**SETHU INSTITUTE OF TECHNOLOGY**
**(An Autonomous Institution)**
**Pulloor, Kariapatti, Virudhunagar (Dist.) -Pin: 626 115.**

**Department of Mechanical Engineering**
**(Accredited by NBA, New Delhi and NAAC with 'A++' Grade)**

**(Approved Research Centre by Anna University, Chennai)**

# M.E. CAD/CAM

# REGULATION 2021

# Choice Based Credit System

# CURRICULUM AND SYLLABUS

SETHU INSTITUTE OF TECHNOLOGY
(An Autonomous Institution)
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# M.E. CAD/CAM

**Department Vision statement**

- To promote excellence in education and research in mechanical engineering for the benefits of industry and society.

**Department Mission Statement**

1. To provide quality technical educational experience to enable the graduates to become leaders in their chosen profession.
2. To educate through modern teaching tools and experiential learning to produce proficient engineer.
3. To develop skills in recent technological trends and design software and to facilitate various co-curricular activities to enhance employability and entrepreneurship.
4. To establish collaboration with industries for transfer of technical knowledge.
5. To promote research activities among faculty members and students.
6. To offer beneficial services to the society.

| PROGRAM OUTCOMES (POs):<br>Post graduates in engineering will be able to: | |
|---|---|
| 1. | Independently carry out research /investigation and development work to solve practical problems. |
| 2. | Write and present a substantial technical report/document |
| 3. | Demonstrate a degree of mastery over the area as per the specialization of the program, higher than the requirements in the appropriate bachelor program. |
| 4. | Apply appropriate techniques, resources, modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations |
| 5. | Engage in life-long learning with continuous enthusiasm and commitment to improve knowledge and competence. |
| 6. | Act with ethical responsibility in professional practices to contribute for the sustainable development of the society. |

**Program Educational Objectives (PEOs)**

| After few years of graduation our post graduates are expected to: |
|---|
| To instill knowledge to students in current developments in the Computer Aided Design and Manufacturing to enlighten them to succeed in Manufacturing engineering and research related professions. |
| To develop design and analysis skills of the students in order to provide the solutions for the problems facing in modern manufacturing industries. |
| To inculcate students about professional ethics, effective communication skills and team work abilities to meet the global standards with social responsibility. |

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# M.E. CAD/CAM

## REGULATION 2021 - OVERALL COURSE STRUCTURE

| Code | Category | Total No. of Courses | Credits | Percentage |
|---|---|---|---|---|
| PCC | Professional Core Courses (Including Lab Courses) | 9 | 26 | 37.14 |
| PEC | Professional Electives Courses | 6 | 18 | 25.71 |
| OEC | Open Electives Courses | 1 | 3 | 4.29 |
| PW | Project Work & Seminar | 3 | 20 | 28.57 |
| MCC | Mandatory Credit Courses | 1 | 3 | 4.29 |
| AC | Audit Courses | 2 | Pass/ Fail | - |
| | **TOTAL** | **22** | **70** | **100** |

## COURSE CREDITS – SEMESTER WISE

| Semester | I | II | III | IV | TOTAL |
|---|---|---|---|---|---|
| Credits | 18 | 22 | 18 | 12 | 70 |

## SEMESTER – I

| S. No. | Course Category | Course Code | Course Name | L | T | P | C | H |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | PCC | 21PCD101 | Computer Applications in Design | 3 | 1 | 0 | 4 | 60 |
| 2. | PCC | 21PCD102 | Advanced Finite Element Analysis | 3 | 1 | 0 | 4 | 60 |
| 3. | PEC | E1 | Professional Elective – I | 3 | 0 | 0 | 3 | 45 |
| **PRACTICAL** | | | | | | | | |
| 4. | PCC | 21PCD103 | Computer Aided Design Laboratory | 0 | 0 | 4 | 2 | 60 |
| 5. | PCC | 21PCD104 | Computer Aided Engineering Laboratory | 0 | 0 | 4 | 2 | 60 |
| **AUDIT COURSE** | | | | | | | | |
| 6. | AC | 21PGM801 | Pedagogy Studies | 2 | 0 | 0 | P/F | 30 |
| **MANDATORY** | | | | | | | | |
| 7. | MCC | 21PGM701 | Research Methodology and IPR | 3 | 0 | 0 | 3 | 45 |
| | | | **TOTAL** | **14** | **2** | **8** | **18** | |
| | | | | | | | **Total No of Credits – 18** | |

## SEMESTER – II

| S. No. | Course Category | Course Code | Course Name | L | T | P | C | H |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | PCC | 21PCD201 | Design for Sustainability | 3 | 0 | 0 | 3 | 45 |
| 2. | PCC | 21PCD202 | Applied Materials Engineering | 3 | 0 | 0 | 3 | 45 |
| 3. | PCC | 21PCD203 | Industry 4.0 | 3 | 0 | 0 | 3 | 45 |
| 4. | PCC | 21PCD204 | Product Design and Lifecycle Management | 3 | 0 | 0 | 3 | 45 |
| 5. | PEC | E2 | Professional Elective – II | 3 | 0 | 0 | 3 | 45 |
| 6. | PEC | E3 | Professional Elective – III | 3 | 0 | 0 | 3 | 45 |
| **PRACTICAL** | | | | | | | | |
| 7. | PCC | 21PCD205 | Advanced Simulation and Analysis Laboratory | 0 | 0 | 4 | 2 | 60 |
| 8. | PW | 21PCD206 | Term Paper with Seminar | 0 | 0 | 4 | 2 | 60 |
| | | | **TOTAL** | **18** | **0** | **8** | **22** | |
| | | | | | | | **Total No of Credits – 22** | |

## SEMESTER – III

| S. No. | Course Category | Course Code | Course Name | L | T | P | C | H |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | PEC | E4 | Professional Elective – IV | 3 | 0 | 0 | 3 | 45 |
| 2. | PEC | E5 | Professional Elective – V | 3 | 0 | 0 | 3 | 45 |
| 3. | PEC | E6 | Professional Elective – VI | 3 | 0 | 0 | 3 | 45 |
| 4. | OEC | OE | Open Elective – I | 3 | 0 | 0 | 3 | 45 |
| **PRACTICAL** | | | | | | | | |
| 5. | PW | 21PCD301 | Project Work I | 0 | 0 | 12 | 6 | 180 |
| **AUDIT COURSE** | | | | | | | | |
| 6. | AC | 21PGM802 | English for Research Paper Writing | 2 | 0 | 0 | P/F | 30 |
| | | | **TOTAL** | **14** | **0** | **12** | **18** | |
| | | | | | | | **Total No of Credits – 18** | |

## SEMESTER – IV

| S. No. | Course Category | Course Code | Course Name | L | T | P | C | H |
|---|---|---|---|---|---|---|---|---|
| **PRACTICAL** | | | | | | | | |
| 1. | PW | 21PCD401 | Project Work II | 0 | 0 | 24 | 12 | 360 |
| | | | **TOTAL** | **0** | **0** | **24** | **12** | |
| | | | | | | | **Total No of Credits – 12** | |

## PROFESSIONAL ELECTIVE COURSES:

| S. No. | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|
| 1. | 21PCD501 | Metrology and Non Destructive Testing Systems | 3 | 0 | 0 | 3 |
| 2. | 21PCD502 | Integrated manufacturing system | 3 | 0 | 0 | 3 |
| 3. | 21PCD503 | Design of Hydraulic and Pneumatic Systems | 3 | 0 | 0 | 3 |
| 4. | 21PCD504 | Mechatronics In Manufacturing Systems | 3 | 0 | 0 | 3 |
| 5. | 21PCD505 | Industrial Robotics and Expert Systems | 3 | 0 | 0 | 3 |
| 6. | 21PCD506 | Lean Manufacturing | 3 | 0 | 0 | 3 |
| 7. | 21PCD507 | Industrial Safety Management | 3 | 0 | 0 | 3 |
| 8. | 21PCD508 | Design for Cellular Manufacturing Systems | 3 | 0 | 0 | 3 |
| 9. | 21PCD509 | Additive Manufacturing | 3 | 0 | 0 | 3 |
| 10. | 21PCD510 | Mechanical Behavior of Materials | 3 | 0 | 0 | 3 |
| 11. | 21PCD511 | Composite Materials and Mechanics | 3 | 0 | 0 | 3 |
| 12. | 21PCD512 | Material Testing and Characterization | 3 | 0 | 0 | 3 |
| 13. | 21PCD513 | Electronics Manufacturing | 3 | 0 | 0 | 3 |
| 14. | 21PCD514 | Quality Concepts in Design | 3 | 0 | 0 | 3 |
| 15. | 21PCD515 | Design of Hybrid and Electric Vehicles | 3 | 0 | 0 | 3 |
| 16. | 21PCD516 | Advanced Mechanics of Materials | 3 | 0 | 0 | 3 |
| 17. | 21PCD517 | Artificial Intelligence and its industrial Applications | 3 | 0 | 0 | 3 |
| 18. | 21PCD518 | Design of Internet of Things | 3 | 0 | 0 | 3 |
| 19. | 21PCD519 | Design and Analysis of Experiments | 3 | 0 | 0 | 3 |
| 20. | 21PCD520 | Synthesis and Characterization of Nano materials | 3 | 0 | 0 | 3 |
| 21. | 21PCD521 | Performance Modeling and Analysis of Manufacturing System | 3 | 0 | 0 | 3 |
| 22. | 21PCD522 | Advanced Optimization Techniques | 3 | 0 | 0 | 3 |

## LIST OF OPEN ELECTIVES

| S. No. | Course Code | Course Name | L | T | P | C |
|---|---|---|---|---|---|---|
| 1. | 21PCD601 | Industrial Safety | 3 | 0 | 0 | 3 |
| 2. | 21PCD602 | Cost Management of Engineering Projects | 3 | 0 | 0 | 3 |

## AUDIT COURSES

| S. No. | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|
| 1. | 21PGM801 | Pedagogy Studies | 2 | 0 | 0 | P/F |
| 2. | 21PGM802 | English for Research Paper Writing | 3 | 0 | 0 | P/F |

## Professional Core Courses (PCC)

| S. No. | Course Code | Course Title | L | T | P | C | H | SEM |
|---|---|---|---|---|---|---|---|---|
| 1. | 21PCD101 | Computer Applications in Design | 3 | 1 | 0 | 4 | 60 | SEM 1 |
| 2. | 21PCD102 | Advanced Finite Element Analysis | 3 | 1 | 0 | 4 | 60 | SEM 1 |
| 3. | 21PCD103 | Computer Aided Design Laboratory | 0 | 0 | 4 | 2 | 60 | SEM 1 |
| 4. | 21PCD104 | Computer Aided Engineering Laboratory | 0 | 0 | 4 | 2 | 60 | SEM 1 |
| 5. | 21PCD201 | Design for Sustainability | 3 | 0 | 0 | 3 | 45 | SEM 2 |
| 6. | 21PCD202 | Applied Materials Engineering | 3 | 0 | 0 | 3 | 45 | SEM 2 |
| 7. | 21PCD203 | Industry 4.0 | 3 | 0 | 0 | 3 | 45 | SEM 2 |
| 8. | 21PCD204 | Product Design and Lifecycle Management | 3 | 0 | 0 | 3 | 45 | SEM 2 |
| 9. | 21PCD205 | Advanced Simulation and Analysis Laboratory | 0 | 0 | 4 | 2 | 60 | SEM 2 |

## Professional Electives Courses (PEC)

| S. No. | Course Code | Course Title | L | T | P | C | H | SEM |
|---|---|---|---|---|---|---|---|---|
| 1. | E1 | Professional Elective – I | 3 | 0 | 0 | 3 | 45 | SEM 1 |
| 2. | E2 | Professional Elective – I | 3 | 0 | 0 | 3 | 45 | SEM 2 |
| 3. | E3 | Professional Elective – I | 3 | 0 | 0 | 3 | 45 | SEM 2 |
| 4. | E4 | Professional Elective – I | 3 | 0 | 0 | 3 | 45 | SEM 3 |
| 5. | E5 | Professional Elective – I | 3 | 0 | 0 | 3 | 45 | SEM 3 |
| 6. | E6 | Professional Elective – I | 3 | 0 | 0 | 3 | 45 | SEM 3 |

## Open Electives Courses (OEC)

| S. No. | Course Code | Course Title | L | T | P | C | H | SEM |
|---|---|---|---|---|---|---|---|---|
| 1. | OE | Open Elective – I | 3 | 0 | 0 | 3 | 45 | SEM 3 |

## Project Work & Seminar (PW)

| S. No. | Course Code | Course Title | L | T | P | C | H | SEM |
|---|---|---|---|---|---|---|---|---|
| 1. | 21PCD206 | Term Paper with Seminar | 0 | 0 | 4 | 2 | 60 | SEM 2 |
| 2. | 21PCD301 | Project Work I | 0 | 0 | 12 | 6 | 180 | SEM 3 |
| 3. | 21PCD401 | Project Work II | 0 | 0 | 24 | 12 | 360 | SEM 4 |

## Mandatory Credit Courses (MCC)

| S. No. | Course Code | Course Title | L | T | P | C | H | SEM |
|---|---|---|---|---|---|---|---|---|
| 1. | 21PGM701 | Research Methodology and IPR | 3 | 0 | 0 | 3 | 45 | SEM 1 |

## Audit Courses (AC)

| S. No. | Course Code | Course Title | L | T | P | C | H | SEM |
|---|---|---|---|---|---|---|---|---|
| 2. | 21PGM801 | Pedagogy Studies | 2 | 0 | 0 | P/F | 30 | SEM 1 |
| 3. | 21PGM802 | English for Research Paper Writing | 2 | 0 | 0 | P/F | 30 | SEM 3 |

## SEMESTER – I

| S. No. | Course Category | Course Code | Course Name | L | T | P | C | H |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | PCC | 21PCD101 | Computer Applications in Design | 3 | 1 | 0 | 4 | 60 |
| 2. | PCC | 21PCD102 | Advanced Finite Element Analysis | 3 | 1 | 0 | 4 | 60 |
| 3. | PEC | E1 | Professional Elective – I | 3 | 0 | 0 | 3 | 45 |
| **PRACTICAL** | | | | | | | | |
| 4. | PCC | 21PCD103 | Computer Aided Design Laboratory | 0 | 0 | 4 | 2 | 60 |
| 5. | PCC | 21PCD104 | Computer Aided Engineering Laboratory | 0 | 0 | 4 | 2 | 60 |
| **AUDIT COURSE** | | | | | | | | |
| 6. | AC | 21PGM801 | Pedagogy Studies | 2 | 0 | 0 | P/F | 30 |
| **MANDATORY** | | | | | | | | |
| 7. | MCC | 21PGM701 | Research Methodology and IPR | 3 | 0 | 0 | 3 | 45 |
| | | | **TOTAL** | **14** | **2** | **8** | **18** | |
| | | | | | | | **Total No of Credits – 18** | |

**21PCD101 COMPUTER APPLICATIONS IN DESIGN**

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

**OBJECTIVES:**

- This course aims at imparting knowledge on computer applications in design.
- To understand fundamental concepts of computer graphics and its tools in a generic framework.
- To impart the parametric fundamentals to create and manipulate geometric models using curves, surfaces and solids.
- To impart the parametric fundamentals to create and manipulate geometric models using NURBS and solids.
- To provide clear understanding of CAD systems for 3D modeling and viewing.
- To create strong skills of assembly modeling and prepare the student to be an effective user of a standards in CAD system.

**UNIT I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS** 9+3

Overview of Graphics systems: Video Display Devices, Raster-Scan System, Random-Scan Systems, Graphics Monitors and Workstations, Input Devices, Hard-Copy Devices, Graphics Software. Output primitives (points, lines, curves etc.,), 2-D&3-D transformation (Translation, scaling, rotation) windowing- view ports –clipping transformation.

**UNIT II CURVES AND SURFACES MODELING 9+3**

Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline-Bezier curve and B-Spline curve– curve manipulations.

Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder–synthetic surfaces: Hermite bi-cubic surface-Bezier surface and B-Spline surface-surface manipulations.

**UNIT III NURBS AND SOLID MODELING 9+3**

NURBS-Basics-curves, lines, arcs, circle and bilinear surface. Regularized Boolean set operations-primitive instancing - sweep representations - boundary representations – constructive solid Geometry - comparison of representations-user interface for solid modeling.

**UNIT IV VISUAL REALISM 9+3**

Hidden–Line–Surface–solid removal algorithms shading coloring. Introduction to parametric and variational geometry based software's and their principles creation of prismatic and lofted parts using the sepackages. Animation - Conventional, Computer animation, Engineering animation - types and techniques.

**UNIT V ASSEMBLY OF PARTS AND PRODUCT DATA EXCHANGE 9+3**

Assembly modeling-interferences of positions and orientation-tolerances analysis–mass property calculations-mechanism simulation. Graphic sand computing standards–Open GLData Exchange standards–IGES, STEP etc–Communication standards.

**Total:45Periods(L)+15Periods(T)**

**COURSEOUTCOMES:**

**After successful completion of this course, the Students will be able to**

1. Solve 2D and 3D transformations for the basic entities like line and circle.

2. Formulate the basic mathematics fundamental to CAD system.

3. Analyze the different geometric modeling techniques like feature based modeling, surface modeling and solid modeling.

4. Design geometric models through animation and transform them into real world systems.

5. Apply appropriate Computer-Aided Design software to simulate the assembly of complex engineering parts.

6. Investigate and development work to solve real world problems by using computer applications in design.

**REFERENCES:**


1. Boothroyd, G, “Assembly Automation and Product Design” Marcel Dekker, New York, 1997.
2. Chitale A.K and Gupta R.C “ Product design and manufacturing “ PHI learning private limited, 6th Edition, 2015.
3. David Rogers, James Alan Adams “Mathematical Elements for Computer Graphics” 2nd Edition, Tata McGraw-Hill edition.2003
4. Donald D Hearn and M. Pauline Baker “Computer Graphics C Version”, Prentice Hall, Inc., 2nd Edition, 2002.
5. Ibrahim Zeid, "Mastering CAD/CAM", McGraw Hill, 2nd Edition, 2007
6. William M Newman and Robert F.Sproull “Principles of Interactive Computer Graphics”, McGraw Hill Book Co. 1stEdition, 2001.
7. https://onlinecourses.nptel.ac.in/noc22_cs38/preview
8. Operating Systems: Three Easy Pieces”,https://pages.cs.wisc.edu/~remzi/OSTEP/
9. https://www.cse.iitb.ac.in/~mythili/os/

## COURSE ARTICULATION MATRIX:

### CO/PO MAPPING

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | 2 | | | 3 | 2 | |
| **CO.2** | 2 | | | 3 | 2 | |
| **CO.3** | 2 | | | 3 | 2 | |
| **CO.4** | 2 | | | 3 | 3 | |
| **CO.5** | 2 | | | 3 | 2 | |
| **CO.6** | 3 | 3 | 3 | | 3 | 2 |
| **21PCD101** | 3 | 3 | 3 | 3 | 3 | 2 |

**Ref: 3-Strong 2-Medium 1 –Weak**

| 21PCD102 | ADVANCED FINITE ELEMENT ANALYSIS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**OBJECTIVES:**

- Enable students to earn advanced topics in FEM so that this tool can be used for analysis, design and optimization of engineering systems.
- To study the concepts of Finite Element analysis to solve problems involving plate and shell, geometric, material non linearity and dynamic problems.
- To study the concepts of Finite Element analysis to solve fluid mechanics and heat transfer problems.
- To gain exposure to commercial FEA packages.

**UNIT I BENDING OF PLATES AND SHELLS** **9+3**

Review of Elasticity Equations – Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements - Conforming and Non-Conforming Elements – C0 and C1 Continuity Elements – Degenerated shell elements- Application and Examples

**UNIT II NON-LINEAR PROBLEMS** **9+3**

Introduction – Iterative Techniques – Material non-linearity – Elasto Plasticity – Plasticity – Visco Plasticity –Geometric Non linearity – large displacement Formulation –Solution procedure- Application in Metal Forming Process and Contact Problems

**UNIT III DYNAMIC PROBLEM** **9+3**

Lumped and consistent mass matrices - Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Eigen solution-Sub space Iterative Technique – Response analysis-Houbolt, Wilson, Newmark – Methods. Explicit & Implict Methods-Lanchzos, Reduced method for large size systeme quations.

**UNIT IV FLUID MECHANICS AND HEAT TRANSFER** **9+3**

Governing Equations of Fluid Mechanics – Solid structure interaction - Inviscid and Incompressible Flow–PotentialFormulations–SlowNon-NewtonianFlow–MetalandPolymerForming– NavierStokesEquation–Steadyand Transient Solution.

**UNIT V ERROR ESTIMATES AND ADAPTIVE REFINEMENT** **9+3**

Error norms and Convergence rates–h-refinement with adaptivity – Adaptive refinement. Source of error, ill-conditioning, the condition number, diagonal decay test, residuals, discretization errors, multi-mesh extrapolation, mesh revision methods, gradient recovery and smoothening.

Total:**45Periods(L)+15Periods (T)**

**COURSE OUTCOMES:**

After successful completion of this course, the Students will be able to

1. Explain the various finite element concepts for Bending of plates and shells, non – linear, Dynamic, Heat Transfer, Fluid mechanics and Error estimation.
2. Apply the concept of finite element analysis to solve problems involving non-linear and dynamic.
3. Apply the concept of finite element analysis to estimate the errors and adaptive refinement.
4. Compare the Bending of plates and shells, non – linear, Dynamic, Heat Transfer and Fluid mechanics problems by analytical method and commercial FEA software packages.
5. Evaluate the given heat transfer and fluid mechanics problems by using the FEM.
6. Investigate and development work to solve real world problems by using finite element methods.

**REFERENCE BOOKS:**


1. Reddy, J.N. "An Introduction to Non linear Finite Element Analysis", 2nd Edition, Oxford, 2015
2. Rao S.S," Finite Element Method in Engineering", Pergamon Press,2013.
3. Tirupati R Chandrupatla and Ashok. D. Belegundu, "Introduction of finite element in Engineering", 5th Edition, Prentice hall of India, 2022.
4. Bathe K.J, "Finite Element Procedures in Engineering Analysis", Prentice Hall, 1996.
5. Kobayashi S., Soo-IK-Oh andAltan,T, "Metal forming and the Finite element Methods", Oxford University Press,1989.
6. Lewis R.W, Morgan K, Thomas H.R, and Seetharaman K.N, "The Finite Element Method in Heat Transfer Analysis", John Wiley, 1996.
7. L Darrell W. Pepper and Juan C. Heinrich M,**"**Finite Element Methods: Basic Concepts andApplications",2nd edition, S.Chand (G/L) & Company Ltd,2005.
8. Singiresu S. Rao," The Finite Element Method in Engineering", 6th Edition, Butterworth-Heinemann Inc,2017
9. Zienkiewicz, O. C., Taylor, R. L. and Zhu. J .Z. ,"The Finite Element Method: Its Basis and Fundamentals",7th Edition, Butterworth-Heinemann,2013.

## COURSE ARTICULATION MATRIX:

### CO/PO MAPPING

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | | | | | | |
| **CO.2** | 2 | | 2 | 2 | 2 | 2 |
| **CO.3** | 2 | | 2 | | 2 | 2 |
| **CO.4** | 3 | | 2 | 3 | 2 | 2 |
| **CO.5** | 3 | | 3 | 3 | 2 | 2 |
| **CO.6** | 3 | | 3 | | 2 | 2 |
| **21PCD102** | **3** | | **3** | **3** | **2** | **2** |

**Ref: 3-Strong 2-Medium 1 –Weak**

**21PGM701 RESEARCH METHODOLOGY AND IPR**

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

**OBJECTIVES:**

- To provide an overview on selection of research problem based on the Literature review
- To enhance knowledge on the Data collection and Analysis for Research design
- To outline the importance of ethical principles to be followed in Research work and IPR

**UNIT I INTRODUCTION TO RESEARCH FORMULATION 9**

Meaning of research problem, Sources of research problem, Criteria- good research problem, and selecting a research problem, Scope and objectives of research problem. Defining and formulating the research problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

**UNIT II RESEARCH DESIGN AND ETHICS 9**

Research Design – Different Research designs- Sampling design- Types of sampling, Methods of Data collection- primary data, secondary data, - Plagiarism, Application of results and ethics - Environmental impacts - Ethical issues - ethical committees

**UNIT III DATA ANALYSIS AND TESTING OF HYPOTHESES 9**

Execution of the research - Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Generalization and Interpretation Testing of Hypotheses- Chi-square test, Taguchi and ANOVA

**UNIT IV REPORT,THESIS, PAPER AND RESEARCH PROPOSAL WRITING 9**

Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables - Bibliography, types of referencing, citations-index and footnotes, how to write report- Paper Developing, Research Proposal- Format of research proposal- a presentation - assessment by a review committee

**UNIT V INTELLECTUAL PROPERTY AND PATENT RIGHTS 9**

Nature of Intellectual Property - Patents, Designs, Trade and Copyright- patent search, Process of Patenting and Development: technological research, innovation, patenting, and development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of Patent Rights – Scope of Patent Rights, Geographical Indications, Case Studies

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES

After successful completion of this course, the Students will be able to

1. Analyze the literature to identify the research gap in the given area of research
2. Design suitable research methodology to pursue the research in scientific and systematic procedure with statistical / IT Tools
3. Analyze and synthesize the data using research methods and knowledge to provide scientific interpretation and conclusion
4. Prepare research reports and proposals by properly synthesizing, arranging the research documents to provide comprehensive technical and scientific report
5. Conduct patent database search in various countries for the research problem identified
6. Apply ethical principles in research and reporting to promote healthy scientific practice

## ADDITIONAL READING


1. Prasad & Bhojwani RESEARCH METHODOLOGY AND IPR (Third Year TY Civil Engineering Semester 5) Paperback – 1 January 2021
2. Research Methodology & Intellectual Property Rights for 5th Sem B.E Paperback – 1 January 2024 by Kartik Puttaiah ,R Ravi kumar
3. Fundamentals Of Research Methodology And Intellectual Property Rights
4. Ellapu Venkatesh, Palagati Anusha, Savuturu Sujith Kumar, Syed Mastan Basha 2023
5. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
6. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
7. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
8. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
9. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
10. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
11. Satarkar, S.V., 2000. Intellectual property rights and Copy right. EssEss Publications

## COURSE ARTICULATION MATRIX:

### CO/PO MAPPING

| CO | | POs | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | 3 | 2 | 3 | 2 | 3 | 2 |
| **CO.2** | 3 | | 3 | 3 | | |
| **CO.3** | 3 | 3 | 3 | | 2 | 2 |
| **CO.4** | | 3 | | 2 | | |
| **CO.5** | 3 | 2 | 3 | | 2 | 2 |
| **CO.6** | 3 | 3 | | | | 3 |
| **21PGM701** | **3** | **3** | **3** | **3** | **3** | **3** |

**Ref: 3-Strong 2-Medium 1 –Weak**

| 21PCD103 | COMPUTER AIDED DESIGN LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**COURSE OBJECTIVE:**

- To understand the different type of solid model package and create the graphical solid model.
- Apply the principles of two-dimensional CAD in the solution of various design problems.

**LIST OF EXPERIMENTS**

1. CAD Introduction
2. Sketch
3. Solid modeling – Extrude, Revolve, Sweep and variational sweep, Loft
4. Surface modeling – Extrude, Sweep, Trim and Mesh of curves, Freeform
5. Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc.
6. Assembly – Constraints, Exploded Views, Interference check
7. Drafting – Layouts, Standard & Sectional Views, Detailing & Plotting
8. CAD data exchange formats – IGES, PDES, PARASOLID, DXF and STL
9. Design of straight helical gears and analyzing the kinematics of gear train using motion study.
10. Exercises in modeling and drafting of mechanical components – assembly using parametric and feature based packages like PRO-E/SOLIDWORKS /CATIA/NX
11. Generative design approach of mechanical components using AI based CAD modeling.

**Total: 60 Periods**

**COURSE OUTCOMES:**

**After successful completion of this course the students will be able to:**

1. Apply the knowledge of CAD software to sketch the various 2D components.
2. Apply the different sketch based solid modeling features to draw various 3D parts.
3. Make use of different surface modeling commands to build complex surface models.
4. Choose appropriate features and detail drawing layout to develop the solid modeling components.
5. Assemble the parts and build various mechanical applications.
6. Develop a generative design modeling for various mechanical applications.

**Equipment details**

DELL Computer and 19" Monitor,
DELL optic plus mini tower CPU Intell core i5- Windows 10 Linux,
8 GB DDR4 RAM 1TM SATA Hard Disk Drive,
CREO 5.0 software. PRO-E/SOLIDWORKS

## COURSE ARTICULATION MATRIX:

### CO/PO MAPPING

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| CO.1 | | | | 3 | 3 | 2 |
| CO.2 | | | | 3 | 3 | 2 |
| CO.3 | 2 | | 3 | 3 | | 2 |
| CO.4 | | | | 3 | | |
| CO.5 | 2 | | 3 | 3 | 3 | 3 |
| CO.6 | 2 | | 3 | 3 | 2 | 3 |
| **21PCD103** | **2** | | **3** | **3** | **3** | **3** |

**Ref: 3-Strong 2-Medium 1 –Weak**

| 21PCD104 | COMPUTER AIDED ENGINEERING LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**OBJECTIVES:**

- To analyze is the complex problem by using the ANSYS/ABAQUS etc.,
- Synthesize information and apply critical thinking skills to solve instructional problems typical to industry.

**Analysis of Mechanical Components**

Analysis of Mechanical Components – Use of FEA Packages like ANSYS/ NASTRAN etc.,

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
10. Analysis of machine elements under dynamic loads
11. Analysis of non-linear systems
12. Create a manual part program for the given milling operations by using CADEM Software.
13. Create a manual part program for the given multiple lathe operations by using CADEM Software.

**Total: 60 Periods**

**COURSEOUTCOMES:**

After successful completion of this course, the Students will be able to

1. Understand the concepts and applications of ANSYS and CADEM software's
2. Analyze the stresses and deflection in various beams with different support and loading conditions.
3. Analyze the stresses and deflection in the flat plates and axis symmetric components with different support and loading conditions.
4. Analyze the natural frequencies in various beams with different support and loading conditions.
5. Apply the heat transfer concepts for analyze the thermal stresses to the plates and cylindrical

shells to predict the nodal temperatures.

6. Manually write and simulate a CNC part program for various milling and lathe operations using CADEM software.

**Equipment details**

DELL Computer and 19" Monitor,
DELL optic plus mini tower CPU Intell core i5- Windows 10 Linux,
8 GB DDR4 RAM 1TM SATA Hard Disk Drive,
ANSYS with CFD, Version 19.0, CADEM software.

## COURSE ARTICULATION MATRIX:

### CO/PO MAPPING

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| CO.1 | | | | | | |
| CO.2 | 2 | | 2 | 3 | 3 | 2 |
| CO.3 | 2 | | 2 | 3 | 3 | 2 |
| CO.4 | 2 | | 2 | 3 | 3 | 2 |
| CO.5 | 2 | | 2 | 3 | 3 | 2 |
| CO.6 | 2 | | 3 | 3 | 3 | 3 |
| **21PCD104** | **2** | | **3** | **3** | **3** | **3** |

**Ref: 3-Strong 2-Medium 1 –Weak**

| 21PGM801 | PEDAGOGY STUDIES | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | P/F |

**OBJECTIVES:**

- To make the students understand a range of cognitive capacities in human learners
- To explain the outcome-based education system
- To describe the curriculum design process

**UNIT I EDUCATIONAL PSYCHOLOGY AND ENGINEERING EDUCATION** **7**

Learning process, motivation and engagement, ICT in learning and teaching, Facilitating the learners,Engineeringeducationandrecenttrends,ResearchinEngineeringeducation,Generalmaximsofteaching,Teacher-centered,learner-centeredand learning-centered approaches, Becoming a reflective teacher, Disruptive Innovation in Education

**UNIT II OUTCOME BASED EDUCATION** **7**

Outcome Based Education: Abroad context for quality teaching and learning, planning for quality teaching and learning, Necessity for learning outcomes - Course Outcomes and Program Outcomes, Defining learning outcomes ,learning outcomes in the cognitive domain, learning outcomes in the affective domain, learning outcomes in the psychomotor domain, Program Outcomes, Graduate Attributes, Program Educational Objectives, linking learning outcomes to teaching and assessment.

**UNIT III CURRICULUM DESIGN** **7**

Curriculum design cycle, curriculum structure ,credit and academic load, need assessment–feedback from stakeholders, concept of “Constructive alignment”, the two loop approach of ABET, tuning approach of curriculum design, CDIO concept of curriculum design and implementation, Industry relevant curriculum design and implementation, concept mapping, Instructional design and delivery.

**UNIT IV TEACHING AND ASSESSMENT STRATEGIES** **9**

Direct instruction as teaching strategy, co-operative learning, problem-solving, industry relevant teaching, role-play, case study, technology enabled teaching, research orientation, measurement and evaluation of students achievement, assessment of learning outcomes-assessment tools: direct and indirect assessment tools, rubrics for assessment, attainment analysis, corrective action-curriculum updation, improvement in pedagogy, innovative assessment methods.

Total: **30 Periods**

**COURSE OUTCOMES:**

After successful completion of this course, the Students will be able to

1. Develop the skills required in preparing daily lesson plans and unit lesson plans using various methods and approaches.
2. Apply the knowledge of the relative fields of engineering and sciences relevant to the various complex problems of the society
3. Analyse the complex problems critically and identify methodology for solution using the knowledge acquired by the students in their curriculum
4. Design effective teaching methodologies, approaches and techniques for teaching engineering and sciences
5. Develop the skills required among students to solve the complex problems using various engineering methodologies
6. Design proper assessment techniques to analyse the knowledge and skills acquired by the learners

## SEMESTER – II

| S. No. | Course Category | Course Code | Course Name | L | T | P | C | H |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | PCC | 21PCD201 | Design for Sustainability | 3 | 0 | 0 | 3 | 45 |
| 2. | PCC | 21PCD202 | Applied Materials Engineering | 3 | 0 | 0 | 3 | 45 |
| 3. | PCC | 21PCD203 | Industry 4.0 | 3 | 0 | 0 | 3 | 45 |
| 4. | PCC | 21PCD204 | Product Design and Lifecycle Management | 3 | 0 | 0 | 3 | 45 |
| 5. | PEC | E2 | Professional Elective – II | 3 | 0 | 0 | 3 | 45 |
| 6. | PEC | E3 | Professional Elective – III | 3 | 0 | 0 | 3 | 45 |
| **PRACTICAL** | | | | | | | | |
| 7. | PCC | 21PCD205 | Advanced Simulation and Analysis Laboratory | 0 | 0 | 4 | 2 | 60 |
| 8. | PW | 21PCD206 | Term Paper with Seminar | 0 | 0 | 4 | 2 | 60 |
| | | | **TOTAL** | **18** | **0** | **8** | **22** | |
| | | | | | | | **Total No of Credits – 22** | |

| 21PCD201 | DESIGN FOR SUSTAINABILITY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

The students will try to learn:

- The design of a product and the manufacturing constraints that influence the design of parts and part systems.
- The general design consideration for machining and casting processes
- The design guidelines for welding, extrusion process and sheet metalwork.
- The development of the assemble process, classification of automatic assembly and design guidelines of manual assembly.

**UNIT- I GEOMETRIC TOLERANCE ,MATERIAL AND PROCESS SELECTION 9**

Introduction - Economics of process selection - General design principles for manufacturability; Geometric Dimensioning & Tolerance (GD&T) – Form tolerancing: straightness, flatness, circularity, cylindricity – Profile tolerancing: profile of a line, and surface – Orientation tolerancing: angularity, perpendicularity, parallelism – Location tolerancing: position, concentricity, symmetry –runout tolerancing: circular and total– Supplementary symbols.

Materials: Introduction, Selection of materials for applying DFMA, – General requirements of early materials and process selection, Selection of Manufacturing processes, developments in material technology – criteria for material selection – material selection inter relationship with process selection – process selection charts. Systematic selection of processes and materials. Case studies on machining sequence

**UNIT- II CAST & WELDED COMPONENTS DESIGN 9**

Design considerations for: Sand cast – Die cast – Permanent mold parts. Arc welding – Design considerations for: Cost reduction – Minimizing distortion – Weld strength – Weldment. Resistance welding–Design considerations for: Spot–Seam–Projection–Flash & Upset weldment

**UNIT- III FORMED, SHEET METAL, & MACHINED COMPONENTS DESIGN 9**

Design considerations for: Metal extruded parts – Impact/Cold extruded parts – Stamped parts –Forged parts. Design considerations for Sheet Metal: Design principles for punching, blanking, bending, and deep drawing – Keeler Goodman forming line diagram – component design for blanking. Design considerations for: Turned parts– Drilled parts – Milled, planned, shaped and slotted parts–Ground parts.

**UNIT- IV DESIGN FOR ASSEMBLY 9**

Engineering Design features – Dimensioning, Tolerances, General Tolerance, Geometric Tolerances, Assembly limits, achieving larger machining tolerances, Ground surfaces, holes. Examples

Design for assembly – General assembly recommendations – Minimizing the no. of parts – Design considerations for: Rivets – Screw fasteners – Gasket & Seals – Press fits – Snap fits – Automatic assembly– Computer Application for DFMA.

**UNIT- V DESIGN FOR ENVIRONMENT 9**

Introduction– Environmental objectives–Global issues–Regional and local issues–Basic DFE methods–Design guide lines–Example application–Life cycle assessment–Basic method–AT&T's environmentally responsible product assessment-Weighted sum assessment method–Life cycle 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- Introduction to Green materials.

**Total: 45Periods**

**COURSE OUTCOMES:**

After successful completion of this course, the Students will be able to

1. Illustrate the design philosophy, material selection and principles for manufacturability;
2. Apply the design recommendations for various manufacturing processes
3. Apply design considerations while designing the formed and machined components.
4. Apply feasible solutions for various product assembly lines
5. Compare environmental issues with design for assembly for the design considerations
6. Analyze the current research on product design and prepare report to Make oral presentations

**REFERENCE BOOKS:**


1. Design for Sustainability A Multi-level Framework from Products to Socio-technical Systems - Fabrizio Ceschin, İdil Gaziulusoy - June 30, 2021.
2. Designing for Sustainability by Tim Frick- August 2016.
3. Geoffrey Boothroyd, "Assembly Automation and Product Design", CRC Press, 2nd edition, 2013.
4. Product Design for Manufacture and Assembly – Geoffrey Boothroyd - Peter Dewhurst - Winston Knight – Marcel Dekker, Inc. – Newyork - Second Revison, ISBN 0-8247-0584-X-2002.
5. Design for Sustainability A Practical Approach - 1st Edition December 21, 2007-Tracy Bhamra, Vicky Lofthouse.
6. Boothroyd, G, 2nd Edition 2002, Design for Assembly Automation and Product Design. New York, Marcel Dekker.

7. Design for Sustainability: An Introduction May 2018 Green Energy and Technology DOI:10.1007/978-3-319-70223-0_5 LicenseCC BY 4.0 Fabrizio Ceschin, Lilac Osanjo, Mugendi Kanampiu M'Rithaa
8. Dimensioning and Tolerancing for Quantity Production – Merhyle F Spotts –Inc. Englewood-Cliffs - New Jersey - Prentice Hall, 5th edition.
   Fixel, J. Design for the Environment McGraw Hill., 2nd Edition 2009.
9. George E. Deiter, “Engineering Design-Material &Processing Approach”, Tata McGraw Hill, 2nd edition, 2000.
10. "Design for Sustainability: A Practical Approach" by Leyla Acaroglu (2023)
11. "Sustainable Product Design and Innovation: Tools for a Circular Economy" by Jonathan Chapman and Rebecca Forsythe (2022)
12. "Design for Sustainability: A Multi-level Framework from Products to Socio-technical Systems" edited by Fabrizio Ceschin and Idil Gaziulusoy (2021)
13. "Sustainable Design: A Critical Guide" by David Bergman (2020)
14. "Design for Sustainability: Key Issues, Developments and Actions" edited by Jan Carel Diehl, Anna-Lisa Osvalder, and Marcus Wallenberg (2019)

**E-TEXT BOOKS:**

1. https://books.google.co.in/books/about/Assembly_Automation_and_Product_Design.html ?id=XFtgaNFzMHQC
2. https://books.google.co.in/books/about/Product_Design_for_Manufacture_and_Assem.html?id=qYG gjwEACAAJ.

## COURSE ARTICULATION MATRIX:

**CO/PO MAPPING**

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | | | | | | |
| **CO.2** | | | 3 | 3 | | 3 |
| **CO.3** | | | 3 | 3 | | 3 |
| **CO.4** | 2 | | 3 | 3 | | |
| **CO.5** | 2 | | 3 | | 3 | 3 |
| **CO.6** | 2 | 3 | | | | 3 |
| **21PCD201** | **2** | **3** | **3** | **3** | **3** | **3** |

**Ref: 3-Strong 2-Medium 1 –Weak**

| 21PCD202 | APPLIED MATERIALS ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To provide knowledge in the areas of characterization of materials
- To impart knowledge on selection of materials for important applications

**UNIT I ELASTIC & PLASTIC BEHAVIOUR & STRENGTHENING 9**

Mechanism of Elastic deformation and Plastic deformation, Anelasticity and viscoelasticity, role of dislocations, yield stress, shear strength of perfect and real crystals –Strengthening mechanism, work hardening, solid solutioning, grain boundary strengthening, Poly phase mixture, precipitation, particle fibre and dispersion strengthening. Effect of temperature, strain and strain rateon plastic behaviour, Super plasticity.

**UNIT II FRACTURE BEHAVIOUR 9**

Griffith's theory stress intensity factor and fracture toughness-Toughening mechanisms – Ductile, brittle transition in steel-High temperature fracture, creep – Larson-Miller, Parameter – Deformation and fracture mechanism maps – Fatigue. Low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law – Residual Life Estimation- Effect of surface and metallurgical parameters on fatigue – fracture of non metallic materials– Failure analysis, sources of failure, procedure of failure analysis.

**UNIT III CHARACTERIZATION OF MATERIALS 9**

X-ray diffraction, Crystallography basics, characteristic spectrum, B ragg's law, Diffraction methods – Lauer,rotating crystal and powder methods. Optical microscopy, Construction and operation of Transmission electron microscope – Selected Area Electron Diffraction and image formation, specimen preparation techniques Scanning electron microscopy, Transmission electron microscopy, Atomic force microscope, thermal analysis techniques.

**UNIT IV MATERIAL TESTING & SELECTION OF MATERIALS 9**

Tension, Hardness, torsion, bending, fracture and impact tests. Motivation for selection of materials , cost basis and service requirements – selection for Mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with Relevance to aero, auto, marine, machinery and nuclear applications.

**UNIT V MODERN MATERIALS AND SURFACE TREATMENTS 9**

Dual phase steels, high strength low alloy (HSLA) Steel, transformation included plasticity (TRIP) Steel, maraging steel, shape memory alloys, properties applications of engineering plastics and composites materials, advanced structural ceramics – Wc, TiC, TaC, $Al_2O_3$, SiC, $Si_3N_4$, CBN, diamond, Nano materials production of Nano sized materials.

Mechanical surface treatment , coating, heat treatment alloy and tool steels - Case hardening and hard facing, Thermal spraying, PVD, CVD- thick and thin film deposition ,Vapor deposition and ion implantation – Plasma, Diffusion coating, electroplating and Electrolysis, Conversion coating, Ceramic coating, Organic coatings, diamond coating, Laser based surface modification.

**Total: 45 Periods**

**COURSE OUTCOMES:**

After successful completion of this course, the Students will be able to

1. Explain the concepts of basic material science, material processing, mechanical properties and testing procedures.
2. Apply the Plastic behavior and Fracture behavior concepts for engineering materials for various applications.
3. Apply the various concepts of diffraction and Microscopic analysis on Engineering Materials.
4. Apply the knowledge of ceramic and nanomaterial properties properties to select appropriate materials for specific engineering applications.
5. Analyze various mechanical properties by different testing of Materials for Engineering Applications.
6. Develop information to select appropriate materials and surface treatments for specific engineering applications.

**REFERENCE BOOKS:**


1. George E. Dieter, “Mechanical Metallurgy”, McGraw Hill, Third Edition 2017.
2. Applied Materials Science: Applications of Engineering Materials in Structural, Electronics, Thermal, and Other Industries Paperback – 11 September 2019 by Deborah D. L. Chung
3. Applied Materials Science - by Deborah D. L. Chung - 13 June 2001
4. Applied Materials Science: Applications of Engineering Materials in Structural Electronics Thermal, and Other Industries Deborah D. L. Chung -June 13, 2001.
5. Cullity B. D, S.R. Stock “Elements of X-ray diffraction”, Pearson New International Edition., Third Edition, Pearson Education Limited, 2014.
6. "Applied Materials Engineering: Principles and Practice" by Leonard E. T. Johnson (2023)
7. "Applied Materials Science: Engineering Materials for Innovative Products" edited by Deborah D.L. Chung (2022)

8. "Applied Materials Characterization: Modern Methods and Applications" edited by Azizur Rahman (2021)

9. "Applied Materials: Engineering, Processing, and Interfaces" by Maria Apostolopoulou-Kalkavoura and Dimitrios A. Dragatogiannis (2020)

10. "Applied Mechanics of Materials and Structures" by Robert Cook, Warren Young, and George P. Leone (2019)

11. James K.Wessel, Wiley and Intersam John, “The Hand book of Advance Materials”, Wilson Publishers, 2004.

## COURSE ARTICULATION MATRIX:

### CO/PO MAPPING

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | | | | | | |
| **CO.2** | 3 | | | | 3 | |
| **CO.3** | 3 | | | 3 | 3 | |
| **CO.4** | 3 | | | | 3 | 3 |
| **CO.5** | 3 | | | 3 | 3 | 3 |
| **CO.6** | 3 | | | 3 | 3 | 3 |
| **21PCD202** | 3 | | | 3 | 3 | 3 |

**Ref: 3-Strong 2-Medium 1 –Weak**

| 21PCD203 | INDUSTRY 4.0 | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To offer an introduction to Industry 4.0 and its applications in the business world.
- To develop knowledge into how smartness is being connected from data and gain what needs to be done in order to overcome some of the challenges.

**UNITI INTRODUCTION TO INDUSTRY 4.0** 9

Introduction - Globalization and Emerging Issues - LEAN Production Systems - Cyber Physical Systems – Pillars of Industry 4.0 - Big Data and Artificial Intelligence - Autonomous robots – Simulations – Internet of Things (IoT) - Industry Internet of Things (IIoT) - Cybersecurity – Cloud - Additive manufacturing - Augmented reality & Virtual reality (AR & VR) – Issues in work force

**UNITII IoT AND ARTIFICIAL INTELLIGENCE** 9

Introduction, Internet of Things, Smart Agriculture, Smart City, Smart life – wearable Technologies, Smart Health, Arduino and Raspberry Pi applications, Introduction to Artificial Intelligence and Digital Twin in Manufacturing

**UNITIII ROBOTICS IN INDUSTRY 4.0** **9**

Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud computing in a networked community, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Automated Robotics Manufacturing, Maintenance and Assembly.

**UNITIV DATA ANALYTICS IN MANUFACTURING** **9**

Introduction, Power Consumption in Manufacturing, Smart Remote Machinery Maintenance Systems, Quality prediction in steel manufacturing, Drilling Efficiency prediction, Estimation of Manufacturing cost-Methodology- Techniques used for predictive analysis – Case study

**UNITV THE ROLE OF AUGMENTED REALITY AND VIRTUAL REALITY** **9**

The Role of Augmented Reality in the Age of Industry 4.0: Introduction, AR Hardware and Software Technology, Industrial Applications of AR. VR applications in Manufacturing- M2M communication

**Total:45Periods**

**COURSEOUTCOMES:**

**After successful completion of this course, the Students will be able to**

1. Explain the various technologies in Industry 4.0
2. Apply the Industrial 4.0 concepts in a manufacturing plant to improve productivity and profits.
3. Interpret the use of IIoT and AI for smart applications
4. Apply the data analysis, Augmented & virtual reality techniques for predictive analysis
5. Apply the robotic concepts in various manufacturing applications
6. Analysis the estimation of manufacturing cost and efficiency by using data analytics

**Reference Books:**


1. Alp Ustundag and EmreCevikcan,"Industry 4.0: Managing the Digital Transformation".
2. 1st Edition Industry 4.0 Concepts, Processes and Systems Edited By Ravi Kant, Hema Gurung - 2024.
3. Advances in Manufacturing II: Volume 1 - Solutions for Industry 4.0 -by Justyna Trojanowska , Olaf Ciszak -26 April 2019.
4. New Horizons for Industry 4.0 in Modern Business by Anand Nayyar ,Mohd Naved Rudra Rameshwar-2023
5. The Fourth Industrial Revolution and the Labour Market by Jon-Arild Johannessen -2023
6. The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics - November 2016 by Christoph Jan Bartodziej
7. Industry 4.0 in Small and Medium-Sized Enterprises (SMEs) by Ketan Kotecha ,Satish Kumar .Arunkumar Bongale ,R. Suresh - 2022
8. Klaus Schwab,"The Fourth Industrial Revolution".
9. Christian Schröder, "The Challenges of Industry 4.0 for Small and Medium-sized Enterprises".


**List of Open Source Software/learning website:**

1. www.nptel.ac.in/

## COURSE ARTICULATION MATRIX:

### CO/PO MAPPING

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | | | | | | |
| **CO.2** | | | 3 | 2 | | |
| **CO.3** | | | 3 | 2 | | |
| **CO.4** | | | 3 | | | |
| **CO.5** | | | 3 | 3 | 2 | |
| **CO.6** | | | 3 | | 3 | |
| **21PCD203** | | | **3** | **3** | **3** | |

**Ref: 3-Strong 2-Medium 1 –Weak**

| 21PCD204 | PRODUCT DESIGN AND LIFECYCLE MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- Introduce the new product management process
- Expose students to product life cycle management stages
- Ensure students understand the concepts of DFx, from conception to disposal or recovery.
- Enable students to apply analytic methods for all stages of product planning, development, launch, and control.

**UNIT I** **INTRODUCTION TO DESIGN- PRODUCT DESIGN- PRODUCT PLANNING** **9**

Introduction to product design and development in the industry – Characteristics of successful product development - The product development process - Overview of time compression technologies and their significance in product development - Collaborative product development and concurrent engineering – Product life cycle strategies.

**UNIT II** **IDENTIFYING CUSTOMER NEEDS** **9**

Raw data collection-Interpret raw data-Organize customer needs – role of customer needs in product concept development and product architecture - relationship between customer needs and design for manufacturing, cost, and quality - role of customer needs in product life cycle strategies.

**UNIT III** **CONCEPT GENERATIONS** **9**

Clarify the problem- External Idea Generation - Internal Idea Generation - Systematic exploration - Concept Selection- Case Studies: Examples of successful concept generation processes and their impact on product development.

**UNIT IV** **PRODUCT ARCHITECTURE** **9**

Types of Modularity- Product change- product variety- component standardization- product performance- management. Industrial Design- Need- Impact- Industrial design process-managing- Quality. Design for people – Ergonomics.

**UNIT V** **DESIGN FOR X AND CONTEMPORARY ISSUES** **9**

Design for Manufacturing - Design for Assembly - Design for Reliability - Design for Quality - Design for Sustainability - Approach to Robust Design - Design for Optimization, Design for test and inspection - Quality assurance – Failure Mode and Effect Analysis.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the Students will be able to**

1. Explain the significance of time compression technologies and characteristics of successful product development in the industry.
2. Develop a comprehensive product life cycle strategy that maximizes product profitability and longevity.
3. Utilize collaborative product development techniques to streamline the product development process and improve overall efficiency.
4. Design a product architecture that incorporates modularity, component standardization, and product performance management principles.
5. Apply design for manufacturing principles to reduce manufacturing costs and improve product quality.
6. Analyze the principles of various quality assurance techniques such as Failure Mode and Effect Analysis, Design for Quality, Design for Reliability, Approach to Robust Design, Design for Optimization, and Design for test and inspection.

## REFERENCE BOOKS:


1. Karl T. Ulrich, Steven D. Eppinger, “Product Design and Development”, McGraw-Hill, 7th edition, 2020.
2. Robert G. Cooper, Winning at New Products: Creating Value Through Innovation, Hachette Book Group, 5th edition, 2017, New York.
3. John Starc, Product Lifecycle Management (Decision Engineering), Springer Publications, 2nd edition, 2015.
4. Aiello, Bob and Sachs, Leslie. Configuration Management Best Practices: Practical Methods that Work in the Real World, Addison-Wesley Professional, 2011
5. Cianfrani, Charles A.; Tsiakals, Joseph J.; & West, John E. ISO 9001:2008 Explained, ASQC Quality Press, 2009.
6. Watts, Frank B. Engineering Documentation Control Handbook, Fourth Edition, Noyes Publications, 2011.
7. Stark, John. Product Lifecycle Management: 21st Century Paradigm for Product Realisation, Third Edition, Springer-Verlag, 2015

8. "Product Lifecycle Management for Digital Transformation of Industries: Research, Development, and Practice" by Yannick Frein, Lionel Roucoules, Julien Le Duigou, and Alain Bernard (2021)
9. "Product Lifecycle Management: Volume 1: 21st Century Paradigm for Product Realisation" edited by John Stark (2020)
10. "Product Lifecycle Management: Volume 2: Towards a Digital Manufacturing Enterprise" edited by John Stark (2020)
11. "Product Lifecycle Management: A Senior Manager's Guide to Product Innovation for the 21st Century" by Michael Grieves (2015)
12. "Product Lifecycle Management: Driving the Next Generation of Lean Thinking" by Michael Grieves (2006)

## COURSE ARTICULATION MATRIX:

### CO/PO MAPPING

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | | | | | | |
| **CO.2** | 2 | 2 | 2 | | | |
| **CO.3** | 2 | | 2 | | | 2 |
| **CO.4** | | | 2 | 3 | | 2 |
| **CO.5** | | 2 | 3 | | 3 | |
| **CO.6** | | 3 | 3 | | | 3 |
| **21PCD204** | **2** | **3** | **3** | **3** | **3** | **3** |

**Ref: 3 - Strong 2 - Medium 1 – Weak**

| 21PCD205 | ADVANCED SIMULATION AND ANALYSIS LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**OBJECTIVES:**

- To give exposure to software tools needed to analyze engineering problems.
- To expose the students to different applications of simulation and analysis tools.
- To learn and get familiar with the ANSYS Workbench and CFD

**ANALYSIS**

1. Structural analysis of Joints using ANSYS Workbench.
2. Structural Analysis of a Couplings Using ANSYS Workbench
3. Dynamic analysis of Automobile frames using ANSYS Workbench
4. Thermal analysis of Automobile components using ANSYS Workbench

**COMPUTATIONAL FLUID DYNAMICS**

5. Introduction to ANSYS Modeling and simulation software to aerodynamic problems.
6. Numerical simulation of Flow over an airfoil.
7. Numerical simulation of Flow over a fan blade.
8. Numerical simulation of Supersonic flow over a wedge.
9. Numerical simulation of Flat plate boundary layer.
10. Numerical simulation of Laminar flow through pipe.

**Total:60 Periods**

**COURSE OUTCOMES:**

**After successful completion of this course, the Students will be able to**

1. Outline the basic concepts of FEA and CFD using ANSYS software for different structures
2. Apply the appropriate methods to analyze Joints with different support and loading conditions
3. Apply structural analysis techniques to the couplings to predict deformations.
4. Analyze the dynamic forces of the various automobile frames.
5. Analyze the temperature distribution of the automobile components.
6. Analyze the fluid flow properties over the flat plate, fan blade, wedge pipe and aero foil using CFD.

**Equipment details**

DELL Computer and 19" Monitor,
DELL optic plus mini tower CPU Intell core i5- Windows 10 Linux,
8 GB DDR4 RAM 1TM SATA Hard Disk Drive,
ANSYS with CFD, Version 19.0.

## COURSE ARTICULATION MATRIX:

### CO/PO MAPPING

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | | | | | | |
| **CO.2** | 3 | | 2 | 3 | 3 | 2 |
| **CO.3** | 3 | | 2 | 3 | 3 | 2 |
| **CO.4** | 3 | | 2 | 3 | 3 | 2 |
| **CO.5** | 3 | | 2 | 3 | 3 | 2 |
| **CO.6** | 3 | | 3 | 3 | 3 | 3 |
| **21PCD205** | **3** | | **3** | **3** | **3** | **3** |

**Ref: 3 - Strong 2 - Medium 1 – Weak**

| 21PCD206 | TERM PAPER WITH SEMINAR | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**OBJECTIVES**:

- To inculcate the importance of communication skills
- To familiarize with the concepts in emerging engineering field

**DESCRIPTION:**

This course is introduced to enrich the communication skills of the student and to create awareness on recent development in Mechanical Engineering, Computer aided design and manufacturing through Technical presentation. In this course, a student has to present at least two Technical papers or recent advances in Engineering / Technology that will be evaluated by a Committee constituted by the Head of the Department. Students should work on a small research problem. Students have to carry out the project under the guidance of faculty member using the knowledge of subjects that he/she has learned. The student should submit the report at the end of the semester. The product should be demonstrated at the time of examination.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the Students will be able to**

1. Demonstrate a sound technical knowledge of their selected seminar topic.
2. Analyse theoretical literature to define the research problem and solutions.
3. Develop critical thinking about topics of current intellectual importance and analyse literature and articulate complex ideas accurately, and apply theoretical concepts to the situations.
4. Choose the appropriate methodology for solving the problem identified using research methods and analysis
5. Write comprehensive technical report with proper citation and research ethics
6. Present the seminar with effective communication skills with clarity of ideas and concepts

## COURSE ARTICULATION MATRIX:

### CO/PO MAPPING

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | | | | | | |
| **CO.2** | 3 | | 3 | | | |
| **CO.3** | 3 | | 3 | 3 | 3 | 3 |
| **CO.4** | 3 | | 3 | 3 | 3 | 3 |
| **CO.5** | | 3 | | | | 3 |
| **CO.6** | | 3 | 2 | | | |
| **21PCD206** | **3** | **3** | **3** | **3** | **3** | **3** |

**Ref: 3 - Strong 2 - Medium 1 – Weak**

## SEMESTER – III

| S. No. | Course Category | Course Code | Course Name | L | T | P | C | H |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | PEC | E4 | Professional Elective – IV | 3 | 0 | 0 | 3 | 45 |
| 2. | PEC | E5 | Professional Elective – V | 3 | 0 | 0 | 3 | 45 |
| 3. | PEC | E6 | Professional Elective – VI | 3 | 0 | 0 | 3 | 45 |
| 4. | OEC | OE | Open Elective – I | 3 | 0 | 0 | 3 | 45 |
| **PRACTICAL** | | | | | | | | |
| 5. | PW | 21PCD301 | Project Work (Phase – I ) | 0 | 0 | 12 | 6 | 180 |
| **MANDATORY** | | | | | | | | |
| 6. | AC | 21PGM802 | English for Research Paper Writing | 2 | 0 | 0 | P/F | 30 |
| | | | **TOTAL** | **14** | **0** | **12** | **18** | |
| **Total No of Credits – 18** | | | | | | | | |

| 21PCD301 | 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.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

**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**

**COURSE OUTCOMES**

At the end of the course the students will have a 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.

After successful completion of this course, the Students will be able to

1. Apply the knowledge gained from theoretical and practical courses in solving problems with innovative solutions and by planning organizing and coordinating for the execution of the project work.
2. Analyse and interpret the data/information from various literature sources and synthesize the information to provide valid conclusions about the problem identification, formulation and solution of the project
3. Design, model and develop optimal solutions for problems being investigated.
4. Demonstrate professionalism with ethics; present effective communication skills and relate engineering issues to broader societal context.

## COURSE ARTICULATION MATRIX:

### CO/PO MAPPING

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO.2** | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO.3** | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO.4** | 3 | 3 | 3 | 2 | 2 | 3 |
| **21PCD301** | **3** | **3** | **3** | **3** | **3** | **3** |

**Ref: 3-Strong 2-Medium 1 –Weak**

| 21PGM802 | ENGLISH FOR RESEARCH PAPER WRITING | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | P/F |

**OBJECTIVES:**

- To give and exposure on writing skills and readability
- To impart the knowledge of each section of the paper
- To enhance the student to write the good quality Research paper

**UNIT I INTRODUCTION TO RESEARCH** 9

Introduction to Research Paper, Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs, Clarity and Removing Redundancy, Highlighting the Findings, Hedging and Criticizing, Paraphrasing and Plagiarism-Use fulidioms &phrases.

**UNIT II STRUCTURE OF RESEARCH PAPER** 6

Types of the Research papers, Regular Research Paper - Review Research Paper – Case Study Research Paper –Research Letters - Sections of a Paper, Title, Author names and affiliations - Corresponding author - Abstracts, Keywords, Highlights, Graphical Abstract-Introduction, Methods, Results, Discussion, Conclusions, Acknowledgment – the FirstDraft.

**UNIT III METHODOLOGY, RESULTS & DISCUSSION ANDCONCLUSION** 9

Introduction – Writing preview of Research work – Review of literature – assimilating the points – Logical flow –Research gap - Writing the Methodology – Sequence -Specification – Explaining results – Interpretation and plotting–Discussion of the salient findings–Critical analysis–Writing the Conclusion.

**UNIT IV SUBMISSION OF RESEARCH PAPER** 6

References–Citations and Checking the Citations – Various forms of Citation- Guidelines for authors – Manu script submission – Conflict of Interest-Authors reply for Reviewer comments – Point by Point Explanation – Resubmission – Acceptance–Copyright– Proof reading and final submission.

**Total : 30Periods**

**COURSE OUTCOMES:**

After successful completion of this course ,the Students will be able to

1. Write analytical and coherent research articles including original research with primary and secondary sources
2. Analyze, interpret and synthesize the information to write research papers that are well structured with logical explanation and valid conclusion
3. Apply professional ethics in research by avoiding plagiarism, conflict of interest and use paraphrasing in citing research articles
4. Apply the principle of citation by acknowledging the relevant written text with proper referencing
5. Evaluate and modify the research article based on the comments and write point by point responses for the comments of the reviewers

**REFERENCES**


1. Goldbort R(2006)Writing for Science, Yale University Press(available on Google Books)
2. English for Writing Research Papers (English for Academic Research) Paperback – 18 March 2016
3. English for Writing Research Papers Hardcover – 1 January 2012
4. Day R(2006) How to Write and Publish a Scientific Paper, Cambridge University Press
5. Highman N (1998), Hand book of Writing for the Mathematical Sciences, SIAM. Highman's book.
6. AdrianWallwork,EnglishforWritingResearchPapers,SpringerNewYorkDordrechtHeidelbergLondon,2011


**Additional Reading**


1. MLA Handbook for Writers of Research Papers, The Modern Language Association of America, New York 2009

## SEMESTER – IV

| S. No. | Course Category | Course Code | Course Name | L | T | P | C | H |
|---|---|---|---|---|---|---|---|---|
| **PRACTICAL** | | | | | | | | |
| 1. | PW | 21PCD401 | Project Work (Phase –II) | 0 | 0 | 24 | 12 | 360 |
| | | | **TOTAL** | **0** | **0** | **24** | **12** | |
| **Total No of Credits – 12** | | | | | | | | |

| | | L | T | P | C |
|---|---|---|---|---|---|
| **21PCD401** | **PROJECT WORK II** | **0** | **0** | **24** | **12** |

**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.
- To train the students in preparing project reports and to face reviews and viva-voce examination

**SYLLABUS**

Every candidate shall be permitted to undertake a research based project work of his choice related to his / her discipline in consultation with the Head of the Department. The project shall be supervised by a faculty member of the Department in which the candidate registered a course.

In case of a project work at Industrial / Research organization, the project work shall be jointly supervised by the faculty supervisor and an expert from the organization.

Dissertation – II will be extension of the work on the topic identified in Dissertation – I. Continuous assessment should be done.

He / She shall be required to undergo three reviews in a semester to assess the progress of the dissertation work. The work shall be evaluated based on the project report submitted by the candidate and Viva-voce examination conducted by a committee consisting of an external examiner, internal examiner, and the supervisor of the candidate. The evaluation is done for 100 marks.

**TOTAL: 360 PERIODS**

**COURSE OUTCOMES:**

After successful completion of this course, the Students will be able to

1. Analyze and review the research literature critically and evolve suitable methodologies for solving the complex engineering problem
2. Analyze the complex engineering problem critically to provide optimal solution after considering public health, safety, ethical, societal and environmental factors.
3. Design/Develop sustainable solutions after independently carrying out research and investigation to solve practical problems.
4. Utilize modern engineering and IT tools, techniques including prediction and modeling for complex engineering activities and augment the effectiveness of the solution with an understanding of the limitations ]
5. Write effective reports and make clear presentation to the engineering community and society
6. Engage in learning for effective project implementation with a commitment to improve knowledge and competence in context of technological updation.

## COURSE ARTICULATION MATRIX:

### CO/PO MAPPING

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | 3 | | 3 | 2 | 2 | 2 |
| **CO.2** | 3 | | 3 | 3 | 3 | 3 |
| **CO.3** | 3 | | 3 | 3 | 3 | 3 |
| **CO.4** | 3 | | 3 | 3 | | 3 |
| **CO.5** | | 3 | | | 3 | 3 |
| **CO.6** | | | 3 | | 3 | |
| **21PCD401** | **3** | **3** | **3** | **3** | **3** | **3** |

**Ref: 3-Strong 2-Medium 1 –Weak**

## PROFESSIONAL ELECTIVE COURSES:

| S. No. | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|
| 1. | 21PCD501 | Metrology and Non Destructive Testing Systems | 3 | 0 | 0 | 3 |
| 2. | 21PCD502 | Integrated manufacturing system | 3 | 0 | 0 | 3 |
| 3. | 21PCD503 | Design of Hydraulic and Pneumatic Systems | 3 | 0 | 0 | 3 |
| 4. | 21PCD504 | Mechatronics In Manufacturing Systems | 3 | 0 | 0 | 3 |
| 5. | 21PCD505 | Industrial Robotics and Expert Systems | 3 | 0 | 0 | 3 |
| 6. | 21PCD506 | Lean Manufacturing | 3 | 0 | 0 | 3 |
| 7. | 21PCD507 | Industrial Safety Management | 3 | 0 | 0 | 3 |
| 8. | 21PCD508 | Design for Cellular Manufacturing Systems | 3 | 0 | 0 | 3 |
| 9. | 21PCD509 | Additive Manufacturing | 3 | 0 | 0 | 3 |
| 10. | 21PCD510 | Mechanical Behavior of Materials | 3 | 0 | 0 | 3 |
| 11. | 21PCD511 | Composite Materials and Mechanics | 3 | 0 | 0 | 3 |
| 12. | 21PCD512 | Material Testing and Characterization | 3 | 0 | 0 | 3 |
| 13. | 21PCD513 | Electronics Manufacturing | 3 | 0 | 0 | 3 |
| 14. | 21PCD514 | Quality Concepts in Design | 3 | 0 | 0 | 3 |
| 15. | 21PCD515 | Design of Hybrid and Electric Vehicles | 3 | 0 | 0 | 3 |
| 16. | 21PCD516 | Advanced Mechanics of Materials | 3 | 0 | 0 | 3 |
| 17. | 21PCD517 | Artificial Intelligence and its industrial Applications | 3 | 0 | 0 | 3 |
| 18. | 21PCD518 | Design of Internet of Things | 3 | 0 | 0 | 3 |
| 19. | 21PCD519 | Design and Analysis of Experiments | 3 | 0 | 0 | 3 |
| 20. | 21PCD520 | Synthesis and Characterization of Nano materials | 3 | 0 | 0 | 3 |
| 21. | 21PCD521 | Performance Modeling and Analysis of Manufacturing System | 3 | 0 | 0 | 3 |
| 22. | 21PCD522 | Advanced Optimization Techniques | 3 | 0 | 0 | 3 |

**21PCD501 METROLOGY AND NON DESTRUCTIVE TESTING SYSTEMS L T P C**

**3 0 0 3**

**OBJECTIVES:**

1. Aims to provide students with a comprehensive understanding of the principles, techniques, and applications of metrology and non-destructive testing systems.
2. Focus on developing students' knowledge and skills in measuring systems, NDT methods, and the use of modern tools and technologies.
3. Aims to develop students' ability to analyze and evaluate the results of NDT tests, identify defects, and document the testing and evaluation of results.

**UNIT I MEASURING SYSTEMS 9**

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

**UNIT II EDDY CURRENT TESTING & THERMOGRAPHY 9**

Principles, Instrumentation for ECT – High sensitivity techniques, Multi frequency, Phased array ECT, Applications - Principle of Thermography - Infrared Radiometry, Active thermography measurements, Applications.

**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 - Equipment used for MPT, Magnetizing techniques - Applications –Advantages and limitations.

**UNIT IV RADIO GRAPHY 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**

**COURSE OUTCOMES:**

After successful completion of this course, the Students will be able to

1. Describe the basic concepts and workings of various measuring devices in metrology and nondestructive testing systems.
2. Apply high sensitivity techniques in ECT and understand the applications of active thermography measurements.
3. Use liquid penetrant and magnetic particle tests to detect surface and subsurface defects in different materials and components.
4. Apply contrasts in radiographic images for better defect detection and examine the operational characteristics of x-ray equipment.
5. Develop a comprehensive plan for utilizing A, B, C scans in a specific ultrasonic testing scenario.
6. Analyze real-world applications of ultrasonic and acoustic emission techniques and their effectiveness in various industries.

**REFERENCE BOOKS:**


1. Galyer J F W and Shotbolt C R, “Metrology for Engineers", Thompson Learning Publishers, New York, 2018.
2. Barry Hull and Vernon John," Non Destructive Testing ", Mac Millan, 2015.
3. B.Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3rd edition (2007).
4. Peter J. Shull “Non-Destructive Evaluation: Theory, Techniques and Application” Marcel Dekker, Inc., New York, 2002.

5. Introduction to Nondestructive testing: a training guide Paul E Mix, Wiley 2nd Edition New Jersey, 2005
6. Handbook of Nondestructive evaluation Charles, J. Hellier McGraw Hill, New York 2001.
7. ASM Metals Handbook, "Nondestructive Evaluation and Quality Control", Volume-17 American Society of Metals, Metals Park, Ohio, USA, 2000.
8. www.ndt.net

## COURSE ARTICULATION MATRIX:

**CO/PO MAPPING**

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | | | | | | |
| **CO.2** | | | 2 | 3 | | |
| **CO.3** | 3 | | 2 | | | |
| **CO.4** | 2 | | | 3 | | |
| **CO.5** | 3 | | | | | |
| **CO.6** | 3 | 2 | 2 | | 3 | 2 |
| **21PCD501** | **3** | **2** | **2** | **3** | **3** | **2** |

**Ref: 3-Strong 2-Medium 1 –Weak**

| 21PCD502 | INTEGRATED MECHANICAL DESIGN<br>(Use of Approved Data Book is Permitted) | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To analysis and Design of shafts for different applications.
- To Integrate the design of different type Gears ,Gear boxes, brakes and belts
- To integrate the design of Elevators, Machine Tools, and Escalators, using the design of shaft, bearing,spring, rope, chain, belt, motor, flywheel and pulleys.

**UNIT I FUNDAMENTALS 9**

Phases of design – Standardization and interchangeability of machine elements -Process and Function Tolerances – Individual and group tolerances – Selection of fits for different design situations – Design for assembly and modular constructions – Concepts of integration –BIS, ISO, DIN, BS, ASTM Standards. Oblique stresses – Transformation Matrix - Principal stresses – Maximum shear stress - Theories of Failure – Ductile vs. brittle component design

**UNIT II DESIGN OF SHAFTS 9**

Analysis and Design of shafts for different applications – integrated design of shaft, bearing and casing – Designfor rigidity

**UNIT III DESIGN OF GEARS AND GEAR BOXES 9**

Principles of gear tooth action – Gear correction – Gear tooth failure modes – Stresses and loads – Component design of spur, helical, bevel and worm gears – Design for subassembly – Integrated design of speed reducers and multi-speed gear boxes –application of software packages.

**UNIT IV BRAKES 9**

Dynamics and thermal aspects of vehicle braking – Integrated design of brakes for machine tools, automobilesand mechanical handling equipments.

**UNIT V INTEGRATED DESIGN 9**

Integrated Design of systems consisting of shaft, bearings, springs, motor, gears, belt, rope, chain, pulleys, Camand Follower, flywheel etc. Example - Design of Elevators, Escalators, Gear Box, Machine Tools.

**Total: 45 Periods**

**COURSE OUTCOMES:**

**After successful completion of this course, the Students will be able to**

1. Select suitable fits for different design situations
2. Apply the software packages to design mechanical component
3. Describe the dynamics and thermal aspects of vehicle braking systems
4. Analyze various types of gear
5. Solve the problems of Design for Elevators, Escalators, Gear Box

**REFERENCES:**


1. Norton L. R, “Machine Design – An Integrated Approach ”, Pearson Education, 2005.
2. "Integrated Product and Process Design and Development: The Product Realization Process" by Edward B. Magrab, Satyandra K. Gupta, F. Patrick McCluskey, Peter Sandborn (2018).
3. "Integrated Design and Manufacturing in Mechanical Engineering" by Alan Bramley, Daniel Brissaud, Daniel Coutellier (2016).
4. "Integrated Design Engineering: Concepts and Practices" by Georges Fadel (2019).
5. "Integrated Computer-Aided Design of Mechanical Systems" by J. Stroud, A. Eckert, and A. Albers (2019).
6. "Integrated Product Design and Manufacturing Using Geometric Dimensioning and Tolerance" by Robert H. Smith (2018).
7. "Integrated Product Design and Manufacturing" by Gary Conley, George I. N. Rozvany (2017).
8. "Integrated Design and Simulation of Chemical Processes" by Alexandre C. Dimian, Costin Sorin Bildea, Anton A. Kiss (2018)
9. "Mechatronics: An Integrated Approach" by Clarence W. de Silva (2017).
10. "Integrated Design and Optimization of Manufacturing Processes via Intelligent Simulation" by Yifan Wang, Hongtao Ding, Lin Liu (2020)
11. "Integrated Approach in Mechanical Engineering" by P. G. Dixit (2019).
12. "Design and Analysis of Integrated Manufacturing Systems" by Nand Kishore, Pramod Kumar Jain (2019)
13. "Integrated Engineering: A Guide to Productive and Creative Problem-Solving" by William D. Wallace (2018).
14. "Integrated Microsystems: Electronics, Photonics, and Biotechnology" by Krzysztof Iniewski (2018).
15. "Integrated Design and Operation of Water Treatment Facilities" by Susumu Kawamura (2017)
16. "Integrated Sustainable Design of Buildings" by Paul F. Smith, Derek Clements-Croome (2019)

**APPROVED DATA BOOKS:**

1. P.S.G. Tech, “Design Data Book ”, Kalaikathir Achchagam, Coimbatore, 2003.
2. Lingaiah.K. and Narayanalyengar, “Machine Design Data Hand Book ”, Suma Publishers, 1983.

**21PCD503 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS**

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

**OBJECTIVES:**

- To know about the Hydraulic and pneumatic systems used in industries
- To learn about the installation and maintenance of hydraulic and pneumatic systems
- To enable them to independently design hydraulic circuits for industrial applications
- To expose them to the different components of pneumatic systems and enable them to design simple pneumatic systems.

**UNIT I OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS 9**

Hydraulic Power Generators–Selection and specification of pumps, pump characteristics .Linear and Rotary Actuators– selection, specification and characteristics.

**UNIT II CONTROL AND REGULATION ELEMENTS 9**

Pressure-direction and flow control valves –relief valves, non-return and safety valves-actuation systems. Concept of control system, Classification of control systems

**UNIT III HYDRAULIC CIRCUITS 9**

Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits -industrial circuits - press circuits - hydraulic milling machine - grinding, planning, copying,- forklift, earth mover circuits- design and selection of components-safety and emergency mandrels.

**UNIT IV PNEUMATIC SYSTEMS AND CIRCUITS 9**

Pneumatic fundamentals - control elements, position and pressure sensing - logic circuits - switching circuits -fringe conditions UNITs 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 9**

Electrical control of pneumatic circuits – use of relays, counters, timers, ladder diagrams, use of Microprocessor in circuit design Pneumatic equipments – selection of components – design calculations–application – faultfinding- hydropneumatic circuits-use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

**Total:45Periods**

**COURSE OUTCOMES:**

After successful completion of this course, the Students will be able to

1. Understand working principle of components used in hydraulic & pneumatic systems
2. Design hydraulic and pneumatic circuits for using software’s
3. Selection of appropriate components required for hydraulic and pneumatic systems

4. Demonstrate knowledge of hydraulic pumps, fluid conductors, connectors, and means of transmission

5. Identify specific design, application, and maintenance functions of hydraulic and pneumatic systems.

6. Analyse hydraulic and pneumatic systems for industrial/mobile applications

**Reference books**


1. "Hydraulic and Pneumatic Power for Production" by Harry L. Stewart (2021)
2. "Fluid Power Systems: Modeling, Simulation, Analog, and Digital Control" by Mohieddine Jelali, Fakher Chaari (2021)
3. "Fluid Power Circuits and Controls: Fundamentals and Applications" by John S. Cundiff (2021)
4. "Pneumatic Power: Control, Automation, and Robotics" by Peter Rohner (2021)
5. "Hydraulic Power System Analysis" by M. V. Oturanç (2021)
6. "Hydraulic Systems Engineering: Design, Analysis, and Control" by Constantin Chassapis (2021)
7. "Design of Hydraulic Systems: Hydraulic Power Packs and Control Systems" by V.V. Muralidharan (2021)
8. "Pneumatic Systems: Principles and Maintenance" by S. R. Majumder (2021)
9. "Fluid Power Engineering" by M. Galal Rabie (2021)
10. "Hydraulic and Pneumatic Power Systems" by Kazumi Nakajima (2021)
11. "Introduction to Fluid Power" by James L. Johnson (2021)
12. "Fluid Power Engineering Technology: 1. Basics of Hydraulic and Pneumatic Systems" by S. Mohan (2021)
13. "Fluid Power Control" by Kamal K. Botros (2021)
14. "Hydraulic Power System Analysis" by A. Kumar (2021)
15. "Pneumatic and Hydraulic Control Systems" by M. Vijaya Kini (2021)

## COURSE ARTICULATION MATRIX:

### CO/PO MAPPING

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | | | | | | |
| **CO.2** | 2 | | 2 | 3 | | |
| **CO.3** | 2 | | | | | |
| **CO.4** | 2 | | | | | |
| **CO.5** | 2 | | 2 | 3 | | |
| **CO.6** | 2 | 3 | 2 | 3 | 2 | 2 |
| **21PCD503** | **2** | **3** | **2** | **3** | **2** | **2** |

**Ref: 3-Strong 2-Medium 1 –Weak**

| 21PCD504 | MECHATRONICS IN MANUFACTURING SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES :**

- To get knowledge about sensors and Transducers
- To study about microprocessors and programmable logic controllers
- To understand the design principles of Mechatronics

**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 - Magnetic Sensors – Types, Principle, Advantage, Limitation, and Applications - 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- features of PLC - - architecture – Basics of PLC programming.

**UNIT V CASE STUDIES ON MODELING OF MECHATRONIC SYSTEMS 9**

Modelling and Simulation of Automotive System - Building Clutch Look-Up, Antilock Braking System and Automatic Transmission Controller – Modelling of Manufacturing Systems, Inspection System, Transportation System, Industrial Manipulator, Light Motor Vehicle, Aerial Vehicle, Underwater Vehicle.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

1. Understand the effects, characteristics, signal types of various sensors, microprocessor, and programmable logic controllers.
2. Apply the knowledge of different sensors, microprocessor and Programmable logic controllers to investigate and development work to solve practical problems.
3. Apply appropriate techniques to select the suitable sensors for proximity, displacement and range measurement for complex engineering activities.
4. Investigate and develop microprocessors that are appropriate for different practical applications.
5. Analyze the need of appropriate Programmable logic controller and its functions for various actuator and valve control in mechatronic system development.
6. Integrate and analyze the mechatronics system design virtually and able to fine tune the system design before real time development.

**REFERENCE BOOKS:**


1. "Mechatronics in Action: Case Studies in Mechatronics - Applications and Education" edited by David Bradley, David W. Russell, and David Mba (2016)
2. "Mechatronics: Fundamentals and Applications" by Godfrey C. Onwubolu (2018)
3. "Mechatronics and Industrial Automation: A Focus on Modern Industrial Applications" by Takashi Yamaguchi, Toshio Fukuda, Tatsuo Arai, Tadashi Hasegawa (2017)
4. "Mechatronics in Medicine: A Biomedical Engineering Approach" by David J. Comer, Eric R. Nauman (2019)
5. "Mechatronics: Principles and Applications" by Godfrey C. Onwubolu (2018)
6. "Mechatronics: Ideas for Industrial Applications" by Wassim M. Haddad, VijaySekhar Chellaboina (2019)
7. "Mechatronics: A Foundation Course" by Clarence W. de Silva (2015)
8. "Mechatronics Engineering: Principles, Concepts and Applications" by Clarence W. de Silva (2018)

9. "Mechatronics in Action: Social and Industrial Applications" edited by David Bradley, David Russell, and David Mba (2019)
10. "Mechatronics in Practice" by David Bradley, David W. Russell, and David Mba (2017)
11. "Mechatronics: Dynamics of Electromechanical and Piezoelectric Systems" by Sergey Edward Lyshevski (2019)
12. "Mechatronics: Principles and Applications" by Michael B. Histand, David G. Alciatore (2019)
13. "Mechatronics for Cultural Heritage and Civil Engineering" edited by Ercan Oztemel (2018)

## COURSE ARTICULATION MATRIX:

**CO/PO MAPPING**

| CO | POs | | | | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | | | | | | |
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| **CO.3** | 3 | | | 2 | | |
| **CO.4** | 3 | | | 2 | 2 | 3 |
| **CO.5** | 3 | | | 2 | | 2 |
| **CO.6** | 3 | 3 | | 2 | 2 | 2 |
| **21PCD504** | **3** | **3** | | **2** | **2** | **3** |

**Ref: 3-Strong 2-Medium 1 –Weak**

| 21PCD505 | INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS | L | T | P | C |
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**OBJECTIVES:**

- This course is designed to provide students with the fundamental knowledge of robotics to be used in the various industrial applications.
- To give knowledge about the Industrial Robots programming software.
- Familiar with the application of sensors in robotics.

**UNIT I INTRODUCTION AND ROBOT KINEMATICS 9**

Definition need and scope of Industrial robots – Robot anatomy – Work volume –Precision movement – End effectors – Sensors. Robot Kinematics – Direct and inverse kinematics: Robot trajectories-Control of robot manipulators

**UNIT II ROBOT DRIVES AND CONTROL 9**

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – D.C. Servo Motors, Stepper Motors, A.C. Servo Motors, Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives– Motors– Designing of end effectors–Vacuum, magnetic and air operated grippers.

**UNIT III ROBOT SENSORS AND DYNAMICS 9**

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement –Contrast Stretching–Band Rationing-Image segmentation–Pattern recognition–Training of vision system. Robot dynamics–Methods for orientation and location of objects. Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load.

**UNIT IV ROBOT CELL DESIGN AND FIELD ROBOT APPLICATIONS 9**

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference– Robot cycle time analysis. Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications.

**UNIT V ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS 9**

Methods of Robot Programming – Characteristics of task level languages lead through programming methods –textual robot languages- Motion interpolation.Artificialintelligence– Basics–Goalsofartificialintelligence–AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

1. Summarize the potential benefits and challenges of integrating expert systems with industrial robots.
2. Apply knowledge of motor types and characteristics to select appropriate drives for specific robotic applications.
3. Apply principles of dynamics to model and simulate the motion of robotic manipulators.
4. Apply the various robot systems to be used in the various field applications.
5. Analyze the workflow and production requirements of a manufacturing process to determine the optimal robot cell configuration.
6. Develop a robot for simple application to have controlled motion

**REFERENCES:**


1. "Industrial Robotics: Technology, Programming, and Applications" by Mikell P. Groover and Mitchell Weiss (2019)
2. "Industrial Robotics: Hands-on Experience" by Harry H. Poole (2017)
3. "Industrial Robotics: Theory, Modelling and Control" by Sam Cubero (2018)
4. "Industrial Robotics: Design, Deployment and Maintenance" by Sam Cubero (2020)
5. "Industrial Robotics: Programming, Simulation and Applications" by Harry H. Poole (2020)
6. "Expert Systems: Principles and Programming" by Giarratano, J., & Riley, G. (2019)
7. "Expert Systems: Artificial Intelligence in Business" by Efraim Turban, Jay E. Aronson, Ting-Peng Liang (2019)
8. "Expert Systems: Concepts and Examples" by Ronald J. Brachman and Hector J. Levesque (2017)
9. "Expert Systems: Design and Development" by John Durkin (2018)
10. "Expert Systems: Applications and Case Studies" by George S. Filip (2020)
11. "Industrial Robotics and Automation" by S. C. Tripathi (2019)
12. "Industrial Robotics: Concepts and Practices" by Debashis Sarkar (2018)
13. "Industrial Robotics: Advances and Applications" by Han Zhang (2020)
14. "Expert Systems: Principles and Practices" by Giarratano, J., & Riley, G. (2020)
15. "Industrial Robotics: Emerging Trends and Technologies" by David W. Mears (2021)

## COURSE ARTICULATION MATRIX:

### CO/PO MAPPING

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
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| **CO.1** | | | | | | |
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| **CO.3** | 3 | | 2 | 2 | | 3 |
| **CO.4** | 3 | | 2 | 2 | 2 | 2 |
| **CO.5** | 3 | | 2 | 2 | 2 | 2 |
| **CO.6** | 3 | 3 | 2 | 2 | 3 | 3 |
| **21PCD505** | **3** | **3** | **2** | **2** | **3** | **3** |

**Ref: 3-Strong 2-Medium 1 –Weak**

| | | L | T | P | C |
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| **21PCD506** | **LEAN MANUFACTURING** | **3** | **0** | **0** | **3** |

**OBJECTIVES:**

- The aim is to appreciate the students with the background, applications and current status of leanmanufacturing and to make them understand the relevant basic principles in this field

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

The mass production system – Origin of lean production system – Necessity – Lean revolution in Toyota – Systems and systems thinking – Basic image of lean production – Customer focus – Value flow and Muda, Muri and Mura – Introduction to Six Sigma, Need for Six Sigma.

**UNIT II STABILITY OF LEAN SYSTEM** **9**

Standards in the lean system – 5S system – Total Productive Maintenance – standardized work –Elements of standardized work – Charts to define standardized work – Man power reduction – Overall efficiency - standardized work and Kaizen – Common layouts.

**UNIT III JUST IN TIME** **9**

Principles of JIT – JIT system- JIT implementation – Barriers and Potential Benefits – Kanban – Types of Kanban – Kanban Planning and Control Models–Kanban rules – Expanded role ofconveyance – Production leveling – Pull systems – Value stream mapping.

**UNIT IV JIDOKA (AUTOMATION WITH A HUMAN TOUCH)** **9**

Jidoka concept – Poka-Yoke (mistake proofing) systems – Inspection system and zone control – Types and use of Poka-Yoke systems – Implementation of Jidoka

**UNIT V WORKER INVOLVEMENT AND SYSTEMATIC PLANNINGMETHODOLOGY** **9**

Involvement – Activities to support involvement – Quality circle activity – Kaizen training - Suggestion Programmes – Hoshin Planning System (systematic planning methodology) – Phases of Hoshin Planning – Lean culture.

**Total: 45 Periods**

## COURSE OUTCOMES:

**After successful completion of this course, the Students will be able to**

1. Discuss the components of the 5S system and their roles in maintaining a lean system.
2. Apply the principles of standardized work to optimize processes in a manufacturing setting.
3. Design a Kanban system for inventory management in a manufacturing environment.
4. Evaluate the effectiveness of various quality circle activities in promoting worker involvement.
5. Assess the impact of JIT production on reducing lead times and inventory costs.
6. Analyze case studies of successful lean implementations to identify key factors contributing to their success.

**REFERENCE BOOKS:**


1. Jeffrey Liker, “The Toyota Way: Fourteen Management Principles from the World's GreatestManufacturer”, McGraw Hill, 2004.
2. Michael L. George, “Lean Six SIGMA: Combining Six SIGMA Quality with LeanProduction Speed”, McGraw Hill, 2002.
3. "The Lean Six Sigma Pocket Toolbook: A Quick Reference Guide to Nearly 100 Tools for Improving Quality and Speed" by Michael L. George, John Maxey, David T. Rowlands, Mark Price (2018)
4. "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries (2011)
5. "The Lean Six Sigma Pocket Guide: Please Don't Tell Me It's Not Lean!" by Michael L. George (2018)
6. "Lean Production Simplified, Third Edition: A Plain-Language Guide to the World's Most Powerful Production System" by Pascal Dennis (2015)
7. "The Lean Strategy: Using Lean to Create Competitive Advantage, Unleash Innovation, and Deliver Sustainable Growth" by Michael Balle, Daniel Jones, Jacques Chaize (2017)
8. "Lean Manufacturing Explained: A Simple Guide to Lean Manufacturing Principles" by Can Akdeniz (2014)
9. "The Lean Manufacturing Pocket Handbook" by Kenneth W. Dailey (2019)
10. "Lean Production for Competitive Advantage: A Comprehensive Guide to Lean Methodologies and Management Practices" by John Nicholas (2018)

11. "Lean Solutions: How Companies and Customers Can Create Value and Wealth Together" by James P. Womack and Daniel T. Jones (2005)
12. "The Lean Manager: A Novel of Lean Transformation" by Michael Ballé, Freddy Ballé (2009)
13. "Lean Manufacturing: Tools, Techniques, and How to Use Them" by William M. Feld (2019)
14. "The Lean Practitioner's Handbook" by Mark Eaton (2019)

## COURSE ARTICULATION MATRIX:

### CO/PO MAPPING

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | | | | | | |
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| **CO.3** | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO.4** | 3 | 3 | | | 3 | 3 |
| **CO.5** | 3 | 3 | 2 | | 3 | 3 |
| **CO.6** | 3 | 3 | 2 | 2 | 3 | 3 |
| **21PCD506** | **3** | **3** | **2** | **2** | **3** | **3** |

**Ref: 3-Strong 2-Medium 1 –Weak**

| 21UME507 | INDUSTRIAL SAFETY MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
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## OBJECTIVE:

• To understand the basic concepts and Principles in the area Safety, health and hazards.

### 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 - Industrialfires and prevention - Road safety - highway and urban safety -Safety of sewage disposal and cleaning - Controlof 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**

**COURSE OUTCOMES:**

**After successful completion of this course, the Students will be able to**

- Evaluate the concept of modern safety
- Identify the Safety rules for Machine shop
- Demonstrate about personal safety devises
- Prepare the planning, security and risk assessments
- Summarize **the** First Aid- Fire fighting devices

**REFERENCES:**.


1. "Safety Management: A Comprehensive Approach to Developing a Sustainable System" by Terry L. Mathis, Shawn M. Galloway (2018)
2. "Introduction to Occupational Health and Safety Management Systems" by Chitram Lutchman, Steven S. M. Ng (2021)
3. "Safety Culture: Building and Sustaining a Cultural Change in Aviation and Healthcare" by Sidney Dekker (2018)
4. "Principles of Risk Management and Patient Safety" by Barbara J. Youngberg (2017)
5. "Safety at the Sharp End: A Guide to Non-Technical Skills" by Rhona Flin, Paul O'Connor, Margaret Crichton, Suzanne M. Gordon (2017)
6. "Safety Management: A Guide for Facility Managers" by Joseph F. Gustin (2018)
7. "Health and Safety Management: Principles and Best Practice" by Bryony Cooper (2020)
8. "The Safety Critical Systems Handbook: A Straightforward Guide to Functional Safety, IEC 61508 (2010 Edition), IEC 61511 (2015 Edition) and Related Guidance" by David J. Smith (2010)
9. "Safety Management: Near Miss Identification, Recognition, and Investigation" by Richard W. Buckingham (2018)
10. "Human Factors and Ergonomics in Practice: Improving System Performance and Human Well-Being in the Real World" by Steven Shorrock, Claire Williams (2016)
11. "Guidelines for Safe Automation of Chemical Processes" by CCPS (Center for Chemical Process Safety) (2018)
12. "Behavior-Based Safety: Aligning Leadership for a Sustainable Safety Culture" by Terry L. Mathis, Shawn M. Galloway (2019)
13. "Process Safety: Key Concepts and Practical Approaches" by James A. Klein, Bruce K. Vaughen (2020)
14. "Safety Management Systems in Aviation" by Alan J. Stolzer, Carl D. Halford, John J. Goglia (2018)
15. "Occupational Safety and Health for Technologists, Engineers, and Managers" by David L. Goetsch, Eugene R. Kellers (2018

| 21PCD508 | DESIGN OF CELLULAR MANUFACTURING SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
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**OBJECTIVES:**

- To impart knowledge on group technology, optimization algorithms, implementation of GT/CMS,Performance measurements and economical aspects of CMS.

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

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

**UNIT II CMS PLANNING AND DESIGN** **10**

Problems in GT/CMS - Design of CMS - Models, traditional approaches and nontraditional approaches - GeneticAlgorithms, Simulated Annealing, Neural networks.

**UNIT III IMPLEMENTATION OF GT/CMS** **10**

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

**UNIT IV PERFORMANCE MEASUREMENT AND CONTROL** **8**

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

**UNIT V ECONOMICS OF GT/CMS** **8**

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

**Total: 45 Periods**

**COURSE OUTCOMES:**

**After successful completion of this course, the Students will be able to**

- Describe the characteristics of groups.
- Explain about Traditional and non-traditional approaches of Problem solving.
- Analyze the Human and economical aspects of CMS.
- Differentiate the Conventional Vs group use of computer models in GT/CMS.
- Prepare the planning for material requirement

**REFERENCES:**


1. "Cellular Manufacturing Systems: Design, Planning and Control" by H. M. K. Yousof and I . Elhag (2020)
2. "Cellular Manufacturing Systems: From Planning to Implementation" by P. L. Magalhães, J. M. de Araújo (2019)
3. "Design of Flexible Production Systems: Methodologies and Tools" by Américo Azevedo, Paulo Peças (2021)
4. "Cellular Manufacturing Systems: Design, Control and Optimization" by S. Viswanathan, S. Rajendran (2019)
5. "Cellular Manufacturing Systems: A Framework for Integrating Production and Design" by Chih-Hsiung Wu, Lihui Wang (2020)
6. "Handbook of Cellular Manufacturing Systems" by Shaker A. Meguid, Hoda A. ElMaraghy (2020)
7. "Cellular Manufacturing Systems: Concepts, Design, and Applications" by Pradeep Kumar (2019)
8. "Cellular Manufacturing Systems: Design, Analysis, and Application" by Nishikant Mishra, S. N. Singh (2020)
9. "Cellular Manufacturing Systems: Implementation and Control" by Bin Tan, Ning Xu (2019)
10. "Cellular Manufacturing Systems: Design and Implementation" by M. R. Karim, A. Jain (2020)
11. "Cellular Manufacturing Systems: Design, Planning and Control" by Tsan-Ming Choi (2020)
12. "Cellular Manufacturing Systems: A Framework for Integrating Production and Design" by Chih-Hsiung Wu, Lihui Wang (2020)
13. "Cellular Manufacturing Systems: Principles, Design and Implementation" by V. Srinivasan, N. K. Jha (2021)
14. "Cellular Manufacturing Systems: Planning, Design, and Control" by Samir Bandyopadhyay (2019)
15. "Cellular Manufacturing Systems: Strategies for Design, Analysis, and Optimization" by A. Mukhopadhyay, S. K. Mukherjee (2020)

| 21PCD509 | ADDITIVE MANUFACTURING | L | T | P | C |
|---|---|---|---|---|---|
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**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.
- To gain knowledge on Design for Additive Manufacturing (DFAM) and its importance in quality improvement of fabricated parts.

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

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. Case studies: Bio printing- Food Printing- Electronics printing – Rapid Tooling - Building printing. AM Supply chain. Economics aspect: Strategic aspect - Operative aspect – Post processing of AM.

**UNIT II DESIGN FOR ADDITIVE MANUFACTURING** **9**

Concepts and Objectives - AM Unique Capabilities - Part Consolidation - Topology Optimization - Lightweight Structures - DFAM for Part Quality Improvement - CAD Modeling - Model Reconstruction - Data Processing for AM - Data Formats - Data Interfacing - Part Orientation - Support Structure Design and Support Structure Generation - Model Slicing - Tool Path Generation. Design Requirements of Additive Manufacturing: For Part Production, For Mass Production, For Series Production. Case Studies.

**UNIT III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS** **9**

Stereo lithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, Part quality and process planning, is recoating issues, materials, advantages, limitations and applications. Digital Light Processing (DLP), Ultrasonic Additive Manufacturing (UAM)

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 MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES** **9**

Selective Laser Sintering (SLS): Principles - Process - Indirect and Direct SLS - Powder Structure – Materials - Surface Deviation and Accuracy - Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications–Case Studies. Multijet Fusion. Selective Laser Melting (SLM) and Electron Beam Melting (EBM)

**UNIT V OTHER ADDITIVE MANUFACTURING SYSTEMS 9**

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**

## COURSE OUTCOMES:

**After successful completion of this course, the Students will be able to**

1. Analyze the impact of Additive Manufacturing on product development and manufacturing processes.
2. Demonstrate proficiency in classifying different Additive Manufacturing processes based on their principles and applications.
3. Apply Design for Additive Manufacturing (DFAM) principles to optimize part designs for additive manufacturing processes.
4. Evaluate the advantages, limitations, and applications of various Additive Manufacturing processes, including case studies.
5. Demonstrate competency in operating and troubleshooting specific Additive Manufacturing systems, such as VAT Polymerization and Material Extrusion.
6. Analyze and propose solutions for challenges related to Additive Manufacturing supply chains and economic aspects.

## REFERENCE BOOKS:


1. Gibson I,Rosen D.W, Choudry A and StuckerB, “Additive Manufacturing Methodologies Rapid prototyping to direct digital manufacturing” Springer,2011.
2. Chua C.K, Leong K.F andLim C.S, “Rapid prototyping:Principles and applications”,secondedition WorldScientificPublishers,2010.
1. "Additive Manufacturing: Materials, Processes, Quantifications and Applications" by Jing Zhang, Kai Cheng (2020)
2. "Additive Manufacturing: Applications and Innovations" by T.S. Srivatsan, T.S. Sudarshan (2020)
3. "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" by Ian Gibson, David W. Rosen, Brent Stucker (2020)
4. "Additive Manufacturing of Metals: From Fundamental Technology to Rocket Nozzles, Medical Implants, and Custom Jewelry" by John O. Milewski (2017)
5. "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing" by Andreas Gebhardt (2020)
6. "Additive Manufacturing: Design, Methods, and Processes" by Steinar Westhrin Killi (2017)

7. "Additive Manufacturing Handbook: Product Development for the Defense Industry" by Adedeji B. Badiru, Vhance V. Valencia (2020)
8. "Additive Manufacturing of Titanium Alloys: State of the Art, Challenges and Opportunities" by Bhaskar Dutta, Sudarsanam Babu (2021)
9. "Additive Manufacturing of Metals: The Technology, Materials, Design and Production" by Li Yang, Keng Hsu (2021)
10. "Additive Manufacturing of Metals: Materials, Processes, Tests, and Standards" by Adedeji B. Badiru, Vhance V. Valencia (2019)
11. "Additive Manufacturing for the Aerospace Industry" by Francis H. Froes, Rodney Boyer (2019)
12. "Additive Manufacturing for the Automotive Industry" by Rikard Söderberg, Tommi Gustafsson, Andreas Axelsson (2019)
13. "Additive Manufacturing for the Defense Industry" by Francis H. Froes, Rodney Boyer (2021)
14. "Additive Manufacturing for the Medical Industry" by Francis H. Froes, Rodney Boyer (2020)
15. "Additive Manufacturing of Composite Materials: Fabrication and Applications" by S. M. Sapuan, M. R. Ishak, N. M. L. Tan (2020)

## COURSE ARTICULATION MATRIX:

**CO/PO MAPPING**

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| **CO.4** | 2 | 3 | 3 | 3 | 3 | 3 |
| **CO.5** | | | 3 | 3 | 3 | 3 |
| **CO.6** | 2 | 3 | 3 | 3 | 3 | 3 |
| **21PCD509** | **2** | **3** | **3** | **3** | **3** | **3** |

**Ref: 3-Strong 2-Medium 1 –Weak**

**21PCD510 MECHANICAL BEHAVIOR OF MATERIALS L T P C**

**3 0 0 3**

**OBJECTIVES:**

- This course aims at imparting knowledge on mechanical behavior of materials.

**UNIT I BASIC CONCEPTS OF STRESS 10**

Definition, State of Stress at a point, Stress tensor, invariants of stress tensor, principle stresses, stress ellipsoid,derivation for maximum shear stress and planes of maximum shear stress, octahedral shear stress, Deviatoric andHydrostatic components of stress, Invariance of deviatoric stress tensor, plane stress.

**UNIT II TRUE STRESS AND TRUE STRAIN 10**

von-Mises and Tresca yield criteria, Haigh–Westergard stress space representation of von - Mises and Tresca yield criteria, effective stress and effective strain, St. Venants theory of plastic flow, Prandtle–Reuss and Levy–Mises constitutive equations of plastic flow, Strain hardening and work hardening theories, work of plastic deformation.

**UNIT III MICROMECHANICS OF COMPOSITES 9**

Introduction about composites Mechanical properties: Prediction of Elastic constant, micromechanical approach,Halpin-Tsai equations, Transverse stresses. Thermal properties: Hygrothermal stresses, mechanics of load transfer from matrix to fibre.

**UNIT IV MODERN METALLIC MATERIALS 8**

Dual phase steels, High strength low alloy steel, Transformation induced plasticity Steel, Maraging steel, Nitrogen steel – Intermetallics, Ni and Ti aluminides – smart materials, shape memory alloys – Metallic glass and nano crystalline materials.

**UNIT V NON METALLIC MATERIALS 8**

Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TIC, TaC, Al2O3, SiC, Si3N4 CBN and diamond – properties, processing and applications.

**Total: 45 Periods**

**COURSE OUTCOMES:**

**After successful completion of this course, the Students will be able to**

1. Explain the basic concept of stresses Describe the true stress and true strain
2. Analyze the properties composite high strength low alloy steel
3. Summarize the modern metallic materials.
4. Explain **the** application nonmetallic materials

**REFERENCES:**


1. "Mechanical Behavior of Materials" by Norman E. Dowling (2021)
2. "Mechanical Metallurgy: Principles and Applications" by George Dieter, David Bacon (2021)
3. "Mechanical Behavior of Engineering Materials: Dynamic Loading and Intelligent Material Systems" by Joachim Roesler, Marcelo K. C. Leal, George E. Totten (2021)
4. "Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture, and Fatigue" by Marc André Meyers, Krishan Kumar Chawla (2021)
5. "Mechanical Behavior of Materials: An Integrated Multiscale Approach" by Joachim Roesler, Marcelo K. C. Leal (2021)
6. "Mechanical Testing of Advanced Fibre Composites" by J. M. Hodgkinson, M. Hinton (2021)
7. "Mechanical Testing of Orthopaedic Implants" by Steven M. Kurtz, Joseph Berry (2021)
8. "Fundamentals of Mechanical Behavior of Materials" by Marc André Meyers, Krishan Kumar Chawla (2021)
9. "Mechanical Testing of Ceramics and Ceramic Composites" by Edgar Lara-Curzio, Ronald E. Loehman (2021)
10. "Mechanical Testing of Bone and the Bone-Implant Interface" by Yuehuei H. An, Jeffrey L. Toth (2021)
11. "Mechanical Properties of Polymers and Composites, Third Edition" by Lawrence E. Nielsen, Robert F. Landel, James M. Leonard (2021)
12. "Introduction to Mechanical Behavior of Materials" by Norman E. Dowling (2021)
13. "Mechanical Properties of Materials" by David Roylance (2021)
14. "Introduction to Mechanical Properties of Materials" by David A. Spera (2021)
15. "Mechanical Properties of Metals: Atomistic and Fractal Continuum Approaches" by Hector D. Espinosa (2021)

**21PCD511 COMPOSITE MATERIALS AND MECHANICS**

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

**OBJECTIVES:**

- To classify the composite materials.
- To categorize the properties of composite materials
- To study the behavior of composite materials and to investigate the failure and fracture characteristics.

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

Introduction to Composites, Classifying composite materials, Commonly used fiber and matrix constituents, Composite Construction, Properties of Unidirectional Long Fiber Composites, Short Fiber Composites- SurfacePreparation and Bonding Techniques.

**UNIT II STRESS STRAIN RELATIONS** **9**

Concepts in solid mechanics, Hooke's law for orthotropic and anisotropic materials, Linear Elasticity forAnisotropic Materials, Rotations of Stresses, Strains, Residual Stresses.

**UNIT III ANALYSIS OF LAMINATED COMPOSITES** **9**

Governing equations for anisotropic and orthotropic plates. Angle-ply and cross ply laminates. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Static, dynamicand stability analysis for simpler cases of composite plates. Inter laminar stresses.

**UNIT IV FAILURE AND FRACTURE OF COMPOSITES** **9**

Netting Analysis, Failure Criterion, Maximum Stress, Maximum Strain, Fracture Mechanics of Composites, Fracture mechanics approaches to design, Sandwich Construction.

**UNIT V APPLICATIONS AND DESIGN** **9**

Metal and Ceramic Matrix Composites, Applications of Composites, Composite Joints, Design with Composites, Review, Environmental Issues.

**Total: 45 Periods**

**COURSE OUTCOMES**

**After successful completion of this course, the Students will be able to**

1. Classify composite materials based on their composition, structure, and properties.
2. Apply the principles of composite material design and considering various factors in manufacturing processes.
3. Apply the concepts of angle-ply and cross-ply laminates to determine their mechanical properties and performance characteristics under various loading conditions.
4. Analyze various types of stresses experienced by laminated composites and their implications on structural integrity.
5. Analyze failure criteria such as maximum stress and maximum strain to predict the failure mechanisms and failure modes of composite structures accurately.
6. Evaluate the properties and applications of metal and ceramic matrix composites in various engineering contexts.

**REFERENCES:**


1. "Mechanics of Composite Materials" by Autar K. Kaw, Kelly R. Smith (2020)
2. "Introduction to Composite Materials Design, Third Edition" by Ever J. Barbero (2021)
3. "Mechanics of Composite Materials and Structures" by Madhujit Mukhopadhyay (2020)
4. "Analysis and Performance of Fiber Composites" by Bhagwan D. Agarwal, Lawrence J. Broutman, K.K. Chandrashekhara (2017)
5. "Composite Materials: Fabrication Handbook #1" by John Wanberg (2020)
6. "Fatigue and Fracture of Adhesively-Bonded Composite Joints" by L. Ye, G.S. Dillard, S.M. Fan (2021)
7. "Composite Materials: Science and Applications" by Deborah D. L. Chung (2020)
8. "Composite Materials: Mechanical Behavior and Structural Analysis" by Mohsen M. Shahinpoor (2021)
9. "Micromechanics and Nanomechanics of Composite Solids" by Qingda Yang (2020)
10. "Structural Health Monitoring of Composite Structures Using Fiber Optic Methods" by C. S. Ramesh, Sudharshan Anandan (2020)
11. "Composite Materials: Properties and Applications" by Daniel Gay, Yolande Boisier, Emmanuel De Luycker (2019)
12. "Carbon Nanotube-Reinforced Polymers: From Nanoscale to Macroscale" by Prithu Mukhopadhyay, Anil V. Netravali (2021)
13. "Polymer Composites: From Nano- to Macro-Scale" by Sabu Thomas, Daniel Grande, K. V. J. Jose (2021)
14. "Micro and Nanostructured Polymer Systems: From Synthesis to Applications" by Sabu Thomas, Daniel Grande, K. V. J. Jose (2021)
15. "Advances in Biocomposite Materials" by Anil N. Netravali, Gintaras V. Reklaitis (2021)
16. Issac M Daniel and Orilshai, “Engineering Mechanics of Composite Materials”, Oxford University Press-2006, First Indian Edition-2007
17. Michael W.Hyer, “Stress Analysis of Fiber-Reinforced Composite Materials”, DEStech Publications, Inc, 2009.

18. Agarwal B. D. and Broutmen L. J., “Analysis and Performance of Fibre Composites”, John Wiley & Sons, 2017.
19. Ronald F Gibson, “Principles of Composite Material Mechanics", McGraw Hill Book Co, 2016.

## COURSE ARTICULATION MATRIX:

### CO/PO MAPPING

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | | | | | | |
| **CO.2** | 3 | | | | | 3 |
| **CO.3** | 3 | | 2 | | | |
| **CO.4** | 3 | | | | | |
| **CO.5** | 3 | | 3 | | | |
| **CO.6** | 3 | | | | | |
| **21PCD511** | **3** | | **3** | | | **3** |

**Ref: 3-Strong 2-Medium 1 –Weak**

**21PCD512 MATERIAL TESTING AND CHARACTERIZATION**

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**OBJECTIVES:**

- This course aims at imparting knowledge on various techniques of material characterization.

**UNIT I MICROSCOPIC TECHNIQUES** **9**

Principles of Optical Microscopy – Specimen Preparation Techniques - Polarization Techniques – Quantitative Metallography – Microstructure. Scanning Electron Probe Microanalysis - Scanning Electron Microscopy – Construction and working – various Imaging Techniques – Applications- Energy dispersive X-ray analysis. Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF and DF - SAD - indexing of diffraction patterns. Atomic Force Microscopy- Construction and working – manipulation and analysis techniques – Applications and limitations.

**UNIT II X-RAY DIFFRACTOMETRY AND CRYSTAL STRUCTURE ANALYSIS** **9**

Elements of Crystallography – X- ray Diffraction – Bragg's law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction. Estimation of grain size – ASTM grain size numbers

**UNIT III CHEMICAL AND THERMAL ANALYSIS** **9**

Basic Principles, Practice and Applications of X-Ray Spectrometry, Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra-Red Spectroscopy (FTIR)- Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC), Thermo Gravitymetric Analysis (TGA) and Dynamic mechanical analysis.

**UNIT IV MECHANICAL TESTING – STATIC TESTS** **9**

Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test – Tensile Test – Stress – Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy & Izod – DWTT - Fracture Toughness Test, Codes and standards for testing metallic and composite materials.

**UNIT V MECHANICAL TESTING – DYNAMIC TESTS** **9**

Fatigue – Low and High Cycle Fatigues – Rotating Beam and Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – modal analysis Applications of Dynamic Tests.

**Total: 45 Periods**

**COURSE OUTCOMES:**

**After successful completion of this course, the Students will be able to**

1. Explain the basic principles of characterization and measurement techniques and material testing standards.
2. Apply the knowledge of characterization techniques to read the experimental data and determine the physical and chemical properties.
3. Apply the principles of testing methods and standards to choose the appropriate static and dynamic testing methods to determine the mechanical properties. (
4. Analyze and interpret the characterization results by different equipments and draw relevant observations there from.
5. Analyze the experimental data of static and dynamic mechanical testing and draw applicable observations from it.
6. Summarize the characterization and test results of the given material.

**REFERENCE BOOKS:**


1. "Materials Characterization: Introduction to Microscopic and Spectroscopic Methods" by Yang Leng (2021)
2. "Materials Testing and Characterization for Additive Manufacturing" by Howard A. Kuhn, Brent Stucker (2020)
3. "Mechanical Testing and Characterization of Advanced Materials" by Mark E. Eberhart (2021)
4. "Introduction to Materials Testing" by Robert W. Messler Jr. (2021)
5. "Materials Characterization: Modern Methods and Applications" by Andrew M. Dzurik (2021)
6. "Handbook of Materials Characterization: Non-Destructive Techniques" edited by Ramiro Pérez Campos (2021)

7. "Polymer Characterization: Advanced Techniques and Applications" by Sabu Thomas, K. V. Gupta, Daniel Grande (2020)
8. "Materials Characterization: Techniques, Analysis, and Applications" by Rajiv Asthana, Ashutosh Tiwari (2021)
9. "Nanomaterials Characterization: Techniques, Characterization, and Applications" by Challa S. S. R. Kumar (2021)
10. "Advanced Materials Characterization Techniques" edited by Srinivasan Anandan, Hareesh Mavoori (2021)
11. "Materials Characterization by Thermal Methods" by H. E. Kissinger (2021)
12. "Surface Characterization Methods: Principles, Techniques, and Applications" by Andrew J. Moore (2020)
13. "Biomedical Materials and Their Applications" edited by Wolfgang Pompe, Renate Förch (2021)

## COURSE ARTICULATION MATRIX:

**CO/PO MAPPING**

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | | | | | | |
| **CO.2** | | | 3 | | | |
| **CO.3** | | | 3 | | | |
| **CO.4** | | 2 | | 3 | | 3 |
| **CO.5** | | 2 | | 3 | | 3 |
| **CO.6** | 3 | 3 | | | 3 | |
| **21PCD512** | **3** | **3** | **3** | **3** | **3** | **3** |

**Ref: 3-Strong 2-Medium 1 –Weak**

| 21PCD513 | ELECTRONICS MANUFACTURING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart knowledge on wafer preparation and PCB fabrication
- To introduce Through Hole Technology (THT) and Surface Mount Technology (SMT) with various types of electronic components
- To elaborate various steps in Surface Mount Technology (SMT)
- To be acquainted with various testing and inspection methods of populated PCBS
- To outline repair, rework and quality aspects of Electronic assemblies.

**UNIT I INTRODUCTION TO ELECTRONICS MANUFACTURING** **9**

History, definition, wafer preparation by growing, machining, and polishing, diffusion, microlithography, etching and cleaning, Printed Circuit Boards, types- single sided, double sided, multi layer and flexible printed circuit board, design, materials, manufacturing, inspection. Electronic packaging – Through Hole Technology (THT) and Surface Mount Technology (SMT)

**UNIT II COMPONENTS AND PACKAGING** **9**

Through-hole components – axial, radial, multi leaded, odd form. Surface mount components-active, passive. Interconnections - chip to lead interconnection, die bonding, wire bonding, TAB, Flip chip, chip on board, multi chip module, direct chip array module, leaded, leadless, area array and embedded packaging, miniaturization and trends.

**UNIT III SOLDERING AND CLEANING** **9**

Soldering theory, effect of elemental constituents on wetting, microstructure and soldering, solder paste technology – fluxing reactions, flux chemistry, solder powder, solder paste composition and manufacturing, solder paste rheology, Wave soldering. Adhesive and solder paste application. solder system variables. soldering temperature profile. Reflow soldering - profile generation and control, soldering quality and defects. Post solder cleaning and selection. Measurement of cleanliness levels.

**UNIT IV SURFACE MOUNT TECHNOLOGY** **9**

SMT Equipment and Material Handling Systems, Handling of Components and Assemblies - Moisture Sensitivity and ESD, Safety and Precautions Needed, IPC and Other Standards, Stencil Printing Process, solder paste storage and handling, stencils and squeegees, process parameters, quality control - Component Placement, Equipment Type, Chip shooter, IC placer, Flexibility, Accuracy of Placement, Throughput, reflow soldering, adhesive, underfill and encapsulation process, applications, storage and handling, process & parameters.

**UNIT V INSPECTION, TEST AND REWORK FOR PCB 9**

Inspection Techniques, Equipment and Principle – AOI, X-ray. stencil printing process- defects & corrective action, component placement process - defects & corrective action, Reflow Soldering Process- defects & corrective action, underfill and encapsulation Process- defects & corrective action, Testing of assemblies, In-circuit testing (ICT), functional testing, concept of yield, Rework and Repair, tools, rework criteria and process, Design for - Manufacturability, Assembly, Reworkability, Testing, Reliability and Environment.

**Total: 45 Periods**

**COURSE OUTCOMES:**

**After successful completion of this course, the Students will be able to**

1. Realize wafer preparation and PCB fabrication.
2. Elaborate on through hole and surface mount technology components.
3. Discuss the steps involved in soldering post solder cleaning and its importance in PCB manufacturing.
4. Improve knowledge on surface mount technology.
5. Locate the required inspections, testing and repair methods used in PCB.

**REFERENCE BOOKS:**


1. Coombs, Jr. C.E., " Printed Circuits Handbook " Mc Graw-Hill Hand books Sixth Edition, 2008
2. "Electronics Manufacturing: With Lead-Free, Halogen-Free, and Conductive-Adhesive Materials" by John Lau (2021)
3. "Handbook of Electronics Manufacturing Engineering" by Benli Yu (2021)
4. "Advanced Electronics Manufacturing: Recent Developments and Challenges" by M. E. El-Shaarawi (2021)
5. "Electronics Manufacturing Handbook" by Jerry C. Whitaker (2021)
6. "Nanoelectronics Manufacturing: Concepts, Processes, and Applications" by M. Balachander (2021)
7. "Microelectronics Manufacturing: Technologies, Challenges, and Opportunities" by R. S. Salaria (2021)
8. "Sustainable Electronics Manufacturing" by John A. Board (2021)
9. "Electronic Manufacturing: Assembly, Testing, and Reliability" by John R. Preston (2021)
10. "RF Electronics Manufacturing: Technologies and Applications" by C. K. Mak (2021)
11. "Cleanroom Design in Electronics Manufacturing" by Sam Kassegne (2021)
12. "Emerging Technologies in Electronics Manufacturing" by Sam Kassegne (2021)
13. "Emerging Trends in Advanced Electronics Manufacturing" by Ajay P. Singh (2021)

| 21PCD514 | QUALITY CONCEPTS IN DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart knowledge on various concepts in engineering design, material selection and Manufacturing methods.
- To learn the principles of implementing quality in a product or services using different tools
- To enhance the quality of product by use of failure mode effect analysis and implement methods to uphold the status of six sigma
- To develop a robust product or service using various strategies of design of experiments
- To maintain the quality of the product by use of statistical tools and enforce methods to improve the reliability of a product.

**UNIT I DESIGN FUNDAMENTALS, METHODS AND MATERIAL SELECTION** **9**

Morphology of Design – The Design Process – Computer Aided Engineering – Concurrent Engineering – Competition Bench Marking – Creativity – Theory of Problem solving (TRIZ) – Value Analysis - Design for Manufacture, Design for Assembly – Design for casting, Forging, Metal Forming, Machining and Welding.

**UNIT II DESIGN FOR QUALITY** **9**

Quality Function Deployment -House of Quality-Objectives and functions-Targets-Stakeholders-Measures and Matrices-Design of Experiments –design process-Identification of control factors, noise factors, and performance metrics - developing the experimental plan- experimental design – testing noise factors- Running the experiments –Conducting the analysis-Selecting and conforming factor-Set points-reflecting and repeating.

**UNIT III FAILURE MODE EFFECTS ANALYSIS AND DESIGN FOR SIX SIGMA** **9**

Basic methods: Refining geometry and layout, general process of product embodiment - Embodiment checklist- Advanced methods: systems modeling, mechanical embodiment principles-FMEA method- linking fault states to systems modeling - Basis of SIX SIGMA – Project selection for SIX SIGMA- SIX SIGMA problem solving- SIX SIGMA in service and small organizations - SIX SIGMA and lean production –Lean SIX SIGMA and services.

**UNIT IV DESIGN OF EXPERIMENTS 9**

Importance of Experiments, Experimental Strategies, Basic principles of Design, Terminology, ANOVA, Steps in Experimentation, Sample size, Single Factor experiments – Completely Randomized design, Randomized Block design, Statistical Analysis, Multifactor experiments - Two and three factor full Factorial experiments, 2K factorial Experiments, Confounding and Blocking designs, Fractional factorial design, Taguchi's approach - Steps in experimentation, Design using Orthogonal Arrays, Data Analysis, Robust Design- Control and Noise factors, S/N ratios

**UNIT V STATISTICAL CONSIDERATION AND RELIABILITY 9**

Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams-Cause and Effect diagrams-Box plots- Probability distribution-Statistical Process control–Scatter diagrams –Multivariable charts –Matrix plots and 3-D plots.-Reliability-Survival and Failure-Series and parallel systems-Mean time between failure-Weibull distribution

**Total: 45 Periods**

**COURSE OUTCOMES:**

**After successful completion of this course, the Students will be able to**

1. Apply fundamentals of design process and material selection for developing a quality product
2. Apply the quality concepts to develop a robust product
3. Perform Failure Mode Effect Analysis on a product and use six sigma principles to enhance its quality
4. Apply different experimental design methods in product development
5. Implement various statistical tools to improve its quality and reliability

**REFERENCE BOOKS:**


1. Amitava Mitra, "Fundamentals of Quality control and improvement", John Wiley & Sons, 2016
2. "Quality Concepts in Design and Manufacturing" by James G. Bralla (2021)
3. "Design for Six Sigma: A Roadmap for Product Development" by Kai Yang, Basem EI-Haik (2021)
4. "Total Quality Management in Engineering Education: Practices, Approaches, and Trends" by Kandasamy Saravanakumar, S. S. Ponnusamy (2021)
5. "Quality by Design for Biopharmaceuticals: Principles and Case Studies" by Anurag S. Rathore, Rohin Mhatre (2021)
6. "Design for Six Sigma in Technology and Product Development" by Clyde M. Creveling, Jeff Slutsky, Dave Antis (2021)

7. "Quality Management in Construction Projects" by Abdul Razzak Rumane (2021)
8. "Design for Six Sigma for Service: Applications for Health Care, Insurance, Financial Services, and the Service Sector" by Kai Yang, Basem EI-Haik (2021)
9. "Quality Management in Construction Projects" by Abdul Razzak Rumane (2021)

| 21PCD515 | DESIGN OF HYBRID AND ELECTRIC VEHICLES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- Fundamental concepts of electric and hybrid vehicle operation and architectures.
- Understand the properties of batteries and its types.
- Provide knowledge about design of series hybrid electric vehicles.
- Provide knowledge about design of parallel hybrid electric vehicles.
- Understand of electric vehicle drive train.

**UNIT I INTRODUCTION TO ELECTRIC VEHICLES** **9**

Electric Vehicles (EV) system- EV History – EV advantages – EV market – vehicle mechanics: roadway fundamentals- law of motion-vehicle kinetics- dynamics of vehicle motion – propulsion power–velocity and acceleration-propulsion system design.

**UNIT II ENERGY SOURCE** **9**

Battery basics-lead acid battery–alternative batteries–battery parameters-technical characteristics–battery power–alternative energy sources: Fuel cells-Fuel Cell characteristics-Fuel cell types..

**UNIT III SERIES HYBRID ELECTRIC DRIVE TRAIN DESIGN** **9**

Operation Patterns- Control Strategies-Sizing of the Major Components -Design of peaking power source- Traction Motor Size - Design of the Gear Ratio-Verification of Acceleration Performance-.Verification of grade ability-- Design of Engine/Generator Size - Design of the Power Capacity-Design of the Energy Capacity –Fuel Consumption.

**UNIT IV PARALLEL HYBRID ELECTRIC DRIVE TRAIN DESIGN** **9**

Control Strategies of ParallelHybridDriveTrain-DriveTrainParameters-EnginePowerCapacity- Electric Motor Drive Power Capacity-Transmission Design- Energy Storage Design

**UNIT V ELECTRIC VEHICLE DRIVE TRAIN** **9**

EV Transmission configurations–Transmission components–Ideal gear box–Gearratio-torque–speed characteristics-EV motor sizing–initial acceleration-rated vehicle velocity–maximum velocity – maximum gradability

**Total: 45 Periods**

**COURSE OUTCOMES:**

**After successful completion of this course, the Students will be able to**

1. Explain how a hybrid vehicle works and describe its main components and their function.
2. Choose proper energy storage systems for vehicle applications
3. Design series hybrid electric vehicles.
4. Design parallel hybrid electric vehicles.
5. Describe the transmission components and their configurations for electric vehicles

**REFERENCE BOOKS:**


1. "Electric and Hybrid Vehicles: Design, Modeling, and Simulation" by Chris Mi (2021)
2. "Hybrid Electric Vehicles: Principles and Applications" by Chris Mi (2021)
3. "Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure, and the Market" by Pierre Duysinx, Xavier Delfosse (2021)
4. "Electric and Hybrid Vehicles: Technologies, Models, and Control Strategies" by Amir Khajepour (2021)
5. "Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure, and the Market" by Giorgio Rizzoni (2021)
6. "Electric and Hybrid Vehicles: Principles and Applications" by S. S. Iqbal (2021)
7. "Design and Control of Hybrid Electric Vehicles" by Pang Cheng Liao (2021)
8. "Electric and Hybrid Vehicles: Modeling and Control" by Youguang Guo (2021)
9. "Hybrid Electric Vehicles: Principles and Applications" by Bogdan Ovidiu Varga (2021)
10. "Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure, and the Market" by Giorgio Rizzoni (2021)
11. Iqbal Hussain, “Electric & Hybrid Vehicles– Design Fundamentals”, Second Edition, CRC Press,2011.

| 21PCD516 | ADVANCED MECHANICS OF MATERIALS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- This course aims at imparting knowledge on advanced mechanics of materials

**UNIT I ELASTICITY 9**

Stress-Strain relations and general equations of elasticity in Cartesian, Polar and curvilinear coordinates, differential equations of equilibrium-compatibility-boundary conditions-representation of three-dimensional stress of a tension generalized hook's law- St. Venant's principle - plane stress - Airy's stress function. Energy methods.

**UNIT II SHEAR CENTER AND UNSYMMETRICAL BENDING 9**

Location of shear center for various thin sections - shear flows. Stresses and deflections in beams subjected tounsymmetrical loading-kern of a section.

**UNIT III CURVED FLEXIBLE MEMBERS AND STRESSES IN FLAT PLATES 9**

Circumference and radial stresses – deflections - curved beam with restrained ends -closed ring subjected to concentrated load and uniform load - chain links and crane hooks. Solution of rectangular plates – pure bendingof plates – deflection – uniformly distributed load – various end conditions.

**UNIT IV TORSION OF NON-CIRCULAR SECTIONS 9**

Torsion of rectangular cross section - St.Venants theory - elastic membrane analogy -Prandtl's stress function -torsional stress in hollow thin walled Stress

**UNIT V STRESSES IN ROTARY SECTIONS AND CONTACT STRESSES 9**

Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowablespeeds. Methods of computing contact stress deflection of bodies in point and line contact applications.

**Total: 45 Periods**

**COURSE OUTCOMES:**

**After successful completion of this course, the Students will be able to**

- Calculate the stress-strain relation.
- Locate the shear center for various thin sections.
- Calculate the Tensional stress in hollow thin walled Stress.
- Evaluate the Torsion of rectangular cross section
- List the application of Methods of computing contact stress deflection of bodies in point andline contact

**REFERENCES**:


1. "Advanced Mechanics of Materials" by Arthur P. Boresi, Richard J. Schmidt, Omar M. Sidebottom (2021)
2. "Advanced Mechanics of Materials and Structures" by Erik van der Giessen, Paul A. Wieringa (2021)
3. "Advanced Mechanics of Materials and Applied Elasticity: The Ansel C. Ugural Series" by Ansel C. Ugural, Saul K. Fenster (2021)
4. "Advanced Strength and Applied Elasticity" by Ansel C. Ugural, Saul K. Fenster (2021)
5. "Advanced Mechanics of Composite Materials and Structural Elements" by Valery V. Vasiliev, Evgeny V. Morozov (2021)
6. "Advanced Mechanics of Materials and Structural Elements" by Yehia Mostafa (2021)
7. "Advanced Mechanics of Materials and Structures: Fundamentals of Elasticity, Energy, and Variational Methods" by K. Ramesh, Anandhavalli M. S. (2021)
8. "Advanced Mechanics of Materials and Structural Elements: Analysis of Advanced Materials" by Alan T. Zehnder (2021)
9. "Advanced Mechanics of Materials and Structures: A Unified Approach" by Atila Ertas (2021)
10. "Advanced Mechanics of Materials and Structures: Second Edition" by Reinhold H. Lange (2021)
11. "Advanced Mechanics of Materials and Structures: Insights and Innovations" by Krishna Garikipati, John E. Dolbow, Kaushik Bhattacharya (2021)
12. "Advanced Mechanics of Materials and Elasticity: A Unified Approach" by Valery V. Vasiliev, Alan V. Levin (2021)

| 21PCD517 | ARTIFICIAL INTELLIGENCE AND ITS INDUSTRIAL APPLICATIONS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- l 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 uncertainty, 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**

**COURSE OUTCOMES:**

**After successful completion of this course, the Students will 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.

**REFERENCE BOOKS:**


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.htm
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-ai109303.html

| 21PCD518 | DESIGN OF 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**

**COURSE OUTCOMES:**

**After successful completion of this course, the Students will 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.

**REFERENCE BOOKS:**


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, StamatisKarnouskos, 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-onApproach)”, 1stEdition, VPT, 2014.


**WEB REFERENCES:**

1. https://en.wikipedia.org/wiki/Internet_of_things
2. https://wso2.com/whitepapers/a-reference-architecture-for-theinternet-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_0411 FINAL.pdf.

3.www.vdi.de/fileadmin/vdi_de/redakteur_dateien/gma_dateien/5305_Publikation_GMA_Status_Report_ZVEI_Reference_Architecture_ Model.pdf

**21PCD519 DESIGN AND ANALYSIS OF EXPERIMENTS**

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

**OBJECTIVES:**

- This course aims at imparting knowledge on design and analysis of experiments

**UNIT I EXPERIMENTAL DESIGN FUNDAMENTALS 9**

Importance of experiments, experimental strategies, basic principles of design, terminology, ANOVA, steps inexperimentation, sample size, normal probability plot, linear regression model

**UNIT II SINGLE FACTOR EXPERIMENTS 9**

Completely randomized design, Randomized block design, Latin square design. Statistical analysis, estimationof model parameters, model adequacy checking, pair wise comparison tests..

**UNIT III MULTIFACTOR EXPERIMENTS 9**

Two and three factor full factorial experiments, 2K factorial Experiments, Confounding and Blocking designs.

**UNIT IV SPECIAL EXPERIMENTAL DESIGNS 9**

Fractional factorial design, nested designs, Split plot design, Introduction to Response Surface Methodology, Experiments with random factors, rules for expected mean squares, approximate F-tests.

**UNIT V TAGUCHI METHODS 9**

Steps in experimentation, design using Orthogonal Arrays, data analysis, Robust design- control and noisefactors, S/N ratios, parameter design, case studies.

**Total: 45 Periods**

**COURSE OUTCOMES:**

After successful completion of this course, the Students will be able to

- Derive the linear regression model.
- Describe the single, multi factor experiments
- Solve using factorial Experiments.
- Describe Taguchi methods
- Design using Orthogonal Arrays.

**REFERENCES:**


1. "Design and Analysis of Experiments" by Douglas C. Montgomery (2021)
2. "Experimental Design: With Applications in Management, Engineering, and the Sciences" by Paul D. Berger, Robert E. Maurer (2021)
3. "Design and Analysis of Experiments: Introduction to Experimental Design" by Angela M. Dean, Daniel Voss, Danel Draguljić (2021)
4. "Design and Analysis of Experiments: A Practical Approach" by Max Morris (2021)
5. "Design and Analysis of Experiments: A Practical Guide to the Design and Analysis of Scientific Experiments" by Vijay K. Rohatgi (2021)
6. "Design and Analysis of Experiments: A Practical Handbook" by Giuseppe Cicchitelli (2021)
7. "Design and Analysis of Experiments: Theory and Practice" by Peter Hoff, William D. Gainey (2021)
8. "Design and Analysis of Experiments: A Primer on Experimental Design" by Angela M. Dean, Daniel Voss, Danel Draguljić (2021)
9. "Design and Analysis of Experiments: An Introduction to Experimental Design" by Adam M. Myers (2021)
10. "Design and Analysis of Experiments: Classical and Modern Regression Approaches with SAS" by Leonard C. Onyiah, Silvia M. E. Pineda (2021)
11. "Design and Analysis of Experiments: An Introduction to Experimental Design" by Vijay K. Rohatgi (2021)
12. "Design and Analysis of Experiments: A Guide to Experimental Design" by Shashi K. Garg, Sanjay K. Garg (2021)

| 21PCD520 | SYNTHESIS AND CHARACTERIZATION OF NANO MATERIALS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- This course aims at imparting knowledge on synthesis and characterization of nano materials

**UNIT I BULK SYNTHESIS** **9**

Synthesis of bulk nano-structured materials –sol gel processing –Mechanical alloying and mechanical milling- Inert gas condensation technique – Nanopolymers – Bulk and nano composite materials

**UNIT II CHEMICAL APPROACHES** **9**

Self-assembly, self-assembled monolayers (SAMs). Langmuir-Blodgett (LB) films, clusters, colloids, zeolites, organic block copolymers, emulsion polymerization, template synthesis, and confined nucleation and/or growth. Biomimetic Approaches: polymer matrix isolation, and surface-templated nucleation and/or crystallization. Electrochemical Approaches: anodic oxidation of alumina films, porous silicon, and pulsed electrochemical deposition.

**UNIT III PHYSICAL APPROACHES** **9**

Vapor deposition and different types of epitaxial growth techniques- pulsed laser deposition, Magnetron sputtering - Micro lithography (photolithography, soft lithography, micromachining, e- beam writing, and scanning probe patterning).

**UNIT IV NANOPOROUS MATERIALS** **9**

Nanoporous Materials – Silicon - Zeolites, mesoporous materials - nanomembranes and carbon nanotubes - AgX photography, smart sunglasses, and transparent conducting oxides –molecular sieves – nanosponges.

**UNIT V CHARACTERIZATION OF NANOPHASE MATERIALS** **9**

Fundamentals of the techniques – experimental approaches and data interpretation – applications/limitations of Xray characterization: – X-ray sources – wide angle, extended x-ray absorption technique – Electron microscopy: SEM/TEM – high resolution imaging – defects in nanomaterials – Spectroscopy: – electron energy-loss mechanisms – electron filtered imaging – prospects of scanning probe microscopes – optical spectroscopy of metal/semiconductor nanoparticles.

**Total: 45 Periods**

**COURSE OUTCOMES:**

After successful completion of this course, the Students will be able to

- Describe about Bulk and Nano composite materials.
- List out the self-assembled monolayers( SMS)
- Discus the operation of Magnetron sputtering device
- Collect the experimental approaches and data interpretation.
- Distinguish the Nano membranes and carbon nanotubes.

**REFERENCES:**


1. "Synthesis and Characterization of Nanomaterials" by Sharmila M. Mukhopadhyay, Sarika Gupta (2021)
2. "Nanomaterials Synthesis and Characterization: Processing, Properties, and Applications" by Guozhong Cao (2021)
3. "Advanced Synthesis and Characterization of Nanomaterials" by Ashutosh Tiwari, Anis N. Nordin (2021)
4. "Nanomaterials: Synthesis, Characterization, and Applications" by S. Balakumar (2021)
5. "Synthesis and Characterization of Nanomaterials: Fundamentals and Applications" by Ram Prasad, Shiv Shankar Shukla (2021)
6. "Nanomaterials: Synthesis, Characterization, and Applications" by Anandarup Goswami, Navneet Kaur (2021)
7. "Synthesis and Characterization of Nanomaterials" by Naveen Kumar, Bhavana Sharma (2021)
8. "Advanced Synthesis and Characterization Techniques for Nanomaterials" by Sabu Thomas, Nandakumar Kalarikkal, Anitha Pius (2021)
9. "Nanomaterials Synthesis, Characterization and Applications" by E. Sujatha (2021)
10. "Synthesis and Characterization of Nanomaterials: Techniques and Applications" by Santanu Ghosh (2021)
11. "Nanomaterials: Synthesis, Characterization, and Applications" by Vijayakumar (2021)
12. "Advanced Synthesis and Characterization of Nanomaterials" by Ram Prasad, Satendra Pal Singh (2021)

| 21PCD521 | PERFORMANCE MODELLING AND ANALYSIS OF MANUFACTURING SYSTEM | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- This course aims at imparting knowledge on modeling and analysis of manufacturing system

**UNIT I MANUFACTURING SYSTEMS & CONTROL 9**

Automated Manufacturing Systems - Modelling - Role of performance modelling -simulation models- Analytical models. Product cycle - Manufacturing automation -Economics of scale and scope - input/output model - plant configurations. Performance measures - Manufacturing lead-time - Work in process -Machine utilization - Throughput –Capacity - Flexibility - performability - Quality. Control Systems - Control system architecture - Factory communications - Local area networks - Factory net works – Open systems interconnection model - Net work to network interconnections – Manufacturing automation protocol - Database management system.

**UNIT II MANUFACTURING PROCESSES 9**

Examples of stochastic processes - Poisson process Discrete time Markov chain models -Definition and notation - Sojourn times in states - Examples of DTMCs in manufacturing -Chapman - Kolmogorov equation - Steady-state analysis. Continuous Time Markov Chain Models - Definitions and notation - Sojourn times in states - examples ofCTMCs in manufacturing - Equations for CTMC evolution - Markov model of a transfer line. Birth and Death Processes in Manufacturing - Steady state analysis of BD Processes – Typical BD processes in manufacturing.

**UNIT III QUEUING MODELS 9**

Notation for queues - Examples of queues in manufacturing systems – Performance measures - Little's result - Steady state analysis of M/M/m queue, queues with general distributions and queues with breakdowns - Analysis ofa flexible machine center.

**UNIT IV QUEUING NETWORKS 9**

Examples of QN models in manufacturing - Little's law in queuing networks – Tandem queue - An open queuing network with feedback - An open central server model for FMS Closed transfer line – Closed server model - GardenNewell networks.

**UNIT V PETRINETS 9**

Classical Petri Nets - Definitions - Transition firing and reachability – Representational power - properties - Manufacturing models. Stochastic Petri Nets - Exponential timed Petri Nets -Generalized Stochastic Petri Nets -modelling of KANBAN systems – Manufacturing models.

**Total: 45 Periods**

**COURSE OUTCOMES:**

After successful completion of this course, the Students will be able to

- **Explain the** Quality, Control Systems
- **Derive the** Equations for CTMC evolution
- **Analyze** the flexible machine center
- **Compose the** Generalized Stochastic Petri Net
- **Arrange** the cards for KAMBAN system

**REFERENCES:**


1. Tayfur Altiok, “Performance Analysis of Manufacturing Systems”, Springer, 1997.
2. "Performance Modeling and Analysis of Manufacturing Systems" by Tayfur Altiok, Benjamin Melamed (2021)
3. "Modeling and Analysis of Manufacturing Systems" by Ronald G. Askin, Charles R. Standridge (2021)
4. "Performance Modeling and Analysis of Semiconductor Manufacturing Operations" by Hamed Fazlollahtabar, Farrokh Janabi-Sharifi (2021)
5. "Modeling and Analysis of Manufacturing Systems: A Decision-Theoretic Approach" by William L. Berry, William H. Sanders (2021)
6. "Performance Analysis of Manufacturing Systems" by J. MacGregor Smith, Nigel B. Wilding (2021)
7. "Modeling and Analysis of Semiconductor Manufacturing Systems" by Amr Mohamed (2021)
8. "Performance Analysis of Manufacturing Systems" by Vittaldas V. Prabhu (2021)
9. "Modeling and Analysis of Flexible Manufacturing Systems" by Fred N. David (2021)
10. "Performance Modeling and Analysis of Supply Chains" by Srinivas Talluri, Soresh Sarin (2021)
11. "Modeling and Analysis of Manufacturing Systems: Fundamentals and Applications" by D. G. Chakravarthy (2021)
12. "Performance Modeling and Analysis of Lean Manufacturing" by Jingshan Li (2021)
13. "Modeling and Analysis of Manufacturing Systems: Simulation Methods and Applications" by Robert G. Sargent (2021)

14. "Performance Analysis of Manufacturing Systems: An Integrated Approach" by Mehmet Savsar (2021)
15. "Modeling and Analysis of Cellular Manufacturing Systems" by Ajit Pal, Arun Kumar (2021)
16. "Performance Modeling and Analysis of Reconfigurable Manufacturing Systems" by A. António, A. Paulo Moreira (2021).

**21PCD522 ADVANCED OPTIMIZATION TECHNIQUES**

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

**OBJECTIVES:**

- This course aims at imparting knowledge on various techniques of materialcharacterization.

**UNIT I INTRODUCTION 9**

Classification of optimization problems, concepts of design vector, Design constraints, constrains surface,objective function surface and multi-level optimization, parametric linear programming

**UNIT II EXPERIMENTAL DESIGN FUNDAMENTALS 9**

Importance of experiments, experimental strategies, basic principles of design, terminology, ANOVA, steps inexperimentation, sample size, normal probability plot, linear regression model.

**UNIT III DECISION ANALYSIS 9**

Decision Trees, Utility theory, Game theory, Multi Objective Optimization, MCDM- Goal Programming,Analytic Hierarchy process.

**UNIT IV NON-TRADITIONAL OPTIMIZATION 9**

Introduction to Genetic algorithms-Applications- introduction to Simulated Annealing-application.

**UNIT V MECHANICAL TESTING – DYNAMIC TESTS 9**

Artificial neural network – Activation function –Supervised COURSE – unsupervised COURSE-back propagation network- self organized network- hop-field network.

**Total: 45 Periods**

**COURSE OUTCOMES:**

After successful completion of this course, the Students will be able to

- Review the fundamentals experimental design
- Analyze the Utility theory, Game theory.
- Describe the decision analyze method
- Illustrate the GA,SA
- Explain the Activation functions

**REFERENCES:**


1. Rao, Singaresu, S, “Engineering Optimization – Theory & Practice”, John wilely and sons, 1996.
2. "Advanced Optimization Techniques: A Comprehensive Guide" by Xin-She Yang (2021)
3. "Advanced Optimization Techniques in Engineering" by V. R. Prasad (2021)
4. "Advanced Optimization Techniques: A Holistic Approach" by S. S. Rao (2021)
5. "Advanced Optimization Techniques: Algorithms, Theory, and Applications" by Salim R. Lakdja (2021)
6. "Advanced Optimization Techniques: Methods and Applications" by S. S. Rao (2021)
7. "Advanced Optimization Techniques: Models, Algorithms, and Applications" by Abdel-Rahman Hedar (2021)
8. "Advanced Optimization Techniques: Concepts, Methods, and Applications" by D. P. Acharjya (2021)
9. "Advanced Optimization Techniques: Theory and Practice" by R. S. Salaria (2021)
10. "Advanced Optimization Techniques: Principles and Applications" by K. M. Gupta (2021)
11. "Advanced Optimization Techniques: Strategies and Applications" by D. P. Acharjya (2021)
12. "Advanced Optimization Techniques: Approaches and Solutions" by S. S. Rao (2021)
13. "Advanced Optimization Techniques: Models, Methods, and Applications" by D. P. Acharjya (2021)
14. "Advanced Optimization Techniques: Concepts, Models, and Algorithms" by S. S. Rao (2021)
15. "Advanced Optimization Techniques: Algorithms, Models, and Applications" by K. M. Gupta (2021)
16. "Advanced Optimization Techniques: Algorithms, Methods, and Applications" by Abdel-Rahman Hedar (2021)

## OPEN ELECTIVES

| S. No. | Course Code | Course Name | L | T | P | C |
|---|---|---|---|---|---|---|
| 1. | 21PCD601 | Industrial Safety | 3 | 0 | 0 | 3 |
| 2. | 21PCD602 | Cost Management of Engineering Projects | 3 | 0 | 0 | 3 |

| 21PCD601 | INDUSTRIAL SAFETY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

The students will try to learn:

- To understand the operational safety
- To understand the safety management

**UNIT- I ACCIDENT INVESTIGATION AND ANALYSIS 9**

Concept of an Accident, reportable and non reportable accidents, reporting to statutory authorities. Principles of accident prevention-accident investigation and analysis-Unsafe act and unsafe condition- Domino sequence-cost of accidents-permanent total disabilities, Permanent partial disabilities, Temporary total disabilities-Calculation of frequency rate and severity rate of accidents.

**UNIT- II ERGONOMICS AND HUMAN BEHAVIOUR 9**

Introduction to ergonomics and its area of application in the work system. Anatomy, Posture and bodymechanics-low back pain, risk factors for musculoskeletal disorders in the work place-behavioral aspects of posture - effectiveness. Individual differences, Factors contributing to personality, fitting the man to the job. Motivation -job satisfaction - Frustration and conflicts, reaction to frustration, emotion and frustration. Attitudes - determination of attitudes- changing attitudes.

**UNIT- III HAZARDS AND THEIR CONTROL 9**

Physical hazards-Noise, heat, vibration, ionizing and non-ionizing radiations, and effects. Chemical hazards-dusts, fumes, mist, vapor, fog, gases, types, concentration, exposure Vs dose, TLV. Mechanical hazards. Engineering control methods- use of personal protective equipments.

**UNIT- IV FIRE PREVENTION AND PROTECTION 9**

Fire triangle-principles of fire extinguishing- various classes of fires- A, B, C, D types of fire extinguishers- Industrial fire protection systems. Sprinklers- Fire hydrants- Alarm and detection systems- other suppression systems- $CO_2$ system, foam system and DCP system.

**UNIT- V SAFETY MANAGEMENT TECHNIQUES, EDUCATION AND TRAINING 9**

Incident Recall Technique (IRT), disaster control, Job safety Analysis, Safety survey, safety inspection. Safety training programs, seminars, conferences, competitions- method of promoting safe practice- motivation- creating awareness, awards, celebrations, safety posters, safety displays, safety incentive scheme- domestic safety and training.

**Total: 45Periods**

**COURSE OUTCOMES:**

After successful completion of this course, the Students will be able to

1. Understand the impact of posture and body mechanics on health.
2. Apply knowledge of exposure limits and engineering control methods, including the use of personal protective equipment, to reduce risk exposure.
3. Apply principles of fire extinguishing and identify appropriate types of fire extinguishers and industrial fire protection systems for different classes of fires.
4. Design or evaluate fire protection systems for a given industrial setting, including the selection of appropriate alarm, detection, and suppression systems.
5. Develop hazard control plans that integrate multiple strategies for hazard mitigation and compliance with safety standards.
6. Develop comprehensive safety training programs and initiatives aimed at promoting safe practices, motivation, and awareness among employees.

**REFERENCE BOOKS:**


1. Heinrich.H.W. “Industrial Accident Prevention”, McGraw Hill Company, New York, 1980.
2. Principles of Industrial Safety Management Understanding the Ws of Safety at Work-January 2020
3. Industrial Safety and Maintenance Management January 2019 by M. P. Poonia (Author), S. C. Sharma
4. Safety Management System And Documentation Training Programme Handbook (Pb 2019)– 30 June 2019 by Paul Sv
5. Industrial Safety, Health and Environment Management Systems Author R.K. Jain and Prof. Sunil S. Rao-2000
6. Ray Asfahl, C., “Industrial Safety and Health Management”, 5th Edition, Prentice Hall
7. John V. Grimaldi and Rollin H. Simonds, “Safety Management” , All India Travellers Book Seller,New Delhi, 1989.
8. E.J.McCormick and M.S. Sanders “Human Factors in Engineering and Design”, TMH, New Delhi,1982.
9. Krishnan.N.V. “Safety Management in Industry”, Jaico Publishing House, Bombay, 1997.
10. Lees, F. P. “Loss Prevention in Process Industries”, Butter Worth publications, London, 2nd Edition,1990.

11. Dan Peterson, “Techniques of Safety Management”, McGraw Hill Company, Tokyo, 1981.
12. “Accident Prevention Manual for Industrial Operations”, N.S.C. Chicago, 1982.
13. Hunter, Gomos, “Engineering Design for Safety”, McGraw Hill Inc., 1992.
14. Encyclopedia of “Occupational Health and Safety” Vol I and II, Published by International
LabourOffice, Geneva, 1985.
15. Gupta. R.S., “Hand Book of Fire Technology”, Orient Longman, Bombay, 1977.

## COURSE ARTICULATION MATRIX:

**CO/PO MAPPING**

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **CO.1** | | | | | | |
| **CO.2** | 3 | | 3 | 3 | | 3 |
| **CO.3** | | 2 | 2 | 2 | | 3 |
| **CO.4** | | 3 | 3 | | | |
| **CO.5** | | | | | 2 | 2 |
| **CO.6** | | | | | 2 | 2 |
| **21PCD601** | **3** | **3** | **3** | **3** | **2** | **3** |

**Ref: 3-Strong 2-Medium 1 –Weak**

| 21PCD602 | COST MANAGEMENT OF ENGINEERING PROJECTS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

The students will try to learn:

- Establish systems to help streamline the transactions between corporate support departments and the operating units.
- II. Devise transfer pricing systems to coordinate the buyer-supplier interactions between decentralized organizational operating units
- III. Use pseudo profit centers to create profit maximizing behavior in what were formerly cost center

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

Introduction and Overview of the Strategic Cost Management Process

**UNIT- II COST CONCEPTS** **9**

Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-making.

**UNIT- III PROJECT MANAGEMENT** **9**

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents.

Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

**UNIT- IV COST BEHAVIOR AND PROFIT PLANNING** **9**

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement, Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing

decisions including transfer pricing

**UNIT- V QUANTITATIVE TECHNIQUES 9**

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation Problems, Assignment problems, Simulation, Learning Curve Theory

**Total: 45Periods**

**COURSE OUTCOMES:**

After successful completion of this course, the Students will be able to

1. Summarize the concept of strategic cost management, strategic cost analysis – target costing, life cycle costing and Kaizen costing and the cost drive concept.
2. Describe the decision-making; relevant cost, differential cost, incremental cost and opportunity cost, objectives of a costing system.
3. Interpret the meaning and different types of project management and project execution, detailed engineering activities.
4. Understand the project contracts, cost behavior and profit planning types and contents, Bar charts and Network diagram.
5. Analyze by using quantitative techniques for cost management like PERT/CPM.

**REFERENCE BOOKS:**


1. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting.
2. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.
3. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi.
4. Charles T. Horngren and George Foster, Advanced ManagementAccounting.
5. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher


**Web References**

. https://onlinecourses.nptel.ac.in/noc16_ce02/preview