUALITY SYSTEMS** **9**

Need for ISO 9000 Systems, clauses Documentation, Implementation, Introduction to ISO14000 and OSHAS18000, Implementation of TQM, Case Studies.

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Brain Rethery, ISO 9000, Productivity and Quality Publishing Pvt.Ltd., 1993.
2. D.Mills, Quality Auditing, Chapman and Hall, 1993.
3. Juran J.M and Frank M.Gryna Jr., "Quality Planning and Analysis", TMH, India, 1982.
4. Narayana V. and Sreenivasan, N.S., "Quality Management – Concepts and Tasks", New Age International 1996.
5. Oakland.J.S. "Total Quality Management", Butterworth–Hcinemann Ltd., Oxford, 1989.
6. Zeiri. "Total Quality Management for Engineers", Wood Head Publishers, 1991.

**WEB REFERENCES:**

1. https://www.unido.org/sites/default/files/2009-04/A_roadmap_to_quality_volume_1_0.pdf
2. http://index-of.co.uk/Misc/McGraw-Hill%20-%20Quality%20Management%20Demystified.pdf
3. https://asq.org/quality-resources/total-quality-management

**ONLINE RESOURCES:**

1. https://nptel.ac.in/courses/110104080/
2. https://nptel.ac.in/courses/110104085/

**OUTCOMES:**

**Upon completion of the course, the student should be able to:**

1. Explain about of the evolution, need and definition of quality and Philosophy of TQM and various models; to appreciate the role of various of quality Gurus and their contribution.
2. Describe the various quality planning like quality statements, quality policy and function deployment, BPR and quality costs.
3. List the various TQM principles which include customer, employee, top level management, continuous process improvement and other related terms.
4. Understand the various TQM tools and their applications

5. Discuss about various quality systems like ISO 9000, ISO 14000.
6. Apply the concepts of TQM tools and principle for various manufacturing and service processes.

**CO- PO, PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | - | - | - | 2 | - | 2 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO2 | 3 | 3 | - | - | - | 2 | - | 2 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 3 | - | - | - | 2 | - | 2 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO4 | 3 | 3 | - | - | - | 2 | - | 2 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO5 | 3 | 3 | - | - | - | 2 | - | 2 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO6 | 3 | 3 | - | - | - | 2 | - | 2 | 3 | 2 | 3 | 3 | 2 | 2 |

# PROFESSIONAL ELECTIVES - II

| 20PCDEL212<br>SDG NO. 4,9&12 | DESIGN FOR CELLULAR MANUFACTURING SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To lean basics of Group Technology, its benefits and issues
- To understand Design steps in CMS, Genetic Algorithms and Neural networks
- To know types of cell layout , models and life cycle issues
- To gain knowledge on performance measurement and control theniques
- To study economics of Group Technology and comparison with conventional models

**UNIT I INTRODUCTION** **9**

Introduction to Group Technology, Limitations of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT.

**UNIT II CMS PLANNING AND DESIGN** **9**

Problems in GT/CMS - Design of CMS - Models, traditional approaches and non-traditional approaches -Genetic Algorithms, Simulated Annealing, Neural networks.

**UNIT III IMPLEMENTATION OF GT/CMS 9**

Inter and Intra cell layout, cost and non-cost based models, establishing a team approach, Managerial structure and groups, batch sequencing and sizing, life cycle issues in GT/CMS.

**UNIT IV PERFORMANCE MEASUREMENT AND CONTROL 9**

Measuring CMS performance - Parametric analysis - PBC in GT/CMS, cell loading, GT and MRP - framework.

**UNIT V ECONOMICS OF GT/CMS 9**

Conventional Vs group use of computer models in GT/CMS, Human aspects of GT/CMS - cases.

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Askin, R.G. and Vakharia, A.J., G.T "Planning and Operation, in The automated factory-Hand
2. Cleland.D.I. and Bidananda, B (Eds), "Book: Technology and Management ", TAB Books , NY, 1991.
3. Burbidge, J.L. Group, "Technology in Engineering Industry ", Mechanical Engineering pub.London, 1979.
4. Irani, S.A. " Cellular Manufacturing Systems ", Hand Book
5. Kamrani, A.K, Parsaei, H.R and Liles, D.H. (Eds), " Planning, design and analysis of cellular manufacturing systems ", Elsevier, 1995

**WEB REFERENCES:**

1. https://doi.org/10.1002/9780470172476.ch
2. https://doi.org/10.1007/s40092-018-0261-y

**ONLINE RESOURCES:**

1. Malmborg, C. J. A heuristic model for simuhaneous storage space allocation and block layout planning. Inr. J. Prod. Res. 1994,32(3), 517-530
2. Heragu, S. S. Group technology and cellular manufacturing. IEEE Trans. Syst. Man Cybernet. 1994, U(2), 203-2 15
3. Winston, W. L. Operations Research: Applications and Algorithms. PWS-KENT Publishing Company, Boston, MA, 1991

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Understand charteristics , benefits and design steps for Group Technology and solving issues.
2. Develop CMS models from design stage.
3. Create Inter and Intra cell layout models, batch sequencing and sizing for reduction in cycle time.
4. Conduct Performance analysis of CMS.
5. Develop economical computer models and carrying out case studies on models.

**CO- PO &PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 1 | 1 | 1 | - | - | - | 2 | 1 | - | 2 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 2 | - | - | - | 2 | 2 | - | 2 | 2 | 2 |
| CO3 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO4 | 2 | 2 | 2 | 3 | 3 | - | 2 | 2 | 2 | 2 | -- | 2 | 2 | 2 |
| CO5 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 |

# PROFESSIONAL ELECTIVES - II

| 20 PCDEL213<br>SDG NO. 4,9&12 | COMPUTER CONTROL IN PROCESS PLANNING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To provide the student with an understanding of the importance of the role of process planning in manufacturing and the application of Computer Aided Process Planning tools in the present manufacturing scenario

**UNIT I INTRODUCTION** **9**

The Place of Process Planning in the Manufacturing cycle - Process Planning and Production Planning – Process Planning and Concurrent Engineering, CAPP, Group Technology.

**UNIT II PART DESIGN REPRESENTATION** **9**

Design Drafting - Dimensioning - Conventional tolerance - Geometric tolerance - CAD - input / output devices - topology - Geometric transformation

- Perspective transformation - Data structure - Geometric modelling for process planning - GT coding - The optiz system - The MICLASS system..

**UNIT III PROCESS ENGINEERING AND PROCESS PLANNING 9**

Experienced, based planning - Decision table and decision trees - Process capability analysis - Process Planning - Variant process planning - Generative approach - Forward and Backward planning, Input format, Al.

**UNIT IV COMPUTER AIDED PROCESS PLANNING SYSTEMS 9**

Logical Design of a Process Planning - Implementation considerations - manufacturing system components, production Volume, No. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.

**UNIT V AN INTEGRATED PROCESS PLANNING SYSTEMS 9**

Totally integrated process planning systems - An Overview - Modulus structure - Data Structure, operation - Report Generation, Expert process planning.

**TOTAL:45 PERIODS**

**REFERENCES :**

1. Chang, T.C., " An Expert Process Planning System ", Prentice Hall, 1985.
2. Gideon Halevi and Roland D. Weill, " Principles of Process Planning ", A logical approach, Chapman & Hall, 1995.
3. Nanua Singh, " Systems Approach to Computer Integrated Design and Manufacturing ", John Wiley & Sons, 1996.
4. Rao, “Computer Aided Manufacturing ", Tata McGraw Hill Publishing Co., 2000.
5. Tien-Chien Chang, Richard A.Wysk, "An Introduction to automated process planning systems ", Prentice Hall, 1985.

**WEB REFERENCES:**

1. http://claymore.engineer.gusu.edu/jackh/eod/automate/capp/capp.htm
2. http://Estraj.ute.sk/journal/engl/027/027.htm
3. https://www.sciencedirect.com/book/9781856171342/computer-aided-process-planning-capp

**ONLINE RESOURCES:**

1. https://www.youtube.com/watch?v=g-zMhN4S8yY
2. https://edurev.in/studytube/Computer-Aided-Process-planning--Part-1--Computer-/8026b025-2f92-4647-a266-9d3a60ed8e84_t

3. http://www.ignou.ac.in/upload/Unit-9-CRC.pdf

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Explain the role of process planning in manufacturing cycle and various terms related with it.
2. Discuss about part design representation including dimensioning, tolerance, geometric modeling and GT coding
3. Enumerate the concepts of process engineering and process planning.
4. Describe about the computer aided process planning systems.
5. Explain about totally integrated process planning systems which includes data structure, report generation and other related concepts.
6. Understand what is process planning and the utilization of computers in process planning in industries.

**CO- PO &PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | - | - | 1 | - | - | - | - | - | 3 | 3 | 3 |
| CO2 | 3 | 2 | 1 | - | - | 1 | - | - | - | - | - | 3 | 3 | 3 |
| CO3 | 3 | 2 | 1 | - | - | 1 | - | - | - | - | - | 3 | 3 | 3 |
| CO4 | 3 | 2 | 1 | - | - | 1 | - | - | - | - | - | 3 | 3 | 3 |
| CO5 | 3 | 2 | 1 | - | - | 1 | - | - | - | - | - | 3 | 3 | 3 |
| CO6 | 3 | 2 | 1 | - | - | 1 | - | - | - | - | - | 3 | 3 | 3 |

# PROFESSIONAL ELECTIVES - II

| 20PCDEL214<br>SDG NO. 4,9&12 | ADVANCED TOOL DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- The purpose of this course is to make the students to get familiarized with the design of various tools that can be implemented for different mechanical operations

**UNIT I INTRODUCTION TO TOOL DESIGN 8**

Introduction –Tool Engineering – Tool Classifications– Tool Design Objectives – Tool Design in manufacturing- Challenges and requirements- Standards in

tool design-Tool drawings -Surface finish – Fits and Tolerances - Tooling Materials- Ferrous and Non ferrous Tooling Materials- Carbides, Ceramics and Diamond -Non metallic tool materials-Designing with relation to heat treatment

**UNIT II DESIGN OF CUTTING TOOLS 9**

Mechanics of Metal cutting – Oblique and orthogonal cutting- Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools- Broaching Tools - Design of Form relieved and profile relieved cutters-Design of gear and thread milling cutters

**UNIT III DESIGN OF JIGS AND FIXTURES 10**

Introduction – Fixed Gages – Gage Tolerances –selection of material for Gages – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – Chip formation in drilling – General considerations in the design of drill jigs – Drill bushings – Methods of construction –Thrust and Turning Moments in drilling - Drill jigs and modern manufacturing- Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures – Modular Fixtures – Cutting Force Calculations.

**UNIT IV DESIGN OF PRESS TOOL DIES 10**

Types of Dies –Method of Die operation–Clearance and cutting force calculations- Blanking and Piercing die design – Pilots – Strippers and pressure pads- Presswork materials – Strip layout – Short-run tooling for Piercing – Bending dies – Forming dies – Drawing dies-Design and drafting.

**UNIT V TOOL DESIGN FOR CNC MACHINE TOOLS 8**

Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools- Sub plate and tombstone fixtures-Universal fixtures– Cutting tools– Tool holding methods– Automatic tool changers and tool positioners – Tool presetting– General explanation of the Brown and Sharp machine.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Cyrll Donaldson, George H.LeCain, V.C. Goold, "Tool Design", Tata McGraw Hill Publishing Company Ltd., 2000.
2. E.G. Hoffman," Jig and Fixture Design", Thomson Asia Pvt Ltd, Singapore, 2004
3. Haslehurst M., "Manufacturing Technology", The ELBS, 1978

4. Prakash Hiralal Joshi, "Tooling data", Wheeler Publishing, 2000
5. Venkataraman K., "Design of Jigs, Fixtures and Press tools", TMH, 2005

**WEB REFERENCES:**

1. http://www.manufacturinget.org/home/tech-4571-tool-design/cutting-tool-design/
2. https://www.engineeringenotes.com/industrial-engineering/machine-tools/jigs-and-fixtures-elements-and-design-steps-machine-tools-engineering/23247
3. http://staff.uny.ac.id/sites/default/files/pendidikan/aan-ardian-mpd/1g-handbook-die-design-2nd-edition.pdf

**ONLINE RESOURCES:**

1. https://youtu.be/xlLxCVuplis
2. https://youtu.be/vOo2MCYPsm4
3. https://youtu.be/gkcNe3BrSBM

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Understand introduction to Tool Design, tool materials , fits and Tolerances.
2. Get familiarized with advanced tool design for tools.
3. Design jigs and fixtures for morden manufacturing processes.
4. Get knowledge on press tool design.
5. Explaination about CNC machine tools.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 3 |
| CO2 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 3 | 3 |
| CO3 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 3 | 3 | 3 |
| CO4 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 3 | 3 | 3 |
| CO5 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 3 | 3 |

# PROFESSIONAL ELECTIVES - III

| 20PCDEL301<br>SDG NO. 4 & 9 | TRIBOLOGY IN DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- Analysis of tribological aspects of machine components, including friction, lubrication, and wear. Design to optimize system tribological performance.

**UNIT I SURFACES, FRICTION AND WEAR 9**

Topography of Surfaces, Surface features, Surface interaction, Theory of Friction, Sliding and Rolling Friction, Friction properties of metallic and non - metallic materials, Friction in extreme conditions, Wear, types of wear, Mechanism of wear, wear resistance materials, Surface treatment, Surface modifications, Surface coatings.

**UNIT II LUBRICATION THEORY 9**

Lubricants and their physical properties, lubricants standards , Lubrication Regimes in Hydrodynamic lubrication, Reynolds Equation, Thermal, inertia and turbulent effects , Elastohydrodynamic (EHD) magneto hydrodynamic lubrication, Hydro static lubrication, Gas lubrication, Solid lubrication.

**UNIT III DESIGN OF FLUID FILM BEARINGS 9**

Design and performance analysis of thrust and journal bearings , Full, Partial, Fixed and pivoted journal bearings design, Lubricant flow and delivery, Power loss, Heat and temperature of steady and dynamically loaded journal bearings, Special bearings , Hydrostatic Bearing design.

**UNIT IV ROLLING ELEMENT BEARINGS 9**

Geometry and kinematics, Materials and manufacturing processes, Contact stresses, Hertzian stress equation, Load divisions, Stresses and deflection, Axial loads and rotational effects, Bearing life capacity and variable loads , ISO standards, Oil films and their effects, Rolling Bearings Failures.

**UNIT V TRIBO MEASUREMENT AND INSTRUMENTATION 9**

Surface Topography measurements, Electron microscope and friction and wear measurements, Laser method, Instrumentation, International standards, Bearings performance measurements, Bearing vibration measurement.

**TOTAL:45 PERIODS**

**REFERENCES :**

1. Cameron A., "Basic Lubrication Theory", Ellis Horwood Ltd., UK, 1981
2. Halling J. (Editor) – "Principles of Tribology ", Macmillian, 1984.
3. Williams J.A., "Engineering Tribology", Oxford Univ. Press, 1994.
4. Neale, M.J., "Tribology Hand Book", Butterworth Heinemann, 1995.
5. StolarskiT.a., "Tribology in Machine Design ", Industrial Press Inc., 1990.

**WEB REFERENCES:**

1. https://ocw.mit.edu/courses/mechanical-engineering/2-800-tribology-fall-2004/lecture-notes/
2. https://www.academia.edu/36361079/INTRODUCTION_TO_TRIBOLOGY

**ONLINE RESOURCES:**

1. https://nptel.ac.in/courses/112102015/
2. https://www.imeche.org/get-involved/special-interest-groups/tribology-group/tribology-group-information-and-resources/trib-design-guides
3. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/103103147/lec14.pdf

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Demonstrate basic understanding of friction, lubrication, and wear processes.
2. Understand the basic concepts of different lubrication theories.
3. Understand the design calculations of lubrication problems, including thrust bearings and journal bearings
4. Understand the design calculations of lubrication problems for rolling element bearings.
5. Able to learn different lubrication measurement systems
6. Understand Lubrication characteristics, materials in extreme environments.

**CO- PO & PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | - | 1 | 2 | 2 | 2 | 2 |
| CO2 | 2 | 1 | 2 | 1 | - | 2 | 2 | 1 | - | 1 | 2 | 2 | 2 | 2 |
| CO3 | 2 | 3 | 3 | 2 | - | 2 | 2 | 1 | 1 | - | 1 | 2 | 2 | 2 |
| CO4 | 2 | 3 | 3 | 2 | - | 2 | 2 | 1 | 1 | - | 1 | 2 | 2 | 2 |
| CO5 | 2 | 1 | 1 | 2 | - | 2 | 2 | 1 | - | 1 | 1 | 2 | 2 | 2 |
| CO6 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | - | 1 | 2 | 2 | 2 | 2 |

# PROFESSIONAL ELECTIVES - III

| 20PCDEL302<br>SDG NO. 4 & 9 | DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- Acquiring fundamental knowledge of hydraulics and pneumatics, and introduction to basic hydraulic components applied in mobile technical systems. The course elaborates principles of hydraulic and pneumatic devices, electro pneumatic components. It gives an overview of control systems associated with hydraulic applications

**UNIT I OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTU ATORS 7**

Hydraulic Power Generators: Selection and Specification of Pumps, Pumps characteristics, Linear and Rotary Actuators: Selection, Specification and characteristics.

**UNIT II CONTROL AND REGULATION ELEMENTS 7**

Pressure, Direction and flow control valves , Relief valves, Non-return and safety valves, Actuation systems, Pressure switches.

**UNIT III HYDRAULIC CIRCUITS 12**

Reciprocation, Quick return, Sequencing, Synchronizing circuits, Accumulator circuits, Industrial circuits, Press circuits, Hydraulic milling machine, Grinding, planning, copying, Hydraulic lift, Earth mover circuits, Design and selection of components , Safety and emergency mandrels.

**UNIT IV PNEUMATIC SYSTEMS AND CIRCUITS 12**

Pneumatic fundamentals, Control elements, Position and pressure sensing, Logic circuits, Switching circuits, Fringe conditions modules and these integration , Sequential circuits, Cascade methods, Mapping methods, Step counter method, Compound circuit design, Combination circuit design.

**UNIT V INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS 7**

Pneumatic equipments: Selection of components, Design calculations, Application, Fault finding, Hydro pneumatic circuits, Use of microprocessors for sequencing , PLC, Low cost automation, Robotic circuits.

**TOTAL:45 PERIODS**

**REFERENCES :**

1. Antony Espossito, "Fluid Power with Applications", 6 th Edition, Prentice Hall, 2002.
2. Dudley A. Pease and John J. Pippenger, "Basic fluid power", Prentice Hal l, 1987.
3. Andrew Parr, "Hydraulic and Pneumatics" (HB), Jaico Publishing House, 1999.
4. Bolton. W., "Pneumatic and Hydraulic Systems ", Butterworth –Heinemann, 1997.
5. Parr Andrew, "Hydraulic and Pneumatic: A Technical and Engineering's Guide", Elsevier, 1999.

**WEB REFERENCES:**

1. https://www.hydraulicspneumatics.com/
2. http://www.infocobuild.com/education/audio-video-courses/mechanical-engineering/FundamentalsOfIndustrialOilHydraulics-IIT-Kharagpur/lecture-34.html
3. https://www.sciencedirect.com/book/9780080966748/hydraulics-and-pneumatics

**ONLINE RESOURCES:**

1. https://nptel.ac.in/courses/112105047/
2. https://youtu.be/zZoNMKpTn1E
3. https://www.youtube.com/watch?v=jKb-KLVzCtw
4. https://www.youtube.com/watch?v=5q7YasmwXCs
5. https://youtu.be/JW0KLCDsMsM

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Apply the fundamentals of fluid power system to select working fluid based on their properties
2. Apply and justify appropriate usage of actuators and pump in fluid power system design
3. Apply and justify appropriate usage of accumulators, valves and intensifier in fluid power system design
4. Design the various fluid power circuits for industrial applications by using basic principles
5. Design the various fluid power circuits for industrial applications by using advanced technology like servo, logical circuit and PLC
6. Draw ladder logic diagrams and explain about low cost automation.

**CO- PO &PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | - | - | 1 | 1 | - | - | - | - | 1 | 2 | 2 |
| CO2 | 1 | 2 | 2 | - | - | 1 | 1 | - | 2 | - | - | 1 | 2 | 2 |
| CO3 | 3 | 2 | 2 | - | - | 1 | 1 | - | - | - | - | 1 | 2 | 2 |
| CO4 | 1 | 2 | 3 | - | - | 1 | 1 | - | - | 2 | - | 1 | 2 | 2 |
| CO5 | 3 | 2 | 3 | - | - | 1 | 1 | - | - | - | - | 1 | 2 | 2 |
| CO6 | 1 | - | - | - | - | 2 | - | - | 2 | 2- | - | 1 | 2 | 2 |

# PROFESSIONAL ELECTIVES - III

| 20PCDEL303<br>SDG NO. 4, 9 & 12 | PRODUCT LIFE CYCLE MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To understand the principal issues involved in technical product management throughout all phases of the product life cycle.

**UNIT I HISTORY, CONCEPTS AND TERMINOLOGY OF PLM 9**

Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (CPDM), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM).PLM/PDM

Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications.

**UNIT II PLM/PDM FUNCTIONS AND FEATURES 9**

User Functions –Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration.

**UNIT II DETAILS OF MODULES IN A PDM/PLM SOFTWARE 9**

Case studies based on top few commercial PLM/PDM tools

**UNIT IV ROLE OF PLM IN INDUSTRIES 9**

Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organization, users, product or service, process performance.

**UNIT V BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE 9**

PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Antti Saaksvuori and AnselmiImmonen, "Product Lifecycle Management", Springer Publisher, 2008 (3rd Edition).
2. International Journal of Product Lifecycle Management, Inderscience Publishers
3. Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, "Implementing and Integrating Product Data Management and Software Configuration Management", Artech House Publishers, 2003.
4. John Stark, "Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question", Springer Publisher, 2007.
5. John Stark, "Product Lifecycle Management: 21st Century Paradigm for Product Realisation", Springer Publisher, 2011 (2nd Edition).
6. Michael Grieves, "Product Life Cycle Management", Tata McGraw Hill, 2006.
7. Jaya Krishna S, "Product Lifecycle Management: Concepts and cases", ICFAI Publications 2011.

8. SOA approach to Enterprise Integration for Product Lifecycle, IBM Red books, 2011.

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Understand product data, information, structures and PLM concepts.
2. Apply the functions and features of PLM/PDM
3. Understand the different modules offered in commercial PLM/PDM tools
4. Understand PLM/PDM implementation approaches
5. Integrate PLM/PDM with other applications and analyse case studies

**CO- PO &PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 2 | 1 | - | - | 1 | 1 | 1 | 3 | 2 | 2 |
| CO2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 2 |
| CO3 | 1 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 3 | 1 | 2 | 2 | 2 |
| CO4 | 1 | 1 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 3 | 1 | 2 | 2 | 2 |
| CO5 | 1 | - | 1 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |

# PROFESSIONAL ELECTIVES - III

| 20PCDEL304<br>SDG NO. 4 & 9 | DATA COMMUNICATIONS IN CAD/CAM | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To enable seamless exchange of data between any two points in the world. This exchange of data takes place over a computer network. Data refers to the raw facts that are collected while information refers to processed data that enables us to take decisions

**UNIT I DIGITAL COMPUTERS & MICRO PROCESSORS 9**

Block diagram, Register transfer language, Arithmetic, logic and shift micro operations , Instruction code, Training and control instruction cycle , I/O and interrupt design of basic computer, Machine language, Assembly language, Assembler. Registers ALU and Bus Systems, Timing and control signals, Machine cycle and timing diagram , Functional block diagrams of 80 x 86 and modes of operation , Features of Pentium Processors.

**UNIT II OPERATING SYSTEM & ENVIRONMENTS 9**

Types, Functions, UNIX & WINDOWS NT, Architecture, Graphical User Interfaces, Compilers, Analysis of the Source program , The phases of a compiler, Cousins of the compiler, The grouping of phases, Compiler construction tools

**UNIT III COMMUNICATION MODEL 9**

Data communication and networking, Protocols and architecture, Data transmission concepts and terminology, Guided transmission media, Wireless transmission, Data encoding, Asynchronous and synchronous communication, Base band interface standards RS232C, RS449 interface.

**UNIT IV COMPUTER NETWORKS 9**

Network structure, Network architecture, The OSI reference model services , Network standardization, Example, Managing remote systems in network , Network file systems, Net working in manufacturing.

**UNIT V INTERNET 9**

Internet services, Protocols, Intranet information services, Mail based service system and network requirements, Internet tools, Usenet, E-mail , IRC, WWW, FTP, Telnet.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Morris Mano. M., "Computer System Architecture", Prentice Hall of India, 1996.
2. Peterson J.L., Galvin P. and Silberschaz, A., "Operating System s Concepts", Addison Wesley, 1997.
3. William Stallings, "Data of Computer Communications" Prentice Hall of India, 1997.
4. Andrew S. Tanenbanum "Computer Networks", Prentice Hall of India 3rd Edition, 1996.
5. Christian Crumlish, "The ABC's of the Internet", BPB P ublication, 1996.
6. Gaonkar R.S., "Microprocessor Architecture, Programming and Applications of 8085", Penram International, 1997

**WEB REFERENCES:**

1. https://www.cs.vu.nl/~ast/CN5/
2. https://2012books.lardbucket.org
3. http://examradar.com/communication-networking-summary-1/

**ONLINE RESOURCES:**

1. https://www.tutorialspoint.com
2. nptel.ac.in
3. https://www.classcentral.com
4. coursera.org

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Explain the concept of communication between machine and computer.
2. Discuss the types and functions of operating systems
3. Understand and explain communication model
4. Discuss network structure and architecture
5. Understand and discuss internet services

**CO- PO & PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 1 | 1 | - | - | - | 2 | 2 | 2 | 3 | 2 |
| CO2 | 2 | 2 | 2 | 2 | 1 | 1 | - | - | - | 2 | 2 | 2 | 3 | 2 |
| CO3 | 2 | 2 | 2 | 2 | 1 | 1 | - | - | - | 2 | 2 | 2 | 3 | 2 |
| CO4 | 2 | 2 | 2 | 2 | 1 | 1 | - | - | - | 2 | 2 | 2 | 3 | 2 |
| CO5 | 2 | 2 | 2 | 2 | 1 | 1 | - | - | - | 2 | 2 | 2 | 3 | 2 |

# PROFESSIONAL ELECTIVES - III

| 20PCDEL305<br>SDG NO. 4, 9 & 11 | ADDITIVE MANUFACTURING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology and the associated Aerospace, Architecture, Art, Medical and industrial applications.

**UNIT I INTRODUCTION** **7**

Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM - Classification of AM processes-Benefits-Applications.

**UNIT II REVERSE ENGINEERING AND CAD MODELING 10**

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

**UNIT III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS 10**

**Stereolithography Apparatus (SLA):** Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications.

**Solid Ground Curing (SGC):** working principle, process, strengths, weaknesses and applications.

**Fused deposition Modeling (FDM):** Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

**UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS 10**

**Selective Laser Sintering (SLS):** Principle, process, Indirect and direct SLS-powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net

**Shaping (LENS):** Processes, materials, products, advantages, limitations and applications– Case Studies.

**UNIT V OTHER ADDITIVE MANUFACTURING SYSTEMS 8**

**Three dimensional Printing (3DP):** Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
3. Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.

4. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications : A tool box for prototype development", CRC Press, 2011.
5. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
6. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.

**WEB REFERENCES:**

1. https://www.ge.com/additive/additive-manufacturing
2. https://www.industrialheating.com/articles/94490-great-pmadditive-manufacturing-articles
3. https://learn-xpro.mit.edu/additive-manufacturing

**ONLINE RESOURCES:**

1. https://www.udemy.com/topic/3d-printing
2. www.izito.co.in/ additive-manufacturing
3. https://learn-xpro.mit.edu/additive-manufacturing

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Understand the basic concepts, need, development of additive manufacturing (am) technologies.
2. Know the reverse engineering concepts and various cad modeling systems.
3. Understand the Additive Manufacturing (AM) system building using liquid based and solid based additive manufacturing systems.
4. Understand the Additive Manufacturing (AM) system building using powder based additive manufacturing systems.
5. Understand the process capabilities and material system developments of various advanced Additive Manufacturing (AM) system.

**CO- PO & PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | - | 1 | 1 | - | 2 | 3 |
| CO2 | 2 | 1 | 2 | 2 | 3 | 1 | 1 | 1 | - | 1 | 1 | - | 2 | 3 |
| CO3 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | - | 1 | 1 | - | 2 | 3 |
| CO4 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | - | 1 | 1 | - | 2 | 3 |
| CO5 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | - | 1 | 1 | - | 2 | 3 |

# PROFESSIONAL ELECTIVES - III

| 20PCDEL306<br>SDG NO. 4, 9 & 11 | DESIGN OF MATERIAL HANDLING EQUIPMENTS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart students on the need, use, application and design of different material handling techniques, equipments and machines used in common use and in industrial sector.

**UNIT I MATERIALS HANDLING EQUIPMENT 5**

Types, selection and applications

**UNIT II DESIGN OF HOISTS 10**

Design of hoisting elements: Welded and roller chains - Hemp and wire ropes - Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs - lifting magnets - Grabbing attachments - Design of arresting gear - Brakes: shoe, band and cone types.

**UNIT III DRIVES OF HOISTING GEAR 10**

Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and monorail cranes - slewing, jib and luffing gear - cogwheel drive - selecting the motor ratings.

**UNIT IV CONVEYORS 10**

Types - description - design and applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors.

**UNIT V ELEVATORS 10**

Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices - Design of fork lift trucks.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.
2. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.
3. Lingaiah. K. and Narayana Iyengar, "Machine Design Data Hand Book", Vol.1 & 2, Suma Publishers, Bangalore, 1983

4. P.S.G. Tech., "Design Data Book", Kalaikathir Achchagam, Coimbatore, 2003.
5. Rudenko, N., Materials handling equipment, ELnvee Publishers, 1970.
6. Spivakovsy, A.O. and Dyachkov, V.K., Conveying Machines, Volumes I and II, MIR Publishers, 1985.

**WEB REFERENCES:**

1. https://www.thomasnet.com/articles/materials-handling/material-handling-equipment/
2. https://www.igi-global.com/chapter/various-aspects-of-material-handling/186028
3. https://www.researchgate.net/publication/261477395_Sustainable_design_of_material_handling_equipment_A_win-win_approach_for_manufacturers_and_customers

**ONLINE RESOURCES:**

1. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112107143/lec36.pdf
2. https://youtu.be/IFFeTrJpzUA, https://youtu.be/WXmIdbVDJqE, https://youtu.be/3tTvVUfwchI
3. https://www.powershow.com/view/470153-ZWY4Z/Automated_Material_Handling_Equipment_powerpoint_ppt_presentation
4. https://www.slideserve.com/MagenToroast/material-handling-equipment-india
5. http://www.authorstream.com/Presentation/mahekpatel-1524375-principles-functions-material-handling/

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Apply the concepts of various material handling equipments and the applications of material handling equipments for restricted and unrestricted areas.
2. Apply the concepts of design to hoisting elements and brakes.
3. Apply the concepts of design to hoisting gears and Cranes.
4. Apply the concepts of design to various Conveyors and Escalators.
5. Apply the concepts of design to Elevators.

**CO- PO & PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | - | - | 1 | 1 | - | - | - | - | 1 | 2 | 2 |
| CO2 | 3 | 2 | 2 | - | - | 1 | 1 | - | - | - | - | 1 | 2 | 2 |
| CO3 | 3 | 2 | 2 | - | - | 1 | 1 | - | - | - | - | 1 | 2 | 2 |
| CO4 | 3 | 2 | 2 | - | - | 1 | 1 | - | - | - | - | 1 | 2 | 2 |
| CO5 | 3 | 2 | 2 | - | - | 1 | 1 | - | - | - | - | 1 | 2 | 2 |

# PROFESSIONAL ELECTIVES - III

| 20PCDEL307<br>SDG NO. 4, 9 & 12 | DESIGN FOR INTERNET OF THINGS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart knowledge on state of art IoT architecture, data and knowledge management and use of devices in IoT technology

**UNIT I INTRODUCTION** **9**

Machine to Machine (M2M) to IoT-The Vision-Introduction, From M2M to IoT, M2M towards IoT- the global context, A use case example, Differing Characteristics.

**UNIT II IoT STRUCTURE** **9**

M2M to IoT – A Market Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

**UNIT III IoT NETWORKING** **9**

M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management.

**UNIT IV IoT ARCHITECTURE 9**

IoT Architecture-State of the Art – Introduction, State of the art, Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model.

**UNIT V ARCHITECTURE MODELING 9**

IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control. Industrial Automation- Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, Commercial Building Automation- Introduction, Case study: phase one-commercial building automation today, Case study: phase two- commercial building automation in the future.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Francis da Costa, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, A press Publications, 2013.
2. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
3. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1stEdition, VPT, 2014.

**WEB REFERENCES:**

1. https://en.wikipedia.org/wiki/Internet_of_things
2. https://wso2.com/whitepapers/a-reference-architecture-for-the-internet-of-things/
3. https://www.internetsociety.org/resources/doc

**ONLINE RESOURCES:**

1. http://scn.sap.com/community/business-trends/blog/2015/06/18/the-business-case-for-iot
2. www.cisco.com/web/about/ac79/docs/innov/IoT_IBSG_0411FINAL.pdf.
3. www.vdi.de/fileadmin/vdi_de/redakteur_dateien/gma_dateien/5305_Publikation_GMA_Status_Report_ZVEI_Reference_Architecture_Model.pdf

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Understand basic concepts of MoM, IoT vision, differing characteristics.
2. Learn about M2M Value Chains, emerging industrial structure for IoT, M2M IoT architecture.
3. Describe the IoT networking, Analytics and knowledge Management.
4. Know the IoT architecture and reference model.
5. Explain the IoT Reference Architecture, . Real-World Design Constraints, Industrial Automation, Commercial Building Automation.

**CO- PO & PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | 2 | 2 | 2 | 3 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 1 | 2 |
| CO2 | 2 | 2 | 1 | 2 | 2 | - | - | 1 | 3 | 3 | 3 | 3 | 1 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 3 |
| CO4 | 2 | 3 | 2 | 3 | 3 | 1 | - | 2 | 3 | 3 | 3 | 3 | 2 | 3 |
| CO5 | - | 2 | 1 | 3 | 2 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 1 | 3 |

# PROFESSIONAL ELECTIVES - IV

| 20PCDEL308<br>SDG NO. 4, 9 & 12 | DESIGN AND ANALYSIS OF EXPERIMENTS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To establish optimal process performance by finding the right settings for key process input variables and also to intelligently form frameworks to decide which course of action you might take.

**UNIT I SIMPLE COMPARATIVE EXPERIMENTS 9**

Strategy of experimentation, applications of experimental design, using statistical design in experimentation. Basic statistical concepts, Sampling and sampling Distribution, Inferences about the Differences in means, randomized designs, Inferences about the Differences in means, Paired comparison Designs, Inferences about the Variances of Normal Distributions.

**UNIT II FACTORIAL DESIGN 9**

Basic definition and principles, Advantages of factorials, two factor factorial design, General factorial design, Fitting response curves and surfaces, Blocking in a factorial design.

**UNIT III FITTING REGRESSION MODELS 9**

Introduction, Linear regression models, Estimate of parameters in linear regression models, Hypothesis testing in multiple regression, Confidence intervals in multiple regression, Prediction of new response observations, Regression model diagnostics, Testing for lack of fit.

**UNIT IV TAGUCHI METHOD OF DESIGN OF EXPERIMENTS 9**

Concept design, Parameter design, Tolerance design, Quality loss function, Signal-to- Noise ratio, Orthogonal array experiments, Analysis of Mean(ANOM), Quality characteristics, Selection and testing of noise factors, Selection of control factors, Parameter optimization experiment, Parameter design case study.

**UNIT V ANALYSIS OF VARIANCE (ANOVA) 9**

Introduction, Example of ANOVA process, Degrees of freedom, Error variance and pooling, Error variance and application, Error variance and utilizing empty columns, the F-test.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Douglas C Montgomery, "Design and Analysis of Experiments", Wiley" Eighth edition' February 2013.
2. George E. P. Box, J. Stuart Hunter, William G. Hunter Statistical Design and Analysis of Experiments, Wiley-Interscience; 2nd edition, 2005
3. MontgomeryD.C., Runger G. C., Introduction to Linear Regression Analysis, Wiley India Pvt Ltd, 3rd edition, December 2006.
4. Raymond H. Myers, Douglas C. Montgomery, Christine M. Anderson-Cook, "Response Surface Methodology: Process Ang Product Optimization Using Designed Experiments, Myres R.H., Montgomery D. C., Wiley-Blackwell; 4th Edition, February 2016
5. Taguchi,G., "Introduction to Quality Engineering", Asian Productivity Organization, UNIPUB, White Plains, New York, 1986.

**WEB REFERENCES:**

1. https://www.moresteam.com/toolbox/design-of-experiments.cfm
2. https://qualitytrainingportal.com/resources/design-experiments/
3. https://asq.org/quality-resources/design-of-experiments

**ONLINE RESOURCES:**

1. https://www.jmp.com/en_us/academic/doe-course-materials.html
2. https://www.coursera.org/lecture/six-sigma-analyze-advanced/intro-to-design-of-experiments-o3bgB
3. https://online.stat.psu.edu/statprogram/stat503
4. https://nptel.ac.in/courses/110105087/
5. https://freevideolectures.com

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Understand statistical tools using experimental design concepts
2. Gain Knowledge about factorial design using experimentation
3. Apply regression techniques for experimental analysis
4. Use taguchi concept for design of experiments
5. Apply the concept of ANOVA for various processes.

**CO- PO & PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | 2 | 3 | 2 |
| CO2 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | 2 | 3 | 2 |
| CO3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | 2 | 3 | 2 |
| CO4 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | 2 | 3 | 2 |
| CO5 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | 2 | 3 | 2 |

# PROFESSIONAL ELECTIVES - IV

| 20PCDEL309<br>SDG NO. 4, 9 & 12 | INTELLIGENT MANUFACTURING SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To acquire the concepts of computer integrated manufacturing systems and manufacturing communication systems.
- To explain the concepts of artificial intelligence and automated process planning.
- To teach various components of knowledge based systems.

**UNIT I STRUCTURE AND FUNCTIONAL AREAS 9**

Computer Integrated Manufacturing Systems Structure and functional areas of CIM system, - Computer aided design, Computer aided process planning, Computer aided manufacturing, CAQC, ASRS. Advantages of Computer integrated manufacturing. Manufacturing Communication Systems - MAP/TOP, OSI Model, Data Redundancy, Top-down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing System Components, System Architecture and Data Flow, System Operation.

**UNIT II KNOWLEDGE BASED SYSTEMS 9**

Components of Knowledge Based Systems -Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition.

**UNIT III ARTIFICIAL NETWORKS 9**

Machine Learning-Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks- Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing.

**UNIT IV PROCESS PLANNING 9**

Automated Process Planning- Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning. Knowledge Based System for Equipment Selection (KBSES)-Manufacturing system design. Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving approaches in KBSES, Structure of the KRSES.

**UNIT V MODELS AND ALGORITHMS METHODS 9**

Group Technology-Models and Algorithms Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation – Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology- Group Technology in Automated Manufacturing System. Structure of Knowledge based system for group technology (KBSCIT)-Data Base, Knowledge Base, Clustering Algorithm.

**TOTAL: 45 PERIODS**

**REFERENCES :**

1. Cihan H. Dagli, "Artificial Neural Networks for Intelligent Manufacturing", Springer science business media,2004.
2. Gérard Morel, Botond Kadar, Laszlo Monostori, "Intelligent Manufacturing Systems 2003: (IMS 2003) a Proceedings", Volume 7, 2003.

3. Mohammed Jamshidi, "Design and Implementation Of Intelligent Manufacturing Systems", pearson education, 2005.
4. Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", 8thedition, PHI, 2008.
5. Yagna Narayana, "Artificial Neural Networks", PHI, 2009.
6. Andre Kusaic, "Intelligent Manufacturing Systems", PHI, 2001.
7. Hamid R. Parsaei and Mohammad Jamshidi, "Design and Implementation of Intelligent Manufacturing Systems", PHI, 2009.

**WEB REFERENCES:**

1. https://ieda.ust.hk/dfaculty/ajay/courses/ieem513/GT/GT.html
2. https://www.birmingham.ac.uk/research/activity/mechanical-engineering/advanced-manufacturing/automation-intelligent-manufacturing/intelligent-manufacturing-systems.aspx

**ONLINE RESOURCES:**

1. https://youtu.be/BBt0ji3zMEk
2. https://youtu.be/De8MQWbhu3k
3. https://nptel.ac.in/courses/112107078/

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Know the selected methods applied for creating and solution of mathematical models in manufacturing system
2. Understand the necessary information and will gain practical experience with algorithms used for these methods.
3. Use various methods to solve group technology problems.
4. Implement process planning effectively
5. Use various Algorithm methods for Group technology.

**CO- PO & PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 3 |

# PROFESSIONAL ELECTIVES - IV

| 20PCDEL310<br>SDG NO. 4, 9 & 12 | MICRO ELECTRO MECHANICAL SYSTEMS DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart knowledge on MEMS with various manufacturing techniques
- To get an exposure on the application of MEMS in various domains

**UNIT I INTRODUCTION** **9**

Introduction to MEMS and Microsystems, typical products, Microsystems and micro electronics – applications of Microsystems in automobile and other industries, working principle of Microsystems – types of micro sensors, Micro actuation techniques ––MEMS with micro actuators – micro pump – micro motors – micro valves – micro grippers – micro accelerometers, micro fluids. MEMS gyroscope, Electrostatic fluid accelerator

**UNIT II MATERIALS FOR MEMS AND MICROSYSTEMS** **9**

Substrates and wafer – active substrate materials, silicon as a substrate material, silicon compounds- silicon dioxide, silicon carbide, silicon nitride, polycrystalline silicon, silicon piezoresistors,– - Gallium arsenide, quartz, - piezoelectric crystals – polymers as industrial materials, polymers for MEMS and Microsystems, conductive polymers – Langmuir-Blodgett films, packing materials. Glass, Tungsten film and Sillimanite.

**UNIT III FABRICATION PROCESSES** **9**

Photolithography – photoresists and application, light sources, phoresist development, removal and postbacking, Ion implantation, diffusion, oxidation process, chemical vapor deposition-working principle, chemical reactions, rate of deposition, physical vapor deposition –sputtering, deposition by epitaxy, etching- chemical etching and plasma etching. Electron beam lithiography and HF etching.

**UNIT IV MICROMANUFACTURING** **9**

Bulk micromanufacturing- etching, isotropic and anisotrotpic etching, wet and dry etching, surface micro machining, – LIGA process- general description materials, electroplating, SLIGA process, Process design- photolithography, thin film fabrication, geometry shaping. Micro cutting and Chemical mechanical planarization

**UNIT V MICROSYSTEM PACKAGING** **9**

Mechanical packaging of microelectronics, Micro system packaging – general

considerations, three levels of packaging-die level, device level and system level, interfaces in microsystem packaging, essential packaging technologies, three dimensional packaging, assembly of Microsystems, selection of packaging materials, signal mapping and transduction. Zero level packaging

**TOTAL:45 PERIODS**

**REFERENCES :**

1. Tai- Ran Hsu, "MEMS & Microsystems Design and Manufacture", TMH, education, 2010.
2. N.P.Mahalik, "MEMS", McGraw-Hill Companies, 2010
3. Gardner, W.Julian, K. Varadan Vijay and O.Awadelkarim, Osama, "Micro sensors MEMS and Smart Devices", Jhon Wiley & Sons Ltd, 2001.
4. Gad-el-Hak, Mhamed, "The MEMS Handbook", CRC Press 2002.
5. S.Fatikow, U.Rembold, "Microsystem Technology and Microrobotics", Springer–Verlag, Berlin, Heidelberg, 2007.
6. E.H. Tay, Francis and W.O.Choong, "Micrfluids and Bio MEMS applications", Springer, 2002.

**WEB REFERENCES:**

1. https://www.mems-exchange.org/MEMS/what-is.html
2. https://internetofthingsagenda.techtarget.com/definition/micro-electromechanical-systems-MEMS
3. https://www.lboro.ac.uk/microsites/mechman/research/ipm-ktn/pdf/Technology_review/an-introduction-to-mems.pdf

**ONLINE RESOURCES:**

1. https://www.youtube.com/watch?v=j9y0gfN9WMg
2. https://nptel.ac.in/courses/117105082/
3. https://media.ccc.de/v/24c3-2190-en-introduction_in_mems
4. https://ieeetv.ieee.org/conference-highlights/embc-2011-workshop-biological-micro-electro-mechanical-systems-biomems-fundamentals-and-applications-utkan-demirci?
5. https://lecturenotes.in/m/15547-note-of-micro-electro-mechanical-systems-video-tutorial-by-bhaktishree-sathpathy/25?reading=true

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Apply the techniques for building microdevices in silicon, polymer, metal and other materials.

2. Analyze microsystems technology for technical feasibility as well as practicality.
3. Understand the limitations and current challenges in microsystems technology.
4. Identify perfect Ceramic Matrix Composites for high temperature applications.
5. Choose various combinations of fibres and resins.

**CO- PO &PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | - | - | - | - | - | - | - | 2 | - | - | - | - | 2 |
| CO2 | 2 | - | - | - | - | - | - | - | 2 | - | - | - | - | 2 |
| CO3 | 2 | - | - | - | - | - | - | - | 2 | - | - | - | - | 2 |
| CO4 | 2 | - | 2 | - | - | - | - | - | 2 | - | - | - | - | 2 |
| CO5 | 2 | - | - | - | - | - | - | - | 2 | - | - | - | - | 2 |

# PROFESSIONAL ELECTIVES - IV

| 20PCDEL311<br>SDG NO. 4, 9 & 12 | COMPUTER AIDED PRODUCTION PLANNING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To understand the various components of production planning such as forecasting, group technology MRP and ERP and applications of computer in such components.
- To study the various methods computer aided and inspection.

**UNIT I INTRODUCTION 7**

Introduction to Process planning in manufacturing, Computer aided production management and computer aided production planning , Process planning and production planning, Process planning and Concurrent engineering, Information requirement for process planning system, Role of process planning, Advantages of conventional process planning over CAPP.

**UNIT II COMPUTER AIDED FORECASTING 7**

Introduction to forecasting, sources of data, Demand patterns, Forecasting models, selection of forecasting technique, Computerized relative allocation of

facility technique, Automated layout design program and computerized relationship layout planning for facility location and layout.

**UNIT III GROUP TECHNOLOGY 7**

Introduction, Significance, Structure, Relative advantages, Implementation and applications , Algorithms and models for G.T, Rank order clustering, Bond energy, Mathematical model for machine, Component cell formation, Design and manufacturing attributes , Parts classification and coding, Concept of composite job machine group, Cell group tooling, Design rationalization, CAD/CAM and GT benefits.

**UNIT IV COMPUTER AIDED PROCESS PLANNING, OPERATIONS MANAGEMENT 12**

MRP: Introduction, Objective, Input, Computational procedure, Information provided by the system. Detailed capacity planning, Manufacturing resources planning.

ERP: Introduction, Main features, Generic model of ERP system, Selection of ERP, Proof of concept approach, Analytic hierarchy approach, ERP implementation, Job sequencings, scheduling, Simulation of machining processes, NC tool path generation, Graphical implementation, Determination of optimal index positions for executing fixed sequence, Quantitative methods.

**UNIT V COMPUTER AIDED MEASUREMENT AND INSPECTION 12**

Computer Aided Testing, Contact type, Non-contact type simulation, Major activities, Purpose, Simulation process, Types methodology, Simulation packages, Process quality simulator, Computer requirements trends and applications simulation of machine shop. Co-ordinate measuring machines, Universal measuring machine, Laser viewers for production profile checks, Image shearing microscope - Use of computers, Machine vision technology, Microprocessors in metrology..

**TOTAL:45 PERIODS**

**REFERENCES :**

1. Gideon Halevi and Roland D. Weill, “Principles of Process Planning ", A logical approach, Chapman & Hall, 1995.
2. Mahapatra P.B., “Computer Aided Production Management”, Printice Hall of India Pvt. Ltd., 2004.
3. Tien – Chien Chang and Richard A wysk, “An introduction to Automated Process Planning” Prentice Hall of India Pvt. Ltd., 1985.
4. Groover M.P., “Automation production systems and computer Integrated manufacturing”, Prentice Hall, 2001.

5. P.N.Rao, N.K.Tewari, Kundra T.K., "Computer Aided Manufacturing", TMH, 2000.

**WEB REFERENCES:**

1. https://www.academia.edu/8420050/Computer-Aided_Inspection_Planning_-_The_state_of_the_art
2. http://home.iitk.ac.in/~jrkumar/download/ME761A/Lecture%201%20Introduction%20Of%20CAM.pdf

**ONLINE RESOURCES:**

1. https://nptel.ac.in/courses/112102102/
2. https://nptel.ac.in/courses/112/102/112102103/

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Understand the necessity of computer aided production planning and the basic concepts.
2. Explain the various components of computer aided forecasting and automated layout design.
3. Describe the concepts of the group technology and its implementation and its benefits.
4. Acquire knowledge on MRP and ERP.
5. Enumerate the techniques computer aided measurements and inspection.

**CO- PO & PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | - | - | 1 | - | - | - | - | - | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | - | - | 1 | - | - | - | - | - | 3 | 3 | 3 |
| CO3 | 3 | 3 | 2 | - | - | 1 | - | - | - | - | - | 3 | 3 | 3 |
| CO4 | 3 | 3 | 2 | - | - | 1 | - | - | - | - | - | 3 | 3 | 3 |
| CO5 | 3 | 3 | 2 | - | - | 1 | - | - | - | - | - | 3 | 3 | 3 |

# PROFESSIONAL ELECTIVES - IV

| 20PCDEL312<br>SDG NO. 4, 9 & 12 | VIRTUAL MANUFACTURING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To understand the basic concept and types of Virtual Manufacturing, Virtual Prototyping and Virtual enterprise.
- To learn the techniques of analyzing, validating and evaluating of manufacturing processes and preparation of production plans and schedules form design concepts.
- To use Internet technology for manufacturing and development of resource models.
- To know simulation techniques and applying the same at different levels.
- To gain knowledge on Network manufacturing, web based work flow management; virtual control methods and latest technology such as e-Supply chain management , Tele manufacturing

**UNIT I BASIC CONCEPT ANF TYPES OF VIRTUAL MANUFACTURING 9**

Paradigms of VM: Design-centered VM, Production-centered VM and Control-centered VM. Generic VM Issues - relationships between VM, Virtual Prototyping, the Virtual Enterprise. Role of object oriented technology in VM.

**UNIT II DESIGN, OPTIMIZATION AND VALIDATION OF VIRTUAL MANUFACTURING 9**

Promising areas of VM and manufacturability analysis, validation and evaluation of process plans, partnering in agile enterprises, process design, and optimization of production plans and schedules. Tools for manufacturability analysis.

**UNIT III ADVANCED VIRTUAL MANUFACTURING TECHNOLOGY AND RESOURCE MODELS 9**

Virtual Manufacturing over the Internet. Transmitting VM Information over the Internet. Manufacturing resource models for distributed manufacturing.

**UNIT IV SIMULATION TECHNIQUES USED IN VIRTUAL MANUFACTURING 9**

Manufacturing process simulation -Factory level, Machine level, Component level, Process level. Integrated Simulation Method to Support Virtual Factory Engineering. Application of Virtual Reality Simulation of a Mechanical Assembly Production Line.

**UNIT V VIRTUAL FACTORY AND NETWORK MANUFACTURING 9**

Dispersed Network Manufacturing - Virtual factory, enterprise collaborative modeling system, virtual manufacturing (VM) system, Web-based work flow management, collaborative product commerce, applications of multi-agent technology, e-supply chain management and tele-manufacturing

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Crabb, C. H., "The Virtual Engineer-21 st Century Product Development", Society of Manufacturing Engineers, 1998.
2. Rao Ming, Qu Wang, Jianzhong Cha, "Integrated Distributed Intelligent Systems in Manufacturing (Intelligent Manufacturing)", Chapman & Hall (1993).

**WEB REFERENCES:**

1. International Journal of Engineering Research & Technology(IJERT) – 2015-www.ijert.org
2. Interactive Collaborative Learning (ICL) -2013 http//www.icl.net

**ONLINE RESOURCES:**

1. Virtual Manufacturing and their applications –International Journal for Research in Applied Science & Engineering Technology (IJRASET)
2. Virtual Manufacturing and systems – Wang. School of Engineering, University of Durham , U.K.
3. Virtual Learning Environment for Manufacturing Education and Training – Computers in Education Journal

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. Understand the concept, types of Virtual Manufacturing and Virtual Prototyping
2. Analyze, evaluate and validate manufacturing process plans with preparation of production plans and schedule and resource allocation.
3. Gain knowledge on use of IT tools for Virtual Manufacturing processes and preparation of Manufacturing Resource Models.
4. Apply the simulation techniques to Virtual Manufacturing Process Plans at different levels and applying Virtual Reality.
5. Develop virtual factory using Network concept and web based work flow management.
6. Understand basic concept, types, analyse, validate, apply resource allocation techniques, preparation of Manufacturing Resource models,

using IT tools such as internet, network etc..for simulation and work flow management.

**CO- PO &PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | 2 | 1 | 1 | - | - | - | 2 | - | - | 2 | 2 | 2 |
| CO2 | 2 | 2 | 3 | 2 | 2 | - | - | 2 | 3 | 2 | - | 2 | 2 | 2 |
| CO3 | - | 1 | 2 | 1 | 3 | 2 | 2 | - | 2 | - | - | 2 | 2 | 2 |
| CO4 | 2 | 2 | 2 | 3 | 3 | - | 2 | 2 | 2 | 3 | - | 2 | 2 | 2 |
| CO5 | 2 | 3 | 3 | 3 | 3 | 2 | - | 2 | 3 | - | - | 2 | 2 | 2 |
| CO6 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | - | 2 | 2 | 2 |

# PROFESSIONAL ELECTIVES - IV

| 20PCDEL313<br>SDG NO. 4, 9 & 11 | ENGINEERING FRACTURE MECHANICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- The purpose of this course is for the students to acquire basic skills and to compute the stress intensity factor, strain energy release rate around crack tips and crack growth rate due to fatigue. To examine the concept of failure in members with pre-existing flaws.

**UNIT I ELEMENTS OF SOLID MECHANICS 9**

The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation - limit analysis – Airy's function – field equation for stress intensity factor.

**UNIT II STATIONARY CRACK UNDER STATIC LOADING 9**

Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation - plastic zone size – Dugdaale model – determination of J integral and its relation to crack opening displacement.

**UNIT III ENERGY BALANCE AND CRACK GROWTH 9**

Griffith analysis – stable and unstable crack growth –Dynamic energy balance – crack arrest mechanism –K1c test methods - R curves - determination of collapse load.

**UNIT IV FATIGUE CRACK GROWTH CURVE 9**

Empirical relation describing crack growth law – life calculations for a given load amplitude – effects of changing the load spectrum -- rain flow method– external factors affecting the K1c values.- leak before break analysis.

**UNIT V APPLICATIONS OF FRACTURE MECHANICS 9**

Crack Initiation under large scale yielding – thickness as a design parameter – mixed mode fractures - crack instability in thermal and residual stress fields - numerical methods

**TOTAL:45 PERIODS**

**REFERENCES:**

1. David Broek, "Elementary Engineering Fracture Mechanics ", Fifthoff and Noerdhoff International Publisher, 1978.
2. KareHellan, "Introduction of Fracture Mechanics", McGraw-Hill Book Company, 1985.
3. Preshant Kumar, "Elements of Fracture Mechanics", Wheeler Publishing, 1999.
4. John M.Barson and StanelyT.Rolfe Fatigue and fracture control in structures Prentice hall Inc. Englewood cliffs. 1977

**WEB REFERENCES:**

1. https://www.gruppofrattura.it/books/Knott/index.html#8
2. https://www.tf.uni-kiel.de/matwis/brocks/milano_lectures.pdf

**ONLINE RESOURCES:**

1. https://nptel.ac.in/courses/112106065/
2. http://materials.iisc.ernet.in/~ramu/Fracture.pdf

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. learn basic elements of solid mechanics and stress intensity factor.
2. analyse the solution for the given model near the crack tip and to determine J-integral and Crack opening displacement.
3. learn appropriate fracture characterizing parameters like KIc and determination of collapse load
4. Analyse the failure of structure by fatigue crack growth.
5. Apply fracture mechanics concept for different applications.
6. Understand experimental techniques to determine the critical values of different parameters at crack tip.

**CO- PO & PSO MAPPING :**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 2 | 1 | 1 | - | - | - | 1 | 2 | 2 | 2 |
| CO2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | - | - | - | 1 | 2 | 2 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | - | - | - | 1 | 2 | 2 | 2 |
| CO4 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | - | - | - | 2 | 2 | 2 |
| CO5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | - | 1 | 1 | - | 2 | 2 | 2 |
| CO6 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | - | - | - | - | 2 | 2 | 2 |

# PROFESSIONAL ELECTIVES - IV

| 20PCDEL314<br>SDG NO. 4 & 9 | COMPUTER APPLICATIONS IN DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To study how computer can be used in Mechanical Engineering Design.

**UNIT I INTRODUCTION 9**

The Design process and role of CAD – Types and applications of design models – Computer representation of drawings – Three-dimensional modeling schemes – Wire frame and surface representation scheme – solid modeling.

**UNIT II INTRODUCTION TO CAD SOFTWARE 9**

Writing interactive programs to solve design problems using C++ - systems customization - Features of various solid-modeling packages.

**UNIT III COMPUTER AIDED DESIGN OF MACHINE ELEMENTS 9**

Development of programs in C++ design, drawing & plotting of Machine Elements shafts gears, pulleys, flywheel, connecting rods.

**UNIT IV ENTITY MANIPULATION AND DATA STORAGE 9**

Manipulation of the model – Model storage – Data structures – Data base considerations – object oriented representations - Organizing data for CIM applications – Design information systems.

**UNIT V EXPANDING THE CAPABILITY OF CAD 9**

Parametric and variation modeling – Feature based modeling – Feature recognition - Design by features – Analysis – Rapid prototyping – AI in Design.

**TOTAL:45 PERIODS**

**REFERENCES :**


1. Charles. S. Knox, "Organising data for CIM Applications", Marcel Dekker Inc. New York 1987.
2. Ibrahim Zeid "CAD/ CAM - Theory and Practice" - McGraw Hill, International Edition, 1998.
3. Chris McMahon and Jimmi Browne, "CAD CAM Principles, practice and Manufacturing Management", Pearson Education Asia, 2000.


**WEB REFERENCES:**

1. http://www.machinedesign.com
2. 2. http://www.cadcamnet.com

**OUTCOMES:**

**Upon completion of the course, the student should be able to**

1. To familiarize the basics of CAD and Solid Modeling Techniques.
2. Write C++ Programs to solve design problems.
3. Develop program for drawing and plotting of Machine Elements.
4. Understand various aspects of data storage, manipulation & expanding its capability
5. Know feature based Modeling, Rapid Prototyping and AI.

**CO- PO & PSO MAPPING:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 3 | 2 | - | - | 2 | 2 | 2 | 3 | 1 | 1 |
| CO2 | 3 | 2 | 1 | 2 | 1 | 2 | - | - | 1 | 1 | 1 | 2 | 1 | 2 |
| CO3 | 3 | 2 | 2 | 1 | 3 | 2 | - | - | 2 | 2 | 2 | 3 | 1 | 1 |
| CO4 | 3 | 2 | 2 | 1 | 3 | 2 | - | - | 2 | 2 | 2 | 3 | 1 | 2 |
| CO5 | 1 | 1 | - | - | 1 | 1 | - | - | 1 | 1 | 1 | 1 | - | 2 |

*Imagine the Future and*

# *Make it happen!*



Together let's build a better world where there is NO POVERTY and ZERO HUNGER.

We have GOOD HEALTH AND WELL BEING QUALITY EDUCATION and full GENDER EQUALITY everywhere.

There is CLEAN WATER AND SANITATION for everyone. AFFORDABLE AND CLEAN ENERGY

which will help to create DECENT WORK AND ECONOMIC GROWTH. Our prosperity shall be fuelled

by investments in INDUSTRY, INNOVATION AND INFRASTRUCTURE that will help us to

REDUCE INEQUALITIES by all means. We will live in SUSTAINABLE CITIES AND COMMUNITIES.

RESPONSIBLE CONSUMPTION AND PRODUCTION will help in healing our planet.

CLIMATE ACTION will reduce global warming and we will have abundant,

flourishing LIFE BELOW WATER, rich and diverse LIFE ON LAND.

We will enjoy PEACE AND JUSTICE through STRONG INSTITUTIONS

and will build long term PARTNERSHIPS FOR THE GOALS.

*For the goals to be reached, everyone needs to do their part: governments, the private sector, civil society and* **People like you.**

*Together we can...*

Sai Prakash Leo Muthu

*CEO – Sairam Institutions*

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*through Quality education.*

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