ANNA UNIVERSITY, CHENNAI
AFFILIATED INSTITUTIONS
REGULATIONS -2017
M.E. PRODUCT DESIGN AND DEVELOPMENT
CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES:

Post graduates of the product design and development engineering program are expected to:

1. Demonstrate technical competency in practice.
2. Function effectively in an industrial and academic environments.
3. Engage in professional ethics and development.
4. Enrich their society and environment through their skills.

PROGRAMME OUTCOMES:

The graduate will demonstrate:

1. an ability to apply knowledge of mathematics, science, and engineering;
2. an ability to design a system, component, or process to meet desired needs;
3. an ability to identify, formulate, and solve engineering problems;
4. an understanding of professional and ethical responsibility;
5. an ability to communicate effectively;
6. the broad education necessary to understand the impact of engineering solutions in a global and societal context;
7. a knowledge of contemporary issues;
8. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice;
9. an ability to select and apply materials and manufacturing processes: ability to design manufacturing processes that result in products that meet specific material and other requirements;
10. a knowledge of process, assembly and product engineering: ability to design products and the equipment, tooling, and environment necessary for their manufacture;

1. PEO / PO Mapping

EXAMPLE

Programme Educational Objectives	Programme Outcomes									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
I	✓	✓	✓					✓	✓	✓
II	✓	✓	✓	✓		✓	✓			
III				✓	✓	✓	✓			
IV			✓					✓	✓	✓

2. Semester Course wise PO mapping

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
YEAR 1	SEM 1	Applied Mathematics for Engineers	✓		✓					✓		
		Introduction to Product Development	✓	✓	✓					✓		
		Computer Applications in Design	✓					✓	✓			
		Advanced Finite Element Analysis	✓	✓	✓					✓		
		Industrial Design		✓						✓	✓	✓
		Professional Elective I										
	SEM 2	Integrated Product Design and Process Development	✓	✓						✓	✓	✓
		Product and Process Engineering Tools	✓	✓	✓					✓	✓	✓
		Materials Selection for Product Development		✓	✓					✓	✓	✓
		Quality Concepts in Product Development						✓	✓	✓	✓	✓
		Professional Elective II										
		Professional Elective III										
YEAR 2	SEM 3	Marketing Research					✓	✓	✓			
		Professional Elective IV										
		Professional Elective V										
		Project Work Phase I										
	SEM 4	Project Work Phase II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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M.E. PRODUCT DESIGN AND DEVELOPMENT

CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA5156	Applied Mathematics for Engineers	FC	4	4	0	0	4
2.	PD5101	Introduction to Product Development	PC	3	3	0	0	3
3.	ED5151	Computer Applications in Design	PC	3	3	0	0	3
4.	ED5153	Advanced Finite Element Analysis	PC	3	3	0	0	3
5.	PD5102	Industrial Design	PC	4	4	0	0	4
6.		Professional Elective I	PE	3	3	0	0	3
PRACTICAL								
7.	ED5161	CAD Laboratory	PC	4	0	0	4	2
8.	ED5162	Advanced Analysis and Simulation Laboratory	PC	4	0	0	4	2
			TOTAL CREDITS	**28**	**20**	**0**	**8**	**24**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	PD5251	Integrated Product Design and Process Development	PC	5	3	2	0	4
2.	PD5201	Product and Process Engineering Tools	PC	3	3	0	0	3
3.	PD5202	Materials Selection for Product Development	PC	3	3	0	0	3
4.	PD5203	Quality Concepts in Product Development	PC	3	3	0	0	3
5.		Professional Elective II	PE	3	3	0	0	3
6.		Professional Elective III	PE	3	3	0	0	3
PRACTICAL								
7.	PD5211	Product Design Laboratory	PC	2	0	0	2	1
8.	PD5212	Design Project	EEC	4	0	0	4	2
			TOTAL CREDITS	**26**	**18**	**2**	**6**	**22**

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	PD5301	Marketing Research	PC	3	3	0	0	3
2.		Professional Elective IV	PE	3	3	0	0	3
3.		Professional Elective V	PE	3	3	0	0	3
PRACTICAL								
4.	PD5311	Project Work Phase I	EEC	12	0	0	12	6
			TOTAL CREDITS	**21**	**9**	**0**	**12**	**15**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICAL								
1.	PD5411	Project Work Phase II	EEC	24	0	0	24	12
			TOTAL CREDITS	**24**	**0**	**0**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE =73

FOUNDATION COURSES (FC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MA5156	Applied Mathematics for Engineers	FC	4	4	0	0	4

PROFESSIONAL CORE (PC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	PD5101	Introduction to Product Development	PC	3	3	0	0	3
2.	ED5151	Computer Applications in Design	PC	3	3	0	0	3
3.	ED5153	Advanced Finite Element Analysis	PC	3	3	0	0	3
4.	PD5102	Industrial Design	PC	4	4	0	0	4
5.	ED5161	CAD Laboratory	PC	4	0	0	4	2
6.	ED5162	Advanced Analysis and Simulation Laboratory	PC	4	0	0	4	2
7.	PD5251	Integrated Product Design and Process Development	PC	5	3	2	0	4
8.	PD5201	Product and Process Engineering Tools	PC	3	3	0	0	3
9.	PD5202	Materials Selection for Product Development	PC	3	3	0	0	3
10.	PD5203	Quality Concepts in Product Development	PC	3	3	0	0	3
11.	PD5211	Product Design Laboratory	PC	2	0	0	2	1
12.	PD5301	Marketing Research	PC	3	3	0	0	3

LIST OF ELECTIVES

SEMESTER I (Elective I)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	PD5001	Creativity in Design	PE	3	3	0	0	3
2.	PD5002	Enterprise Resource Planning	PE	3	3	0	0	3
3.	ED5071	Optimization Techniques in Design	PE	3	3	0	0	3
4.	CC5292	Additive Manufacturing and Tooling	PE	3	3	0	0	3
5.	ED5073	Information Analytics	PE	3	3	0	0	3

SEMESTER II (Elective II & III)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	PD5003	Design Thinking	PE	3	3	0	0	3
2.	CM5072	Micro Electro Mechanical Systems	PE	3	3	0	0	3
3.	CD5091	Industrial Robotics and Expert Systems	PE	3	3	0	0	3
4.	CC5291	Design for Manufacture, Assembly and Environments	PE	3	3	0	0	3
5.	ED5093	Computational Fluid Dynamics	PE	3	3	0	0	3
6.	PD5004	Reverse Engineering	PE	3	3	0	0	3

SEMESTER III
(Elective IV & V)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	PD5091	Product Lifecycle Management	PE	3	3	0	0	3
2.	ED5075	Design for Internet of Things	PE	3	3	0	0	3
3.	PD5005	Intellectual Property Rights and Patent Laws	PE	3	3	0	0	3
4.	PD5006	Maintenance Engineering	PE	3	3	0	0	3
5.	PD5007	Integrated Manufacturing Systems	PE	3	3	0	0	3
6.	ED5076	Product Design for Sustainability	PE	3	3	0	0	3
7.	PD5008	Product Testing and Qualification	PE	3	3	0	0	3
8.	PD5009	Financial Engineering	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	PD5212	Design Project	EEC	4	0	0	4	2
2.	PD5311	Project Work Phase I	EEC	12	0	0	12	6
3.	PD5411	Project Work Phase II	EEC	24	0	0	24	12

MA5156 APPLIED MATHEMATICS FOR ENGINEERS L T P C
4 0 0 4

OBJECTIVES :

This course is designed to enrich the knowledge in various advanced mathematical techniques such as matrix theory, calculus of variations, probability and random variables, Laplace transforms and Fourier transforms. The fundamental concepts in these areas will be more useful for the students to model the engineering problems and solving them by applying these methods.

UNIT I MATRIX THEORY 12

The Cholesky decomposition - Generalized Eigenvectors - Canonical basis - QR factorization - Least squares method - Singular value decomposition.

UNIT II CALCULUS OF VARIATIONS 12

Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems - Direct methods : Ritz and Kantorovich methods.

UNIT III PROBABILITY AND RANDOM VARIABLES 12

Probability – Axioms of probability – Conditional probability – Baye's theorem - Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

UNIT IV LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Laplace transform - Definitions - Properties – Transform error function - Bessel's function - Dirac delta function - Unit step functions – Convolution theorem – Inverse Laplace transform : Complex inversion formula – Solutions to partial differential equations : Heat equation - Wave equation.

UNIT V FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Fourier transform : Definitions - Properties – Transform of elementary functions - Dirac delta function – Convolution theorem – Parseval's identity – Solutions to partial differential equations : Heat equation - Wave equation - Laplace and Poison's equations.

TOTAL : 60 PERIODS

OUTCOMES :

After completing this course, students should demonstrate competency in the following skills:

- Apply various methods in matrix theory to solve system of linear equations.
- Maximizing and minimizing the functional that occur in various branches of engineering disciplines.
- Computation of probability and moments, standard distributions of discrete and continuous random variables and functions of a random variable.
- Application of Laplace and Fourier transforms to initial value, initial–boundary value and boundary value problems in Partial Differential Equations.

REFERENCES :

1. Andrews L.C. and Shivamoggi, B. "Integral Transforms for Engineers", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
2. Bronson, R. "Matrix Operations", Schaum's outline series, 2nd Edition, McGraw Hill, 2011.
3. James, G., "Advanced Modern Engineering Mathematics ", 3rd Edition, Pearson Education, 2004.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

5. O'Neil, P.V., "Advanced Engineering Mathematics ", Thomson Asia Pvt. Ltd., Singapore, 2003.
6. Sankara Rao, K., “Introduction to Partial Differential Equations”, Prentice Hall of India Pvt. Ltd., New Delhi, 1997.

PD5101 INTRODUCTION TO PRODUCT DEVELOPMENT L T P C
3 0 0 3

OBJECTIVE:

- This course aims at introducing the students to the basic concepts of engineering design and product development with focus on the front end processes. At the end of this course the student is expected to demonstrate an understanding of the overview of all the product development processes and knowledge of concept generation and selection tools.

UNIT I **9**

Need for developing products – the importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- societal considerations in engineering design –generic product development process – various phases of product development-planning for products –establishing markets- market segments- relevance of market research

UNIT II **9**

Identifying customer needs –voice of customer –customer populations- hierarchy of human needs-need gathering methods – affinity diagrams – needs importance- establishing engineering characteristics-competitive benchmarking- quality function deployment- house of quality- product design specification-case studies

UNIT II **9**

Creative thinking –creativity and problem solving- creative thinking methods- generating design concepts-systematic methods for designing –functional decomposition – physical decomposition –functional representation –morphological methods-TRIZ- axiomatic design

UNIT IV **9**

Decision making –decision theory –utility theory –decision trees –concept evaluation methods –Pugh concept selection method- weighted decision matrix –analytic hierarchy process – introduction to embodiment design –product architecture – types of modular architecture –steps in developing product architecture

UNIT V **9**

Industrial design – human factors design –user friendly design – design for serviceability – design for environment – prototyping and testing – cost evaluation –categories of cost – overhead costs – activity based costing –methods of developing cost estimates – manufacturing cost –value analysis in costing

TOTAL: 45 PERIODS

Note: Since the idea is to provide an overview of the design process, the questions in the examination should have more number of sub-divisions leading to not more than 4 or 5 marks each and need to be generic in the Part-B part.

REFERENCES
1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, “Product Design and Development “, 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9
2. Clive L.Dym, Patrick Little, “Engineering Design: A Project-based Introduction”, 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7
3. George E.Dieter, Linda C.Schmidt, “Engineering Design”, McGraw-Hill International Edition, 4th Edition, 2009, ISBN 978-007-127189-9
4. Kevin Otto, Kristin Wood, “Product Design”, Indian Reprint 2004, Pearson Education,ISBN 9788177588217
5. Yousef Haik, T. M. M. Shahin, “Engineering Design Process”, 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141

ED5151 COMPUTER APPLICATIONS IN DESIGN

L	T	P	C
3	0	0	3

OBJECTIVE:
- To impart knowledge on computer graphics which are used routinely in diverse areas as science, engineering, medicine, etc.

UNIT I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 9

Output primitives (points, lines, curves etc.,), 2-D & 3-D transformation (Translation, scaling, rotation) windowing - view ports - clipping transformation.

UNIT II CURVES AND SURFACES MODELING 9

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

Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic surfaces: Hermite bicubic 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 – Surface – solid removal algorithms shading – coloring. Introduction to parametric and variational geometry based software’s and their principles creation of prismatic and lofted parts using these packages.

UNIT V ASSEMBLY OF PARTS AND PRODUCT DATA EXCHANGE 9

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

TOTAL : 45 PERIODS

OUTCOMES:
- It helps the students to get familiarized with the computer graphics application in design.
- This understanding reinforces the knowledge being learned and shortens the overall learning curve which is necessary to solve CAE problems that arise in engineering.

REFERENCES:

1. David F. Rogers, James Alan Adams “Mathematical elements for computer graphics” second edition, Tata McGraw-Hill edition.2003
2. Donald Hearn and M. Pauline Baker “Computer Graphics”, Prentice Hall, Inc., 1992.
3. Foley, Wan Dam, Feiner and Hughes – Computer graphics principles & practices, Pearson Education – 2003.
4. Ibrahim Zeid Mastering CAD/CAM – McGraw Hill, International Edition, 2007.
5. William M Neumann and Robert F.Sproull “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 1989.

ED5153 ADVANCED FINITE ELEMENT ANALYSIS L T P C
3 0 0 3

OBJECTIVE:

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

UNIT I BENDING OF PLATES AND SHELLS 9

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

UNIT II NON-LINEAR PROBLEMS 9

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

UNIT III DYNAMIC PROBLEM 9

Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Eigen solution-Subspace Iterative Technique – Response analysis-Houbolt, Wilson, Newmark – Methods – Explicit & Implict Methods- Lanchzos, Reduced method for large size system equations.

UNIT IV FLUID MECHANICS AND HEAT TRANSFER 9

Governing Equations of Fluid Mechanics – Solid structure interaction - Inviscid and Incompressible Flow – Potential Formulations – Slow Non-Newtonian Flow – Metal and Polymer Forming – Navier Stokes Equation – Steady and Transient Solution.

UNIT V ERROR ESTIMATES AND ADAPTIVE REFINEMENT 9

Error norms and Convergence rates – h-refinement with adaptivity – Adaptive refinement.

OUTCOMES:

1. The students will understand the Finite Element Formulation of Plate and Shell Elements and its application.
2. The students will be able to gain knowledge in material & geometric non-and plasticity.
3. The students will be able to solve problems under dynamic conditions by applying various techniques.
4. The students can arrive at the solutions for fluid mechanics and heat transfer problems.
5. The students will acquire knowledge in error norms, convergence rates and refinement.
6. The students will solve the real world engineering problems using FEA.

TOTAL: 45 PERIODS

REFERENCES:
1. Bathe K.J., “Finite Element Procedures in Engineering Analysis”, Prentice Hall, 1990.
2. Cook R.D., “Concepts and Applications of Finite Element Analysis”, John Wiley and Sons Inc.,Newyork, 1989.
3. Zienkiewicz, O.C. and Taylor, R.L., “The Finite Element Method”, Fourth Edition, Volumes 1 &2, McGraw Hill International Edition, Physics Services, 1991.

PD5102 INDUSTRIAL DESIGN L T P C
4 0 0 4

OBJECTIVE:
To expose the students to the various aspects of Industrial Design so as to develop new products considering aesthetics, ergonomics, environment and other human factors.

UNIT I INTRODUCTION 12
Definition – Human & Machine system – Manual; Mechanical; Automated system, Input of Information - Auditory, Visual, Oral, Olfactory display & Communication. Human Output and Control – Physical work, Manual material handling, Physiological performance: Motor Skill, human control of systems, controls & data entry devices, hand tools & devices.

UNIT II WORK PLACE AND EQUIPMENT DESIGN 12
Applied anthropometry, Workspace design and seating, arrangement of components within a physical space, interpersonal aspects of work place design, and design of repetitive task, design of manual handling activity task, work capacity, stress, and fatigue. Design of Equipment : Ergonomic factors to be considered in the design of displays and control, design for maintainability, design of human computer interaction.

UNIT III ENVIRONMENTAL DESIGN 12
Vision and illumination design – Climate, Noise, Motion, Sound, and Vibration.

UNIT IV BIOMECHANICS, BIOTHERMODYNAMICS, BIOENERGETICS 12
Biostatic mechanics, statics of rigid bodies, upper extremity of hand, lower extremity and foot, bending, lifting and carrying, biodynamic mechanics, human body kinematics, kinetics, impact and collision, human activity analysis, ergonomic tools, RULA, REBA, NOISH lifting equation – Biothermal fundamentals, human operator heat transfer, human system bioenergetics, thermoregulatory physiology, human operator thermo regularity, passive operator, active operator, heat stress.

UNIT V COGNITIVE ERGONOMICS & HUMAN FACTOR APPLICATION 12
Information Theory Information processing, Signal detection theory, Human response, human errors, cognitive task analysis. Human factors applications: Human error, accidents, human factors and the automobile, organizational and social aspects, steps according to ISO.DIS6385, OSHA’s approach, virtual environments.

OUTCOMES:
Upon completion of the course, the students will be able to
1. Get knowledge in manual, mechanical and automated systems.
2. Understand the importance of ergonomics in the design of new products.
3. Carry out environmental friendly design.
4. Gain knowledge on the effect of biomechanics, bio thermodynamics, bioenergetics on the design and development of new products
5. Do information processing.
6. Understand the effects of other human factors.

TOTAL: 60 PERIODS

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. MeCormik, J., Human Factors Engineering and Design, McGraw Hill, 1992.

ED5161 CAD LABORATORY L T P C
0 0 4 2

OBJECTIVE:

- To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modelling software’s

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

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

OUTCOME:

- With laboratory classes, it helps the students to get familiarized with the computer applications in design and preparing drawings for various mechanical components.

TOTAL: 60 PERIODS

ED5162 ADVANCED ANALYSIS AND SIMULATION LABORATORY L T P C
0 0 4 2

OBJECTIVES:

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

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.

TOTAL: 60 PERIODS

OUTCOME:

- Upon completion of this course, the Students can model, analyse and simulate experiments to meet real world system and evaluate the performance.

PD5251	**INTEGRATED PRODUCT DESIGN AND PROCESS DEVELOPMENT**[**]	**L T P C** **3 2 0 4**

OBJECTIVE

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

UNIT I INTRODUCTION 8

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

UNIT II CONCEPT GENERATION, SELECTION AND TESTING 10

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

UNIT III PRODUCT ARCHITECTURE 8

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

UNIT IV INDUSTRIAL DESIGN 8

Integrate process design - Managing costs - Robust design - Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically - Need for industrial design-impact – design process - investigation of customer needs - conceptualization - refinement - management of the industrial design process - technology driven products - user - driven products - assessing the quality of industrial design.

UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT 11

Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs – Minimize system complexity - Prototype basics - Principles of prototyping - Planning for prototypes - Economic Analysis - Understanding and representing tasks-baseline project planning - accelerating the project-project execution.

T= 15, TOTAL: 60 PERIODS

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

OUTCOMES:

On completion of the course the student will be able to

- understand the integration of customer requirements in product design
- Apply structural approach to concept generation, selection and testing
- Understand various aspects of design such as industrial design , design for manufacture , economic analysis and product architecture

TEXT BOOK

1. Product Design and Development, Karl T.Ulrich and Steven D.Eppinger, McGraw –Hill International Edns.1999

REFERENCES:

1. Concurrent Engg./Integrated Product Development. Kemnneth Crow, DRM Associates, 6/3,ViaOlivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book
2. Effective Product Design and Development, Stephen Rosenthal, Business One Orwin, Homewood, 1992,ISBN, 1-55623-603-4
3. Tool Design – Integrated Methods for successful Product Engineering, Stuart Pugh, Addison Wesley Publishing,Neyourk,NY,1991, ISBN 0-202-41639-5
4. www.me.mit/2.7444

PD5201 PRODUCT AND PROCESS ENGINEERING TOOLS L T P C
3 0 0 3

OBJECTIVES

To study about the tools used for concept development, optimization, design verification, process improvement and process control, bench marking and project management.

OUTCOME:

On completion of the course the student will be able to

- understand and apply the various tools used for design development analysis and optimization.
- Learn about the various methodology for process improvement
- Use various statistical process control methods and control charts
- Appreciate the need for bench marking and project management

UNIT I TOOLS FOR CONCEPT DEVELOPMENT 9

Products division, Quality function Deployment, concept engineering –Tools for Design Development: design failure mode and design analysis, Reliability prediction- Tools for Design Optimization: The Taguchi Loss Function, Optimizing Reliability- Tools for Design Verification: Reliability Testing.

UNIT II TOOLS FOR PROCESS IMPROVEMENT 9

Process improvement methodologies, The Deming Cycle-FADE-Basic tools for process improvement: flow charts, run charts and control charts, check sheets, histograms, Pareto diagrams, Cause and Effect Diagrams-Scatter Diagrams-Other tools for process improvement: Kaizen Blitz, Poka-yoke (mistake proofing), process simulation-Engaging the work force in process improvement.

UNIT III STATISTICAL PROCESS CONTROL 9

Quality control measurements-SPC Methodology-Process capacity evaluation- Control charts for variables data-Special Control charts for variables data- Process Capability Evaluation- Control Charts for Attributes- Summary of control charts construction chart, np-charts,c& u charts –Designing control charts: sampling , size, frequency-SPC,ISO 9000:2000, AND SIX SIGMA-Pre control- Measurement system Evaluation.

UNIT IV BENCH MARKING AND ESTABLISHING ENGINEERING SPECIFICATIONS 9

A Benchmarking Approach – Support tools for the benchmarking process: intended assembly cost analysis, form diagram, trend analysis- Setting product specifications: Basic & Advanced method.

UNIT V PROJECT MANAGEMENT 9

Understanding and representing tasks: Tasks, charts- Baseline project planning – Accelerating projects-project execution- Postmortem execution.

TORAL: 45 PERIODS

TEXT BOOK:

1. Product Design & Development, Karl t. Ulrich, Steven d. Eppinger, Tata Mcgraw-Hill- 3rd Edition, 2003

REFERENCES:

1. Product Design Techniques in Reverse Engineering and New Product Development, Kevin Otto & Kristin Wood, Pearson Education (LPE),
2. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub:son south-western(www.swlearning.com) 2001.

PD5202 MATERIALS SELECTION FOR PRODUCT DEVELOPMENT L T P C
3 0 0 3

OBJECTIVE:

To expose to the material aspect of Product design, Process modelling, Design for assembly and newer material processing techniques

UNIT-I MATERIAL BEHAVIOUR AND SELECTION 9

Elastic and Plastic deformation- Mechanism of Plastic deformation-yield stress and shear strength-Perfect and Real crystals- Effect of strain rate and temperature on plastic behaviour- Super plasticity- Deformation of non-crystalline materials Material selection- Cost and service requirement- Recycling- Selection of material for mechanical properties- Strength, toughness and fatigue- Material selection for durability and surface wear and Corrosion resistance- Functional relation between materials and processing- Manufacturing characteristics of metals- Material selection charts and other aids material selection for aero, auto and nuclear application-Structural Product analysis-End Use behaviour – Tooling in product design- Case studies in material and selection.

UNIT-II PROCESS MODELING 9

Methods of analysis- Slab, slip line and upper bound solutions- Numerical methods- Effect of Friction- Contact problem- Basic analysis of process Forging, Drawing and sheet metal forming- machining- Turning- modern materials- micro alloyed and dual phase steel- High strength low alloy metals- Smart materials- Shape memory metals- Metallic Glasses- Nano Materials- Metal foams- Properties and applications for product design.

UNIT-III NON METALS AND MANUFACTURING 9

General properties and its importance of polymers Thermal and electrical properties mechanical properties- Criteria for selection Composite materials- fibers- Boron, glass, carbon, organic- Ceramic and metallic fibres- - Matrix materials- Polymer, metal and ceramics- properties and applications- Manufacturing methods of plastic products- Injection and blow moulding –Rotational moulding-Compression moulding-Transfer moulding layering of composites.

UNIT-IV PRODUCT DESIGN AND ASSEMBLY REQUIREMENTS 9

Structural product analysis- End use behaviour- Effect of tooling in product design-Design for joining and assembling- Design for live hinges- Snap fits, design of corners, bushes and ribs-Design considerations- New product design Methods of decoration-Bonding and cementing techniques- Thermal bonding Machining of plastics-Parameters and effect- Case studies in material selection with relevance to product design and development.

UNIT-V DEVELOPMENT IN MATERIALS PROCESSING 9

Micro fabrication technologies- Tool for micro fabrication- Diamond and high speed machining- LIGA micro fabrication process- Multilayer X-ray lithography.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the student will

1. Understand the behaviour of various metals and non-metals.
2. Learn about process modelling.
3. Learn about the selection of material for different applications.
4. Gain knowledge in new product design methods and requirements for assembly.
5. Get exposure to the manufacturing processes in micro fabrication.
6. Appreciate design for assembly.

REFERENCES

1. Asbhay, Selection of Materials, El Sevier Publications, 2006
2. Beck- Plastic Product Design- van Nostrand Reignhold 2nd Edition
3. Harfold Belofsky- Plastic design and processing hand book, Hanser publication- 2005
4. Paul Degarmo, Black and Kohsher- Materials and processes in Manufacturing Wiley Student Edition- 9th Edition- 2005
5. Sami Franssile- Introduction to Micro Fabrication- John Wiley and Sons- UK 2004
6. Serope Kalpakjian and Schmid- Manufacturing process for Engineering materials Pearson- 2005.

PD5203 QUALITY CONCEPTS IN PRODUCT DEVELOPMENT L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on various principles of implementing quality in a product or service through tools such as quality houses, control charts, statistical process control method, failure mode effect analysis
- To develop a thorough understanding of the strategies of designing experiments, methods to uphold the status of six sigma and improve the reliability of a product.

UNIT-I DESIGN FOR QUALITY 9

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

UNIT-II FAILURE MODE EFFECT ANALYSIS 9

Basic methods: Refining geometry and layout, general process of product embodiment-Embodiment checklist- Advanced methods: systems modeling, mechanical embodiment principles-FMEA method- linking fault states to systems modeling-Case study- computer monitor stand for a docking station.

UNIT-III DESIGN OF EXPERIMENTS 9

Design of experiments-Basic methods- Two factorial experiments-Extended method reduced tests and fractional experiments, orthogonality, base design method, higher dimensional fractional factorial design-Statistical analysis of experiments: Degree of freedom, correlation coefficient, standard error of the residual t-test, ANOVA-ratio test, other indicators-residual plots, Advanced DOE method for product testing-Product applications of physical modeling and DOE, Blender panel display evaluation, coffee grinder experimental optimization-Taguchi method.

UNIT-IV STATISTICAL DESIGN AND RELIABILITY 9

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

UNIT-V DESIGN FOR SIX SIGMA 9

Basis of SIX SIGMA –Project selection for SIX SIGMA- SIX SIGMA problem solving- SIX SIGMA in service and small organizations - SIX SIGMA and lean production –Lean SIX SIGMA and services.

TOTAL: 45 PERIODS

OUTCOMES:

The student will

1. Understand about the quality function deployment, design process.
2. Be able to apply failure mode effect analysis adopting both basic methods and advanced methods.
3. Learn about design of experiments – ANOVA and Taguchi method.
4. Apply statistical design methods and reliability procedures.
5. Gain knowledge in Six Sigma.
6. Be able to apply the quality concepts for real-time situations.

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

PD5211 PRODUCT DESIGN LABORATORY L T P C
0 0 2 1

OBJECTIVE:

- To impart knowledge on the use of various media such as clay, wood and RP techniques for development of prototypes

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 :30 PERIODS

OUTCOME:

Upon conclusion of this course the student will be able to

- appreciate the use of physical prototype models for evaluating product concept
- apply theoretical knowledge to design and development of physical products using clay, wood, sheet metal and RP techniques

PD5212 DESIGN PROJECT L T P C
0 0 4 2

OBJECTIVE:

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

Each student is required to select any new component or an integrated mechanical system that involves various sub components which are to be designed as per design standards and further required to be analyzed for optimum dimensions with respect to the strength and stiffness.

OUTCOME:

- It helps the students to get familiarized with respect to design standards, design calculations and analysis in designing any mechanical component or system.

TOTAL: 60 PERIODS

PD5301 MARKETING RESEARCH L T P C
3 0 0 3

OBJECTIVE:

To provide the student with an overview of marketing research techniques. At the end of this course the student will gain a fundamental knowledge marketing research and its application in the front end of product development.

RECOMMENDED:

Students should be encouraged to have hands on experience on the use of any of the software packages like SPSS, SAS, etc.

UNIT I INTRODUCTION TO MARKETING RESEARCH 9

Introduction – definition of marketing research – classification of MR – MR process – role of MR in decision making – defining the problem – developing an approach – Research design-definition – classification –exploratory research –descriptive research – causal research – potential sources of error –research proposal

UNIT II EXPLORATORY RESEARCH DESIGN 9

Exploratory research– primary and secondary data –classification of secondary data – sources of secondary data – qualitative research – primary data –classification of qualitative research procedures- focus groups –advantages & disadvantages –depth interviews – projective techniques –analysis of qualitative data- Descriptive research design – survey methods –observations- causal research design – experimentation

UNIT III MEASUREMENT AND SCALING 9

Measurement and scaling –scale characteristics and levels of measurement –comparative scales – paired comparison, rank order, constant sum- non-comparative scales- continuous rating, itemized rating-questionnaire and form design –sampling design –sampling techniques – non-probability and probability techniques-sample size determination- sampling distribution-confident interval approach

UNIT IV FREQUENCY DISTRIBUTION 9

Data analysis – univariate techniques- multivariate techniques –frequency distribution-measures of location- measures of variability- measures of shape- hypothesis testing-cross tabulations- Chi-square distribution- hypothesis testing related to differences-parametric tests- nonparametric tests-analysis software

UNIT V DATA ANALYSIS 9

Analysis of variance and covariance- one way analysis of variance – analysis of covariance-correlation and regression- product moment correlation- partial correlation- regression analysis-bivariate regression- basic concepts of cluster analysis-very brief introduction to multi-dimensional scaling and conjoint analysis **(not for examination purposes)**

TOTAL: 45 PERIODS

REFERENCES:

1. Donald S.Tull, Del I.Hawkins, “Marketing Research: Measurement and Method”,6th Edition,Eastern Economy Edition, Prentice Hall India, ISBN-978-81-203-0961-6
2. Naresh K.Malhotra, Satyabhushan Dash, “Marketing Research: An Applied Orientation”,6th Edition, Pearson, ISBN 978-81-317-3181-9
3. Paul E.Green, Donald S.Tull, Gerald Albaum, “Research for Marketing Decisions", Eastern Economy Edition,5th Edition, Prentice Hall India, ISBN-978-81-203-0757-5

PD5311	PROJECT WORK PHASE I	L	T	P	C
		0	0	12	6

OBJECTIVES:

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

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

TOTAL: 180 PERIODS

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.

PD5411 **PROJECT WORK PHASE II** **L T P C**
0 0 24 12

OBJECTIVES:

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

SYLLABUS:

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

TOTAL: 360 PERIODS

OUTCOME:

- 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.

PD5001 **CREATIVITY IN DESIGN** **L T P C**
3 0 0 3

OBJECTIVE:

- To highlight the importance of creativity for new product development and impart the skills needed for enhancing creative thinking and encouraging innovation.

UNIT I INTRODUCTION **4**

Need for design creativity – creative thinking for quality – essential theory about directed creativity –

UNIT II MECHANISM OF THINKING AND VISUALIZATION **11**

Definitions and theory of mechanisms of mind heuristics and models : attitudes, Approaches and Actions that support creative thinking - Advanced study of visual elements and principles- line, plane, shape, form, pattern, texture gradation, color symmmetry. Spatial relationships and compositions in 2 and 3 dimensional space - procedure for genuine graphical computer animation – Animation aerodynamics – virtual environments in scientific Visualization – Unifying principle of data management for scientific visualization – Unifying principle of data management for scientific visualization - Visualization benchmarking

UNIT III CREATIVITY **11**

Methods and tools for Directed Creativity – Basic Principles – Tools of Directed Creativity – Tools that prepare the mind for creative thought – stimulation of new ideas – Development and Actions: - Processes in creativity ICEDIP – Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation The Bridge between man creativity and the rewards of innovativeness – Applying Directed Creativity to the challenge of quality management

UNIT IV DESIGN **9**

Process Design, Emotional Design – Three levels of Design – Viceral, Behavioral and Reflective- Recycling and availability-Creativity and customer needs analysis – Innovative product and service designs, future directions in this application of creativity thinking in quality management

UNIT V INNOVATION 10

Achieving Creativity – Introduction to TRIZ methodology of Inventive Problem Solving - the essential factors – Innovator's solution – creating and sustaining successful growth – Disruptive Innovation model – Segmentive Models – New market disruption - Commoditation and DE-commoditation – Managing the Strategy Development Process – The Role of Senior Executive in Leading New Growth – Passing the Baton

TOTAL: 45 PERIODS

OUTCOMES:

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

- understand the various techniques adopted for stimulating creativity and innovation
- apply the techniques to the design and development of new products

REFERENCES

1. Clayton M. Christensen Michael E. Raynor," The Innovator's Solution", Harvard Business School Press Boston, USA, 2003
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 NowFloydHurr, ISBN 1560525479, Crisp Publications Inc. 1999
5. Semyon D. Savransky," Engineering of Creativity – TRIZ", CRC Press New YorkUSA," 2000

PD5002 ENTERPRISE RESOURCE PLANNING L T P C
3 0 0 3

OBJECTIVE:

- To impart to students the basic concepts of Enterprise Resource Planning and its role in improving the business dynamics

UNIT I ENTERPRISE RESOURCE PLANNING 10

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 10

Client/Server architecture – Technology choices – Internet direction – Evaluation framework – CRM – CRM pricing – chain safety – Evaluation framework.

UNIT III ERP SYSTEM PACKAGES 10

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 – Organisational and social issues.

UNIT IV ERP ARCHITECTURE 7

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 8

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 provide an integrated view of the various facets of business, including planning, manufacturing, sales, finance and marketing.
- To understand the development of software to integrate business activities such as inventory management and control, order tracking, customer service, finance and human resources.
- To become aware of the software applications and tools that are available to business to use to drive out costs and improve efficiency.

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. Vinod Kumar Crag and N.K.Venkitakrishnan ,Enterprise Resource Planning –Concepts and Practice, Prentice Hall of India, 1998.

ED5071 OPTIMIZATION TECHNIQUES IN DESIGN L T P C
3 0 0 3

OBJECTIVE:

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

UNIT I UNCONSTRAINED OPTIMIZATION TECHNIQUES 10

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

UNIT II CONSTRAINED OPTIMIZATION TECHNIQUES 10

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

UNIT III ADVANCED OPTIMIZATION TECHNIQUES 10

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

UNIT IV STATIC APPLICATIONS 8

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

UNIT V DYNAMIC APPLICATIONS 7

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

TOTAL: 45 PERIODS

OUTCOME:

- It helps the students to get familiarized with the different approaches of optimizing (maximizing or minimizing) an engineering problem or a function.

REFERENCES:

1. Goldberg, D.E., "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson, 2008.
2. Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, 1990.
3. Kalyanmoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. 2004.
4. Rao, Singaresu, S., "Engineering Optimization – Theory & Practice", New Age International (P) Limited, New Delhi, 2000.

CC5292 ADDITIVE MANUFACTURING AND TOOLING L T P C
3 0 0 3

OBJECTIVE:

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

UNIT I INTRODUCTION: 9

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

UNIT II REVERSE ENGINEERING AND CAD MODELING: 9

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

UNIT III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS 9

Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS 9

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

UNIT V TOOLING 9

Classification, Soft tooling, Production tooling, Bridge tooling, direct and indirect tooling, Fabrication processes, Applications Case studies automotive, aerospace and electronics industries

TOTAL: 45 PERIODS

OUTCOMES:

The students will be able to

1. Understand history, concepts and terminology of additive manufacturing
2. Apply the reverse engineering concepts for design development
3. Understand the variety of additive manufacturing techniques
4. Design and develop newer tooling models
5. Analyse the cases relevant to mass customization and some of the important research challenges associated with AM and its data processing tools

REFERENCES:

1. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
2. Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.
3. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
4. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
5. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.
6. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2011.

ED5073 INFORMATION ANALYTICS L T P C
3 0 0 3

OBJECTIVE:

- To expose the students with fundamental concepts and the tools needed to understand emerging role of information analytics in the organisation.

UNIT – I DATA ANALYTICS LIFE CYCLE 9

Introduction to Big data Business Analytics - State of the practice in analytics role of data scientists - Key roles for successful analytic project - Main phases of life cycle - Developing core deliverables for stakeholders.

UNIT – II STATISTICS 9

Sampling Techniques - Data classification, Tabulation, Frequency and Graphic representation - Measures of central value - Arithmetic mean, Geometric mean, Harmonic mean, Mode, Median, Quartiles, Deciles, Percentile - Measures of variation – Range, IQR, Quartile deviation, Mean deviation, standard deviation, coefficient variance, skewness, Moments & Kurtosis.

UNIT – III PROBABILITY AND HYPOTHESIS TESTING 9

Random variable, distributions, two dimensional R.V, joint probability function, marginal density function. Random vectors - Some special probability distribution - Binomial, Poison, Geometric, uniform, exponential, normal, gamma and Erlang. Multivariate normal distribution - Sampling distribution – Estimation - point, confidence - Test of significance, 1& 2 tailed test, uses of t distribution, F-distribution, χ 2 distribution.

UNIT – IV PREDICTIVE ANALYTICS 9

Predictive modeling and Analysis - Regression Analyisis, Multicollinearity , Correlation analysis, Rank correlation coefficient, Multiple correlation, Least square, Curve fitting and goodness of fit.

UNIT – V TIME SERIES FORECASTING AND DESIGN OF EXPERIMENTS 9

Forecasting Models for Time series: MA, SES, TS with trend, season - Design of Experiments, one way classification, two way classification, ANOVA, Latin square, Factorial Design.

TOTAL: 45 PERIODS

OUTCOMES:

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

1. Understand the importance of data analysis in the design of new products.
2. Carry out statistical analysis.
3. Do probability analysis and hypothesis testing.
4. Perform predictive analysis.
5. Learn the effect of forecasting methods and to apply for business process.
6. Build a reliable, scalable, distributed information system.

REFERENCES:

1. Alberto Cordoba, “Understanding the Predictive Analytics Lifecycle”, Wiley, 2014.
2. Chris Eaton, Dirk Deroos,Tom Deutsch et al.,“Understanding Big Data”, McGraw Hill, 2012.
3. James R Evans, “Business Analytics – Methods, Models and Decisions”, Pearson 2013.
4. R. N. Prasad, Seema Acharya, “Fundamentals of Business Analytics”, Wiley, 2015.
5. S M Ross, “Introduction to Probability and Statistics for Engineers and Scientists”, Academic Foundation, 2011.

PD5003 DESIGN THINKING L T P C

3 0 0 3

OBJECTIVE:

- To highlight the importance of thinking and creativity for new product development and impart the skills needed for enhancing creative thinking and encouraging innovation.

UNIT I INTRODUCTION 9

Need for design creativity – creative thinking for quality – essential theory about directed creativity

UNIT II MECHANISM OF THINKING AND VISUALIZATION 9

Definitions and theory of mechanisms of mind heuristics and models: attitudes, Approaches and Actions that support creative thinking - Advanced study of visual elements and principles- line, plane, shape, form, pattern, texture gradation, color symmetry. Spatial relationships and compositions in 2 and 3 dimensional space - procedure for genuine graphical computer animation – Animation aerodynamics – virtual environments in scientific Visualization – Unifying principle of data management for scientific visualization – Unifying principle of data management for scientific visualization - Visualization benchmarking

UNIT III CREATIVITY 9

Methods and tools for Directed Creativity – Basic Principles – Tools of Directed Creativity – Tools that prepare the mind for creative thought – stimulation of new ideas – Development and Actions, Processes in creativity ICEDIP – Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation The Bridge between man creativity and the rewards of innovativeness – Applying Directed Creativity to the challenge of quality management

UNIT IV DESIGN 9

Process Design, Emotional Design – Three levels of Design – Viceral, Behavioral and Reflective-Recycling and availability-Creativity and customer needs analysis – Innovative product and service designs, future directions in this application of creativity thinking in quality management

UNIT V INNOVATION 10

Achieving Creativity – Introduction to TRIZ methodology of Inventive Problem Solving - the essential factors – Innovator's solution – creating and sustaining successful growth – Disruptive Innovation model – Segmentive Models – New market disruption - Commoditation and Decommoditation – Managing the Strategy Development Process – The Role of Senior Executive in Leading New Growth – Passing the Baton

TOTAL: 45 PERIODS

OUTCOMES:

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

1. Understand the various techniques adopted for stimulating creativity.
2. Improve their visualization.
3. Motivate and Implement their creativity.
4. Apply the techniques to the design and development of new products.
5. Present innovative products as required by the customers.
6. Improve their creativity and innovation.

REFERENCES

1. Clayton M. Christensen Michael E. Raynor," The Innovator's Solution", Harvard Business School Press Boston, USA, 2003
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 NowFloyd Hurr, ISBN 1560525479, Crisp Publications Inc. 1999
5. Semyon D. Savransky," Engineering of Creativity – TRIZ", CRC Press New York ,USA,

CM5072 MICRO ELECTRO MECHANICAL SYSTEMS L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge of design, fabrication and characterization of Micro Electro Mechanical systems.

UNIT I INTRODUCTION 9

Overview of MEMS and Microsystems: MEMS and Microsystems, Evolution of Micro fabrication, Microsystems and Microelectronics, Microsystems and miniaturization-Materials for MEMS and Microsystems: substrates and wafers, active substrate materials, Silicon, Gallium Arsenide, Piezoelectric Crystals, Polymers, Packaging materials-Working principles of Microsystems: micro sensors, micro actuation, MEMS with micro actuators, Micro accelerometers, micro fluidics-Applications of Microsystems in various industries.

UNIT II MECHANICS, SCALING AND DESIGN 9

Engineering Mechanics for Microsystems design: Introduction, Static bending of Thin Plates, Mechanical Vibration, Thermomechanics, Thermofluid, Engineering and micro system design, Laminar fluid flow, Incompressible fluid Flow, Heat conduction in solids-Scaling Laws in Miniaturization, Introduction to scaling, Scaling in (Electrostatic forces electromagnetic forces, Electricity, fluid mechanics, heat transfer)-Microsystems Design: Design Consideration, Process design, Mechanical Design, Design of Micro fluidic Network systems

UNIT III MICRO SYSTEM FABRICATION PROCESSES 11

Introduction- Photolithography- Ion implantation- Chemical Vapor Deposition-Physical Vapor Deposition - clean room- Bulk micromachining :etching, isotropic and anisotropic etching, wet and dry etching- Surface micro machining :process, mechanical problems associated with surface micro machining- LIGA process :general description, materials for substrates and photo resists-SLIGA process-Abrasive jet micro machining-Laser beam micro machining- Micro Electrical Discharge Micro Machining –Ultrasonic Micro Machining- Electro chemical spark micro machining- Electron beam micro machining-Focused Ion Beam machining

UNIT IV MICROSYSTEMS PACKAGING 8

Introduction - Microsystems Packaging-Interfaces in Microsystems Packaging-Essential Packaging Technologies- Die preparation, surface bonding, wire bonding, sealing- Three dimensional Packaging- Assembly of Microsystems, Signal Mapping and Transduction

UNIT V MICROMETROLOGY AND CHARACTERIZATION 8

Microscopy and visualization- Lateral and vertical dimension- optical microscopy, Scanning white light interferometry, Confocal Laser scanning microscopy, Molecular measuring machine, Micro coordinate measuring machine- Electrical measurements – Physical and chemical analysis – XRD- SEM - Secondary Ion mass spectrometry- Auger Electron Spectroscopy, SPM

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the student will be able to apply the knowledge in mechanics, scaling, design, fabrication and characterization of micro systems.

REFERENCES

1. Franssila, S., “Introduction to Micro Fabrication” John Wiley & sons Ltd, 2004.ISBN:470-85106-6
2. Hak M.G., “MEMS Handbook”, CRC Press, ISBN: 8493-9138-5, 2006.
3. Hsu, T.R., “MEMS & Microsystems Design and Manufacture”, Tata McGraw Hill, 2002, ISBN: 9780070487093.
4. Jackson, M.J., “Microfabrication and Nanomanufacturing” Taylor and Francis 2006.
5. Jain, V.K., “Introduction to Micromachining” Narosa Publishing House, 2010.
6. McGeough, J.A., “Micromachining of Engineering Materials”, CRC Press, ISBN: 0824706447, 2001.

CD5091 INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS L T P C

3 0 0 3

OBJECTIVES:

- To teach students the basics of robotics, construction features, sensor applications, robot cell design, robot programming and application of artificial intelligence and expert systems in robotics.

UNIT I INTRODUCTION AND ROBOT KINEMATICS 10

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 AND EXPERT SYSTEMS 8

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

OUTCOME:

- The student will be able to design robots and robotic work cells and write program for controlling the robots.
- The student will be able to apply artificial intelligence and expert systems in robotics.

REFERENCES

1. Deb, S.R." Robotics Technology and Flexible Automation", Tata Mc Graw-Hill, 1994.
2. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, "Robotics Control, Sensing, Vision and Intelligence", Mc Graw Hill, 1987.
3. Kozyrey, Yu. "Industrial Robots", MIR Publishers Moscow, 1985.
4. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey," Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int. 1986.
5. Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 1984.
6. Timothy Jordanides et al ,"Expert Systems and Robotics ", Springer –Verlag, New York, May 1991.
7. Yoram Koren," Robotics for Engineers' Mc Graw-Hill, 1987.

CC5291 DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS L T P C
3 0 0 3

OBJECTIVE:

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

UNIT I INTRODUCTION 5

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

UNIT II FACTORS INFLUENCING FORM DESIGN 13

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

UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION 8

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

UNIT IV COMPONENT DESIGN – CASTING CONSIDERATION 10

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

UNIT V DESIGN FOR THE ENVIRONMENT 9

Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method –AT&T's environmentally responsible product assessment - Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture – Design for energy efficiency – Design to regulations and standards.

TOTAL: 45 PERIODS

OUTCOME:

- To make the students get acquainted with the design for manufacturing, assembly and environment.

REFERENCES:

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

ED5093	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

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 discretized forms of the CFD equations.
- To formulate explicit & implicit algorithms for solving the Euler Equations & Navier Strokes Equations.

UNIT I GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES 8

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 10

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 8

Discretisation of incompressible flow equations – Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms

UNIT V MODELING OF COMBUSTION AND TURBULENCE 10

Mechanisms of combustion and Chemical Kinetics, Overall reactions and intermediate reactions, Reaction rate, Governing equations for combusting flows. Simple Chemical Reacting System (SCRS), Turbulence - Algebraic Models, One equation model & k – ε, k – ω models - Standard and High and Low Reynolds number models.

TOTAL: 45 PERIODS

OUTCOME:

- On successful completion of this course the student will be able to apply the concepts of CFD to analyse the fluid flow and heat transfer in thermal systems.

REFERENCES:

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

PD5004 REVERSE ENGINEERING L T P C

3 0 0 3

OBJECTIVE:

To impart knowledge to the students about the need for and the various tools required for reverse engineering with exposure to the software needed for implementing reverse engineering.

UNIT I INTRODUCTION 5

Scope and tasks of RE - Domain analysis- process of duplicating

UNIT II TOOLS FOR RE 8

Functionality- dimensional- developing technical data - digitizing techniques - construction of surface model - solid-part material- characteristics evaluation -software and application-prototyping - verification

UNIT III CONCEPTS 12

History of Reverse Engineering – Preserving and preparation for the four stage process – Evaluation and Verification- Technical Data Generation, Data Verification, Project Implementation

UNIT IV DATA MANAGEMENT 10

Data reverse engineering – Three data Reverse engineering strategies – Definition – organization data issues - Software application – Finding reusable software components – Recycling real-time embedded software – Design experiments to evaluate a Reverse Engineering tool – Rule based detection for reverse Engineering user interfaces – Reverse Engineering of assembly programs: A model based approach and its logical basics

UNIT V INTEGRATION 10

Cognitive approach to program understated – Integrating formal and structured methods in reverse engineering – Integrating reverse engineering, reuse and specification tool environments to reverse engineering -–coordinate measurement – feature capturing – surface and solid members

TOTAL: 45 PERIODS

OUTCOME:

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

- Understand the basic principles of reverse engineering
- Select the suitable tools and methodology for reverse engineering any product

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

PD5091 PRODUCT LIFECYCLE MANAGEMENT L T P C

3 0 0 3

OBJECTIVES:

To understand history, concepts and terminology of PLM
To understand functions and features of PLM/PDM
To understand different modules offered in commercial PLM/PDM tools
To understand PLM/PDM implementation approaches
To understand integration of PLM/PDM with other applications

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 A PDM/PLM SOFTWARE 9

Case studies based on top few commercial PLM/PDM tools

UNIT IV ROLE OF PLM IN INDUSTRIES 9

Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organisation, 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. Understand history, concepts and terminology of PLM.
2. Apply the functions and features of PLM/PDM.
3. Understand different modules offered in commercial PLM/PDM tools.
4. Understand PLM/PDM implementation approaches.
5. Integrate PLM/PDM with other applications.
6. Analyse the case studies.

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.

ED5075 DESIGN FOR INTERNET OF THINGS L T P C
3 0 0 3

OBJECTIVE:

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

UNIT-I INTRODUCTION 9

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

UNIT-II IoT STRUCTURE 9

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

UNIT-III IoT NETWORKING 9

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

UNIT-IV IoT ARCHITECTURE 9

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

UNIT-V ARCHITECTURE MODELING 9

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

TOTAL: 45 PERIODS

OUTCOMES:

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

1. Understand the vision of IoT from a global context.
2. Determine the Market perspective of IoT.
3. Use of Devices, Gateways and Data Management in IoT.
4. Build state of the art architecture in IoT.
5. Understand the design constraints in the real world.
6. Apply of IoT in Industrial and Commercial Building Automation and Real World Design Constraints.

REFERENCES:

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

PD5005 INTELLECTUAL PROPERTY RIGHTS AND PATENT LAWS L T P C
3 0 0 3

OBJECTIVE:

- To impart the knowledge about the Intellectual property rights and patent registering

UNIT I INTELLECTUAL PROPERTY (IP) FUNDAMENTALS 9

Introduction – Legal concept of Property – Kinds of properties - Movable Property - Immovable Property. IP and Classification of IP– Patents, Industrial Designs, Copy Right, Trade Mark - Importance of IP and Terms of protection

UNIT II PATENTS 12

Purpose of a Patent – Recognised conditions for Patentability – Originality of Inventions – Novelty – Non-obviousness – Utility. Exclusive rights conferred by a Patent – National Protection – International Protection. - Patent Filing Procedure and Prosecution - Infringement of Patents –Acquisition and Transfer of Patent Rights.

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UNIT III INDUSTRIAL DESIGNS 9

Subject matter of Industrial Designs - Requirements for obtaining protection for industrial Design – Differences between Patent protection and Industrial design Protection – benefits of Industrial Design protection – National and International Procedure for filing – Rights granted to 'Design' holders.

UNIT IV COPY RIGHT AND TRADEMARKS 9

Copyright subsists – Meaning of word 'Original' – Fair dealing - Rights of Owners of Copy Rights – Procedures - Authorities and Institutions under the Copy Right Act – Infringement and remedies.

Trademarks (TM) – Different types of Trade marks – Service Mark – Classification Mark – Collective Mark - Importance of TM – Difference between registered TM and TM in use – Basic requirements for the registration of TM – Procedure for registration – Rights of registered TM owners – Infringement and remedies

UNIT V INTELLECTUAL PROPERTY MANAGEMENT 6

Introduction to Intellectual Property Management (IPM) – Need for IP management - Interrelationships between legal advocacy and IPM – Role of Legal Practioners – Role of Managers – IP Commercialisation – IP Audit and its Importance

TOTAL: 45 PERIODS

OUTCOME:

Upon completion of the course, the students will

- Understand the procedures involved in obtaining Patent Rights
- Understand the rules and regulations involved in Copyrights and Trade Marks and infringement of the same
- Be exposed to the legal issues involved in New Product development

REFERENCES

1. G. B. Reddy, "Intellectual Property Rights and the Law", Gogia Law Agency, 7th Edition - Reprint, 2009.
2. N. R. Subbaram, "Demystifying Intellectual Property Rights", Lexis Nexis Butterworths Wadhwa, First Edition, 2009
3. N.R.Subbaram, "Patent law – Practices and Procedures", Wadhwa, Second Edition, 2007
4. N. S. Gopalakrishnan & T. G. Agitha, 'Principles of Intellectual Property", Eastern Book Company, First Edition, 2009

PD5006 MAINTENANCE ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on various aspects of Maintenance and condition monitoring of equipments and safety engineering.

OUTCOME:

Upon completion of the course, the students will

- Be exposed to maintenance systems and reliability based design
- Gain knowledge about the various techniques of condition monitoring of systems
- Learn about reliability based maintenance, safety engineering and Asset planning

UNIT I INTRODUCTION TO MAINTENANCE SYSTEMS 8

Introduction to repair and Maintenance -Maintenance as business - Maintenance systems such as reactive, preventive, predictive or proactive systems - Human resources management in Maintenance management -maintainability- Inherent and overall availability. - Mean time between failures, mean time to repairs and mean down time - Testability and supportability - "Design for Maintenance" - Poor maintainability aspects - Design for reliability.

UNIT II CONDITION BASED MAINTENANCE 7

Condition based monitoring of equipment and systems -condition monitoring techniques such as a) Vibration analysis, b) Ultrasonic detection techniques, c) Thermography, d) Oil and lubricant analysis, e) Motor condition monitoring (MCM) - Shaft alignments through laser - Vibration instruments -Outline on Thermography

UNIT III MAINTENANCE TECHNIQUES SUCH AS RELIABILITY CENTRED MAINTENANCE (RCM),TOTAL PRODUCTIVE MAINTENANCE (TPM) & CMMS 10

Reliability centered Maintenance-Failure Mode and Effect Analysis-Root cause Analysis-logic tree analysis-Criticality matrix - Total Productive Maintenance, Overall Equipment Effectiveness-Lean manufacturing- TPM and TPO- Relationship between OEE and world-class Maintenance- Ladder of Maintenance improvement- Computerized Maintenance management system in a business scenario- data acquisition for effective management of CMMS.

UNIT IV ASSET PLANNING AND SCHEDULING OF ACTIVITIES IN MAINTENANCE 10

Asset and spare part management, - Conventional spare Parts management techniques such as Economic Order Quantity, two bin systems - Latest trends in monitoring through bar codes, mobile computer and wireless data transmissions -. Different aspects of planning and scheduling of Maintenance, such as shutdowns- Critical aspects of both routine and shut down Maintenance -. bar charts - PERT network during shut down -Man power Training and utilization of skilled manpower - Sequencing of activities.

UNIT V SAFETY AND OTHER ASPECTS OF MAINTENANCE FUNCTIONS 10

Safety Engineering. - Hazard analysis -General rules and guidelines in safety and hazard prevention - Analytical tools - Hazard analysis- Fault Tree Analysis - Sneak Circuit analysis - Integrated approach to Maintenance- Statistical distributions such as normal, gamma and "Weibull" in Maintenance- Maintenance effectiveness.

TOTAL: 45 PERIODS

REFERENCES:

1. "Maintenance Engineering and Management": K.Venkataraman-PHI Learning - 2007
2. David J. Smith, "Reliability and Maintainability in Perspective", McMillan,2nd Edition, 1985.
3. Gwidon W Stachowiakand Andrew W. Batchelor, "Engineering Tribology", Butterwork-Heinmann, 2001

4. John V.Grimaldi& Rollin H.Simonds, “Safety Management”, AITBS Publishers & Distributors, 2001
5. Kelly. A and Harris, M. J, “Management of Industrial maintenance”, Butter worth & Co., 1978

PD5007 INTEGRATED MANUFACTURING SYSTEMS L T P C
3 0 0 3

OBJECTIVE:
At the end of this course the students would have developed a thorough understanding of the group technology, manufacturing process planning and control, modern manufacturing systems

UNIT I INTRODUCTION 5
Objectives of a manufacturing system-identifying business opportunities and problems classification production systems-linking manufacturing strategy and systems analysis of manufacturing operations.

UNIT II GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS 5
Introduction-part families-parts classification and cooling - group technology machine cells-benefits of group technology. Process planning function CAPP - Computer generated time standards.

UNIT III COMPUTER AIDED PLANNING AND CONTROL 10
Production planning and control-cost planning and control-inventory management-Material requirements planning (MRP)-shop floor control-Factory data collection system-Automatic identification system-barcode technology- automated data collection system.

UNIT IV COMPUTER MONITORING 10
Types of production monitoring systems-structure model of manufacturing process-process control & strategies- direct digital control-supervisory computer control-computer in QC - contact inspection methods non-contact inspection method - computer-aided testing - integration of CAQC with CAD/CAM.

UNIT V INTEGRATED MANUFACTURING SYSTEM 15
Definition - application - features - types of manufacturing systems-machine tools-materials handling system- computer control system - DNC systems manufacturing cell. Flexible manufacturing systems (FMS) - the FMS concept-transfer systems - head changing FMS - variable mission manufacturing system - CAD/CAM system - human labor in the manufacturing system-computer integrated manufacturing system benefits. Rapid prototyping - Artificial Intelligence and Expert system in CIM.

TOTAL: 45 PERIODS

OUTCOME:
It helps the students to get familiarized with the computer aided process planning, group technology, process planning and control and computer integrated manufacturing systems

REFERENCES:
1. David Bedworth, "Computer Integrated Design and Manufacturing", TMH, New Delhi, 1998.
2. Groover, M.P., "Automation, Production System and CIM", Prentice-Hall of India, 1998.
3. R.W. Yeomamas, A. Choudry and P.J.W. Ten Hagen, "Design rules for a CIM system", North Holland Amsterdam, 1985.
4. Ranky, Paul G., "Computer Integrated Manufacturing", Prentice Hall International 1986.
5. Yorem Koren, "Computer Integrated Manufacturing Systems", McGraw Hill, 1983.

ED5076 PRODUCT DESIGN FOR SUSTAINABILITY L T P C
3 0 0 3

OBJECTIVE:

- To understand the basic concepts of sustainability.
- To gain knowledge about the tools and techniques for sustainable design.
- To improve the design by assessing the customer needs.

UNIT-I BASIC CONCEPTS IN SUSTAINABILITY

Understanding the language of sustainable engineering design, construction and operation. Natural resources terminology. Carrying capacity. Sustainable development, corporate responsibility, biophysical constraints, environmental management.

UNIT-II TOOLS AND TECHNIQUES

Sustainable Engineering Design Tools – Life cycle analysis, carbon footprinting. Life cycle assessment (LCA), Types of LCA's: baseline, comparative, streamlined. LCA inventory analysis: process or input-output. Hybrid inventory analysis. Sustainable Product Design. Whole systems design. Lightweighting and materials reduction. Designing for a lifetime. Design for durability, repair and upgrade, disassembly and recycling. Energy use in design. Reducing energy losses in design.

UNIT-III FOUNDATIONAL CONCEPTS & PRINCIPLES FOR SUSTAINABLE BREAKTHROUGH DESIGN

Infrastructure for managing flows of materials, energy and activities; sustainable value creation approaches for all stakeholders, environmental design characteristics; design changes & continual improvement; inclusive sustainable design principles, crowd sourcing, multiple-objective designs; infrastructures that support system thinking; knowledge management for sustainable design, learning systems and experimentation; smart data systems, understanding variation.

UNIT-IV SUSTAINABLE DESIGN

Industrial ecology, multiple life cycle design, principles of design, green engineering, cradle to cradle design, The Natural Step, biomimicry, design for reuse, dematerialization, modularization, design for flexibility, design for disassembly, design for inverse manufacturing, design for the environment, etc.

UNIT-V CUSTOMER AND USER NEEDS ASSESSMENT

Identification & breakdown structures that describe customers & stakeholders, green marketing, socially conscious consumerism, sources of customer information, collecting information, analyzing customer behavior, translating the voice of the customer, use analysis, structuring customer needs, service gap analysis, prioritizing customer needs, strategic design, Kano technique.

TOTAL: 45 PERIODS

OUTCOMES

The student will

1. Understand the concept of sustainability in terms of design, construction and development.
2. Gain knowledge in engineering design tools and life cycle assessment.
3. Be able to apply sustainable value creation approaches, design changes & continual improvement.
4. Carry out sustainable design, green engineering, flexible design etc.
5. Able to design according to the customer needs.
6. Design the products that are environmental friendly.

REFERENCES

1. Clarke, Abigail & John K. Gershenson 2006. Design for the Life Cycle. Life-cycle Engineering Laboratory, Department of Mechanical Engineering-Engineering Mechanics, Michigan Technological University.
2. Finster, Mark P., 2013. Sustainable Perspectives to Design and Innovation.
3. Ramaswamy, Rohit, 1996. Design and Management of Service Processes: Keeping Customers for Life, Prentice Hall.
4. Schmitt, Brent, 2003. Customer Experience Management, Wiley and Sons.

PD5008 PRODUCT TESTING AND QUALIFICATION L T P C
3 0 0 3

OBJECTIVES

- To gain knowledge about different types of product testing.
- To understand the type of testing required to be covered during product testing.
- To understand how testing need to be performed, understand importance of it and apply in future.
- To learn about product qualification and non-conformance investigation.

UNIT-I TESTS IN INTERACTIVE MODEL 9

Unit test process, Component test process, Integration test process, System integration test process, Acceptance test process, Test automation, Defect fixing and verification, waterfall methodology, Agile methodology.

UNIT-II TESTING PROCESS OVERVIEW 9

Testing process flow, Types, Unit testing, Environmental testing, Regression testing, Automated testing, Test claims to global platform, product testing agreement.

UNIT-III STATISTICAL CONSIDERATIONS AND RELIABILITY 9

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

UNIT-IV NON DESTRUCTIVE TESTING 9

Visual inspection and eddy current testing, Liquid p[penetration testing, Magnetic particle testing, radio graphic testing, ultrasonic testing

UNIT-V PRODUCT QUALIFICATION PROCESS OVERVIEW 9

Product qualification process flow, Test report generation, qualification and listing agreement form, analysis of non-conformances and rejection, Product qualification renewal

TOTAL: 45 PERIODS

OUTCOMES:

The student will

1. Gain knowledge in product testing – globalization and localization testing.
2. Learn about the different types of product testing.
3. Acquire knowledge in automated testing, analysis of results and test metrics.
4. Be able to apply the product qualification process, do test reports and renewal of product qualification.
5. Be able to do non-conformance investigation to products and tools.
6. Understand the methods to improve the product quality.

REFERENCES:

1. American Metals Society," Non- Destructive Examination and Quality Control", Metal Hand book, Vol 17 9th Metal park,OH,2012
2. Bralla, James G., Handbook of Product Design for Manufacturing, McGraw Hill Pub
3. Fundamentals of Quality control and improvement 2nd edition, AMITAVA MITRA, Pearson Education Asia, 2002
4. Kevin Otto and Kristin Wood, Product Design : Techniques in Reverse Engineering and New Product Development ,Pearson Education Inc.
5. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub: son south-western

PD5009 FINANCIAL ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on use of financial ratios to analyze a company situation To identify companies' main sources of funds -ascertain the link between investors and managers - consider lenders' requirements and expectations.

UNIT-I OPTIMIZATION MODELS AND METHODS 9

Modeling financial decisions as constrained optimization problems, selecting appropriate optimization methods to solve these problems- linear programming, quadratic and general nonlinear programming, dynamic and stochastic programming; discrete optimization techniques.

UNIT-II STOCHASTIC MODELS 9

Introduction to stochastic processes/modeling - discrete-time Markov chains; Gambler's ruin problem, Binomial Lattice Model for stock and derivative pricing; exponential distribution and the Poisson process; other Point processes; Renewal processes, Renewal reward theorem; continuous-time Markov chains; introduction to martingales and applications of the optional stopping theorem; introduction to Brownian motion; geometric Brownian motion; black-Scholes option pricing formula.

UNIT-III CONTINUOUS TIME MODELS 9

Introduction to stochastic calculus and stochastic differential equations; the Black-Scholes model and framework; the volatility surface; foreign exchange models and pricing quanto options; and advanced models including local volatility, stochastic volatility and jump-diffusion models.

UNIT-IV STATISTICAL ANALYSIS AND TIME SERIES 9

Black-Litterman asset pricing model; empirical analysis of asset prices: heavy tails, test of the predictability of stock returns; financial time series: ARMA, stochastic volatility, and GARCH models. Stationary tests; inference for continuous-time models, Bayesian MCMC; time series regression and empirical test of CAPM.

UNIT-V PROFESSIONAL DEVELOPMENT 9

Recognize the skills necessary to compete effectively, increase student professional intelligence, develop own professional self and identify developmental needs, information on employment trends, resources and networking opportunities, refine resume writing, interviewing, and job search skills.

TOTAL: 45 PERIODS

OUTCOMES:

On the completion, the students possess knowledge of the following:

1. Basic principles, theories and applications in the field of financial engineering.
2. A range of quantitative financial disciplines, including risk management, fixed income analysis, investments and stochastic modelling in financial engineering.
3. Design mathematical models of the financial functions of organisations and solve the formulated problems by a range of quantitative techniques, including simulation and optimisation techniques.
4. Carry out risk assessment by disciplines of risk management and decision analysis.
5. Understand and carry out statistical analysis.
6. Adapt quickly to new problems and challenges arising in the context of financial engineering.

REFERENCES

1. Brigham, Ehrhardt, Financial Management Theory and Practice, 12th edition, Cengage Learning 2010.
2. Hass J., 2010, Corporate finance in a nut shell - 2nd ed-, West Publishing.
3. Hillier D., Ross S., Westerfield R., Jaffe J., Bradford J., 2010, Corporate finance, McGraw-Hill.Walsh C., 2008 , Key management ratios, Prentice hall.
4. M. Pandey Financial Management, Vikas Publishing House Pvt. Ltd., 10th edition, 2012.
5. M.Y. Khan and P.K.Jain Financial management, Text, Problems and cases Tata McGraw Hill, 6th edition, 2011.