**ANNA UNIVERSITY, CHENNAI**

**NON- AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY**

**REGULATIONS -2021**

**M.E. PRODUCT DESIGN AND DEVELOPMENT**

**CHOICE BASED CREDIT SYSTEM**

## 1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

| I. | To prepare students to excel in new product design and development through application of knowledge and practical skills |
|---|---|
| II. | To provide students with a solid foundation in mathematical modeling of engineering problems required for bringing new products fast into the market |
| III. | To provide students with required scientific and engineering knowledge so as to comprehend, analyze, design and create innovative products and solutions for real life problems |

## 2. PROGRAMME OUTCOMES (POs):

| PO# | Programme Outcomes |
|---|---|
| 1 | An ability to independently carry out research/investigation and development work to solve practical problems |
| 2 | An ability to write and present a substantial technical report/document |
| 3 | Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program |
| 4 | Students will understand the importance of creativity in design process and will demonstrate an ability to identify, formulate, design a system and solve engineering problems. |
| 5 | an ability to use the techniques, and modern engineering tools necessary for engineering practice in product development |
| 6 | Responsibility of understanding ethically and professionally and develop confidence for self-education and ability for life-long learning. |

## 3. PEO/PO Mapping:

| PEO | PO | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| I | - | - | 1 | 3 | 3 | 1 |
| II | 2 | 2 | 2 | 3 | 1 | 1 |
| III | 1 | 1 | 1 | 3 | 2 | 3 |

**MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME**

| | | Subjects | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|
| YEAR 1 | SEM1 | Computer Applications in Design | 2 | - | 2 | 3 | 2 | - |
| | | Reverse Engineering | 1 | - | - | 3 | 2 | 1 |
| | | Creativity and Innovation | - | 1 | 1 | 3 | 1 | 3 |
| | | Integrated Product Development | 1 | - | 1 | 2 | 2 | 2 |
| | | Research Methodology and IPR | | | | | | |
| | | CAD Laboratory and Multibody Dynamics Laboratory | - | - | - | - | 3 | - |
| | | Reverse Engineering Laboratory | - | - | - | 2 | 3 | - |
| | | Professional Elective I | | | | | | |
| | | Audit course | | | | | | |
| | SEM2 | Finite Element Methods in Mechanical Design | 2 | - | - | 3 | 2 | - |
| | | Designing with Advanced Materials | 2 | 1 | - | 2 | - | - |
| | | Solid Freeform Manufacturing | 1 | 2 | 1 | - | 3 | |
| | | Design for Manufacture and Assembly | | | | | | |
| | | Concepts of Engineering Design | - | 2 | - | 2 | 3 | 2 |
| | | Professional Elective II | | | | | | |
| YEAR 2 | | Product Design Laboratory | - | - | - | 1 | 3 | - |
| | | Advanced Analysis and Simulation Laboratory | - | - | - | 1 | 3 | - |
| | SEM3 | Product Lifecycle Management | - | 1 | 2 | - | 2 | 3 |
| | | Professional Elective III | | | | | | |
| | | Professional Elective IV | | | | | | |
| | | Open Elective | | | | | | |
| | | Project Work I | | | | | | |
| | SEM4 | Project Work II | 3 | 3 | 2 | 2 | 2 | 3 |

PROGRESS THROUGH KNOWLEDGE

ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
M.E. PRODUCT DESIGN AND DEVELOPMENT
REGULATIONS – 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABUS

**SEMESTER I**

| SI. No. | Course Code | Course Title | Category | Periods per Week | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| THEORY | | | | | | | | |
| 1 | ED4153 | Computer Applications in Design | PCC | 3 | 0 | 0 | 3 | 3 |
| 2 | PD4153 | Reverse Engineering | PCC | 3 | 0 | 0 | 3 | 3 |
| 3 | PD4151 | Creativity and Innovation | PCC | 3 | 0 | 0 | 3 | 3 |
| 4 | PD4152 | Integrated Product Development | PCC | 3 | 0 | 0 | 3 | 3 |
| 5 | RM4151 | Research Methodology and IPR | RMC | 2 | 0 | 0 | 2 | 2 |
| 6 | | Professional Elective - I | PEC | 3 | 0 | 0 | 3 | 3 |
| 7 | | Audit Course - I* | AC | 2 | 0 | 0 | 2 | 0 |
| PRACTICAL | | | | | | | | |
| 8 | PD4111 | CAD Laboratory and Multibody Dynamics Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 9 | PD4112 | Reverse Engineering Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| | | | TOTAL | 19 | 0 | 8 | 27 | 21 |

* Audit Course is optional

**SEMESTER II**

| SI. No. | Course Code | Course Title | Category | Periods per Week | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| THEORY | | | | | | | | |
| 1 | ED4251 | Finite Element Methods in Mechanical Design | PCC | 3 | 1 | 0 | 4 | 4 |
| 2 | PD4291 | Designing with Advanced Materials | PCC | 3 | 0 | 0 | 3 | 3 |
| 3 | CM4152 | Solid Freeform Manufacturing | PCC | 3 | 0 | 0 | 3 | 3 |
| 4 | MF4071 | Design for Manufacture and Assembly | PCC | 3 | 0 | 0 | 3 | 3 |
| 5 | CD4151 | Concepts of Engineering Design | PEC | 3 | 0 | 0 | 3 | 3 |
| 6 | | Professional Elective - II | PEC | 3 | 0 | 0 | 3 | 3 |
| 7 | | Audit Course - II* | AC | 2 | 0 | 0 | 2 | 0 |
| PRACTICAL | | | | | | | | |
| 8 | PD4211 | Advanced Analysis and Simulation Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 9 | PD4261 | Product Design Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| | | | TOTAL | 20 | 1 | 8 | 29 | 23 |

* Audit Course is optional

## SEMESTER III

| SI. No. | Course Code | Course Title | Category | Periods per Week | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1 | PD4391 | Product Lifecycle Management | PCC | 3 | 0 | 0 | 3 | 3 |
| 2 | | Professional Elective - III | PEC | 3 | 0 | 0 | 3 | 3 |
| 3 | | Professional Elective - IV | PEC | 3 | 0 | 0 | 3 | 3 |
| 4 | | Open Elective | OEC | 3 | 0 | 0 | 3 | 3 |
| **PRACTICAL** | | | | | | | | |
| 5 | PD4311 | Project Work I | EEC | 0 | 0 | 12 | 12 | 6 |
| | | | **TOTAL** | **12** | **0** | **12** | **24** | **18** |

## SEMESTER IV

| SI. No. | Course Code | Course Title | Category | Periods per Week | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **PRACTICAL** | | | | | | | | |
| 1. | PD4411 | Project Work II | EEC | 0 | 0 | 24 | 24 | 12 |
| | | | **TOTAL** | **0** | **0** | **24** | **24** | **12** |

**TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE:74**
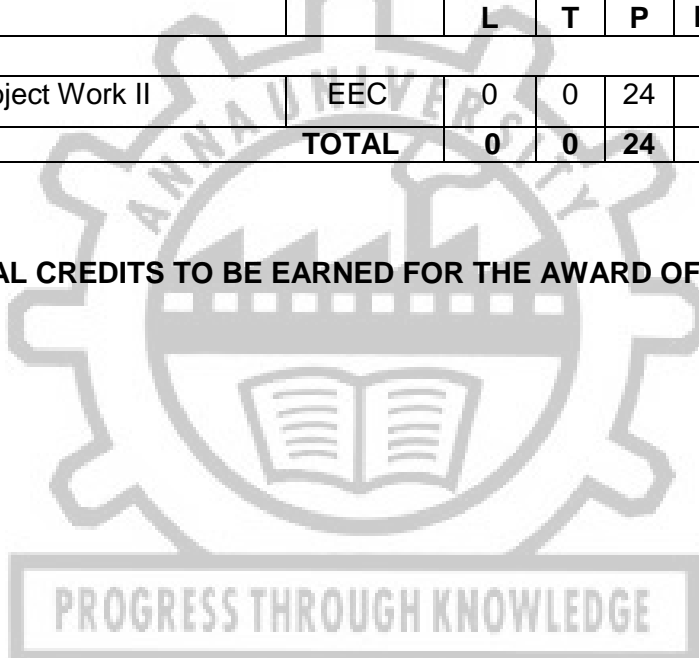
## PROFESSIONAL CORE COURSES (PCC)

| SI. No. | Course Code | Course Title | Category | Periods per Week | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | ED4153 | Computer Applications in Design | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | PD4153 | Reverse Engineering | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | PD4151 | Creativity and Innovation | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | PD4152 | Integrated Product Development | PCC | 3 | 0 | 0 | 3 | 3 |
| 5. | PD4111 | CAD Laboratory and Multibody Dynamics Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 6. | PD4112 | Reverse Engineering Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 7. | ED4251 | Finite Element Methods in Mechanical Design | PCC | 3 | 1 | 0 | 4 | 4 |
| 8. | PD4291 | Designing with Advanced Materials | PCC | 3 | 0 | 0 | 3 | 3 |
| 9. | CM4152 | Solid Freeform Manufacturing | PCC | 3 | 0 | 0 | 3 | 3 |
| 10. | MF4071 | Design for Manufacture and Assembly | PCC | 3 | 0 | 0 | 3 | 3 |
| 11. | PD4211 | Advanced Analysis and Simulation Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 12. | PD4261 | Product Design Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 13. | PD4391 | Product Lifecycle Management | PCC | 3 | 0 | 0 | 3 | 3 |

## PROFESSIONAL ELECTIVES

### SEMESTER I, ELECTIVE I

| SI. No. | Course Code | Course Title | Category | Periods per Week | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1 | ED4080 | Tribology in Design | PEC | 3 | 0 | 0 | 3 | 3 |
| 2 | CC4071 | Advanced Machine Tool Design | PEC | 3 | 0 | 0 | 3 | 3 |
| 3 | PD4001 | Generative Design and Topology Optimization | PEC | 3 | 0 | 0 | 3 | 3 |
| 4 | IS4071 | Data Analytics | PEC | 3 | 0 | 0 | 3 | 3 |

## SEMESTER II, ELECTIVE II

| Sl. No. | Course Code | Course Title | Category | Periods per Week | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1 | CD4092 | Industrial Robotics and Expert Systems | PEC | 3 | 0 | 0 | 3 | 3 |
| 2 | ED4092 | Engineering Fracture Mechanics | PEC | 3 | 0 | 0 | 3 | 3 |
| 3 | PD4002 | Enterprise Resource Planning and Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 4 | AO4091 | Artificial Intelligence and Machine Learning | PEC | 3 | 0 | 0 | 3 | 3 |
| 5 | PD4003 | Design for Additive Manufacturing | PEC | 3 | 0 | 0 | 3 | 3 |

## SEMESTER III, ELECTIVE III

| Sl. No. | Course Code | Course Title | Category | Periods per Week | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1 | PD4004 | Quality and Financial Concepts in Product Development. | PEC | 3 | 0 | 0 | 3 | 3 |
| 2 | ED4093 | Optimization Techniques in Design | PEC | 3 | 0 | 0 | 3 | 3 |
| 3 | ED4154 | Vibration Analysis and Control | PEC | 3 | 0 | 0 | 3 | 3 |
| 4 | PD4005 | IOT Technologies | PEC | 3 | 0 | 0 | 3 | 3 |
| 5 | IC4291 | Computational Fluid Dynamics | PEC | 3 | 0 | 0 | 3 | 3 |

## SEMESTER III, ELECTIVE IV

| Sl. No. | Course Code | Course Title | Category | Periods per Week | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1 | PD4006 | Human Factors Engineering in Product Design | PEC | 3 | 0 | 0 | 3 | 3 |
| 2 | ED4071 | Design of Hybrid and Electric Vehicles | PEC | 3 | 0 | 0 | 3 | 3 |
| 3 | PD4007 | Rotor Dynamics | PEC | 3 | 0 | 0 | 3 | 3 |
| 4 | CD4091 | Bio materials | PEC | 3 | 0 | 0 | 3 | 3 |

## EMPLOYABILITY ENHANCEMENT COURSES (EEC)

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | PD4311 | Project Work I | EEC | 0 | 0 | 12 | 12 | 6 |
| 2. | PD4411 | Project Work II | EEC | 0 | 0 | 24 | 24 | 12 |

## AUDIT COURSES (AC)
### Registration for any of these courses is optional to students

| SL. NO | COURSE CODE | COURSE TITLE | PERIODS PER WEEK | | | CREDITS |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| 1. | AX4091 | English for Research Paper  Writing | 2 | 0 | 0 | 0 |
| 2. | AX4092 | Disaster Management | 2 | 0 | 0 | 0 |
| 3. | AX4093 | Constitution of India | 2 | 0 | 0 | 0 |
| 4. | AX4094 | நற்றமிழ் இலக்கியம் | 2 | 0 | 0 | 0 |

## LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

| SL. NO. | COURSE CODE | COURSE TITLE | PERIODS PER WEEK | | | CREDITS |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| 1. | OCE431 | Integrated Water Resources Management | 3 | 0 | 0 | 3 |
| 2. | OCE432 | Water, Sanitation and Health | 3 | 0 | 0 | 3 |
| 3. | OCE433 | Principles of Sustainable Development | 3 | 0 | 0 | 3 |
| 4. | OCE434 | Environmental Impact Assessment | 3 | 0 | 0 | 3 |
| 5. | OIC431 | Blockchain Technologies | 3 | 0 | 0 | 3 |
| 6. | OIC432 | Deep Learning | 3 | 0 | 0 | 3 |
| 7. | OBA431 | Sustainable Management | 3 | 0 | 0 | 3 |
| 8. | OBA432 | Micro and Small Business Management | 3 | 0 | 0 | 3 |
| 9. | OBA433 | Intellectual Property Rights | 3 | 0 | 0 | 3 |
| 10. | OBA434 | Ethical Management | 3 | 0 | 0 | 3 |
| 11. | ET4251 | IoT for Smart Systems | 3 | 0 | 0 | 3 |
| 12. | ET4072 | Machine Learning and Deep Learning | 3 | 0 | 0 | 3 |
| 13. | PX4012 | Renewable Energy Technology | 3 | 0 | 0 | 3 |
| 14. | PS4093 | Smart Grid | 3 | 0 | 0 | 3 |
| 15. | CP4391 | Security Practices | 3 | 0 | 0 | 3 |
| 16. | MP4251 | Cloud Computing Technologies | 3 | 0 | 0 | 3 |
| 17. | IF4072 | Design Thinking | 3 | 0 | 0 | 3 |
| 18. | MU4153 | Principles of Multimedia | 3 | 0 | 0 | 3 |
| 19. | DS4015 | Big Data Analytics | 3 | 0 | 0 | 3 |
| 20. | NC4201 | Internet of Things and Cloud | 3 | 0 | 0 | 3 |
| 21. | MX4073 | Medical Robotics | 3 | 0 | 0 | 3 |
| 22. | VE4202 | Embedded Automation | 3 | 0 | 0 | 3 |
| 23. | CX4016 | Environmental Sustainability | 3 | 0 | 0 | 3 |
| 24. | TX4092 | Textile Reinforced Composites | 3 | 0 | 0 | 3 |
| 25. | NT4002 | Nanocomposite Materials | 3 | 0 | 0 | 3 |
| 26. | BY4016 | IPR, Biosafety and Entrepreneurship | 3 | 0 | 0 | 3 |

| **ED4153** | **COMPUTER APPLICATIONS IN DESIGN** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **0** | **3** |

**COURSE OBJECTIVES:**
- 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**
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: Line Drawing Algorithm - DDA, Bresenham's and Parallel Line Algorithm. Circle generating algorithm – Midpoint Circle Algorithm.
Geometric Transformations: Coordinate Transformations, Windowing and Clipping,  2D Geometric transformations-Translation, Scaling, Shearing, Rotation and Reflection, Composite transformation, 3D transformations.

**UNIT – II    CURVES AND SURFACES MODELLING    9**
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: Hermitebicubic surface- Bezier surface and B-Spline surface- surface manipulations.

**UNIT – III    NURBS AND SOLID MODELING    9**
NURBS- Basics- curves, lines, arcs, circle and bi linear 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**
Hidden Line removal,   Hidden Surface removal, – Hidden Solid Removal algorithms - Shading – Coloring.
Animation - Conventional, Computer animation, Engineering animation - types and techniques.

**UNIT – V    ASSEMBLY OF PARTS AND PRODUCT LIFE CYCLE    9**
**    MANAGEMENT**
Assembly modeling – Design for manufacture – Design for assembly – computer aided DFMA - inferences of positions and orientation - tolerances analysis –Center of Gravity and mass property calculations - mechanism simulation.  Graphics and computing standards - Data Exchange standards.  Product development and management – new product development –models utilized in various phases of new product development – managing product life cycle.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**
Upon 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. Use the different geometric modeling techniques like feature based modeling, surface modeling and solid modeling.
4. Create geometric models through animation and transform them into real world systems
5. Simulate assembly of parts using Computer-Aided Design software.

**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, 1996.
5. Ibrahim Zeid, "Mastering CAD/CAM", McGraw Hill, 2nd Edition, 2006
6. William M Newman and Robert F.Sproull "Principles of Interactive Computer Graphics", McGraw Hill Book Co. 1stEdition, 2001.

**Mapping of CO with PO**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 1 | 2 | 1 | 3 | 3 | 2 |
| **2** | 1 | 2 | 1 | 3 | 3 | 2 |
| **3** | 1 | 2 | 1 | 3 | 3 | 2 |
| **4** | 1 | 2 | 1 | 3 | 3 | 2 |
| **Avg.** | 1 | 2 | 1 | 3 | 3 | 2 |

**1-low, 2-medium, 3-high, '-"- no correlation**

| PD4153 | REVERSE ENGINEERING | L T P C |
|---|---|---|
| | | 3 0 0 3 |

**COURSE OBJECTIVES:**
1. Applying the fundamental concepts and principles of reverse engineering in product design and development.
2. Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
3. Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
4. Applying the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
5. Analyzing the various legal aspect and applications of reverse engineering in product design and development.

## UNIT I INTRODUCTION TO REVERSE ENGINEERING & GEOMETRIC FORM    9

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

## UNIT II MATERIAL CHARACTERISTICS, PART DURABILITY AND LIFE LIMITATION    9

Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure

## UNIT III MATERIAL IDENTIFICATION AND PROCESS de VERIFICATION    9

Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

## UNIT IV DATA PROCESSING, PART PERFORMANCE AND SYSTEM COMPATIBILITY    9

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

## UNIT V ACCEPTANCE, LEGALITY AND INDUSTRIAL APPLICATIONS OF RE    9

Legality of Reverse Engineering – Patent – Copyrights –Trade Secret – Third-Party Materials – Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

1. Apply the fundamental concepts and principles of reverse engineering in product design and development.
2. Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
3. Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.
4. Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
5. Analyze the various legal aspect and applications of reverse engineering in product design and development

**REFERENCES**

1. Co-ordinate Measurement and reverse engineering, Donald R. Honsa, ISBN 1555897, American Gear Manufacturers Association
2. Data Reverse Engineering, Aiken, Peter, McGraw-Hill, 1996
3. Design Recovery for Maintenance and Reuse, T J Biggerstaff, IEEE Corpn. July 1991
4. Reverse Engineering, Katheryn, A. Ingle, McGraw-Hill, 1994
5. Reverse Engineering, Linda Wills, Kluiver Academic Publishers, 1996
6. White paper on RE, S. Rugaban, Technical Report, Georgia Instt. of Technology, 1994

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 3 | 2 | 1 | 1 | - | - |
| 2 | 3 | 3 | 1 | 2 | - | - |
| 3 | 3 | 3 | 1 | 2 | - | 1 |
| 4 | 3 | 3 | 1 | 2 | - | 1 |
| 5 | 1 | 2 | 1 | 1 | - | 1 |
| AVg. | 2.6 | 2.6 | 1 | 1.6 | - | 1 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**PD4151**             **CREATIVITY AND INNOVATION**             **L  T  P  C**
                                                                **3  0  0  3**

**COURSE OBJECTIVES:**
1. Applying the principles of essential theory of creativity in new product design and development.
2. Applying the principles of various methods and tools for creativity in new product design and development.
3. Applying the design principles of creativity in new product design and development.
4. Applying the various innovation principles and practices in new product design and development.
5. Applying the principles of innovation management in new product design and development.

**UNIT I          INTRODUCTION TO ESSENTIAL THEORY OF CREATIVITY          9**
Directed creativity: The Need for Creative Thinking in the Pursuit of Quality - Essential Theory for Directed Creativity: Definitions and the Theory of the Mechanics of Mind; Heuristics and Models: Attitudes, Approaches, and Actions That Support Creative Thinking.

**UNIT II          METHODS AND TOOLS FOR CREATIVITY          9**
Three basic principles behind the tools of directed creativity – Tools that prepare the mind for creative thought – Tools that stimulate the imagination for new idea – Development and action: the bridge between mere creativity and the rewards of innovation - ICEDIP: Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation

**UNIT III          DESIGN AND APPLICATION OF CREATIVITY          9**
Three levels of emotional design: Visceral, Behavioral and Reflective – Process design, reengineering, and creativity – Creativity and customer needs analysis – Innovative product and service design – Creative problem solving and incremental improvement.

**UNIT IV          INNOVATION PRINCIPLES & PRACTICES          9**
Methods of Creativity Activation: Morphological Box – Requirements for Inventive Problem Solving – Altshuller's Engineering Parameters– Altshuller's Inventive Principles– Altshuller's Contradiction Matrix Algorithm.

**UNIT V          INNOVATION MANAGEMENT          9**
Disruptive Innovation Model – Two Types of Disruption – Three Approaches to Creating New- Growth Businesses – New Market Disruptions: Three Case Histories – Product Architectures and Integration – Process of commoditation and de-commoditation – Two Processes of Strategy Formulation – Role of senior executive in leading new growth: The Disruptive Growth Engine.

                                                                **TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**
Upon completion of the course, the students will be able to
  1. Apply the principles of essential theory of creativity in new product design and development.
  2. Apply the principles of various methods and tools for creativity in new product design and development.
  3. Apply the design principles of creativity in new product design and development.
  4. Apply the various innovation principles and practices in new product design and development.
  5. Apply the principles of innovation management in new product design and development

**REFERENCES**
1. Clayton M. Christensen Michael E. Raynor," The Innovator's Solution", Harvard Business School Press Boston, USA, 2013
2. Donald A. Norman," Emotional Design", Perseus Books Group New York , 2004
3. Geoffrey Petty," how to be better at Creativity", The Industrial Society 1999
4. Rousing Creativity: Think New Now Floyd Hurr, ISBN 1560525479, Crisp Publications Inc. 1999
5. Semyon D. Savransky," Engineering of Creativity – TRIZ", CRC Press New York USA 2003.

| CO | PO | | | | | |
|-----|---|---|---|---|---|---|
|     | 1 | 2 | 3 | 4 | 5 | 6 |
| 1   | 2 | 2 | 2 | 3 | 2 | 3 |
| 2   | 2 | 2 | 2 | 3 | 2 | 3 |
| 3   | 2 | 2 | 2 | 3 | 2 | 3 |
| 4   | 2 | 2 | 2 | 3 | 2 | 3 |
| 5   | 2 | 2 | 2 | 3 | 2 | 3 |
| AVg. | 2 | 2 | 2 | 3 | 2 | 3 |

**1-low, 2-medium, 3-high, '-"- no correlation**

| PD4152 | INTEGRATED PRODUCT  DEVELOPMENT | L | T | P | C |
|--------|--------------------------------|---|---|---|---|
|        |                                | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**
1. To Understand the principles of generic development process; product planning; customer need analysis for new product design and development.
2. To enhance the understanding of setting product specifications and generate, select, screen, and test concepts for new product design and development.
3. To apply the principles of product architecture and the importance of industrial design principles and DFM principles for new product development.
4. To expose the different Prototyping techniques, Design of Experiment principles to develop a robust design and importance to patent a developed new product.
5. Applying the concepts of economics principles; project management practices in development of new product.

**UNIT– I       INTRODUCTION TO PRODUCT DESIGN                                    9**
Characteristics of Successful Product development –Duration and Cost of Product Development – Challenges of Product Development - Product Development Processes and Organizations – Product Planning Process - Process of Identifying Customer Needs

**UNIT– II      PRODUCT SPECIFICATIONS, CONCEPT GENERATION,                     9**
**SELECTION AND TESTING**
Establish Target and Final product specifications – Activities of Concept Generation - Concept Screening and Scoring - Concept Testing Methodologies.

## UNIT–III  PRODUCT ARCHITECTURE AND INDUSTRIAL DESIGN                    9

Product Architecture – Implications and establishing the architecture – Delayed Differentiation – Platform Planning – Related system level design issues - Need and impact of industrial design - Industrial design process - management of the industrial design process - assessing the quality of industrial design

## UNIT– IV  DESIGN FOR MANFACTURE,  PROTOTYPING AND ROBUST DESIGN                    9

DFM Definition - Estimation of Manufacturing cost- Reducing the component costs, costs of supporting function and assembly costs – Impact of DFM decision on other factors - Prototype basics - Principles of prototyping – Prototyping technologies - Planning for prototypes - Robust design –Robust Design Process

## UNIT– V  PRODUCT DEVELOPMENT ECONOMICS AND MANAGING PROJECTS                    9

Economic Analysis – Elements of Economic Analysis - Understanding and representing tasks- Baseline Project Planning - Accelerating the project - Project execution – Postmortem project evaluation.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:
1. Apply the principles of generic development process; product planning; customer need analysis for new product design and development.
2. Set product specifications and generate, select, screen, test concepts for new product design and development.
3. Apply the principles of product architecture, industrial design and design for manufacturing principles in new product development.
4. Apply the adopt Prototyping techniques and Design of Experiment principles to develop a  robust design and document a new product for patent.

**REFERENCES:**

1. Karl T.Ulrich, Steven D.Eppinger, Anita Goyal, "Product Design and Development", McGraw –Hill Education (India) Pvt. Ltd, 4th Edition, 2012.
2. Kenneth Crow, "Concurrent Engineering/Integrated Product Development". DRM Associates, 6/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book
3. Kevin N Otto, Kristin L Wood, "Product Design – Techniques in Reverse Engineering and New Product Development", Pearson Education, Inc, 2016
4. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin Homewood, 1992
5. Stuart Pugh, "Total Design – Integrated Methods for successful Product Engineering", Addison Wesley Publishing, Neyourk, NY, 1991**.**

| CO | PO | | | | | |
|----|----|----|----|----|----|----|
|    | 1  | 2  | 3  | 4  | 5  | 6  |
| 1  | 3  | 3  | 3  | 3  | 3  | -  |
| 2  | 3  | 3  | 3  | 3  | 3  | -  |
| 3  | 3  | 3  | 3  | 3  | 3  | -  |
| 4  | 3  | 3  | 3  | 3  | 3  | -  |
| 5  | 3  | 3  | 3  | 3  | 3  | -  |
| AVg. | 3 | 3 | 3 | 3 | 3 | - |

**1-low, 2-medium, 3-high, '-"- no correlation**

**RM4151**          **RESEARCH METHODOLOGY AND IPR**          **L T P C**
                                                                          **2 0 0 2**

**UNIT I          RESEARCH DESIGN                                6**
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

**UNIT II          DATA COLLECTION AND SOURCES                  6**
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods.
Data - Preparing, Exploring, examining and displaying.

**UNIT III          DATA ANALYSIS AND REPORTING                 6**
Overview of Multivariate analysis, Hypotheses testing and Measures of Association.
Presenting Insights and findings using written reports and oral presentation.

**UNIT IV          INTELLECTUAL PROPERTY RIGHTS                 6**
Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

**UNIT V          PATENTS                                       6**
Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.
                                                        **TOTAL : 30 PERIODS**
**REFERENCES**
1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

**PD4111     CAD LABORATORY AND MULTIBODY DYNAMICS LABORATORY   L   T   P   C**
                                                                          **0   0   4   2**

**COURSE OBJECTIVE:**
- To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modelling software's.
- To expose the students to understand the forces and torques that come into action in various kinds of mechanical systems.

1.     CAD Introduction & Sketcher
2.     Solid modeling–Extrude, Revolve, Sweep, etc and Variational sweep, Loft, etc
3.     Surface modeling–Extrude, Sweep, Trim..etc and Mesh of curves, Free form etc
4.     Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc.
5.     Assembly-Constraints, Exploded Views, Interference check
6.     Drafting - Layouts, Standard & Sectional Views, Detailing &Plotting.

7. CAD data Exchange formats-IGES,PDES, PARASOLID,DXF and STL.
8. Free fall of rigid body
9. Projectile motion
10. Simulation of simple & Compound Pendulum
11. Kinematic & Dynamic Analysis four bar and slider crack mechanism and its inversions
12. Design of cam Profile for various follower output motion
13. Kinematic & Dynamic Analysis of Gear Tracks
14. Vibration Analysis SDOF and MDOF
15. Project on virtual product design using ADAMS

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

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES:**
- With laboratory classes, it helps the students to get familiarized with the computer applications in design and preparing drawings for various mechanical components.
- The students get familiarized with modeling different systems and importing them into the multi body dynamic software.
- The students will be trained to obtain required dynamic properties by conducting multi body dynamic tests.
- The students will learn how to use this data in additional stress analysis software.

| CO | PO | | | | | |
|----|----|----|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 3 | 3 | 3 | 2 | - | - |
| 2 | 3 | 3 | 3 | 2 | - | - |
| 3 | 3 | 3 | 3 | 2 | - | - |
| 4 | 3 | 3 | 3 | 2 | - | - |
| 5 | 3 | 3 | 3 | 2 | - | - |
| AVg. | 3 | 3 | 3 | 2 | - | - |

**1-low, 2-medium, 3-high, '-"- no correlation**

**PROGRESS THROUGH KNOWLEDGE**

| PD4112 | REVERSE ENGINEERING LABORATORY | L T P C |
|--------|-------------------------------|---------|
| | | 0 0 4 2 |

**COURSE OBJECTIVES:**
1. Applying the fundamental concepts and principles of reverse engineering in product design and development.
2. Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
3. Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
4. Applying the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
5. Analyzing the various legal aspect and applications of reverse engineering in product design and development.

**Exercises**
1. Surface measurement – CMM.
2. 3D Laser scanning of components.
3. Reverse engineering of Automotive components-cam shaft.
4. Material identification and process verification of welded components.
5. Reverse engineering of dental components - Bio medical applications.

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES:**
Upon completion of the course, the students will be able to
- Apply the fundamental concepts and principles of reverse engineering in product design and development.
- Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
- Analyze the various legal aspect and applications of reverse engineering in product design and development.

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 3 | 2 | 1 | 1 | - | |
| 2 | 3 | 3 | 1 | 2 | - | |
| 3 | 3 | 3 | 1 | 2 | - | 1 |
| 4 | 3 | 3 | 1 | 2 | - | 1 |
| 5 | 1 | 2 | 1 | 1 | - | 1 |
| AVg. | 2.6 | 2.6 | 1 | 1.6 | - | 1 |

**1-low, 2-medium, 3-high, '-"- no correlation**

| ED4251 | FINITE ELEMENT METHODS IN MECHANICAL DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**COURSE OBJECTIVES**
1. To learn mathematical models for one dimensional problems and their numerical solutions
2. To learn two dimensional scalar and vector variable problems to determine field variables
3. To learn Iso parametric transformation and numerical integration for evaluation of elementmatrices
4. To study various solution techniques to solve Eigen value problems
5. To learn solution techniques to solve non-linear problems

**UNIT- I          FINITE ELEMENT ANALYSIS OF ONEDIMENSIONAL          9+3
                  PROBLEMS**

Historical Background – Weighted Residual Methods - Basic Concept of FEM – Variational Formulation of B.V.P. – Ritz Method – Finite Element Modelling – Element Equations – Linear and Higher order Shape functions – Bar, Beam Elements –Applications to Heat Transfer problems.

**UNIT- II          FINITE ELEMENT ANALYSIS OF TWO          9+3
                  DIMENSIONAL PROBLEMS**

Basic Boundary Value Problems in two-dimensions – Linear and higher order Triangular, quadrilateral elements – Poisson's and Laplace's Equation – Weak Formulation – Element Matrices and Vectors – Application to scalar variable problems - Introduction to Theory of Elasticity – Plane Stress – Plane Strain and Axisymmetric Formulation – Principle of virtual work – Element matrices using energy approach

**UNIT- III          ISO-PARAMETRIC FORMULATION          9+3**

Natural Co-ordinate Systems – Lagrangian Interpolation Polynomials – Iso parametric Elements –Formulation – Shape functions -one dimensional , two dimensional triangular and quadrilateral elements -Serendipity elements- Jacobian transformation - Numerical Integration – Gauss quadrature – one, two and three point integration

**UNIT- IV          EIGEN VALUE PROBLEMS          9+3**

Dynamic Analysis – Equations of Motion – Consistent and lumped mass matrices – Free Vibration analysis – Natural frequencies of Longitudinal, Transverse and torsional vibration – Solution of Eigenvalue problems - Introduction to transient field problems

**UNIT-V          NON-LINEAR ANALYSIS          9+3**

Introduction to Non-linear problems - some solution techniques- computational procedure- material non-linearity-Plasticity and viscoplasticity, stress stiffening, contact interfaces- problems of gaps and contact - geometric non-linearity - modeling considerations - Free and Mapped meshing -Mesh quality- Error estimate

**TOTAL = 60  PERIODS**

**COURSE OUTCOMES:**
On Completion of the course the student will be able to
- **CO1**     Develop mathematical models for one dimensional problems and their numericalsolutions
- **CO2**     Determine field variables for two dimensional scalar  and vector variable problems
- **CO3**     Apply Isoparametric transformation and numerical integration for  evaluation of elementmatrices
- **CO4**     Apply various solution techniques to solve Eigen value problems
- **CO5**     Formulate  solution techniques to solve non-linear  problems

**REFERENCES:**
1.    Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall, 1990
2.    David Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw Hill, 2005
3.    Rao, S.S., "The Finite Element Method in Engineering", 6th Edition, Butterworth-Heinemann,2018.
4.    Reddy, J.N. "Introduction to the Finite Element Method", 4 th Edition, Tata McGraw Hill,2018
5.    Seshu.P, "Text Book of Finite Element Analysis", PHI Learning Pvt. Ltd., New Delhi, 2012.
6.    Tirupathi R. Chandrupatla and Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", International Edition, Pearson Education Limited, 2014.

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 3 | 2 | 2 | 2 | 3 | - |
| **2** | 3 | 2 | 2 | 2 | 3 | - |
| **3** | 3 | 2 | 2 | 2 | 3 | - |
| **4** | 3 | 2 | 2 | 2 | 3 | - |
| **5** | 3 | 2 | 2 | 2 | 3 | - |
| **AVg.** | 3 | 2 | 2 | 2 | 3 | - |

**1-low, 2-medium, 3-high, '-"- no correlation**

**PD4291      DESIGNING WITH ADVANCED MATERIALS**      L  T  P  C
                                                      3  0  0  3

**OBJECTIVES**:
The main learning objective of this course is to prepare the students for:
1. Analyzing the different strengthening and failure mechanism of the metals
2. Applying the effects of metallurgical parameters in the materials design
3. Analyzing the relationship between the selection of materials and processing
4. Developing the novel material through understanding the properties of the existing metallic materials
5. Analyzing the different materials used in the engineering applications.

**UNIT I      INTRODUCTION TO REVERSE ENGINEERING & GEOMETRICFORM      9**
Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

**UNIT II      MATERIAL CHARACTERISTICS, PART DURABILITY AND LIFE LIMITATION 9**
Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure

**UNIT III      MATERIAL IDENTIFICATION AND PROCESS VERIFICATION      9**
Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

**UNIT IV      DATA PROCESSING, PART PERFORMANCE AND
               SYSTEM COMPATIBILITY      9**
Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

**UNIT V      ACCEPTANCE, LEGALITY AND INDUSTRIAL APPLICATIONS OF RE      9**
Legality of Reverse Engineering – Patent – Copyrights –Trade Secret – Third-Party Materials – Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry.

**TOTAL : 45 PERIODS**

**OUTCOMES:**
On Completion of the course the student will be able to
- Analyze the different strengthening and failure mechanism of the metals
- Apply the effects of metallurgical parameters in the materials design
- Analyze the relationship between the selection of materials and processing
- Develop the novel material through understanding the properties of the existing metallic materials
- Analyze the different materials used in the engineering applications

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 3 | - | 3 | 1 | 1 | 2 |
| **2** | 3 | - | 3 | 1 | 1 | 2 |
| **3** | 3 | - | 3 | 1 | 1 | 2 |
| **4** | 3 | - | 3 | 1 | 1 | 2 |
| **5** | 3 | - | 3 | 1 | 1 | 2 |
| **Avg.** | 3 | - | 3 | 1 | 1 | 2 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**REFERENCES:**
1. George E.Dieter, Mechanical Metallurgy, McGraw Hill, 1988
2. Thomas H. Courtney, Mechanical Behavior of Materials, (2nd edition), McGraw Hill, 2000
3. Willam D. CallisterJr.and David G. Rethwisch, Callister's Materials Science and Engineering,(2nd edition)Wiley Editorial,2018
4. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials,(34d edition), Butterworth-Heiremann, 1997
5. Flinn, R.A., and Trojan, P.K., Engineering Materials and their Applications, (4th Edition) Jaico, 1999
6. Metals Hand book, Vol.10, Failure Analysis and Prevention, (10th Edition), Jaico, 1999
7. Ashby M.F., materials selection in Mechanical Design 2nd Edition, Butter worth 1999
8. www.astm.org/labs/pages/131350.htm

| CM4152 | **SOLID FREEFORM MANUFACTURING** | L T P C |
|---|---|---|
| | | 3 0 0 3 |

**COURSE OBJECTIVES:**
- To acquaint the students with evolution of Solid Freeform Manufacturing (SFM) / Additive Manufacturing (AM), proliferation into various fields and its effects on supply chain.
- To gain knowledge on Design for Additive Manufacturing (DFAM) and its importance in quality improvement of fabricated parts.
- To acquaint with polymerization and sheet lamination processes and their applications.
- To acquaint with material extrusion and powder bed fusion processes.
- To gain knowledge on jetting and direct energy deposition processes and their applications.

**UNIT I       INTRODUCTION                                                                          9**
Need - Development of SFM systems – Hierarchical structure of SFM - SFM process chain – Classification – Applications. Case studies: Bio printing- Food Printing- Electronics printing – Rapid Tooling - Building printing. AM Supply chain. Economics aspect: Strategic aspect- Operative aspect.

**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        VAT POLYMERIZATION AND SHEET LAMINATION PROCESSES        9**
Stereolithography Apparatus (SLA): Principles – Photo Polymerization of SL Resins - Pre Build Process – Part-Building and Post-Build Processes - Part Quality and Process Planning, Recoating Issues - Materials - Advantages - Limitations and Applications. Digital Light Processing (DLP) - Materials - Process - Advantages and Applications.
Laminated Object Manufacturing (LOM): Working Principles - Process - Materials, Advantages, Limitations and Applications. Ultrasonic Additive Manufacturing (UAM) - Process - Parameters - Applications. Case Studies.

**UNIT IV        MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES        9**
Fused deposition Modeling (FDM): Working Principles - Process - Materials and Applications. Design Rules for FDM.
Selective Laser Sintering (SLS): Principles - Process - Indirect and Direct SLS - Powder Structure – Materials - Surface Deviation and Accuracy - Applications. Multijet Fusion.
Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Principles – Processes – Materials – Advantages - Limitations and Applications. Case Studies.

**UNIT V        JETTING AND DIRECT ENERGY DEPOSITION PROCESSES        9**
Binder Jetting: Three dimensional Printing (3DP): Principles – Process - Physics of 3DP - Types of printing: Continuous mode – Drop on Demand mode - Process – Materials - Advantages - Limitations - Applications.
Material Jetting: Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.
Laser Engineered Net Shaping (LENS): Processes- Materials- Advantages - Limitations and Applications. Case Studies.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**
At the end of this course, the students shall be able to:
CO1:  Relate the importance in the evolution of SFM/AM, proliferation into the various fields and its effects on supply chain.
CO2:  Analyze the design for AM and its importance in the quality of fabricated parts.
CO3:  Build knowledge on principles and applications of polymerization and sheet lamination processes with case studies.
CO4:  Explain the principles of material extrusion and powder bed fusion processes and design guidelines.
CO5:  Elaborate jetting and direct energy deposition processes and their applications.

**REFERENCES:**
1.  Andreas Gebhardt and Jan-Steffen Hotter, "Additive Manufacturing:3D Printing for Prototyping and Manufacturing", Hanser publications Munchen, Germany, 2016. ISBN:978-1-56990-582-1.
2.  Ben Redwood, Brian Garret, FilemonSchöffer, and Tony Fadel, "The 3D Printing Handbook: Technologies, Design and Applications", 3D Hubs B.V., Netherland, 2017. ISBN-13: 978-9082748505.
3.  Ian Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" Springer - New York, USA, 2nd Edition, 2015. ISBN-13: 978-1493921126.
4.  Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 1st Edition, 2007 FL, USA. ISBN- 9780849334092.
5.  Milan Brandt., "Laser Additive Manufacturing 1st Edition Materials, Design, Technologies, and Applications", Woodhead Publishing, UK, 2016. ISBN- 9780081004333.

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 2 | 3 | 1 | 3 | 3 | 2 |
| **2** | 3 | 2 | 3 | 3 | 3 | 2 |
| **3** | 3 | 3 | 2 | 3 | 2 | 1 |
| **4** | 3 | 3 | 2 | 3 | 2` | 1 |
| **5** | 3 | 3 | 2 | 3 | 2 | 1 |
| **Avg.** | (14/5)=2.8 | (14/5)=2.8 | (10/5)=2 | (15/5)=3 | (10/4)=2.5 | (7/5)=1.4 |

**MF4071**      **DESIGN FOR MANUFACTURE AND ASSEMBLY**      **L T P C**
                                                              **3 0 0 3**

**OBJECTIVES:**
(1) To apply various design rules in manufacturing processes
(2) To evaluate the process by design guidelines for optimum design
(3) To analyze the rules of concepts of GD& T
(4) To make the students to learn about tolerance analysis and allocation, geometrical tolerances
(5) Guidelines for design for manufacturing and assembly with suitable examples.

**UNIT I      TOLERANCE ANALYSIS                                              9**
Introduction – Concepts, definitions and relationships of tolerancing – Matching design tolerances with appropriate manufacturing process – manufacturing process capability metrics – Worst care, statistical tolerance Analysis – Linear and Non-Linear Analysis – Sensitivity Analysis – Taguchi's Approach to tolerance design.

**UNIT II      TOLERANCE ALLOCATION                                          9**
Tolerance synthesis – Computer Aided tolerancing – Traditional cost based analysis – Taguchi's quality loss function – Application of the Quadratic loss function to Tolerancing – Principles of selective Assembly – Problems.

**UNIT III      GD&T                                                         9**
Fundamentals of geometric dimensioning and tolerancing – Rules and concepts of GD&T – Form controls – Datum systems – Orientation controls – Tolerance of position – Concentricity and symmetry controls – Run out controls – Profile controls.

**UNIT IV      TOLERANCE CHARTING                                           9**
Nature of the tolerance buildup – structure and setup of the tolerance chart – piece part sketches for tolerance charts – Arithmetic ground rules for tolerance charts – Determination of Required balance dimensions – Determination of Mean working Dimensions – Automatic tolerance charting – Tolerance charting of Angular surfaces.

**UNIT V      MANUFACTURING GUIDELINES                                      9**
DFM guidelines for casting, weldment design – Formed metal components – Turned parts – Milled, Drilled parts – Non-metallic parts – Computer Aided DFM software – Boothroyd and Dewhurst method of DFMA – DCS – Vis/VSA – 3D Dimensional control – Statistical tolerance Analysis Software – Applications.

                                                              **TOTAL: 45 PERIODS**
**OUTCOMES :**
At the end of this course the students are expected
(1)To impart the knowledge about the significance of design for manufacturing and assembly
(2)To apply the principle of tolerancing in design
(3)Evaluate the process of GD & T using design guidelines
(4)Apply tolerance allocation and tolerance charting in design
(5)Apply guidelines for manufacturing and assembly

**REFERENCES:**
1. Alex Krulikowski, "Fundamentals GD&T", Delmar Thomson Learning, 1997.
2. C.M. Creveling, "Tolerance Design – A handbook for Developing Optimal Specifications", Addison – Wesley, 1997.
3. James D. Meadows, 'Geometric Dimensioning and Tolerancing", Marcel Dekker Inc., 1995.
4. James G. Bralla, "Handbook of Product Design for Manufacturing", McGraw Hill, 1986.
5. Oliver R. Wade, "Tolerance Control in Design and Manufacturing", Industrial Press, NY, 1967.

**CO-PO Mapping**

| CO | PO | | | | | |
|-----|-----|-----|-----|------|-----|-----|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 1 | - | - | 3 | - | - |
| 2 | 1 | 1 | - | 2 | 2 | - |
| 3 | - | - | 3 | 2 | 2 | - |
| 4 | 1 | - | - | - | - | - |
| 5 | - | - | - | 2 | 2 | 2 |
| Avg | 1 | 1 | 3 | 2.25 | 2 | 2 |

| CD4151 | CONCEPTS OF ENGINEERING DESIGN | L T P C |
|--------|-------------------------------|---------|
| | | 3 0 0 3 |

**COURSE OBJECTIVES**
- To impart knowledge on basic concepts in engineering design.
- To develop a product catering to the need sofa customer and considering quality and societal aspects in design
- To incorporate various design methods to develop a creative product.
- To gain knowledge on the selection of materials and manufacturing techniques for product design.
- To develop a robust and reliable product.

**UNIT-I       DESIGN FUNDAMENTALS                                    9**
Importance of design- The design process-Considerations of Good Design – Morphology of design–Organization for design–Computer-Aided Engineering–Designing to codes and standards–Concurrent Engineering–Product and process cycles–Technological Forecasting
– Market Identification –Competition Benchmarking

**UNIT-II       CUSTOMER-ORIENTED DESIGN&SOCIETAL CONSIDERATIONS       9**
Identification of customer needs- customer requirements- Quality Function Deployment- Product Design Specifications-Human Factors in Design–Ergonomics, and Aesthetics, Societal consideration - Contracts – Product liability – Protecting intellectual property – Legal and ethical domains – Codes of ethics - Ethical conflicts – Environment responsible design-future trends in interaction of engineering with society

**UNIT-III       DESIGN METHODS                                        9**
Creativity and problem solving–Creativity methods-Theory of Inventive Problem Solving(TRIZ)–Conceptual decomposition-Generating design concepts-Axiomatic Design–Evaluation methods-Embodiment Design-Product Architecture-Configuration Design- Parametric Design. Role of models in design-Mathematical Modeling – Simulation – Geometric Modeling –Rapid prototyping-Finite Element Analysis– Optimization–Search Methods

**UNIT-IV          MATERIAL SELECTION PROCESSING AND DESIGN          9**

Material Selection Process–Economics–Cost Vs Performance–Weighted property Index–Value Analysis–Role of Processing in Design–Classification of Manufacturing Process–Design for Manufacture – Design for Assembly –Designing for castings, Forging, Metal Forming, Machining and Welding– Residual Stresses–Fatigue, Fracture, and Failure**.**

**UNIT-V          PROBABILITY CONCEPTS IN DESIGN FOR          9
                   RELIABILITY**

Probability–Distributions–Test of Hypothesis–Design of Experiments–Reliability Theory–Design for Reliability–Reliability centered Maintenance-Robust Design-Failure mode Effect Analysis

**TOTAL= 45 PERIODS**

**OUTCOMES:**

On Completion of the course, the student will be able to

- Appreciate the aspects of the need for design, design process used for designing various components.
- Get familiarized with concepts related to legal, human, and marketing factors during the design of products.
- Get acquainted with the knowledge of designing creative components.
- Gain knowledge on the material selection process and various design procedures.
- Get equipped with tools for improving quality, reliability, and performance of a product.

**REFERENCES:**

1. George E. Dieter, Linda C. Schmidt, "Engineering Design", McGraw Hill Education Pvt.Ltd.,2013
2. Pahl.G,Beitz.W,"Engineering Design- A systematic approach", Springer–Verlag,2005
3. Ray,M.S.,"Elements of Engineering Design", Prentice HallInc.1985
4. Nam P. Suh, Ralph & Eloise F. Cross, "The Principles of Design", Oxford University Press,1990
5. Karl T. Ulrich, Steven D. Eppinger, "Product Design And Development, Tata Mcgraw-Hill Education,2015

**Mapping of CO with PO**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 3 | 2 | 2 | - | - | - |
| **2** | 3 | 2 | 2 | - | - | 1 |
| **3** | 3 | 2 | 2 | - | 1 | - |
| **4** | 3 | 2 | 2 | - | - | - |
| **5** | 3 | 2 | 2 | 2 | 1 | - |
| **AVg.** | 15/5=3 | 10/5=2 | 10/5=2 | 2/1 = 2 | 2/2=1 | 1/1=1 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**PD4211    ADVANCED ANALYSIS AND SIMULATION LABORATORY    L  T  P  C**
                                                          **0  0  4  2**

**OBJECTIVES:**
1.  To give exposure to software tools needed to analyze engineering problems.
2.  To expose the students to different applications of simulation and analysis tools.

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

**B. ANALYSIS**
1.  Force and Stress analysis using link elements in Trusses, cables etc.
2.  Stress and deflection analysis in beams with different support conditions.
3.  Stress analysis of flat plates and simple shells.
4.  Stress analysis of axi – symmetric components.
5.  Thermal stress and heat transfer analysis of plates.
6.  Thermal stress analysis of cylindrical shells
7.  Vibration analysis of spring-mass systems.
8.  Model analysis of Beams.
9.  Harmonic, transient and spectrum analysis of simple systems.
10. Analysis of machine elements under dynamic loads
11. Analysis of non-linear systems

**TOTAL : 60 PERIODS**

**List of Equipment / Software:**
Finite Element Analysis packages

**COURSE OUTCOMES:**
Upon completion of this course, the students will be able to:
1.  Solve engineering problems numerically using Computer Aided Finite Element Analysis packages.

| CO | PO | | | | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 3 | 3 | 3 | 2 | - | - |
| 2 | 3 | 3 | 3 | 2 | - | - |
| 3 | - | - | - | - | - | - |
| 4 | - | - | - | - | - | - |
| 5 | - | - | - | - | - | - |
| Avg | 3 | 3 | 3 | 2 | - | - |

**1-low, 2-medium, 3-high, '-"- no correlation**

**PD4261**                    **PRODUCT DESIGN LABORATORY**              **L  T  P  C**
                                                                        **0  0  4  2**

**OBJECTIVE:**
- To give exposure to develop digital and physical prototype models using RP machine / clay models of a new product/ existing product.

  The students in a group have to develop digital and physical prototype models using RP machine / clay models of a new product/ existing product with enhanced feature involving the following areas:
    - Automotive components
    - Tool and die components
    - Press tool components
    - Consumer product
    - Injection moulded products.

The fabricated models may be in the form of RP models, clay models, sheet metal models or cardboard models etc.

The design and development of the product will be reviewed in two stages for awarding internal marks. The end semester examination mark will be based on the demonstration of the new product developed and oral examination on the same by internal examiners.

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES:**
Upon conclusion of this course the student will be able to

**CO1**    Appreciate the use of physical prototype models for evaluating product concept
**CO2**    Apply theoretical knowledge to design and development of physical products usingclay, wood, sheet metal and RP techniques

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 3 | 3 | 3 | 3 | 3 | - |
| **2** | 3 | 3 | 3 | 3 | 2 | 2 |
| **Avg.** | 3 | 3 | 3 | 3 | 2.5 | 2 |

1-low, 2-medium, 3-high, '-"- no correlation

| PD4391 | PRODUCT LIFECYCLE MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**
1. To understand history, concepts and terminology of PLM
2. To understand functions and features of PLM/PDM
3. To understand different modules offered in commercial PLM/PDM tools
4. To demonstrate PLM/PDM approaches for industrial applications
5. To Use PLM/PDM with legacy data bases, CAx & ERP systems

**UNIT I    HISTORY, CONCEPTS AND TERMINOLOGY OF PLM    9**
Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (cPDm), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM).PLM/PDM Infrastructure - Network and Communications, Data Management, Heterogeneous data sources and applications.

**UNIT II    PLM/PDM FUNCTIONS AND FEATURES    9**
User Functions - Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions - Communication and Notification, data transport, data translation, image services, system administration and application integration.

**UNIT III    DETAILS OF MODULES IN APDM/PLM SOFTWARE    9**
Case studies based on top few commercial PLM/PDM tools

**UNIT IV    ROLE OF PLM ININDUSTRIES    9**
Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for-business, organization, users, product or service, process performance.

**UNIT V    BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE  9**
PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP

**TOTAL:45 PERIODS**

**OUTCOMES:**
The students will be able to
1. Summarize the history, concepts and terminology of PLM
2. Use the functions and features of PLM/PDM
3. Use different modules offered in commercial PLM/PDM tools.
4. Implement PLM/PDM approaches for industrial applications.
5. Integrate PLM/PDM with legacy data bases, CAx& ERP systems.

| CO | PO | | | | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 1 | 2 | 2 | 1 | - | - |
| 2 | 2 | 2 | 2 | 1 | - | - |
| 3 | 2 | 1 | 2 | 1 | - | - |
| 4 | 1 | 1 | 3 | 1 | - | - |
| 5 | 1 | 1 | 1 | 1 | - | - |
| Avg | 1.4 | 1.4 | 2 | 1 | - | - |

1- Low                    2- Medium                    3- High

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

| PD4311 | PROJECT WORK I | L T P C |
|--------|----------------|---------|
|        |                | 0 0 12 6 |

**OBJECTIVES:**
1. To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
2. To develop the methodology to solve the identified problem.
3. 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**

**OUTCOME:**
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.

| PD4411 | PROJECT WORK II | L T P C |
|--------|-----------------|---------|
|        |                 | 0 0 24 12 |

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

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

**TOTAL : 360 PERIODS**

**OUTCOMES:**
• On completion of the project work students will be in a position to take up any challenging practical problem in the field of engineering design and find better solutions to it.

| ED4080 | TRIBOLOGY IN DESIGN | L T P C |
|---|---|---|
| | | 3 0 0 3 |

**COURSE OBJECTIVES:**
1. To study and measure the different types of surface features associated with the friction of metals and non-metals.
2. To study the different types of wear mechanism and surface modification techniques.
3. To analyze the various types of lubricants and lubrication system in the tribology.
4. To develop the methodology for deciding lubricants and lubrication regimes for different operating conditions.
5. To study the different types of high-pressure contacts and rolling bearings

**UNIT I          SURFACE INTERACTION AND FRICTION                          9**
Surface Topography – Surface features-Properties and measurement – Surface interaction – Laws of friction- Adhesive Theory of Sliding Friction – Static friction -Rolling Friction – Friction in extreme conditions –Thermal considerations in sliding contact.

**UNIT II          WEAR AND SURFACE TREATMENT                          9**
Types of wear mechanism – Laws of wear –Theoretical wear models- Abrasive wear – Adhesive wear – Fatigue wear – fretting wear – Cavitation wear - Wear of Metals and Nonmetals – Surface treatments – Surface modifications –Laser processing – instrumentation – International standards in friction and wear measurements

**UNIT III          LUBRICANTS AND LUBRICATION REGIMES                          9**
Lubricants and their physical properties- Viscosity and other properties of oils –Additives-and selection of Lubricants- Lubricants standards ISO,SAE,AGMA, BIS standards – Lubrication Regimes –Solid Lubrication-Dry and marginally lubricated contacts- Boundary Lubrication-Hydrodynamic lubrication-Elasto and plasto hydrodynamic - Magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication

**UNIT IV          THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION          9**
Reynolds Equation-Assumptions and limitations-One and two dimensional Reynolds Equation Reynolds and Sommerfeld boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings-Squeeze film effects-Thermal considerations-Hydrostatic lubrication of Pad bearing Pressure, flow, load and friction calculations-Stiffness considerations- Various types of flow restrictors in hydro static bearings.

**UNIT V          HIGH PRESSURE CONTACTS AND ELASTO**
**                    HYDRODYNAMIC LUBRICATION                          9**
Rolling contacts of Elastic solids- contact stresses – Hertzian stress equation- Spherical and cylindrical contacts-Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubrication Theory Soft and hard EHL Reynolds equation for elasto hydrodynamic lubrication- - Film shape within and outside contact zones-Film thickness and friction calculation- Rolling bearings- Stresses and deflections-Traction drives.

**                                                                        TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**
On Completion of the course the student will be able to
- Develop the knowledge on the surface features and its role on the friction behavior of metals and nonmetals
- Understand the various types of wear mechanism and surface modification techniques
- Familiarize the different types of lubricants and lubrication systems in the tribology
- Methodology for deciding lubricants and lubrication regimes for different operating conditions
- Ability to understand the different types of high pressure contacts and rolling bearings

**REFERENCES:**
1. Rabinowicz.E, "Friction and Wear of materials", John Willey & Sons ,UK,1995
2. Cameron, A. "Basic Lubrication Theory", Ellis Herward Ltd., UK, 1981
3. Halling, J. (Editor) – "Principles of Tribology ", Macmillian – 1984
4. Williams J.A. "Engineering Tribology", Oxford Univ. Press, 1994
5. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,"Fundamentals of Tribology", Prentice –Hall of India Pvt Ltd , New Delhi, 2005
6. G.W.Stachowiak& A.W .Batchelor , Engineering Tribology, Butterworth - Heinemann, UK, 2005

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 1 | 1 | 1 | 2 | 2 | 1 |
| 2 | 1 | 1 | 1 | 2 | 2 | 1 |
| 3 | 1 | 1 | 1 | 2 | 2 | 1 |
| 4 | 1 | 1 | 1 | 2 | 2 | 1 |
| 5 | 1 | 1 | 1 | 2 | 2 | 1 |
| AVg. | 1 | 1 | 1 | 2 | 2 | 1 |

| CC4071 | ADVANCED MACHINE TOOL DESIGN | L T P C |
|---|---|---|
| | | 3 0 0 3 |

**COURSE OBJECTIVES**
 **The main learning objective of this course is to prepare the students for:**
1. Selecting the different machine tool mechanisms.
2. Designing the Multi speed Gear Box and feed drives.
3. Designing the machine tool structures.
4. Designing the guideways and power screws.
5. Designing the spindles and bearings.

**UNIT I        INTRODUCTION TO MACHINE TOOL DESIGN        9**
 Introduction to Machine Tool Drives and Mechanisms, Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission

**UNIT II        REGULATION OF SPEEDS AND FEEDS        9**
Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design

**UNIT III        DESIGN OF MACHINE TOOL STRUCTURES        9**
Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity, Materials for Machine Tool Structures, Machine Tool Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriage.

**UNIT IV**        **DESIGN OF GUIDEWAYS AND POWER SCREWS**       **9**

Functions and Types of Guideways, Design of Guideways, Design of Aerostatic Slide ways, Design of Anti-Friction Guideways, Combination Guideways, Design of Power Screws.

**UNIT V**        **DESIGN OF SPINDLES AND SPINDLE SUPPORT**       **9**

Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Antifriction Bearings. Dynamics of Machine Tools: Machine Tool Elastic System, Static and Dynamic Stiffness

**TOTAL = 45 PERIODS**

**OUTCOMES**:
On Completion of the course the student will be able to
1. Select the different machine tool mechanisms.
2. Design the Multi speed Gear Box and feed drives.
3. Design the machine tool structures.
4. Design the guideways and power screws.
5. Design the spindles and bearings.

**REFERENCES**:
1. N.K. Mehta, Machine Tool Design and Numerical Control, TMH, New Delhi, 3rd edition 2012
2. G.C. Sen and A. Bhattacharya, Principles of Machine Tools, New Central Book Agency, 2015
3. K Pal, S. K. Basu, "Design of Machine Tools", 6th Edition. Oxford IBH, 2014
4. N. S. Acherkhan, "Machine Tool Design", Volume 2 University Press of the Pacific, 2000
5. F. Koenigsberger, Design Principles of Metal-Cutting Machine Tools, Pergamon Press, 1964
6. F. Koenigsberger, Machine Tool Structures, Pergamon Press,1970.

| CO | PO | | | | | |
|----|----|----|----|----|----|----|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 3 | 3 | 3 | 2 | - | 3 |
| **2** | 3 | 3 | 3 | 2 | - | 3 |
| **3** | 3 | 3 | 3 | 2 | - | 3 |
| **4** | 3 | 3 | 3 | 2 | - | 3 |
| **5** | 3 | 3 | 3 | 2 | - | 3 |
| **AVg.** | 3 | 3 | 3 | 2 | - | 3 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**PD4001**      **GENERATIVE DESIGN AND TOPOLOGY OPTIMIZATION**     **L T P C**
                                                               **3 0 0 3**

**COURSE OBJECTIVES:**
1. To impart knowledge on basic concepts in generative design.
2. To develop design methods to meet the needs of a customer.
3. To incorporate various design methods to develop a creative product.
4. To gain knowledge on topology aspects of design.
5. To gain knowledge on optimization in design.

## UNIT I INTRODUCTION 9

Introduction to Generative design - Benefits of generative design -Design exploration-Examine multiple design options and review tradeoffs in materials. Performance, and manufacturing methods.

## UNIT II GENERATIVE DESIGN 9

Editable geometry - Integrated workflows- Multiple manufacturing methods- Additive – 3 or 5 axis milling – Applications.

## UNIT III LOW-DENSITY AREAS IN TOPOLOGY OPTIMIZATION 9

Localized mode in low-density areas - Localized deformation, Polynomial interpolation model, Breakdown issue in ESO. Dynamics – analysis and topology optimization under harmonic and random force excitations, Thermo-elastic problems - topology optimization in single and multiple materials.

## UNIT IV INTEGRATED LAYOUT AND TOPOLOGY OPTIMIZATION 9

Introduction to integrated optimization, Finite-circle method, Density points and embedded, meshing, MPC-based component-structure connections, integrated optimization based on implicit model.

## UNIT V POTENTIAL APPLICATIONS OFTOPOLOGY OPTIMIZATION 9

Shape-preserving design, Smart structure design, Structural features design, Topology optimization and additive manufacturing.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On Completion of the course the student will be able to

- Appreciate the aspects of need for design, design process used for designing various components
- Get familiarized with concepts related to design methods during the design of products
- Get acquainted with the knowledge of designing creative components
- Gain knowledge on topology aspects of design.
- Get equipped with optimization tools for improving quality, reliability and performance of a product.

**REFERENCES:**

1. Martin Philip Bendsoe, Ole Sigmund, "Topology Optimization: Theory, Methods, and Applications", Springer Science & Business Media, 2003.
2. Eris, Ozgur, "Effective Inquiry for Innovative Engineering Design", Springer,2004.
3. George I. N. Rozvany, Tomasz LewinskiTopology "Optimization in Structural and Continuum Mechanics". Springer; 2015 edition.
4. Gregoire Allaire "Shape Optimization by the Homogenization Method" Springer-Verlag New York 2002
5. Behrooz Hassani, Ernest Hinton "Homogenization and Structural Topology Optimization" Springer-Verlag London, 1999.

| CO | PO | | | | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 1 | 2 | 3 | 4 | 5 | 6 |
| 2 | 3 | 3 | 3 | 3 | 3 | 2 |
| 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| 4 | 3 | 3 | 3 | 3 | 3 | 2 |
| 5 | 3 | 3 | 3 | 3 | 3 | 2 |
| AVg. | 3 | 3 | 3 | 3 | 3 | 2 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**IS4071**                              **DATA ANALYTICS**                        **L  T  P  C**
                                                                                 **3  0  0  3**

**COURSE OBJECTIVES:**
1. Recognize the importance of data analytics
2. Exhibit competence on data analytics packages
3. Apply solution methodologies for industrial problems.

**UNIT I          INTRODUCTION                                                    9**
Introduction to Multivariate Statistics-Degree of Relationship among Variables-Review of Univariate and Bivariate Statistics-Screening Data Prior to Analysis-Missing Data, Outliers, Normality, Linearity, and Homoscedasticity.

**UNIT II         MULTIPLE REGRESSION                                             9**
Multiple Regression- Linear and Nonlinear techniques- Backward-Forward-Stepwise Hierarchical regression-Testing interactions (2way interaction) - Analysis of Variance and Covariance (ANOVA & ANCOVA) - Multivariate Analysis of Variance and Covariance (MANOVA & MANCOVA).

**UNIT III        LOGISTIC REGRESSION                                            9**
Regression with binary dependent variable -Simple Discriminant Analysis Multiple Discriminant analysis-Assessing classification accuracy- Conjoint analysis (Full profile method).

**UNIT IV         PRINCIPAL COMPONENT ANALYSIS                                   9**
Principal Component Analysis -Factor Analysis- Orthogonal and Oblique Rotation-Factor Score Estimation-Multidimensional Scaling-Perceptual Map-Cluster Analysis (Hierarchical Vs Nonhierarchical Clustering).

**UNIT V          LATENT VARIABLE MODELS                                         9**
Latent Variable Models an Introduction to Factor, Path, and Structural Equation Analysis- Time series data analysis (ARIMA model) – Decision tree analysis (CHAID, CART) - Introduction to Big Data Management.

                                                                 **TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**
On completion of the course, the student will be able to:
- To recognize the importance of data analytics
- To Exhibit competence on data analytics packages
- To apply solution methodologies for industrial problems.

**REFERENCES:**
1. Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. "Multivariate data analysis", (7th edition). Pearson India. 2015
2. Tabachnick, B. G., & Fidell, L. S., "Using multivariate statistics", (5th edition). Pearson Prentice Hall, 2001
3. Gujarati, D. N. , "Basic econometrics", Tata McGraw-Hill Education, 2012
4. Malhotra, N. K., " Marketing research: An applied orientation", 5/e. Pearson Education India, 2008
5. Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. " Applied multiple regression/correlation analysis for the behavioral sciences", Routledge., 2013
6. Han, J., Kamber, M., & Pei, J. "Data mining: concepts and techniques: concepts and techniques", Elsevier, 2011.

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 1 | 1 | 1 | 1 | 1 | 1 |
| **2** | 1 | 1 | 1 | 1 | 1 | 1 |
| **3** | 1 | 1 | 1 | 1 | 1 | 1 |
| **AVG** | 1 | 1 | 1 | 1 | 1 | 1 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**CD4092**         **INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS**     **L T P C**
                                                                                  **3 0 0 3**

**OBJECTIVES:**

- To appreciate the need and scope for robotics and to understand the principles of robot kinematics
- To design the drive systems and its control
- To understand the principles of sensors and vision systems
- To envision the industrial applications of robots and its safety
- To gain knowledge on artificial intelligence and expert systems.

**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 - Robot dynamics - Methods for orientation and location of objects.

**UNIT II**        **ROBOT DRIVES AND CONTROL**                  **9**

Controlling the Robot motion – Position and velocity sensing devices - Design of drive systems – Hydraulic and Pneumatic drives - 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**                                  **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.

**UNIT IV**        **ROBOT CELL DESIGN AND APPLICATION**           **9**

Robot work cell design and control – Safety in Robotics - Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Industrial application of robots.

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

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence - Basics - Goals of artificial intelligence - AI techniques-problem representation in AI - Problem reduction and solution techniques - Application of AI and KBES in Robots.

                                         **TOTAL : 45 PERIODS**

**OUTCOMES:**

On Completion of the course the student will be able to

- Understand robot kinematics
- Incorporate mechanical components and concepts in robotics
- Understand the basics of various sensors to effectively design a robot
- Design suitable robots for specific applications
- Optimize the robots using Artificial Intelligence

**REFERENCES**

1. K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill, 1987
2. Koren,Y., "Robotics for Engineers", McGraw-Hill, 1987
3. Kozyrey, Yu. "Industrial Robots", MIR Publishers Moscow, 1985.
4. Klafter,R.D., Chmielewski, T.A. and Negin,M., "Robotics Engineering – An Integrated Approach",Prentice-Hall of India Pvt. Ltd., 1984

5. Deb, S.R."Robotics Technology and Flexible Automation", Tata McGraw-Hill, 1994
6. Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., "Industrial Robotics Technology, Programming and Applications", McGraw-Hill, Int., 1986
7. Jordanides,T. and Torby,B.J., ,"Expert Systems and Robotics", Springer -Verlag, New York, May 1991

**Mapping of CO with PO**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 1 | 3 | 3 | | 2 | 1 |
| **2** | 1 | 3 | 3 | | 2 | 1 |
| **3** | 1 | 3 | 3 | | 2 | 1 |
| **4** | 1 | 3 | 3 | | 2 | 1 |
| **5** | 1 | 3 | 3 | | 2 | 1 |
| **AVg.** | 1 | 3 | 3 | | 2 | 1 |

**1-low, 2-medium, 3-high, '-'- no correlation**

| ED4092 | ENGINEERING FRACTURE MECHANICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**
1. Formulation of governing equations for elastic problems
2. Stresses calculations/displacements around the crack tip for different modes of fracture
3. Estimation of K1c/SIF/critical flaws/failure stresses for different crack geometries
4. Life assessment of the cracked components under different types of repeated/variable fatigue loads and design for its life extension.
5. Analysis of failed engineering components under different modes of fracture.

**UNIT-I ELEMENTS OF SOLID MECHANICS 9**
Introduction to Failure and Fracture- Spectacular Failures-Basics Principles-Governing equations for the deformable body-Stress-Strain relations and general equations of elasticity in Cartesian and Polar Coordinates-vectors and tensors-differential equations of equilibrium-compatibility-boundary conditions-representation of three-dimensional stress system -generalized hook's law – plane stress and stain problems - Airy's stress function. Methods of formulation of Governing Differential equations for plane elasticity-Naviers Equation-Biharmonic equation in Cartesian and polar coordinates.

**UNIT-II STRESS AND DISPLACEMENT AROUND THE 9**
**CRACK TIP FOR DIFFERENT MODES OF FRACTURE**
Brittle and Ductile Fracture-Modes of Fracture-Weakness of the components due to Flaws-Need for Linear Elastic Fracture Mechanics (LEFM) – Evaluation of Structural Design-Stress and displacement around the crack tip in K-annulus for Mode-I and Mode-II plane crack problems – Stress and displacement around the crack tip in K-annulus for Mode III crack problems

**UNIT-III STATIONARY CRACK UNDER STATIC LOADING 9**
Griffith analysis- Irwin's approximation-CTOD and stress ahead of the crack tip- Westergaard solutions: Analytical Calculations for SIF for different crack geometries-Critical crack length and fracture stress calculations.
Two dimensional elastic fields – Analytical solutions for small scale yielding near a crack front –- plastic zone size –Specimen size calculations: K1c Testing for Fracture toughness of the Material.

**UNIT-IV**        **FATIGUE FAILURE AND ENVIRONMENTAL-ASSISTED**        **9**
                   **FRACTURE**

Introduction to fatigue failure-S-N Curve-Crack Initiation-Crack propagation- Effect of an Overload-Variable amplitude Fatigue load-Crack closure- Characteristics of fatigue crack-Paris Law- Fatigue Crack Growth Test to evaluate Paris constants- life calculations for a given load amplitude –effects of changing the load spectrum
Environmental-assisted Fracture-Micro mechanisms-factors influencing Environmental-assisted fracture-Environment-assisted Fatigue Failure affecting fatigue performance, fatigue loading, constant and variable amplitude loading.

**UNIT-V**        **APPLICATIONS OF FRACTURE MECHANICS**        **9**

J-integral, Mixed-mode fracture, Crack arrest methodologies - Case studies: Analysis on failedcomponents and design for the extension of its life

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**
On Completion of the course the student will be able to
**CO1**  Formulate governing equation for elastic problems
**CO2**  Calculate stresses/displacements around the crack tip for different modes of fracture
**CO3**  Estimate K1c/SIF/critical flaws/failure stresses for different crack geometries
**CO4** Assess the life of the cracked components under different types of repeated/variable
        fatigue loads and design for its life extension.
**CO5**  Analyze failed engineering components under different modes of fracture.

**REFERENCES:**
1. Broek, David, "Elementary Engineering Fracture Mechanics ", Springer Netherlands,1982.
2. John M.Barson and Stanely T.Rolfe, "Fatigue and fracture control in structures", Butterworth-Heinemann; 3rd edition. 1999
3. Kare Hellan, "Introduction of Fracture Mechanics", McGraw-Hill Book Company, 1985
4. Prashant Kumar, "Elements of Fracture Mechanics", Tata McGraw-Hill Publishing Company Ltd, 2009.
5. Ted L. Anderson, "Fracture Mechanics: Fundamentals and Applications", CRC Taylor and Francis, 4th Edition, 2017
6. Tribikram Kundu, "Fundamentals of Fracture Mechanics", Ane Books Pvt. Ltd. New Delhi/ CRC Press, 1st Indian Reprint, 2012

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| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 1 | 1 | 1 | 2 | 2 | 1 |
| **2** | 1 | 1 | 1 | 2 | 2 | 1 |
| **3** | 1 | 1 | 1 | 2 | 2 | 1 |
| **4** | 1 | 1 | 1 | 2 | 2 | 1 |
| **5** | 1 | 1 | 1 | 2 | 2 | 1 |
| **AVg.** | 5 | 5 | 5 | 10 | 10 | 5 |

1-low, 2-medium, 3-high, '-"- no correlation

**PD4002      ENTERPRISE RESOURCE PLANNING AND MANAGEMENT      L  T  P  C**
**3  0  0  3**

**OBJECTIVES:**
1.      Students will be able to identify the needs of Enterprise resource planning.
2.      Students will be able to understand the various technologies of ERP.
3.      Students will be able to distinguish the various ERP packages.
4.      Students will be able to understand the various architecture of ERP.
5.      Students will be able to identify the issues in ERP procurement.

**UNIT I        ENTERPRISE RESOURCEPLANNINGANDVALUECHAINMANAGEMENT  9**
Principle – ERP framework – Business Blue Print – Business Engineering vs Business process Re-Engineering – Tools – Languages – Value chain – Supply and Demand chain – Extended supply chain management – Dynamic Models –Process Models

**UNIT II        TECHNOLOGY AND ARCHITECTURE                              9**
Client/Server architecture – Technology choices – Internet direction – Evaluation framework – CRM – CRM pricing– chain safety – Evaluation framework.

**UNIT III        ERP SYSTEMPACKAGES                                        9**
SAP, People soft, Baan and Oracle – Comparison – Integration of different ERP applications – ERP as sales force automation – Integration of ERP and Internet – ERP Implementation strategies – Organizational and social issues.

**UNIT IV        ERP ARCHITECTURE                                          9**
Overview – Architecture – AIM – applications – Oracle SCM.SAP: Overview – Architecture – applications -Before and after Y2k – critical issues – Training on various modules of IBCS ERP Package-Oracle ERP and MAXIMO, including ERP on the NET

**UNIT V        ERP PROCUREMENT ISSUES                                    9**
Market Trends – Outsourcing ERP – Economics – Hidden Cost Issues – ROI – Analysis of cases from five Indian Companies.

**TOTAL: 45 PERIODS**

**OUTCOMES:**
Upon completion of the course, the students will be able to
1.      Able to acquire integrated view of the various facets of business, including planning, manufacturing, sales, finance and marketing.
2.      Able to understand the development of software to integrate business activities such as inventory management and control, order tracking, customer service, finance and human resources.
3.      Awareness on the software applications and tools that are available to business to use to drive out costs and improve efficiency.
4.      Understand the architecture of various ERP packages available in the market.
5.      Ability to learn the outsourcing concepts of ERP and its economics.

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

**1-low, 2-medium, 3-high, '-"- no correlation**

**REFERENCES:**
1. ERPWARE, ERP Implementation Framework, Garg & Venkitakrishnan, Prentice Hall, 1999.
2. Jose Antonio Fernandez , The SAP R/3 Handbook, Tata Mcgraw Hill, 1998.
3. Sadagopan.S , ERP-A Managerial Perspective, Tata Mcgraw Hill, 1999.
4. Thomas E Vollmann and BeryWhybark , Manufacturing and Control Systems, Galgothia Publications, 1998.
5. 5.Vinod Kumar Crag and N.K.Venkitakrishnan ,Enterprise Resource Planning – Concepts and Practice, Prentice Hall of India, 1998.

| AO4091 | ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING | L T P C |
|---|---|---|
| | | 3 0 0 3 |

**OBJECTIVES:**
1. To gain knowledge on artificial intelligence.
2. To understand the concepts of Machine Learning.
3. To appreciate supervised learning and their applications.
4. To appreciate the concepts and algorithms of unsupervised learning.
5. To understand the theoretical and practical aspects of Probabilistic Graphical Models.

**UNIT I          ARTIFICIALINTELLIGENCE                                    9**
Artificial intelligence – Basics – Goals of artificial intelligence– AItechniques–problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

**UNIT II          INTRODUCTION TO MACHINE LEARNING                      9**
Machine Learning–Types of Machine Learning –Machine Learning process- preliminaries, testing Machine Learning algorithms, turning data into Probabilities, and Statistics for Machine Learning-Probability theory – Probability Distributions – Decision Theory.

**UNIT III          SUPERVISED LEARNING                                    9**
Linear Models for Regression – Linear Models for Classification- Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models – Decision Tree Learning – Bayesian Learning, Naïve Bayes – Ensemble Methods, Bagging, Boosting, Neural Networks, Multi-layer Perceptron, Feed- forward Network, Error Back propagation - Support Vector Machines.

**UNIT IV          UNSUPERVISED LEARNING                                  9**
Clustering- K-means – EM Algorithm- Mixtures of Gaussians –Dimensionality Reduction, Linear Discriminant Analysis, Factor Analysis, Principal Components Analysis, Independent Components Analysis.

**UNIT V          PROBABILISTIC GRAPHICAL MODELS                         9**
Graphical Models – Undirected Graphical Models – Markov Random Fields – Directed Graphical Models –Bayesian Networks – Conditional Independence properties – Markov Random Fields-Hidden Markov Models – Conditional Random Fields (CRFs).

**TOTAL: 45 PERIODS**

**OUTCOMES:**
On Completion of the course the student will be able to
• Optimize the robots using Artificial Intelligence.
• Design a learning model appropriate to the application.
• Implement Probabilistic Discriminative and Generative algorithms for an application of your choice and analyze the results.
• Use a tool to implement typical Clustering algorithms for different types of applications.
• Identify applications suitable for different types of Machine Learning with suitable justification.

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

**1-low, 2-medium, 3-high, '-"- no correlation**

**REFERENCES:**
1. Christopher Bishop, "Pattern Recognition and Machine Learning" Springer, 2007.
2. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Chapman and Hall, CRC Press, Second Edition,2014.
3. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
4. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Third Edition, 2014.
5. Tom Mitchell, "Machine Learning", McGraw-Hill,1997.

| PD4003 | DESIGN FOR ADDITIVE MANUFACTURING | L T P C |
|---|---|---|
| | | 3 0 0 3 |

**OBJECTIVES:**
- To acquaint the students with evolution of Additive Manufacturing (AM).
- To gain knowledge on Design aspects of Additive Manufacturing (DFAM).
- To acquaint with Photo polymerization and Sintering processes and their applications.
- To acquaint the students with applications aspects of Additive Manufacturing.
- To gain knowledge in Future trends of Additive Manufacturing

**UNIT I          BASICS PRINCILPES OF ADDITIVE MANUFACTURING          9**
Introduction to the Basic Principles of Additive Manufacturing, Additive Manufacturing Processes, Extrusion, Beam Deposition

**UNIT II          DESIGN CONCEPTS IN ADDITIVE MANUFACTURING          9**
Design/Fabrication Processes: Data Sources, Software Tools, File Formats, Model Repair and Validation, Pre- & Post-processing, Designing for Additive Manufacturing, Multiple Materials, Hybrids, Composite Materials, current and future directions.

**UNIT III          DESIGN FORADDITIVE 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 IV          DESIGNING FOR 3D PRINTING          9**
General design considerations for 3D printing, 3D printed features, Designing for Material Jetting, Binder Jetting,  FFF, SLA/DLP, SLS, DMLS/SLM, design rules.

**UNIT V          DESIGNSTANDARDS FOR ADDITIVE MANUFACTURING          9**
Methods of testing and Testing organization - ASTM, ANSI, NBS, NEMA, NFPA, VL, SPI AND SPE.

**TOTAL : 45 PERIODS**

**OUTCOMES:**
On Completion of the course the student will be able to

CO1: Recognize the importance in the evolution of SFM/AM, proliferation into the various fields and its effects on supply chain.

CO2: Evaluate the design for AM and its importance in the quality of fabricated parts.

CO3: Acquire knowledge on principles and applications of polymerization and sheet lamination processes with case studies.

CO4: Acquire knowledge on principles of material extrusion and powder bed fusion processes and design guidelines.

CO5: Perceive jetting and direct energy deposition processes and their applications.

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| 4 | 2 | 2 | 2 | 3 | 3 | 1 |
| 5 | 3 | 1 | 3 | 3 | 3 | 3 |
| Avg | 2.4 | 1.6 | 2.2 | 2.8 | 2.6 | 1.4 |

0.3-Low          0.6-Medium          0.9-High

**REFERENCES:**

1. Andreas Gebhardt and Jan-Steffen Hotter, "Additive Manufacturing:3D Printing for Prototypingand Manufacturing", Hanser publications Munchen, Germany, 2015. ISBN:978-1-56990-582-1.

2. Ben Redwood, Brian Garret, Filemon Schöffer, and Tony Fadel, "The 3D Printing Handbook:Technologies,DesignandApplications",3DHubsB.V.,Netherland,2017.ISBN-13: 978-9082748505.

3. Ian Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: RapidPrototyping to Direct Digital Manufacturing" Springer - New York, USA, 2nd Edition, 2015.ISBN-13:978-1493921126.

4. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box forprototypedevelopment",CRCPress,1st Edition,2007FL,USA.ISBN- 9780849334092.

5. Milan Brandt., "Laser Additive Manufacturing 1st Edition Materials, Design, Technologies, andApplications",WoodheadPublishing,UK,2016.ISBN-9780081004333.

| PD4004 | QUALITY AND FINANCIAL CONCEPTS IN PRODUCT DEVELOPMENT | L T P C |
|---|---|---|
| | | 3 0 0 3 |

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

1. Applying the concept and principles of quality tools such as seven old and new tools of quality, SPC, multivariate charts, box plots, Pareto charts in product development.

2. Applying the concept and principles of quality tools such as benchmarking, QFD, HoQ, and reliability in product development.

3. Applying the concept and principles of Six Sigma and Lean manufacturing in product development.

4. Applying the concept and principles of robust design and embodiment design in product development.

5. Applying the concept and principles of finance and working capital management in product development.

**UNIT I           QUALITY TOOLS I                                                    9**
Seven Statistical Tools of Quality – New Seven Management Tools – Multivariable Charts
and 3D Plot – Statistical Process Control: Problems in Mean and Range Chart; p, np, u and
c chart; Problems in Box Plot and Pareto Chart.

**UNIT II          QUALITY TOOLS II                                                   9**
Benchmarking: Types; Process; Benefits – Quality Function Deployment (QFD): Concept;
Benefits; Process; House of Quality: Structure and Methodology – Reliability: Hazard /
Failure Rate; Mean Time Between Failure; Simple problems in Series; Parallel;
Combination; Standby Systems.

**UNIT III         DESIGN FOR SIXSIGMA AND LEAN PRINCIPLES                             9**
Six Sigma: Definition; Concept ;Process (DMAIC Methodology) – Project selection for Six
Sigma (Types of Quality Problems) – Key Tools in Lean Production / Manufacturing – 4R
Total Improvement – PDSA Cycle: Phases; Benefits – Kaizen and Kairyo – 5S House
Keeping – TPM: Definition; Objective; Pillars; Steps.

**UNIT IV          ROBUST DESIGN AND EMBODIMENT DESIGN                                 9**
Robust Design: Definition; Process Steps – Embodiment Design: Basic methods: Refining
geometry and layout – General process of product embodiment – Embodiment checklist –
Advanced methods: Systems modeling – Mechanical embodiment principles – FMEA
Procedure; benefits.

**UNIT V           FINANCE AND WORKING CAPITAL MANAGEMENT                              9**
Financial Planning: Definition; Need; Sources; Capital Structure; Capitalization; Term Loans;
Short term Finance; Venture Capital; Export Finance – Working Capital Management:
Definition; Significance; Assessment; Factors; Sources; Management.

**TOTAL:45 PERIODS**

**OUTCOMES:**
The student will
1. Apply the concept and principles of quality tools such as seven old and new tools of
   quality, SPC, multivariate charts, box plots, Pareto charts in product development.
2. Apply the concept and principles of quality tools such as benchmarking, QFD, HoQ, and
   reliability in product development.
3. Apply the concept and principles of Six Sigma and Lean manufacturing in product
   development.
4. Apply the concept and principles of robust design and embodiment design in product
   development.
5. Apply the concept and principles of finance and working capital management in product
   development.

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

**1-low, 2-medium, 3-high, '-"- no correlation**

**REFERENCES:**
1. Fundamentals of Quality control and improvement 2nd edition, AMITAVA MITRA, Pearson Education Asia, 2002.
2. Product Design and Development, KARL T. ULRICH, STEVEN D. EPPINGER, TATA McGraw-HILL- 3rd Editions, 2003.
3. Product Design Techniques in Reverse Engineering and New Product Development, KEVIN OTTO & KRISTIN WOOD, Pearson Education (LPE), 2001.
4. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub: son south-western University of Mumbai, Mechanical Engineering, M E Product Design and Development (New 2014) Page 8/48.

| **ED4093** | **OPTIMIZATION TECHNIQUES IN DESIGN** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **0** | **3** |

**COURSEOBJECTIVES:**
1. To understand the basic concepts of unconstrained optimization techniques.
2. To understand the basic concepts of constrained optimization techniques.
3. To provide the mathematical foundation of artificial neural networks and swarm intelligence for design problems.
4. To implement optimization approaches and to select appropriates solution for design application.
5. To demonstrate selected optimization algorithms commonly used in static and dynamic applications.

**UNIT– I      UNCONSTRAINED OPTIMIZATION TECHNIQUES**                    **9**

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

**UNIT– II      CONSTRAINED OPTIMIZATION TECHNIQUES**                    **9**

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

**UNIT–III      ARTIFICIAL NEURAL NETWORKS AND SWARM INTELLIGENCE**                    **9**

Introduction-Activation functions, types of activation functions, neural network architectures, Single layer feed forward network, multi layer feed forward network, Neural network applications. Swarm intelligence-Various animal behaviors, Ant Colony optimization, Particle Swarm optimization.

**UNIT– IV      ADVANCED OPTIMIZATION TECHNIQUES**                    **9**

Multistage optimization-dynamic programming, stochastic programming Multi objective optimization Genetic algorithms and Simulated Annealing technique.

**UNIT– V      STATIC AND DYNAMIC APPLICATIONS**                    **9**

Structural applications - Design of simple truss members - Design of simple axial, transverse loaded members for minimum cost, weight - Design of shafts and torsionally loaded members - Design of springs. Dynamic Applications - Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms-Optimum design of simple linkage mechanisms.

**TOTAL: 45 PERIODS**

**COURSEOUTCOMES:**

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

**CO1** Formulate unconstrained optimization techniques in engineering design application.

**CO2** Formulate constrained optimization techniques for various applications.

**CO3** Implement neural network technique to real world design problems.

**CO4** Apply genetic algorithms to combinatorial optimization problems.

**CO5** Evaluate solutions by various optimization approaches for a design problem.

**REFERENCES:**
1. Goldberg, David.E, "Genetic Algorithms in Search,Optimization and MachineLearning",Pearson,2009.
2. Jang, J.S.R,Sun, C.TandMizutaniE.,"Neuro-Fuzzy and Soft Computing",PearsonEducation.2015,
3. JohnsonRay,C.,"Optimumdesignofmechanicalelements",Wiley,2ndEdition1980.
4. KalyanmoyDeb,"OptimizationforEngineeringDesign:AlgorithmsandExamples",PHILear ningPrivateLimited,2nd Edition,2012.
5. RaoSingiresu S.,"Engineering Optimization - Theory and Practice", New Age InternationalLimited,NewDelhi,3rdEdition,2013.
6. Rajasekaran S and Vijayalakshmi Pai, G.A,"Neural Networks,FuzzyLogic and Genetic Algorithms", PHI, 2011

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| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 3 | 3 | 2 | - | - | 1 |
| **2** | 3 | 2 | 2 | - | 2 | - |
| **3** | 3 | 2 | 3 | - | 2 | - |
| **4** | 3 | 3 | 3 | - | 2 | - |
| **5** | 3 | 3 | 3 | 3 | 2 | - |
| **AVg.** | 3 | 2.6 | 2.6 | 3 | 2 | 1 |

1-low, 2-medium, 3-high, '-"- no correlation

| ED4154 | **VIBRATION ANALYSIS AND CONTROL** | **L** | **T** | **P** | **C** |
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**COURSE OBJECTIVES**

1. To appreciate the basic concepts of vibration in damped and undamped systems
2. To calculate the natural frequencies and mode shapes of the two degree freedom systems
3. To determine the natural frequencies and mode shapes of the multi degree freedom and continuous systems
4. To learn the fundamentals of control techniques of vibration and noise levels
5. To use the instruments for the measuring and analyzing the vibration levels in a body

**UNIT-I          FUNDAMENTALS OF VIBRATION                    9+3**

Introduction -Sources of Vibration-Mathematical Models- Displacement, velocity and Acceleration-Review Of Single Degree Freedom Systems -Vibration isolation Vibrometers and accelerometers - Response To Arbitrary and non- harmonic Excitations – Transient Vibration –Impulse loads-Critical Speed Of Shaft-Rotor systems

**UNIT-II**       **TWO DEGREE FREEDOM SYSTEM**       **9+3**

Introduction-Free Vibration Of Undamped And Damped - Forced Vibration With Harmonic Excitation System –Coordinate Couplings And Principal Coordinates.

**UNIT-III**       **MULTI-DEGREE FREEDOM SYSTEM AND**       **9+3**
                        **CONTINUOUS SYSTEM**

Multi Degree Freedom System –Influence Coefficients and stiffness coefficients- Flexibility Matrix and Stiffness Matrix – Eigen Values and Eigen Vectors-Matrix Iteration Method –Approximate Methods: Dunkerley, Rayleigh's, and Holzer Method -Geared Systems-Eigen Values & Eigenvectors for large system of equations using sub space, Lanczos method - Continuous System: Vibration of String, Shafts and Beams

**UNIT-IV**       **VIBRATION AND NOISE CONTROL**       **9+3**

Specification of Vibration Limits – Vibration severity standards- Vibration as condition Monitoring Tool-Vibration Isolation methods - Dynamic Vibration Absorber - Static and Dynamic Balancing machines – Field balancing - Major sources of noise – Noise survey techniques – Measurement technique for vehicular noise – Road vehicle noise standards – Industrial noise sources – Control Strategies – Noise control at the source and along the path – use of acoustic barriers – Noise control at the receiver.

**UNIT-V**       **EXPERIMENTAL METHODS IN VIBRATION ANALYSIS**       **9+3**

Vibration Analysis Overview - Experimental Methods in Vibration Analysis.-Vibration Measuring Instruments - Selection of Sensors- Accelerometer Mountings. -Vibration Exciters-Mechanical, Hydraulic, Electromagnetic And Electrodynamics –Frequency Measuring Instruments-. System Identification from Frequency Response -Testing for resonance and mode shapes

                                                    **TOTAL = 60 PERIODS**

**COURSE OUTCOMES:**

On Completion of the course the student will be able to
- **CO1** Apply the basic concepts of vibration in damped and undamped systems
- **CO2** Determine the natural frequencies and mode shapes of the two degree freedom systems.
- **CO3** Calculate the natural frequencies and mode shapes of the multi degree freedom andcontinuous systems
- **CO4** Control the vibration and noise levels in a body
- **CO5** Measure and analyze the vibration levels in a body

**REFERENCES:**
1. Graham Kelly, Sand Shashidhar K. Kudari, "Mechanical Vibrations", Tata McGraw – Hill Publishing Com. Ltd., 2007
2. Singiresu S. Rao,"Mechanical Vibrations,"Pearson Education Incorporated, 2017
3. Ramamurti.V,"MechanicalVibrationPracticewithBasicTheory",NarosaPublishingHouse, 2010
4. WilliamT.Thomson,"TheoryofVibrationwithApplications",Taylor&Francis,2018

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 3 | 3 | 2 | - | - | 1 |
| **2** | 3 | 2 | 2 | - | 2 | - |
| **3** | 3 | 2 | 3 | - | 2 | - |
| **4** | 3 | 3 | 3 | - | 2 | - |
| **5** | 3 | 3 | 3 | 3 | 2 | - |
| **AVG** | 3 | 2.6 | 2.6 | 3 | 2 | 1 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**PD4005**                        **IOT TECHNOLOGIES**                        **L T P C**
                                                                            **3 0 0 3**

**OBJECTIVES:**
1. To understand the different architectures for IoT.
2. To learn various protocols at the different layers for IoT.
3. To develop prototype systems using Arduino / RasberryPi.
4. To apply the use of data analytics in IoT.
5. To develop applications of IoT in Industrial contexts.

**UNIT I          ARCHITECTURES AND MODELS                        9**
Introduction to IoT – IoT Architectures – Core IoT Functional Stack, Sensors and Actuators Layer, Communications Network Layer, Applications and Analytics Layer – IoT Data Management and Compute Stack, Fog Computing, Edge Computing, Cloud Computing – Sensors, Actuators, Smart Objects, Sensor networks.

**UNIT II          CONNECTIVITY                        9**
Communications Criteria – Access Technologies – IP as IoT Network Layer – Business case – Optimization – Profiles and compliances – Application Protocols – Transport Layer – Application Transport Methods.

**UNIT III          SYSTEM DEVELOPMENT                        9**
Design Methodology – Case study – Basic blocks of IoT device – Raspberry Pi – Board, Interfaces, Linux, Setting up, Programming – Arduino – Other IoT Devices.

**UNIT IV          DATA ANALYTICS AND IoT SECURITY                        9**
Data Analytics for IoT – Big Data Analytics Tools and Technology – Edge Streaming Analytics – Network Analytics, Applications. Security history, challenges, variations – Risk Analysis Structures– Application in Operational Environment.

**UNIT V          IoT IN INDUSTRY                        9**
Manufacturing, Architecture, Protocols – Utilities, Grid Blocks - Smart Cities, Architecture, Use cases – Transportation, Architecture, Use cases.

.                                                                **TOTAL = 45PERIODS**

**OUTCOMES:**
On Completion of the course the student will be able to
- Explain the underlying architectures and models in IoT.
- Analyze different connectivity technologies for IoT.
- Develop simple applications using Arduino/RaspberryPi.
- Apply data analytics techniques to IoT.
- Study the need and suggest appropriate solutions for Industrial applications.

**REFERENCES:**
1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, "IoTFundamentals:NetworkingTechnologies,ProtocolsandUseCasesforInternetofThings",CiscoPress,2017
2. Olivier Hersent, David Boswarthick, Omar Elloum, "The Internet of Things — KeyapplicationsandProtocols",Wiley,2012.
3. Michael Miller,"The Internet of Things",Pearson Education, 2015.
4. Arshdeep Bahga, Vijay Madisetti, "Internet of Things–Ahands-on approach", Universities Press,2015.
5. Jan Ho¨ ller, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand.David Boyle, "From Machine-to-Machine to the Internet of Things-Introduction to a New Age of Intelligence", Elsevier, 2014.
6. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet ofThings",Springer,2011.

| CO | PO | | | | | |
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| 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| 2 | 1 | 1 | 1 | 2 | 1 | 1 |
| 3 | 1 | 1 | 1 | 2 | 1 | 1 |
| 4 | 1 | 1 | 1 | 2 | 1 | 1 |
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| AVG | 1 | 1 | 1 | 2 | 1 | 1 |

**1-low, 2-medium, 3-high, '-"- no correlation**

| IC4291 | COMPUTATIONAL FLUID DYNAMICS | L | T | P | C |
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**COURSE OBJECTIVES:**
- This course aims to introduce numerical modeling and its role in the field of heat, fluid flow and combustion. It will enable the students to understand the various discretisation methods and solving methodologies and to create confidence to solve complex problems in the field of heat transfer and fluid dynamics.
- To develop finite volume discretised forms of the governing equations for diffusion processes.
- To develop finite volume discretised forms of the convection-diffusion processes.
- To develop pressure-based algorithms for flow processes.
- To introduce various turbulence models, Large Eddy Simulation and Direct Numerical Simulation.

**UNIT – I        GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION        9
                      TECHNIQUES**
Basics of Heat Transfer, Fluid flow – Mathematical description of fluid flow and heat transfer – Conservation of mass, momentum, energy and chemical species - Classification of partial differential equations – Initial and Boundary Conditions – Discretisation techniques using finite difference methods – Taylor's Series - Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

**UNIT – II        DIFFUSION PROCESSES:  FINITE VOLUME METHOD        9**
Steady one-dimensional diffusion, Two- and three-dimensional steady state diffusion problems, Discretisation of unsteady diffusion problems – Explicit, Implicit and Crank-Nicholson's schemes, Stability of schemes.

**UNIT – III        CONVECTION-DIFFUSION PROCESSES: FINITE VOLUME METHOD        9**
One dimensional convection – diffusion problem, Central difference scheme, upwind scheme – Hybrid and power law discretization techniques – QUICK scheme.

**UNIT – IV        FLOW PROCESSES: FINITE VOLUME METHOD        9**
Discretisation of incompressible flow equations – Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms.

**UNIT – V        TURBULENCE MODELS        9**
Turbulence – RANS equation - Algebraic Models, One equation model, Two equation models – k & standard k – $\epsilon$ model, Low Reynold number models of k- $\epsilon$, Large Eddy Simulation (LES), Direct Numerical Simulation (DNS) - Introduction. Solving simple cases using standard CFD codes.

**TOTAL:45 PERIODS**

## COURSE OUTCOMES:
On successful completion of this course the students will be able to:
- Analyse the governing equations and boundary conditions.
- Analyse various discretization techniques for both steady and unsteady diffusion problems.
- Analyse the various convection-diffusion problems by Finite-Volume method.
- Analyse the flow processes by using different pressure bound algorithms.
- Select and use the different turbulence models according to the type of flows.

## PO &CO Mapping:

| CO | PO | | | | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 2 | 1 | 3 | - | - | - |
| 2 | 2 | 1 | 3 | - | - | - |
| 3 | 3 | 1 | 3 | - | 3 | - |
| 4 | 3 | 1 | 3 | - | 3 | - |
| 5 | 3 | 1 | 3 | - | 3 | - |
| Avg | 2.6 | 1 | 3 | - | 3 | - |

## REFERENCES:
1. Versteeg and Malalasekera, N, "An Introduction to computational Fluid Dynamics The Finite Volume Method," Pearson Education, Ltd., Second Edition, 2014.
2. Ghoshdastidar, P.S., "Computer Simulation of Flow and Heat Transfer", Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998.
3. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.
4. Subas and V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
5. JiyuanTu, Guan Heng Yeoh, Chaogun Liu, "Computational Fluid Dynamics A Practical Approach" Butterworth – Heinemann An Imprint of Elsevier, Madison, U.S.A., 2008
6. John D. Anderson. JR. "Computational Fluid Dynamics the Basics with Applications" McGraw-Hill International Editions, 1995.

| PD4006 | HUMAN FACTORS ENGINEERING IN PRODUCT DESIGN | L T P C |
|---|---|---|
| | | 3 0 0 3 |

## OBJECTIVES:
The main learning objective of this course is to prepare students for
1. Applying the fundamental concepts and principles of ergonomics in product design and development.
2. Applying the concept and principles of work place design in product design and development.
3. Applying the concept and principles of equipment design in product design and development.
4. Applying the concept and principles of environmental design in product design and development.
5. Applying the concept and principles of cognitive ergonomics & human factor application in product design and development.

## UNIT I          FUNDAMENTALS OF ANTHROPOMETRYIN ERGONOMICS          9
Anthropometry and its uses in ergonomics – Principles of applied anthropometry in ergonomics – Application of anthropometry in design – Design for everyone.

**UNIT II**    **ERGONOMICS IN WORKPLACE DESIGN**    **9**

Design for standing workers – Design for seated workers – Design for repetitive task – Design for manual handling activity task – Design for work capacity, stress, and fatigue.

**NIT III**    **ERGONOMICS INEQUIPMENTDESIGN**    **9**

Design for visual displays – Design for auditory displays – Design for controls – Design for virtual environments.

**UNIT IV**    **ERGONOMICS INENVIRONMENTAL DESIGN**    **9**

Heat, cold and the design of the physical environment – Vision, light and lighting – Hearing, sound, noise and vibration

**UNIT V**    **COGNITIVE ERGONOMICS & HUMANFACTORAPPLICATION**    **9**

Human information processing, skill and performance – Human–computer interaction, memory and language – Human–machine interaction, human error and safety. Resonance and mode shapes.

**TOTAL = 45PERIODS**

**OUTCOMES:**

Upon completion of this course, the students will be able to:
1. Apply the fundamental concepts and principles of ergonomics in product design and.
2. Apply the concept and principles of work place design in product design and development.
3. Apply the concept and principles of equipment design in product design and development.
4. Apply the concept and principles of environmental design in product design and development.
5. Apply the concept and principles of cognitive ergonomics & human factor application in product design anddevelopment.

**REFERENCES:**
1. Bridger R S, "Introduction to Ergonomics", Taylor and Francis, London,2003.
2. Chandler Allen Phillips, "Human Factors Engineering", John Wiley and sons, New York, 2000
3. Mark S Sanders, "Human Factors in Engineering and Design", McGraw Hill, New York, 1993.
4. Martin Helander, "A guide to Human Factors and Ergonomics", 2nd Edition, CRC, Taylor & Francis Group 2006.
5. McCormik, J., "Human Factors Engineering and Design", McGraw Hill,1992.

| CO | PO | | | | | |
|----|----|----|----|----|----|----|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 2 | 2 | 2 | 3 | 2 | 2 |
| **2** | 2 | 2 | 2 | 3 | 2 | 2 |
| **3** | 2 | 2 | 2 | 3 | 2 | 2 |
| **4** | 2 | 2 | 2 | 3 | 2 | 2 |
| **5** | 2 | 2 | 2 | 3 | 2 | 2 |
| **AVG** | 2 | 2 | 2 | 3 | 2 | 2 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**ED4071**        **DESIGN OF HYBRID AND ELECTRIC VEHICLES**        L    T    P    C
                                                                   3    0    0    3

## COURSE OBJECTIVES:
1. Fundamental concepts of electric and hybrid vehicle operation and architectures.
2. Understand the properties of batteries and its types.
3. Provide knowledge about design of series hybrid electric vehicles.
4. Provide knowledge about design of parallel hybrid electric vehicles.
5. 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:
Upon completion of this course, the students will be ableto:
   **CO1**    Explain how  a hybrid vehicle works and describe its main components and their function.
   **CO2**    Choose proper energy storage systems for vehicle applications
   **CO3**    Design series hybrid electric vehicles.
   **CO4**    Design parallel hybrid electric vehicles.
   **CO5**    Describe the transmission components and their configurations for electric vehicles

## REFERENCES:
1. Ehsani,M, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press,2005
2. "Hybrid Electric Vehicle Technology Assessment: Methodology, Analytical Issues, and Interim Results,"CenterforTransportationResearchArgonneNationalLaboratory,United States Department of Energy.
3. Iqbal Hussain, "Electric & Hybrid Vehicles– Design Fundamentals", Second Edition, CRC Press,2011.
4. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.
5. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes, 2000 .http://nptel.ac.in/courses/108103009/

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 2 | 1 | 3 | 2 | 2 | 3 |
| **2** | 2 | 1 | 3 | 2 | 2 | 3 |
| **3** | 2 | 1 | 3 | 2 | 2 | 3 |
| **4** | 2 | 1 | 3 | 2 | 2 | 3 |
| **5** | 2 | 1 | 3 | 2 | 2 | 3 |
| **AVg.** | 2 | 1 | 3 | 2 | 2 | 3 |

1-low, 2-medium, 3-high, '-"- no correlation

**PD4007**                       **ROTOR DYNAMICS**                       **L T P C**
                                                                         **3  0  0 3**

**OBJECTIVES:**
The main learning objective of this course is to prepare students for
1. Apply and develop mathematical model of a system
2. Applying the design and suggest bearings for specific applications
3. Applying a fatigue life calculation for various types of bearings
4. Apply and analyze bearing behavior
5. Study the dynamics of rotors mounted on Hydrodynamic Bearings.

**UNIT I            INTRODUCTION TO ROTOR DYNAMICS                      9**
Torsional vibrations analysis – critical speeds and response to imbalance- Transfer matrix
analysis- Instability of rotors- Gyroscopic effects

**UNIT II           HYDRODYNAMIC BEARINGS                               9**
Hydrodynamic Lubrication equation for dynamic loadings-Squeeze film effects in journal
bearings and thrust bearings -Rotating loads , alternating and impulse loads in journal bearings
– Journal center Trajectory- Analysis of short bearings under dynamic conditions- Finite
difference solution for dynamic conditions.

**UNIT III          BALANCING OF ROTORS                                9**
Classification of rotors and balancing criteria, balancing of rigid and flexible rotors- balance
criteria for flexible rotors

**UNIT IV           ROTOR DYNAMICS IN TURBOMACHINEY DESIGN             9**
Motion of the shaft in the bearing- Rotor supported on rigid and flexible supports-Campbell
diagram, Rotor Dynamic Analyses- Undamped critical speed - Unbalance response- Damped
eigenvalue analysis- Bearing stiffness and damping coefficients- Mechanics of Hydro dynamic
Instability- Half frequency whirl and Resonance whip- bearing instability and Oil Whirl
Technologies to Improve the Stability of Rotor-bearing Systems--Design configurations of stable
journal bearings.

**UNIT V            DYNAMICS OF ROTORS MOUNTED ON HYDRODYNAMIC BEARINGS9**
Hydrodynamic Lubrication equation for dynamic loadings-Squeeze film effects in journal
bearings and thrust bearings -Rotating loads , alternating and impulse loads in journal bearings
– Journal center Trajectory- Analysis of short bearings under dynamic conditions- Finite
difference solution for dynamic conditions.

                                                          **TOTAL = 45  PERIODS**

**OUTCOMES:**
Upon completion of this course, the students will be able to:
- understand application of various types of bearings and their operating principles
- design and suggest bearings for specific applications
- perform fatigue life calculations for various types of bearings,
- understand and analyze bearing behavior
- study the dynamics of rotors mounted on Hydrodynamic Bearings

| CO | PO | | | | | |
|-----|-----|-----|-----|-----|-----|-----|
|     | 1   | 2   | 3   | 4   | 5   | 6   |
| 1   | 3   | 3   | 2   | -   | -   | 1   |
| 2   | 3   | 2   | 2   | -   | 2   | -   |
| 3   | 3   | 2   | 2   | -   | 2   | -   |
| 4   | 3   | 3   | 2   | -   | 2   | -   |
| 5   | 3   | 3   | 3   | 3   | 2   | -   |
| Avg | 3   | 2.6 | 2.2 | 3   | 2   | 1   |

**1-low, 2-medium, 3-high, '-"- no correlation**

**REFERENCES:**
1. Ehrich(ed.), F.F., 1992, Handbook of Rotor dynamics, McGraw-Hill.
2. Genta, G., 1999, Vibration of Structures and Machines, 3rd edition, Springer
3. Genta, G., 2005, Dynamics of Rotating Systems, Springer, NY
4. Goodwin M.J., 1989, Dynamics of Rotor-Bearing Systems, Unwin Hyman, Sydney.
5. Krämer E., 1993, Dynamics of Rotors and Foundations, Springer-Verlag, New York.

| CD4091 | BIO MATERIALS | L T P C |
|---|---|---|
| | | 3 0 0 3 |

**OBJECTIVES:**
1. To study different concepts in selecting bio and smart materials
2. To import knowledge on different electro-rheological and piezoelectric materials
3. To import knowledge on different shape memory materials and their applications of materials in biomedical engineering and special materials for actuators, sensors, etc.
4. To import knowledge on Materials for oral and maxillofacial surgery
5. To import knowledge on materials for cardiovascular ophthalmology and skin regeneration.

**UNIT I        INTRODUCTION                                                                          9**
Human anatomy- tissues- organs- repair- regeneration- Wolff's Law – biomaterial – compatibility – classification - Biomimetics – Material response: swelling and leaching, corrosion and dissolution, deformation and failure, friction and wear – host response: the inflammatory process – coagulation and hemolysis- in vitro and in vivo evaluation of biomaterials – Testing and validation- government regulatory bodies.

**UNIT II        DENTAL MATERIALS                                                                  9**
Teeth composition, formation and properties – temporary fixation devices - classification – biomaterials used- metals and alloys - Fillings and restoration materials – oral and maxillofacial surgery – dental cements and dental amalgams – dental adhesives.

**UNIT III       ORTHOPAEDIC MATERIALS                                                        9**
Bone composition, formation and regeneration - properties – defects - temporary fixation devices – joint replacement – biomaterials used in bone and joint replacement metals and alloys- stress shielding effect- bone tissue engineering.

**UNIT IV        WOUND DRESSING MATERIALS AND SURGICAL AIDS        9**
Skin structure – defects ( burn, ulcer, trauma etc)  and disease- skin regeneration – classification
of regenerative material – Sutures- Adhesives – classification – Surgical tools- materials –
sterilization -  Laparoscopic tools

**UNIT V        CARDIOVASCULAR, OPTHALMOLOGY AND DRUG DELIVERY MATERIALS        9**
Blood clotting – blood theology– approaches to thrombo resistance materials development–
blood vessels – The heart – aorta and valves – geometry of blood circulation – cardiac
pacemakers – extracorporeal blood circulation devices. lungs – vascular implants: vascular graft,
cardiac valve prostheses – Eye- defects – correction- Biomaterials in opthalmology – drug
delivery methods and materials.

**TOTAL: 45 PERIODS**

**OUTCOMES:**
On Completion of the course the student will be able to
- Use of Bio materials for cardiovascular Opthalmology and Skin Regeneration
- Use of Bio materials for Dental & Bone application
- Use of shape memory alloys in engineering application
- Explain the characteristics of Bio and smart materials
- Use of smart materials as sensors, actuators.

| CO | PO | | | | | | PSO | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|     | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| 1 | 2 |   |   | 3 |   |   | 1 |   |   |
| 2 | 3 | 1 |   |   |   |   |   |   | 1 |
| 3 | 3 |   | 1 |   |   |   | 2 |   |   |
| 4 | 3 | 1 |   |   |   |   |   |   | 2 |
| 5 | 3 |   |   |   |   |   |   |   | 1 |
| Avg | 2.8 | 1 | 1 | 3 |   |   | 1.5 |   | 1.33 |

**REFERENCES:**
1. M. V. Gandhi and B. S. Thompson, "Smart Materials and Structures", Chapman and Hall,
   London, First Edition, 1992.
2. Sujata V., Bhat., "Biomaterials", Narosa Publication House, New Delhi, 2002.
3. Buddy D. Ratner (Editor), Allan S. Hoffman (Editor), Frederick J. Schoen (Editor), Jack E.
   Lemons, "Biomaterials Science: An Introduction to Materials in Medicine", Academic Press,2nd
   edition, 2004.
4. Duerig,T. W., Melton, K. N, Stockel, D. and Wayman, C.M., "Engineering aspects of
   Shapememory Alloys", Butterworth – Heinemann, 1990.
5. Mohsen Shahinpoor and Hans-Jo¨rg Schneider "Intelligent Materials", RSC Publishing,2008.

# AUDIT COURSES

**AX4091**        **ENGLISH FOR RESEARCH PAPER WRITING**      **L T P C**
                                                            **2 0 0 0**

## OBJECTIVES
- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

## UNIT I       INTRODUCTION TO RESEARCH PAPER WRITING           6
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

## UNIT II       PRESENTATION SKILLS           6
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

## UNIT III       TITLE WRITING SKILLS           6
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

## UNIT IV       RESULT WRITING SKILLS           6
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

## UNIT V       VERIFICATION SKILLS           6
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

                                                   **TOTAL: 30 PERIODS**

## COURSE OUTCOMES
CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

## REFERENCES
1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

**AX4092**                    **DISASTER MANAGEMENT**                    **L  T  P  C**
                                                                        **2  0  0  0**

## COURSE OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

## UNIT I          INTRODUCTION                                                          6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

## UNIT II          REPERCUSSIONS OF DISASTERS AND HAZARDS                              6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

## UNIT III          DISASTER PRONE AREAS IN INDIA                                      6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

## UNIT IV          DISASTER PREPAREDNESS AND MANAGEMENT                                6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

## UNIT V          RISK ASSESSMENT                                                      6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

                                                              **TOTAL : 30 PERIODS**

## COURSE OUTCOMES

CO1: Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

**REFERENCES**
1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company,2007.
3. Sahni, Pardeep Et.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi, 2001.

| AX4093 | CONSTITUTION OF INDIA | L T P C |
|---|---|---|
| | | 2 0 0 0 |

**OBJECTIVES**
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

**UNIT I        HISTORY OF MAKING OF THE INDIAN CONSTITUTION**
History, Drafting Committee, (Composition & Working)

**UNIT II        PHILOSOPHY OF THE INDIAN CONSTITUTION**
Preamble, Salient Features

**UNIT III        CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES**
Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

**UNIT IV        ORGANS OF GOVERNANCE**
Parliament,  Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

**UNIT V        LOCAL ADMINISTRATION**
District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

**UNIT VI        ELECTION COMMISSION**
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

**TOTAL: 30 PERIODS**

**OUTCOMES**
Students will be able to:
- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

**SUGGESTED READING**
- The Constitution of India,1950(Bare Act),Government Publication.
- Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
- M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

| AX4094 | நற்றமிழ் இலக்கியம் | L T P C |
|---|---|---|
| | | 2 0 0 0 |

**UNIT I        சங்க இலக்கியம்                                                          6**

1.  தமிழின் துவக்க நூல் தொல்காப்பியம்

– எழுத்து,  சொல், பொருள்

2.  அகநானூறு (82)

- இயற்கை இன்னிசை அரங்கம்

3.  குறிஞ்சிப் பாட்டின் மலர்க்காட்சி

4.  புறநானூறு (95,195)

 - போரை நிறுத்திய ஒளவையார்

**UNIT II        அறநெறித் தமிழ்                                                          6**

1.  அறநெறி வகுத்த திருவள்ளுவர்

   - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல், ஈகை, புகழ்

2.  பிற அறநூல்கள் - இலக்கிய மருந்து

– ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம்,     ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல் )

**UNIT III        இரட்டைக் காப்பியங்கள்                                                  6**

1.  கண்ணகியின் புரட்சி

   - சிலப்பதிகார வழக்குரை காதை

2.  சமூகசேவை இலக்கியம் மணிமேகலை

   - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

**UNIT IV        அருள்நெறித் தமிழ்                                                        6**

1. சிறுபாணாற்றுப்படை

   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஒளவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்

2. நற்றிணை

   - அன்னைக்குரிய புன்னை சிறப்பு

3. திருமந்திரம் (617, 618)

   - இயமம் நியமம் விதிகள்

4. தர்மச்சாலையை நிறுவிய வள்ளலார்

5.  புறநானூறு

    - சிறுவனே வள்ளலானான்

6.  அகநானூறு (4)  - வண்டு

நற்றிணை (11)     - நண்டு
கலித்தொகை (11)   - யானை, புறா
ஐந்திணை 50 (27)     - மான்
ஆகியவை பற்றிய செய்திகள்

**UNIT V        நவீன தமிழ் இலக்கியம்                                        6**

1. உரைநடைத் தமிழ்,
   - தமிழின் முதல் புதினம்,
   - தமிழின் முதல் சிறுகதை,
   - கட்டுரை இலக்கியம்,
   - பயண இலக்கியம்,
   - நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

**TOTAL: 30 PERIODS**

**தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்**

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
- www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
-https://ta.wikipedia.org
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
   - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

## LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

| SL. NO. | COURSE CODE | COURSE TITLE | PERIODS PER WEEK | | | CREDITS |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| 27. | OCE431 | Integrated Water Resources Management | 3 | 0 | 0 | 3 |
| 28. | OCE432 | Water, Sanitation and Health | 3 | 0 | 0 | 3 |
| 29. | OCE433 | Principles of Sustainable Development | 3 | 0 | 0 | 3 |
| 30. | OCE434 | Environmental Impact Assessment | 3 | 0 | 0 | 3 |
| 31. | OIC431 | Blockchain Technologies | 3 | 0 | 0 | 3 |
| 32. | OIC432 | Deep Learning | 3 | 0 | 0 | 3 |
| 33. | OBA431 | Sustainable Management | 3 | 0 | 0 | 3 |
| 34. | OBA432 | Micro and Small Business Management | 3 | 0 | 0 | 3 |
| 35. | OBA433 | Intellectual Property Rights | 3 | 0 | 0 | 3 |
| 36. | OBA434 | Ethical Management | 3 | 0 | 0 | 3 |
| 37. | ET4251 | IoT for Smart Systems | 3 | 0 | 0 | 3 |
| 38. | ET4072 | Machine Learning and Deep Learning | 3 | 0 | 0 | 3 |
| 39. | PX4012 | Renewable Energy Technology | 3 | 0 | 0 | 3 |
| 40. | PS4093 | Smart Grid | 3 | 0 | 0 | 3 |
| 41. | CP4391 | Security Practices | 3 | 0 | 0 | 3 |
| 42. | MP4251 | Cloud Computing Technologies | 3 | 0 | 0 | 3 |
| 43. | IF4072 | Design Thinking | 3 | 0 | 0 | 3 |
| 44. | MU4153 | Principles of Multimedia | 3 | 0 | 0 | 3 |
| 45. | DS4015 | Big Data Analytics | 3 | 0 | 0 | 3 |
| 46. | NC4201 | Internet of Things and Cloud | 3 | 0 | 0 | 3 |
| 47. | MX4073 | Medical Robotics | 3 | 0 | 0 | 3 |
| 48. | VE4202 | Embedded Automation | 3 | 0 | 0 | 3 |
| 49. | CX4016 | Environmental Sustainability | 3 | 0 | 0 | 3 |
| 50. | TX4092 | Textile Reinforced Composites | 3 | 0 | 0 | 3 |
| 51. | NT4002 | Nanocomposite Materials | 3 | 0 | 0 | 3 |
| 52. | BY4016 | IPR, Biosafety and Entrepreneurship | 3 | 0 | 0 | 3 |

PROGRESS THROUGH KNOWLEDGE

**OCE431**       **INTEGRATED WATER RESOURCES MANAGEMENT**       **L T  P C**
                                                                **3  0  0 3**

### OBJECTIVE

- Students will be introduced to the concepts and principles of IWRM, which is inclusive of the economics, public-private partnership, water & health, water & food security and legal & regulatory settings.

## UNIT I CONTEXT FOR IWRM 9

Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

## UNIT II WATER ECONOMICS 9

Economic view of water issues: economic characteristics of water good and services – Non-market monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

## UNIT III LEGAL AND REGULATORY SETTINGS 9

Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework.

## UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT 9

 Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies.

## UNIT V AGRICULTURE IN THE CONCEPT OF IWRM 9

Water for food production: 'blue' versus 'green' water debate – Water foot print - Virtual water trade for achieving global water and food security –- Irrigation efficiencies, irrigation methods - current water pricing policy– scope to relook pricing.

**TOTAL: 45 PERIODS**

## OUTCOMES

- On completion of the course, the student is expected to be able to

| CO1 | Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management. |
| --- | --- |
| CO2 | Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies. |
| CO3 | Apply law and governance in the context of IWRM. |
| CO4 | Discuss the linkages between water-health; develop a HIA framework. |
| CO5 | Analyse how the virtual water concept pave way to alternate policy options. |

## REFERENCES:
1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga .P. etal " Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.
3. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.
4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.
5. Technical Advisory Committee, Effective Water Governance". Technical Advisory Committee Background paper No: 7. Global water partnership, Stockholm, Sweden, 2003.

## CO – PO Mapping - INTEGRATED WATER RESOURCES MANAGEMENT

| POs/PSOs | Course Outcome | | | | | Overall Correlation of COs to POs |
| --- | --- | --- | --- | --- | --- | --- |
| | CO1 | CO2 | CO3 | CO4 | CO5 | |

| PO1 | Knowledge of Engineering Sciences | 3 | 2 | 2 | 2 | 2 | 2 |
|-----|-----------------------------------|---|---|---|---|---|---|
| PO2 | Problem analysis | 1 | 3 | 2 | 2 | 2 | 2 |
| PO3 | Design / development of solutions | | 2 | 2 | 2 | 2 | 2 |
| PO4 | Investigation | 1 | 2 | | | 1 | 1 |
| PO5 | Modern Tool Usage | 1 | 1 | 2 | 1 | 1 | 1 |
| PO6 | Individual and Team work | | 2 | 2 | | | 2 |
| PO7 | Communication | | 2 | 2 | | | 2 |
| PO8 | Engineer and Society | 2 | 2 | 3 | 2 | 3 | 3 |
| PO9 | Ethics | | 2 | 3 | 2 | 2 | 2 |
| PO10 | Environment and Sustainability | 3 | 3 | 3 | 3 | 3 | 3 |
| PO11 | Project Management and Finance | 1 | 1 | 1 | | 1 | 1 |
| PO12 | Life Long Learning | | 2 | 2 | 2 | 2 | 2 |
| PSO1 | Knowledge of field research methodology, gender, legal and environmental aspects in the context of integrated water resources management | 3 | 2 | 2 | 2 | 2 | 2 |
| PSO2 | Formulate, analyze and comprehend the differences in social and environmental variability in South Indian context with their peers and strive to work towards sustainability | 2 | 2 | 2 | 2 | 2 | 2 |
| PSO3 | Produce and publish professional reports, peer-reviewed journal, on contemporary and state of the art research in integrated water resources management | 2 | 2 | 2 | 2 | 2 | 2 |

**OCE432**  **WATER, SANITATION AND HEALTH**  **L T P C**
**3 0 0 3**

**OBJECTIVES:**
• Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario

**UNIT I   FUNDAMENTALS WASH   9**
Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues-Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of PROGRESS THROUGH KNOWLEDGE

**UNIT II   MANAGERIAL IMPLICATIONS AND IMPACT   9**
Third World Scenario – Poor and Multidimensional Deprivation--Health Burden in Developing Scenario -Factors contribute to water, sanitation and hygiene related diseases-Social: Social Stratification and Literacy Demography: Population and Migration- Fertility - Mortality- Environment: Water Borne-Water Washed and Water Based Diseases - Economic: Wage - Water and Health Budgeting -Psychological: Non-compliance - Disease Relapse - Political: Political Will.

**UNIT III   CHALLENGES IN MANAGEMENT AND DEVELOPMENT   9**
Common Challenges in WASH - Bureaucracy and Users- Water Utilities -Sectoral Allocation:- Infrastructure-Service Delivery: Health services: Macro and Micro- level: Community and Gender Issues- Equity Issues - Paradigm Shift: Democratization of Reforms and Initiatives.

**UNIT IV   GOVERNANCE   9**
Public health -Community Health Assessment and Improvement Planning (CHA/CHIP)-Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance -

## UNIT V INITIATIVES 9

Management vs Development -Accelerating Development- Development Indicators -Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets - Five Year Plans - Implementation - Capacity Building - Case studies on WASH.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

| | |
|-----|---|
| **CO1** | Capture to fundamental concepts and terms which are to be applied and understood all through the study. |
| **CO2** | Comprehend the various factors affecting water sanitation and health through the lens of third world scenario. |
| **CO3** | Critically analyse and articulate the underlying common challenges in water, sanitation and health. |
| **CO4** | Acquire knowledge on the attributes of governance and its say on water sanitation and health. |
| **CO5** | Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects. |

**REFERENCES**

1. Bonitha R., Beaglehole R.,Kjellstorm, 2006, "Basic Epidemiology", 2nd Edition, World Health Organization.
2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning: An expanded agenda. New Directions for Teaching and Learning, 2002: 91–98. doi: 10.1002/tl.83Improving the Environment for learning: An Expanded Agenda
3. National Research Council. *Global Issues in Water, Sanitation, and Health: Workshop Summary*. Washington, DC: The National Academies Press, 2009.
4. Sen, Amartya 1997. On Economic Inequality. Enlarged edition, with annex by JamesFoster and Amartya Sen, Oxford: Claredon Press, 1997.
5. Intersectoral Water Allocation Planning and Management, 2000, World Bank Publishers www. Amazon.com
6. Third World Network.org (www.twn.org).

## CO PO MAPPING : WATER, SANITATION AND HEALTH

| PO/PSO | | Course Outcome | | | | | Overall Correlation of COs to POs |
|--------|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Knowledge of Engineering Sciences | | 1 | 1 | M | 1 | 1 |
| PO2 | Problem analysis | | 2 | 2 | 2 | 2 | 2 |
| PO3 | Design / development of solutions | | | 2 | 1 | 2 | 2 |
| PO4 | Investigation | | 2 | 3 | 3 | 3 | 3 |
| PO5 | Modern Tool Usage | | | | 1 | | 1 |
| PO6 | Individual and Team work | | 2 | 2 | 1 | 2 | 2 |
| PO7 | Communication | | | | 2 | 2 | 2 |
| PO8 | Engineer and Society | | 3 | 3 | 3 | 3 | 3 |
| PO9 | Ethics | | | 1 | 2 | 2 | 2 |
| PO10 | Environment and Sustainability | | 3 | | | 3 | 3 |
| PO11 | Project Management and Finance | | | | | 1 | 1 |
| PO12 | Life Long Learning | 2 | 3 | 2 | 3 | 3 | 3 |
| PSO1 | Explain the concepts of water management, field research methodology, gender, legal and environmental aspects in the context of integrated water resources management | | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Formulate, analyse and comprehend the differences in social and economic variability in South Asian context with their peers and strive to | | 3 | 2 | 3 | 3 | 3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | work towards sustainability. | | | | | |
| PSO3 | Produce and publish professional reports, peer reviewed journal on contemporary and state of art research in water resources Engineering. | 3 | 3 | 3 | 2 | 3 |

| OCE433 | PRINCIPLES OF SUSTAINABLE DEVELOPMENT | L T P C |
|---|---|---|
| | | 3 0 0 3 |

## OBJECTIVES:

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

## UNIT I        SUSTAINABILITY AND DEVELOPMENT CHALLEGES                9

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development- millennium  development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues –  social insecurity - resource degradation –climate change – desertification.

## UNIT II        PRINCIPLES AND FRAME WORK                9

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step- peoples earth charter – business charter for sustainable development –UN Global Compact - Role of civil society, business and government – United Nations' 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas

## UNIT III        SUSTAINABLE DEVELOPMENT AND WELLBEING                9

The Unjust World  and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and  Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry  for Prevention, Precaution , Preservation and Public participation.

## UNIT IV        SUSTAINABLE SOCIO-ECONOMIC SYSTEMS                10

Sustainable Development Goals and Linkage to Sustainable Consumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity –Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation –– Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

## UNIT  V        ASSESSING PROGRESS AND WAY FORWARD                8

Nature of sustainable development strategies and current practice- Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals

**TOTAL: 45 PERIODS**

## OUTCOMES:

- On completion of the course, the student is expected to be able to

| | |
|---|---|
| CO1 | Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises. |
| CO2 | Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals |
| CO3 | Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption |
| CO4 | Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems. |
| CO5 | Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability. |

**REFERENCES:**

1. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012
2. A guide to SDG interactions:from science to implementation, International Council for Science, Paris,2017
3. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Rouledge Taylor and Francis, 2017.
4. The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - *George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla,* IIED and UNFPA, Earthscan, UK, 2008
5. Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006
6. Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book", Earthscan Publications Ltd, London, 2002.

**CO – PO Mapping –Principles of Sustainable Development**

| PO/PSO | | Course Outcome | | | | | Overall Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Knowledge of Engineering Sciences | | | | | | |
| PO2 | Problem analysis | 3 | 3 | | | | 3 |
| PO3 | Design / development of solutions | | | | 3 | 3 | 3 |
| PO4 | Investigation | | 2 | 2 | 2 | 2 | 2 |
| PO5 | Modern Tool Usage | | | | | | |
| PO6 | Individual and Team work | | 2 | 2 | | | 2 |
| PO7 | Communication | | | | | 1 | 1 |
| PO8 | Engineer and Society | 3 | | | 3 | | 3 |
| PO9 | Ethics | | | | 2 | 2 | 2 |
| PO10 | Environment and Sustainability | 3 | 3 | 3 | 3 | 3 | 3 |
| PO11 | Project Management and Finance | | | | | | |
| PO12 | Life Long Learning | | | | | 1 | 1 |
| PSO1 | Knowledge of Environmental Management discipline | 3 | 3 | 3 | 3 | | 3 |
| PSO2 | Environmental Performance Evaluation and coordination | | | | | | |
| PSO3 | Conceptualization of Environmental Management Systems | | | | | | |

**OCE434**      **ENVIRONMENTAL IMPACT ASSESSMENT**      **L T P C**

     **3 0 0 3**

**OBJECTIVES:**
- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

**UNIT I        INTRODUCTION                                                            9**
Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

**UNIT II        IMPACT INDENTIFICATION AND PREDICTION                      10**
Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological –– cumulative impact assessment

**UNIT III        SOCIO-ECONOMIC IMPACT ASSESSMENT                        8**
Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

**UNIT IV        EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN        9**
Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

**UNIT V        CASE STUDIES                                                            9**
Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects
**TOTAL: 45 PERIODS**

**OUTCOMES:**
- On completion of the course, the student is expected to be able to

| CO1 | Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles |
|-----|------------------------------------------------------------------------------------------------------------------------|
| CO2 | Understand various impact identification methodologies, prediction techniques and model of impacts on various environments |
| CO3 | Understand relationship between social impacts and change in community due to development activities and rehabilitation methods |
| CO4 | Document the EIA findings and prepare environmental management and monitoring plan |
| CO5 | Identify, predict and assess impacts of similar projects based on case studies |

**REFERENCES:**
1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India
3. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
5. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey
6. World Bank –Source book on EIA ,1999
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

## CO – PO Mapping- ENVIRONMENTAL IMPACT ASSESSMENT

| PO/PSO | | Course Outcome | | | | | Overall Correlation of COs to Pos |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Knowledge of Engineering Sciences | | 3 | | | 3 | 3 |
| PO2 | Problem analysis | | 2 | 2 | | | 2 |
| PO3 | Design / development of solutions | | 3 | 3 | 3 | | 3 |
| PO4 | Investigation | | 2 | 2 | | 2 | 2 |
| PO5 | Modern Tool Usage | | 2 | 2 | 3 | | 2 |
| PO6 | Individual and Team work | | 2 | 2 | 2 | | 2 |
| PO7 | Communication | | | | 1 | | 1 |
| PO8 | Engineer and Society | 2 | | | 2 | | 2 |
| PO9 | Ethics | 3 | 3 | 3 | 2 | 2 | 3 |
| PO10 | Environment and Sustainability | 3 | | | 2 | | 2 |
| PO11 | Project Management and Finance | | | | 1 | | L |
| PO12 | Life Long Learning | | 1 | 1 | | | L |
| PSO1 | Knowledge of Environmental Engineering discipline | 2 | | | | | 2 |
| PSO2 | Environmental Performance Evaluation and coordination | | 2 | 2 | 2 | | 2 |
| PSO3 | Conceptualization of Environmental Engineering Systems | | 2 | | 2 | | 2 |

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**OIC431**    **BLOCKCHAIN TECHNOLOGIES**    **L T P C**
                                                          **3 0 0 3**

**COURSE OBJECTIVES**:
- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

**UNIT I        INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN        9**
Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

**UNIT II        BITCOIN AND CRYPTOCURRENCY        9**
Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

**UNIT III        INTRODUCTION TO ETHEREUM        9**
Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts.

**UNIT-IV        INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING        10**
Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

**UNIT V        BLOCKCHAIN APPLICATIONS        8**
Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

**COURSE OUTCOMES:**
After the completion of this course, student will be able to
**CO1**: Understand and explore the working of Blockchain technology
**CO2:** Analyze the working of Smart Contracts
**CO3:** Understand and analyze the working of Hyperledger
**CO4:** Apply the learning of solidity to build de-centralized apps on Ethereum
**CO5**: Develop applications on Blockchain

**REFERENCES:**
1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction" Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O'Reilly Publishing, 2014. .
4. Antonopoulos and G. Wood, "Mastering Ethereum: Building Smart Contracts and Dapps", O'Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.

**CO-PO Mapping**

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| **1** | 2 | 1 | 3 | 2 | 2 | 3 |
| **2** | 2 | 1 | 2 | 3 | 2 | 2 |
| **3** | 2 | 1 | 3 | 1 | 2 | 1 |
| **4** | 2 | 1 | 2 | 3 | 2 | 2 |
| **5** | | | | | | |
| **Avg** | 2.00 | 1.00 | 2.50 | 2.25 | 2.00 | 2.00 |

**OIC432**                         **DEEP LEARNING**                         **L  T  P C**
                                                                            **3  0  0 3**

**COURSE OBJECTIVES:**
- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

**UNIT I    DEEP LEARNING CONCEPTS                                             6**
Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

**UNIT II    NEURAL NETWORKS                                                   9**
About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

**UNIT III  CONVOLUTIONAL NEURAL NETWORK                                      10**
About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer

Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

## UNIT VI  NATURAL LANGUAGE PROCESSING USING RNN                     10
About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

## UNIT V   DEEP REINFORCEMENT & UNSUPERVISED LEARNING                 10
About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

### COURSE OUTCOMES:
**CO1:** Feature Extraction from Image and Video Data
**CO2:** Implement Image Segmentation and Instance Segmentation in Images
**CO3**: Implement image recognition and image classification using a pretrained network (Transfer Learning)
**CO4:** Traffic Information analysis using Twitter Data
**CO5:** Autoencoder for Classification & Feature Extraction

                                                                  **TOTAL :   45 PERIODS**
### REFERENCES
1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

| OBA431 | SUSTAINABLE MANAGEMENT | LT P C |
|---|---|---|
| | | 3 0 0 3 |

### COURSE OBJECTIVES:
- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

## UNIT I        MANAGEMENT OF SUSTAINABILITY                          9
Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

## UNIT II       CORPORATE SUSTAINABILITY AND RESPONSIBILITY           9
Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

## UNIT III      SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES   9
Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches

and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

## UNIT IV SUSTAINABILITY AND INNOVATION 9
Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

## UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS
9
Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES:
CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
CO2: An understanding of corporate sustainability and responsible Business Practices
CO3: Knowledge and skills to understand, to measure and interpret sustainabilityperformances.
CO4: Knowledge of innovative practices in sustainable business and community management
CO5: Deep understanding of sustainable management of resources and commodities

## REFERENCES:
1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

## MAPPING OF POs AND COs:

|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-----|-----|-----|-----|-----|-----|-----|
| CO1 | 3   | 3   | 2   | 1   | 2   | 2   |
| CO2 | 3   | 2   | 2   | 2   | 1   | 2   |
| CO3 | 3   | 3   | 1   | 2   | 2   | 3   |
| CO4 | 3   | 3   | 2   | 1   | 1   | 2   |
| CO5 | 3   | 3   | 2   | 1   | 2   | 2   |

| OBA432 | MICRO AND SMALL BUSINESS MANAGEMENT | L T P C |
|--------|-------------------------------------|---------|
|        |                                     | 3 0 0 3 |

## COURSE OBJECTIVES
- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

## UNIT I INTRODUCTION TO SMALL BUSINESS 9
Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

## UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

## UNIT III    BUILDING THE RIGHT TEAM AND MARKETING STRATEGY    9
Management and Leadership – employee assessments – Tuckman's stages of group development - The entrepreneurial process model - Delegation and team building -  Comparison of HR management in small and large firms -  Importance of coaching and how to apply a coaching model.
Marketing within the small business - success strategies for small business marketing -  customer delight and business generating systems, - market research, - assessing market performance- sales management and strategy -  the marketing mix and marketing strategy.

## UNIT IV    FINANCING SMALL BUSINESS    9
Main sources of entrepreneurial capital; Nature of 'bootstrap' financing -  Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin-  Pricing for profit -  Credit policy issues and relating these to cash flow management and profitability.

## UNIT V    VALUING SMALL BUSINESS AND CRISIS MANAGEMENT    9
Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it -  Advantages and disadvantages of buying an established small firm -  Process of preparing a business for sale.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES
CO1. Familiarise the students with the concept of small business
CO2. In depth knowledge on small business opportunities and challenges
CO3. Ability to devise plans for small business by building the right skills and marketing    strategies
CO4. Identify the funding source for small start ups
CO5. Business evaluation for buying and selling of small firms

## REFERENCES
1.  Hankinson,A.(2000). "The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000." Industrial and Commercial Training 32(3):94-98.
2.  Parker,R.(2000). "Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia." Australian Journal of Political Science 35(2):239-253.
3.  Journal articles on SME's.

## MAPPING OF POs AND COs

|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 1 | 1 | - | - |
| CO2 | 3 | 3 | 3 | 3 | 2 | 3 |
| CO3 | 3 | 3 | 2 | 2 | 3 | 3 |
| CO4 | 3 | 2 | 2 | 2 | 1 | 1 |
| CO5 | 3 | 2 | 2 | 3 | 2 | 1 |

**OBA433**    **INTELLECTUAL PROPERTY RIGHTS**    **L T P C**
**3 0 0 3**

## COURSE OBJECTIVE

➢    To understand intellectual property rights and its valuation.

## UNIT I INTRODUCTION 9
Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

## UNIT II PROCESS 9
New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

## UNIT III STATUTES 9
International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh- Dole Act and Issues of Academic Entrepreneurship.

## UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY 9
Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

## UNIT V MODELS 9
The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES
CO1: Understanding of intellectual property and appreciation of the need to protect it
CO2: Awareness about the process of patenting
CO3: Understanding of the statutes related to IPR
CO4: Ability to apply strategies to protect intellectual property
CO5: Ability to apply models for making strategic decisions related to IPR

## REFERENCES
1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.
4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
5. WIPO Intellectual Property Hand book.

## MAPPING OF POs AND COs

|      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|------|-----|-----|-----|-----|-----|-----|
| CO1  | 3   | 3   | 2   | 3   | 2   | 3   |
| CO2  | 3   | 3   | 2   | 3   | 1   | 3   |
| CO3  | 3   | 3   | 3   | 3   | 2   | 3   |
| CO4  | 3   | 3   | 3   | 2   | 1   | 3   |
| CO5  | 3   | 3   | 3   | 2   | 2   | 3   |

**OBA434** **ETHICAL MANAGEMENT** **L T P C**
**3 0 0 3**

## COURSE OBJECTIVE
➢ To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

## UNIT I ETHICS AND SOCIETY 9
Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations-

Individual and organizational responsibility to society and the community.

## UNIT II     ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS             9
Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

## UNIT III     STAKEHOLDERS IN ETHICAL MANAGEMENT                          9
Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

## UNIT IV     INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT                  9
Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology- ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

## UNIT V     PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS                  9
Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES
 CO1:  Role modelling and influencing the ethical and cultural context.
 CO2:  Respond to ethical crises and proactively address potential crises situations.
 CO3:  Understand and implement stakeholder management decisions.
 CO4:  Develop the ability, knowledge, and skills for ethical management.
 CO5:  Develop practical skills to navigate, resolve and thrive in management situations

### REFERENCES
1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

### MAPPING OF POs AND COs

|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-----|-----|-----|-----|-----|-----|-----|
| CO1 | 3   | 3   | 2   | 3   | 2   | 3   |
| CO2 |     | 3   | 2   | 3   | 1   | 3   |
| CO3 | 3   | 3   | 3   | 3   | 2   | 3   |
| CO4 | 3   | 3   | 3   | 2   | 1   | 3   |
| CO5 | 3   | 3   | 3   | 2   | 2   | 3   |

**ET4251**                          **IoT FOR SMART SYSTEMS**                          **LT P C**
                                                                                      **3 0 0 3**

### COURSE OBJECTIVES:
1. To study about **Internet of Things** technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.

4.    To provide insight about the embedded processor and sensors required for IoT
5.    To familiarize the different platforms and Attributes for IoT

## UNIT I        INTRODUCTION TO INTERNET OF THINGS                                    9
Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

## UNIT II       IOT ARCHITECTURE                                                       9
IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture, IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

## UNIT III      PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT                            9
**PROTOCOLS:**
NFC, SCADA and RFID, Zigbee      MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe      GSM, CDMA, LTE, GPRS, small cell.

**Wireless technologies for IoT:** WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

## UNIT IV       IOT PROCESSORS                                                         9
**Services/Attributes:** Big-Data Analytics for IOT, Dependability,Interoperability, Security, Maintainability.
**Embedded processors for IOT** :Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.

## UNIT V     CASE STUDIES                                                              9
Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**
At the end of this course, the students will have the ability to
CO1:  Analyze the concepts of IoT and its present developments.
CO2:  Compare and contrast different platforms and infrastructures available for IoT
CO3:  Explain different protocols and communication technologies used in IoT
CO4:  Analyze the big data analytic and programming of IoT
CO5:  Implement IoT solutions for smart applications

| CO | PO | | | | | |
|------|------|------|------|------|------|------|
|      | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 1 | 2 | 1 | - | - | - |
| 2 | - | 2 | - | - | - | - |
| 3 | 1 | 2 | - | 1 | 3 | - |
| 4 | 2 | | 3 | 3 | 3 | 3 |
| 5 | 3 | 2 | 3 | 3 | 3 | 3 |
| Avg. | 1.75 | 2 | 2.33 | 2.33 | 3 | 2 |

**REFERENCES:**
1.    ArshdeepBahga and VijaiMadisetti : A Hands-on Approach "Internet of Things",Universities Press 2015.
2.    Oliver Hersent , David Boswarthick and Omar Elloumi " The Internet of Things", Wiley,2016.
3.    Samuel Greengard, " The Internet of Things", The MIT  press, 2015.
4.    Adrian McEwen and Hakim Cassimally"Designing the Internet of Things "Wiley,2014.

5. Jean- Philippe Vasseur, Adam Dunkels, "Interconnecting Smart Objects with IP: The Next Internet" Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain," Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers Series in Communication, 2013.
9. Vijay Madisetti , ArshdeepBahga, "Internet of Things (A Hands on-Approach)", 2014.
10. Zach Shelby, Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet", John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, "Smart Grid applications, communications and security", Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, " Smart Grid Technology and Applications", Wiley, 2015.
13. UpenaDalal,"Wireless Communications & Networks,Oxford,2015.

**ET4072**              **MACHINE LEARNING AND DEEP LEARNING**              **L T P C**
                                                                          **3 0 0 3**

**COURSE OBJECTIVES:**
The course is aimed at
1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

**UNIT I      LEARNING PROBLEMS AND ALGORITHMS**                                      **9**      Various
paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

**UNIT II     NEURAL NETWORKS**                                                        **9**
Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

**UNIT III    MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS &**
              **CLASSIFICATIONS**                                                      **9**
Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

**UNIT IV     DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS**                           **9** Feed
forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

**UNIT V      DEEP LEARNING: RNNS, AUTOENCODERS AND GANS**                             **9** State,
Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional

Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

**TOTAL : 45 PERIODS**

## COURSE OUTCOMES (CO):
At the end of the course the student will be able to
CO1 : Illustrate the categorization of machine learning algorithms.
CO2: Compare and contrast the types of neural network architectures, activation functions
CO3: Acquaint with the pattern association using neural networks
CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks
CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

| CO | PO | | | | | |
|------|------|---|------|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | 1 | 3 | 1 | - | - | - |
| **2** | 2 | 3 | 2 | - | - | - |
| **3** | 3 | - | 3 | - | 3 | - |
| **4** | 2 | 3 | 3 | - | - | - |
| **5** | 3 | 3 | 3 | - | 3 | - |
| **6** | 3 | 3 | 3 | - | 3 | - |
| **7** | 3 | 3 | 3 | - | 3 | - |
| **Avg.** | 2.42 | 3 | 2.57 | - | 3 | - |

## REFERENCES:
1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

| PX4012 | RENEWABLE ENERGY TECHNOLOGY | L T P C |
|---|---|---|
| | | 3 0 0 3 |

## OBJECTIVES:
To impart knowledge on
- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

## UNIT I        INTRODUCTION        9
Classification of energy sources – Co2 Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - $CO_2$ Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

## UNIT II        SOLAR PHOTOVOLTAICS        9
Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell-characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

**UNIT III** **PHOTOVOLTAIC SYSTEM DESIGN** **9**

Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

**UNIT IV** **WIND ENERGY CONVERSION SYSTEMS** **9**

Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

**UNIT V** **OTHER RENEWABLE ENERGY SOURCES** **9**

Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

**TOTAL : 45 PERIODS**

**OUTCOMES:**
After completion of this course, the student will be able to:
  CO1:   Demonstrate the need for renewable energy sources.
  CO2:   Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.
  CO3:   Design a stand-alone and Grid connected PV system.
  CO4:   Analyze the different configurations of the wind energy conversion systems.
  CO5:   Realize the basic of various available renewable energy sources

**REFERENCES:**
1.   S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford UniversityPress, 2009.
2.   Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3.   Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4.   Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, 2012.
5.   John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006
6.   Gray, L. Johnson, "Wind energy system", prentice hall of India, 1995.
7.   B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8.   Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

**CO-PO MAPPING :**

|      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|------|-----|-----|-----|-----|-----|-----|
| CO1  | 3   |     | 2   | 2   | 2   | 1   |
| CO2  | 3   |     | 2   | 3   | 3   | 3   |
| CO3  | 3   |     | 2   | 3   | 3   | 3   |
| CO4  | 3   |     | 2   | 3   | 3   | 2   |
| CO5  | 3   |     | 2   | 2   | 2   | 2   |

**PS4093**                                    **SMART GRID**                          **L  T  P  C**
                                                                                      **3  0  0  3**
**COURSE OBJECTIVES**
- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

**UNIT I       INTRODUCTION TO SMART GRID                              9**
Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

**UNIT II      SMART GRID TECHNOLOGIES                                 9**
Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

**UNIT III     SMART METERS AND ADVANCED METERING INFRASTRUCTURE       9**
Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

**UNIT IV      POWER QUALITY MANAGEMENT IN SMART GRID                  9**
Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

**Unit V       HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS  9**
Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

                                                                    **TOTAL : 45 PERIODS**
**COURSE OUTCOME:**
Students able to
CO1: Relate with the smart resources, smart meters and other smart devices.
CO2: Explain the function of Smart Grid.
CO3: Experiment the issues of Power Quality in Smart Grid.
CO4: Analyze the performance of Smart Grid.
CO5**:** Recommend suitable communication networks for smart grid applications


**REFERENCES**
1.  Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2.  JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama,
    'Smart Grid: Technology and Applications', Wiley, 2012.
3.  Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
4.  Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart     Grids', Springer, 2014
5.  SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

**MAPPING OF CO'S WITH PO'S**

| CO | PO | | | | | |
|----|------|------|------|------|------|------|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| 1 | 3 | 2 | - | 2 | 2 | 2 |
| 2 | 3 | - | 2 | 2 | - | 2 |
| 3 | 2 | - | 1 | - | - | - |
| 4 | 1 | - | - | 3 | 3 | 1 |
| 5 | - | 2 | 2 | 2 | 2 | 3 |
| AVG | 2.25 | 2 | 1.66 | 2.25 | 2.3 | 2 |

| | | | |
|---|---|---|---|
| **CP4391** | **SECURITY PRACTICES** | | **L T P C** |
| | | | **3 0 0 3** |

**COURSE OBJECTIVES:**
- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

**UNIT I          SYSTEM SECURITY                                              9**
Model of network security – Security attacks, services and mechanisms – OSI security architecture -A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

**UNIT II          NETWORK SECURITY                                              9**
Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

**UNIT III          SECURITY MANAGEMENT                                        9**
Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

**UNIT IV          CYBER SECURITY AND CLOUD SECURITY                         9**
Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

**UNIT V          PRIVACY AND STORAGE SECURITY                              9**
Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**
**CO1:** Understand the core fundamentals of system security
**CO2:** Apply the security concepts to wired and wireless networks
**CO3**: Implement and Manage the security essentials in IT Sector
**CO4:** Explain the concepts of Cyber Security and Cyber forensics
**CO5:** Be aware of Privacy and Storage security Issues.

**REFERENCES**
1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017

2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5. John Sammons, "The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics", Syngress, 2012
6. Cory Altheide and Harlan Carvey, "Digital Forensics with Open Source Tools",2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

## CO-PO Mapping

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1 | 1 | 2 | 1 | 1 | 2 | 1 |
| 2 | 2 | 1 | 3 | 1 | 1 | 2 |
| 3 | | | 2 | 3 | 3 | 3 |
| 4 | 2 | 2 | 1 | 2 | 1 | 3 |
| 5 | 1 | | 1 | 1 | 2 | 3 |
| Avg | 1.50 | 1.67 | 1.60 | 1.60 | 1.80 | 2.40 |

**MP4251**                    **CLOUD COMPUTING TECHNOLOGIES**                    **L  T  P  C**
                                                                               **3  0  0  3**

**COURSE OBJECTIVES:**
- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

**UNIT I          VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE                    6**
Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization –– Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation

**UNIT II         CLOUD PLATFORM ARCHITECTURE                    12**
Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

**UNIT III         AWS CLOUD PLATFORM - IAAS                    9**
**Amazon Web Services:** AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes-  AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager

**UNIT IV         PAAS CLOUD PLATFORM                    9**
Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows

Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services-REST API- Blops

## UNIT V             PROGRAMMING MODEL            9

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES:
**CO1:** Employ the concepts of virtualization in the cloud computing
**CO2:** Identify the architecture, infrastructure and delivery models of cloud computing
**CO3:** Develop the Cloud Application in AWS platform
**CO4:** Apply the concepts of Windows Azure to design Cloud Application
**CO5:** Develop services using various Cloud computing programming models.

## REFERENCES

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.
3. Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010.
4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , MCGraw Hill Education (India) Pvt. Ltd., 2013.
5. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner"s Guidell, McGraw-Hill Osborne Media, 2009.
6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.

9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

| IF4072 | DESIGN THINKING | L T P C |
|---|---|---|
| | | 3 0 0 3 |

## COURSE OBJECTIVES:
- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

## UNIT I           UX LIFECYCLE TEMPLATE       8

Introduction. A UX process lifecycle template. Choosing a process instance for your project. The system complexity space. Meet the user interface team. Scope of UX presence within the team. More about UX lifecycles. Business Strategy. Value Innovation. Validated User Research. Killer UX Design. The Blockbuster Value Proposition. What Is a Value Proposition?.

## UNIT II          CONTEXTUAL INQUIRY       10

The system concept statement. User work activity data gathering. Look for emotional aspects of work practice. Abridged contextual inquiry process. Data-driven vs. model-driven inquiry. Organizing concepts: work roles and flow model. Creating and managing work activity notes. Constructing your work activity affinity diagram

(WAAD). Abridged contextual analysis process. History of affinity diagrams.

**UNIT III**  **DESIGN THINKING, IDEATION, AND SKETCHING**  **9**
Design-informing models: second span of the bridge . Some general "how to" suggestions. A New example domain: slideshow presentations. User models. Usage models. Work environment models. Barrier summaries. Model consolidation. Protecting your sources. Abridged methods for design-informing models extraction. Design paradigms. Design thinking. Design perspectives. User personas. Ideation. Sketching

**8**
**UNIT IV**  **UX GOALS, METRICS, AND TARGETS**
Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring instruments. UX metrics. Baseline level. Target level. Setting levels. Observed results. Practical tips and cautions for creating UX targets. How UX targets help manage the user experience engineering process.

**UNIT V**  **ANALYSING USER EXPERIENCE**  **10**
Sharpening Your Thinking Tools. UX Research and Strength of Evidence. Agile Personas. How to Prioritize Usability Problems. Creating Insights, Hypotheses and Testable Design Ideas. How to Manage Design Projects with User Experience Metrics. Two Measures that Will Justify Any Design Change. Evangelizing UX Research. How to Create a User Journey Map. Generating Solutions to Usability Problems. Building UX Research Into the Design Studio Methodology. Dealing with Common objections to UX Research. The User Experience Debrief Meeting. Creating a User Experience Dashboard.

**SUGGESTED ACTIVITIES:**
1: Hands on Design Thinking process for a product
2: Defining the Look and Feel of any new Project
3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
4: Identify a customer problem to solve.
5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**
**CO1:** Build UI for user Applications
**CO2:** Use the UI Interaction behaviors and principles
**CO3:** Evaluate UX design of any product or application
**CO4:** Demonstrate UX Skills in product development
**CO5:** Implement Sketching principles

**REFERENCES**
1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018
2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012
3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers, Writers, Designers, and Developers, Edward Stull. Apress, 2018
4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016
5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

**PRINCIPLES OF MULTIMEDIA**

**COURSE OBJECTIVES:**
- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

**UNIT I INTRODUCTION 9**

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

**Suggested Activities:**
1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

**Suggested Evaluation Methods:**
1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

**UNIT II ELEMENTS OF MULTIMEDIA 9**

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

**Suggested Activities:**
1. Flipped classroom on different file formats of various media elements.
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition.

**Suggested Evaluation Methods:**
1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

**UNIT III MULTIMEDIA TOOLS 9**

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

**Suggested Activities:**
1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

**Suggested Evaluation Methods:**
1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

**UNIT IV MULTIMEDIA SYSTEMS 9**

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

**Suggested Activities:**
1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

**Suggested Evaluation Methods:**
1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

## UNIT V  MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS      9

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval.

**Suggested Activities:**
1. External learning – Game consoles.
2. External learning – VRML scripting languages.

**Suggested Evaluation Methods:**
1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

**TOTAL : 45 PERIODS**

### COURSE OUTCOMES:
**CO1:**Handle the multimedia elements effectively.
**CO2:**Articulate the concepts and techniques used in multimedia applications.
**CO3:**Develop effective strategies to deliver Quality of Experience in multimedia applications.
**CO4:**Design and implement algorithms and techniques applied to multimedia objects.
**CO5:**Design and develop multimedia applications following software engineering models.

### REFERENCES:
1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, "Fundamentals of Multimedia", Springer, Third Edition, 2021.
2. Prabhat K.Andleigh, Kiran Thakrar, "MULTIMEDIA SYSTEMS DESIGN", Pearson Education, 2015.
3. Gerald Friedland, Ramesh Jain, "Multimedia Computing", Cambridge University Press, 2018. (digital book)
4. Ranjan Parekh, "Principles of Multimedia", Second Edition, McGraw-Hill Education, 2017

**DS4015**                                    **BIG DATA ANALYTICS**                        **L T P C**
                                                                                            **3 0 0 3**

### COURSE OBJECTIVES:
- To understand the  basics of big data analytics
- To understand the search methods and visualization
- To learn mining data streams
- To learn frameworks
- To gain knowledge on R language

## UNIT I              INTRODUCTION TO BIG DATA                                            9

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis –Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools- Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

## UNIT II             SEARCH METHODS AND VISUALIZATION                                    9

Search by simulated Annealing – Stochastic, Adaptive search by Evaluation – Evaluation Strategies –Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques – Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques

## UNIT III         MINING DATA STREAMS        9

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing -Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

## UNIT IV         FRAMEWORKS        9

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Case Study- Preventing Private Information Inference Attacks on Social Networks- Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

## UNIT V         R LANGUAGE        9

Overview, Programming structures: Control statements -Operators -Functions -Environment and scope issues - Recursion -Replacement functions, R data structures: Vectors -Matrices and arrays -Lists -Data frames - Classes, Input/output, String manipulations

**COURSE OUTCOMES:**
CO1:understand the  basics of big data analytics
**CO2:** Ability to use Hadoop, Map Reduce Framework.
**CO3:** Ability to identify the areas for applying big data analytics for increasing the business outcome.
CO4:gain knowledge on R language
**CO5:** Contextually integrate and correlate large amounts of information to gain faster insights.

**TOTAL:45 PERIODS**

**REFERENCE:**
1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge
   University Press, 3rd edition 2020.
3. Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design,
   No Starch Press, USA, 2011.
4. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data
   Streams with Advanced Analytics, John Wiley & sons, 2012.
5. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007.

### CO-PO Mapping

| CO | POs | | | | | |
|-----|-----|-----|-----|-----|-----|-----|
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1 | 3 | 3 | 3 | 3 | 2 | 1 |
| 2 | 3 | 3 | 3 | 3 | 2 | 1 |
| 3 | 3 | 3 | 3 | 3 | 2 | 1 |
| 4 | 3 | 3 | 3 | 3 | 2 | 1 |
| 5 | 3 | 3 | 3 | 3 | 2 | 1 |
| Avg | 3 | 3 | 3 | 3 | 2 | 1 |

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**NC4201**        **INTERNET OF THINGS  AND CLOUD**        **L T P C**
                                                          **3 0 0 3**

**COURSE OBJECTIVES:**
- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

## UNIT I        FUNDAMENTALS OF IoT        9

Introduction to IoT – IoT definition – Characteristics – IoT Complete Architectural Stack – IoT enabling Technologies – IoT Challenges. Sensors and Hardware for IoT – Hardware Platforms – Arduino, Raspberry Pi,

Node MCU. A Case study with any one of the boards and data acquisition from sensors.

**UNIT II        PROTOCOLS FOR IoT                                                9**
Infrastructure protocol (IPV4/V6/RPL), Identification (URIs), Transport (Wifi, Lifi, BLE), Discovery, Data Protocols, Device Management Protocols. – A Case Study with MQTT/CoAP usage-IoT privacy, security and vulnerability solutions.

**UNIT III       CASE STUDIES/INDUSTRIAL APPLICATIONS                          9**
Case studies with architectural analysis: IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management.

**UNIT IV        CLOUD COMPUTING INTRODUCTION                                  9**
Introduction to Cloud Computing - Service Model – Deployment Model- Virtualization Concepts – Cloud Platforms – Amazon AWS – Microsoft Azure – Google APIs.

**UNIT V         IoT AND CLOUD                                                  9**
IoT and the Cloud - Role of Cloud Computing in IoT - AWS Components - S3 – Lambda - AWS IoT Core - Connecting a web application to AWS IoT using MQTT- AWS IoT Examples. Security Concerns, Risk Issues, and Legal Aspects of Cloud Computing- Cloud Data Security

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**
**At the end of the course, the student will be able to:**
**CO1:** Understand the various concept of the IoT and their technologies.
**CO2:** Develop IoT application using different hardware platforms
**CO3**: Implement the various IoT Protocols
**CO4**: Understand the basic principles of cloud computing.
**CO5:** Develop and deploy the IoT application into cloud environment

**REFERENCES**
1.   "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman ,CRC Press, 2017
2.   Adrian McEwen, Designing the Internet of Things, Wiley,2013.
3.   EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, 2015.
4.   Simon Walkowiak, "Big Data Analytics with R" PackT Publishers, 2016
5.   Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2015.

| MX4073 | MEDICAL ROBOTICS | L T P C |
|---|---|---|
| | | 3 0 0 3 |

**COURSE OBJECTIVES:**
- To explain the basic concepts of robots and types of robots
- To discuss the designing procedure of manipulators, actuators and grippers
- To impart knowledge on various types of sensors and power sources
- To explore various applications of Robots in Medicine
- To impart knowledge on wearable robots

**UNIT I        INTRODUCTION TO ROBOTICS                                        9**
Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization
**Sensors and Actuators**
Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models

## UNIT II      MANIPULATORS & BASIC KINEMATICS      9

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

**Navigation and Treatment Planning**
Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser – Acoustic, Magnetic, fiber optic and Tactile sensor

## UNIT III      SURGICAL ROBOTS      9

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study

## UNIT IV      REHABILITATION AND ASSISTIVE ROBOTS      9

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study

## UNIT V      WEARABLE ROBOTS      9

Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication - case study

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**
**CO1:** Describe the configuration, applications of robots and the concept of grippers and actuators
**CO2:** Explain the functions of manipulators and basic kinematics
**CO3:** Describe the application of robots in various surgeries
**CO4:** Design and analyze the robotic systems for rehabilitation
**CO5:** Design the wearable robots

**REFERENCES**
1. Nagrath and Mittal, "Robotics and Control", Tata McGraw Hill, First edition, 2003
2. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and Sons, First edition, 2008
3. Fu.K.S, Gonzalez. R.C., Lee, C.S.G, "Robotics, control", sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008
4. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008
5. Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016
6. Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007
7. Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd, England, 2008
8. Howie Choset, Kevin Lynch, Seth Hutchinson, "Principles of Robot Motion: Theory, Algorithms, and Implementations", Prentice Hall of India, First edition, 2005
9. Philippe Coiffet, Michel Chirouze, "An Introduction to Robot Technology", Tata McGraw Hill, First Edition, 1983
10. Jacob Rosen, Blake Hannaford & Richard M Satava, "Surgical Robotics: System Applications & Visions", Springer 2011
11. Jocelyn Troccaz, Medical Robotics, Wiley, 2012
12. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

**CO-PO Mapping**

| CO | POs |
|----|-----|
|    |     |

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| 1 | | | | 1 | | |
| 2 | | | | 2 | | |
| 3 | 2 | | 2 | 2 | 2 | 2 |
| 4 | 2 | | 2 | 2 | 3 | 2 |
| 5 | 2 | | 2 | 2 | 3 | 3 |
| Avg | 2 | | 2 | 1.8 | 2.6 | 2.3 |

**VE4202**                    **EMBEDDED AUTOMATION**                    **L T P C**
                                                                          **3 0 0 3**

**COURSE OBJECTIVES:**
- To learn about the process involved in the design and development of real-time embedded system
- To develop the embedded C programming skills on 8-bit microcontroller
- To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
- To learn about the tools, firmware related to microcontroller programming
- To build a home automation system

**UNIT - I        INTRODUCTION TO EMBEDDED C PROGRAMMING                    9**
C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers And Arrays - FIFO and LIFO - C Structures - Development Tools

**UNIT - II       AVR MICROCONTROLLER                    9**
ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features : Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters

**UNIT – III      HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS      9**
Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Convertors - Interfacing Digital To Analog Convertors - LED Displays : Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface - Serial EEPROM - Real Time Clock - Accessing Constants Table - Arbitrary Waveform Generation - Communication Links - System Development Tools

**UNIT – IV       VISION SYSTEM                    9**
Fundamentals of Image Processing - Filtering - Morphological Operations - Feature Detection and Matching - Blurring and Sharpening - Segmentation - Thresholding - Contours - Advanced Contour Properties - Gradient - Canny Edge Detector - Object Detection - Background Subtraction

**UNIT – V        HOME AUTOMATION                    9**
Home Automation - Requirements - Water Level Notifier - Electric Guard Dog - Tweeting Bird Feeder - Package Delivery Detector - Web Enabled Light Switch - Curtain Automation - Android Door Lock - Voice Controlled Home Automation - Smart Lighting - Smart Mailbox - Electricity Usage Monitor -Proximity Garage Door Opener - Vision Based Authentic Entry System

**TOTAL:  45 PERIODS**

**COURSE OUTCOMES:**
On successful completion of this course, students will be able to
**CO1:** analyze the 8-bit series microcontroller architecture, features and pin details
**CO2:** write embedded C programs for embedded system application
**CO3**: design and develop real time systems using AVR microcontrollers
**CO4**: design and develop the systems based on vision mechanism
**CO5**: design and develop a real time home automation system

**REFERENCES:**
1. Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller", McGraw-Hill, 2001.

2. Joe Pardue, "C Programming for Microcontrollers ", Smiley Micros, 2005.
3. Steven F. Barrett, Daniel J. Pack, "ATMEL AVR Microcontroller Primer : Programming and Interfacing", Morgan & Claypool Publishers, 2012
4. Mike Riley, "Programming Your Home - Automate With Arduino, Android and Your Computer", the Pragmatic Programmers, Llc, 2012.
5. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.
6. Kevin P. Murphy, "Machine Learning - a Probabilistic Perspective", the MIT Press Cambridge, Massachusetts, London, 2012.

## CO-PO Mapping

| CO | POs | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| 1 | 1 | | 1 | 1 | 1 | |
| 2 | 1 | 3 | 1 | 1 | 1 | 3 |
| 3 | 1 | 3 | 1 | 1 | 1 | 3 |
| 4 | 1 | 3 | 1 | 1 | 1 | 3 |
| 5 | 1 | 3 | 1 | 1 | 1 | 3 |
| Avg | (5/5)=1 | (12/4)=3 | (5/5)=1 | (5/5)=1 | (5/5)=1 | (12/4)=3 |

| CX4016 | ENVIRONMENTAL SUSTAINABILITY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**UNIT I    INTRODUCTION    9**

Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems

**UNIT II    CONCEPT OF SUSTAINABILITY    9**

Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture

**UNIT III    SIGNIFICANCE OF BIODIVERSITY    9**

Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation

**UNIT IV    POLLUTION IMPACTS    9**

Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.

**UNIT V    ENVIRONMENTAL ECONOMICS    9** Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics

**TOTAL : 45 PERIODS**

**REFERENCES**
1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

**TX4092**  **TEXTILE REINFORCED COMPOSITES**  **L T P C**
                                                        **3 0 0 3**

**UNIT I  REINFORCEMENTS  9**
Introduction – composites –classification and application; reinforcements- fibres and its properties; preparation of reinforced materials and quality evaluation; preforms for various composites

**UNIT II  MATRICES  9**
Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices

**UNIT III  COMPOSITE MANUFACTURING  9**
Classification; methods of composites manufacturing for both thermoplastics and thermosets- Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing of composites and composite design requirements

**UNIT IV  TESTING  9**
Fibre volume and weight fraction, specific gravity of composites, tensile, flexural, impact, compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.

**UNIT V  MECHANICS  9**
Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical lamination theory, failure theories and prediction of inter laminar stresses using at ware

**TOTAL: 45 PERIODS**

**REFERENCES**
1. BorZ.Jang,"Advanced Polymer composites",ASM International,USA,1994.
2. Carlsson L.A. and Pipes R.B., "Experimental Characterization of advanced composite Materials",SecondEdition,CRCPress,NewJersey,1996.
3. George LubinandStanley T.Peters, "Handbook of Composites", Springer Publications,1998.
4. Mel. M. Schwartz, "Composite Materials", Vol. 1 &2, Prentice Hall PTR, New Jersey,1997.
5. RichardM.Christensen,"Mechanics of compositematerials",DoverPublications,2005.
6. Sanjay K. Mazumdar, "Composites Manufacturing: Materials, Product, and Process Engineering",CRCPress,2001

**NT4002**  **NANOCOMPOSITE MATERIALS**  **L T P C**
                                                        **3 0 0 3**

**UNIT I  BASICS OF NANOCOMPOSITES  9**
Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

**UNIT II  METAL BASED NANOCOMPOSITES  9**
Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal- Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

## UNIT III     POLYMER BASED NANOCOMPOSITES                                   9
Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

## UNIT IV     NANOCOMPOSITE FROM BIOMATERIALS                                 9
Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.

## UNIT V     NANOCOMPOSITE TECHNOLOGY                                         9
Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

**TOTAL : 45 PERIODS**

**REFERENCES:**
1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization- Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V.Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Vepr¡ek (Review Article) JVST   A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles,  Woodhead publication, London, 2006

| BY4016 | IPR, BIOSAFETY AND ENTREPRENEURSHIP | L T P C |
| | | 3 0 0 3 |

## UNIT I     IPR                                                             9
Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D,IP's of relevance to biotechnology and few case studies.

## UNIT II     AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES               9
History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties  – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of "prior art" – Patent databases – Searching International Databases – Country-wise patent searches (USPTO,espacenet(EPO) –  PATENT Scope (WIPO) – IPO, etc  National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

## UNIT III     BIOSAFETY                                                      9

Introduction – Historical Backround – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

## UNIT IV        GENETICALLY MODIFIED ORGANISMS                    9

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

## UNIT V        ENTREPRENEURSHIP DEVELOPMENT                    9

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

**TOTAL : 45 PERIODS**

## REFERENCES
1. Bouchoux, D.E., "Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal", 3rd Edition, Delmar Cengage Learning, 2008.
2. Fleming, D.O. and Hunt, D.L., "Biological Safety: Principles and Practices", 4th Edition, American Society for Microbiology, 2006.
3. Irish, V., "Intellectual Property Rights for Engineers", 2nd Edition, The Institution of Engineering and Technology, 2005.
4. Mueller, M.J., "Patent Law", 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. Young, T., "Genetically Modified Organisms and Biosafety: A Background Paper for Decision-Makers and Others to Assist in Consideration of GMO Issues" 1st Edition, World Conservation Union, 2004.
6. S.S Khanka, "Entrepreneurial Development", S.Chand & Company LTD, New Delhi, 2007.