ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
REGULATIONS – 2015
CHOICE BASED CREDIT SYSTEM
M.E. PRODUCT DESIGN AND DEVELOPMENT (PT)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

I. To prepare students to excel in new product design and development through application of knowledge and practical skills.

II. To provide students with a solid foundation in mathematical modeling of engineering problems required for bringing new products fast into the market.

III. To provide students with required scientific and engineering knowledge so as to comprehend, analyze, design and create innovative products and solutions for real life problems.

IV. To inculcate professional and ethical values in students and enable them to work in multidisciplinary teams.

V. To provide students an academic environment which can facilitate life-long learning needed for a successful career in new product development.

PROGRAMME OUTCOMES (POs):

On successful completion of the programme,

1. Graduates will demonstrate knowledge of mathematical modeling and analytical skills.
2. Graduates will demonstrate ability to identify, formulate and solve engineering problems.
3. Graduate will demonstrate ability to design, analyze and interpret data.
4. Graduates will demonstrate ability to design a system, component or process as per needs and specifications.
5. Graduates will demonstrate ability to visualize and create physical prototypes using computer tools and other techniques.
6. Graduates will demonstrate ability to understand ethical and professional responsibilities.
7. Graduates will be able to communicate effectively in verbal, graphical and written form.
8. Graduates will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.
9. Graduates will develop confidence for self-education and ability for life-long learning.

Mapping of PEOs with POs

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

		Subjects	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
YEAR 1	SEM 1	Advanced Numerical Methods	√	√					√		√
		Introduction to Product Development		√					√	√	
		Computer Applications in Design	√		√		√	√	√		
		CAD and CAM Lab					√	√			
	SEM 2	Finite Element Methods in Mechanical Design	√	√	√				√		
		Integrated Product Design and Process Development		√		√			√	√	
		Product and Process Engineering Tools	√	√					√		
		Analysis and Simulation Lab for Product Design and Development	√		√		√		√		
YEAR 2	SEM 3	Quality Concepts in Product Development	√	√	√				√		
		Industrial Design	√	√	√				√		
		Professional Elective-I									
		Rigid Body Dynamics Lab									
	SEM 4	Materials for Product Design		√	√					√	
		Professional Elective-II									
		Professional Elective-III									
		Product Design Lab					√	√			√
YEAR 3	SEM 5	Engineering Economics and Marketing Research	√	√	√				√	√	
		Professional Elective-III									
		Professional Elective-III									
		Project Work Phase I		√		√	√	√			√
	SEM 6	Project Work Phase II		√		√	√	√			√

** **Professional Electives are listed in next page**

ELECTIVES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
Creativity in Design		√		√			√		
Design Paradigm	√	√	√				√		
Intellectual Property Rights and Patent Laws						√	√	√	
Maintenance Engineering							√		
Micro Electro Mechanical Systems	√	√	√				√		
Product Design for Energy and Environment	√	√	√	√		√	√	√	
Integrated Manufacturing Systems				√			√	√	
Additive Manufacturing					√		√		
Industrial Robotics and Expert systems	√	√	√				√		
Advanced Finite Element Analysis	√	√	√				√		
Bearing Design and Rotor Dynamics	√	√	√				√		
Design for Manufacture, Assembly and Environments	√	√	√			√	√	√	
Design of Hydraulic and Pneumatic Systems		√	√				√		
Modal Analysis of Mechanical Systems	√	√	√				√		
Optimization Techniques in Design	√	√	√				√		
Tribology in Design	√	√	√				√		
Enterprise Resource Planning							√		
Reverse Engineering	√	√	√				√		
Computational Fluid Dynamics	√	√	√				√		
Vibration Analysis and Control	√	√	√				√		

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI

M.E PRODUCT DESIGN AND DEVELOPMENT (PART TIME)

SEMESTER I

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	ED7151	Computer Applications in Design	PC	3	3	0	0	3
2.	ED7155	Integrated Product Design and Process Development	FC	3	3	0	0	3
3.	MA7154	Advanced Numerical Methods	FC	4	4	0	0	4
PRACTICALS								
4.	PD7111	CAD and CAM Lab	PC	2	0	0	2	1
			TOTAL	**12**	**10**	**0**	**2**	**11**

SEMESTER II

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	CI7251	Additive Manufacturing	PC	3	3	0	0	3
2.	PD7201	Creativity in Design	PC	3	3	0	0	3
3.	PD7202	Materials for Product Design	PC	4	4	0	0	4
PRACTICALS								
4.	PD7211	Multi Body Dynamics Lab	PC	2	0	0	2	1
			TOTAL	**12**	**10**	**0**	**2**	**11**

SEMESTER III

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	ED7154	Finite Element Methods in Mechanical Design	PC	4	4	0	0	4
2.	PD7301	Industrial Design	PC	4	4	0	0	4
3.		Elective-I	PE	3	3	0	0	3
PRACTICALS								
4.	PD7311	Analysis and Simulation Lab for Product Design and Development	PC	2	0	0	2	1
			TOTAL	**13**	**11**	**0**	**2**	**12**

SEMESTER IV

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	PD7401	Quality Concepts in Product Development	PC	3	3	0	0	3
2.		Elective-II	PE	3	3	0	0	3
3.		Elective-III	PE	3	3	0	0	3
PRACTICALS								
4.	PD7411	Product Design Lab	PC	2	0	0	2	1
			TOTAL	**11**	**9**	**0**	**2**	**10**

SEMESTER V

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	PD7501	Engineering Economics and Marketing Research	PC	3	3	0	0	3
2.		Elective IV	PE	3	3	0	0	3
3.		Elective V	PE	3	3	0	0	3
PRACTICALS								
4.	PD7511	Project Work Phase I	EEC	12	0	0	12	6
			TOTAL	**21**	**9**	**0**	**12**	**15**

SEMESTER VI

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1.	PD7611	Project Work Phase II	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF DEGREE = 71

FOUNDATION COURSES (FC)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Advanced Numerical Methods	FC	4	4	0	0	4
2.		Integrated Product Design and Process Development	FC	3	3	0	0	3

PROFESSIONAL CORE (PC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Creativity in Design	PC	3	3	0	0	3
2.		Quality Concepts in Product Development	PC	3	3	0	0	3
3.		Computer Applications in Design	PC	5	3	0	2	4
4.		Industrial Design	PC	4	4	0	0	4
5.		Materials for Product Design	PC	4	4	0	0	4
6.		Additive Manufacturing	PC	3	3	0	0	3
7.		Finite Element Methods in Mechanical Design	PC	4	4	0	0	4
8.		Engineering Economics and Marketing Research	PC	3	3	0	0	3
9.		CAD / CAM Lab	PC	2	0	0	2	1
10.		Product Design Lab	PC	2	0	0	2	1
11.		Multi Body Dynamics Lab	PC	2	0	0	2	1
12.		Analysis and Simulation Lab for Product Design and Development	PC	2	0	0	2	1

PROFESSIONAL ELECTIVES (PE)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CD7071	Integrated Manufacturing Systems	PE	3	3	0	0	3
2.	CD7072	Product Design for Energy and Environment	PE	3	3	0	0	3
3.	CI7072	Industrial Robotics and Expert Systems	PE	3	3	0	0	3
4.	CI7075	Micro Electro Mechanical Systems	PE	3	3	0	0	3
5.	ED7072	Bearing Design and Rotor Dynamics	PE	3	3	0	0	3
6.	ED7074	Concepts of Design for Manufacture and Assembly	PE	3	3	0	0	3
7.	ED7075	Design of Hydraulic and Pneumatic Systems	PE	3	3	0	0	3
8.	ED7077	Modal Analysis of Mechanical Systems	PE	3	3	0	0	3
9.	ED7078	Optimization Techniques in Design	PE	3	3	0	0	3
10.	ED7082	Tribology in Design	PE	3	3	0	0	3
11.	IC7071	Computational Fluid Dynamics	PE	3	3	0	0	3
12.	MS7251	Enterprise Resource Planning	PE	3	3	0	0	3

13.	PD7001	Design Paradigm	PE	3	3	0	0	3
14.	PD7002	Intellectual Property Righ Laws and Patents Law	PE	3	3	0	0	3
15.	PD7003	Maintenance Engineering	PE	3	3	0	0	3
16.	PD7004	Vibration Analysis	PE	3	3	0	0	3
17.	PD7071	Advanced Finite Element Analysis	PE	3	3	0	0	3
18.	PD7072	Reverse Engineering	PE	3	3	0	0	3
19.	PD7005	Product Lifecycle Management	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

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

ED7151 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, rotators) windowing - view ports - clipping transformation.

UNIT II CURVES AND SURFACES MODELLING 9

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

Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic surfaces: 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

OUTCOME:

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

ED7155 INTEGRATED PRODUCT DESIGN AND PROCESS DEVELOPMENT L T P C
3 0 0 3

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 of the common features a product has and how they can be incorporated suitably in products.

UNIT I INTRODUCTION 7

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 9

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 9

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 9

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.

TOTAL: 45 PERIODS

OUTCOMES:

Upon 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, analysis and product architecture

TEXT BOOK

1. "Product Design and Development", Karl T.Ulrich and Steven D.Eppinger, McGraw –Hill International Edns.2012

REFERENCES:

1. "Concurrent Engineering/Integrated Product Development". Kenneth Crow, DRM Associates, 6/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book

2. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin, Homewood, 1992
3. Stuart Pugh, "Total Design – Integrated Methods for successful Product Engineering", Addison Wesley Publishing, Neyourk,NY,1991, ISBN 0-202-41639-5

MA7154 ADVANCED NUMERICAL METHODS L T P C
4 0 0 4

OBJECTIVE:

- To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

UNIT I ALGEBRAIC EQUATIONS 12

Systems of linear equations: Gauss Elimination method, pivoting techniques, Thomas algorithm for tridiagonal system – Jacobi, Gauss Seidel, SOR iteration methods - Systems of nonlinear equations: Fixed point iterations, Newton Method, Eigen value problems: power method, inverse power method, Faddeev – Leverrier Method.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS 12

Runge Kutta Methods for system of IVPs, numerical stability, Adams-Bashforth multistep method, solution of stiff ODEs, shooting method, BVP: Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

UNIT III FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATION 12

Parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions – Two dimensional parabolic equations – ADI method; First order hyperbolic equations – method of characteristics, different explicit and implicit methods; numerical stability analysis, method of lines – Wave equation: Explicit scheme-Stability of above schemes.

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 12

Laplace and Poisson's equations in a rectangular region: Five point finite difference schemes, Leibmann's iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes – approximation of derivatives near a curved boundary while using a square mesh.

UNIT V FINITE ELEMENT METHOD 12

Partial differential equations – Finite element method - orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

TOTAL: 60 PERIODS

OUTCOME:

- It helps the students to get familiarized with the numerical methods that are necessary to solve numerically the problems that arise in engineering.

REFERENCES

1. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
2. Gupta S.K., "Numerical Methods for Engineers", New Age Publishers, 1995.
3. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", Cengage Learning, India Edition, New Delhi, 2009

4. Jain M. K., Iyengar S. R., Kanchi M. B., Jain , “Computational Methods for Partial Differential Equations”, New Age Publishers, 1993.
5. Morton K.W. and Mayers D.F., “Numerical solution of partial differential equations”,Cambridge University press, Cambridge, 2002.

PD7111 **CAD AND CAM LAB** **L T P C**
0 0 2 1

OBJECTIVE:

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

- **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.

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

Introduction to Rapid Prototyping – Conversion of PRT file to STL file -Slicing Software
CNC Machines – Features, Tooling

CNC program simulation in **FANUC/SINUMERIC** systems.

CAD/CAM connection & DNC link.

Cutter path generation for Planar machining, Surface Machining, Cavity machining, Fixed & variable contour machining, Drilling, Turning, tool & die and mould machining

Practical in Production CNC **Machining & Turning Centres** and **Rapid Prototyping** Machine
Post processing & CNC code Generation for advanced machining.
Exercises in tool path and NC code generation using software such as NX

TOTAL: 30 PERIODS

OUTCOMES:

- The laboratory classes helps the students to gain competence in the use of integrated computer aided tools for creation of solid models of various mechanical components.
- They will also be trained on using the solid models for various down stream operations.

CI7251 **ADDITIVE MANUFACTURING** **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: 8

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

UNIT II REVERSE ENGINEERING AND CAD MODELING: 10

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

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

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

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS: 10

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

UNIT V OTHER ADDITIVE MANUFACTURING SYSTEMS 7

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

TOTAL: 45 PERIODS

OUTCOME:

- On completion of this course, the students will learn about a variety of Additive Manufacturing (AM) technologies, their potential to support design and manufacturing, case studies relevant to mass customized manufacturing, and some of the important research challenges associated with AM and its data processing tools

REFERENCES:

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

PD 7201	CREATIVITY IN DESIGN	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION TO VISUAL ELEMENTS & ANIMATION 9

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

UNIT II ESSENTIAL THEORY OF CREATIVITY 9

Need for creative thinking in the pursuit of quality – Definitions and the theory of the mechanics of mind – Heuristics and models: Attitudes, Approaches and Actions that support creative thinking – ICEDIP: Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation.

UNIT III METHODS AND TOOLS FOR CREATIVITY 9

Three basic principles behind the tools of directed creativity – Tools that prepare the mind for creative thought – Tools that stimulate the imagination for new idea – Development and action: the bridge between mere creativity and the rewards of innovation.

UNIT IV DESIGN AND APPLICATION OF CREATIVITY 9

Three levels of emotional design: Visceral, Behavioral and Reflective – Process design, reengineering, and creativity – Creativity and customer needs analysis – Innovative product and service design – Creative problem solving and incremental improvement.

UNIT V INNOVATION 9

Introduction to TRIZ methodology – TRIZ principles & parameters – Disruptive innovation model – Segmenting markets – New market disruption – Process of commoditation and de-commoditation.

TOTAL : 45 PERIODS

REFERENCE BOOKS:

1. Paul E. Plsek, “Creativity, Innovation and Quality”, ASQ Quality Press, Milwaukee, Wisconsin, 2000.
2. Floyd Hurr, “Rousing Creativity: Think New Now”, Crisp Publications Inc., ISBN 1560525479, 1999.
3. Geoffrey Petty, “How to be better at Creativity”, The Industrial Society, 1999.
4. Donald A. Norman, “Emotional Design”, Perseus Books Group, New York, 2004.
5. Clayton M. Christensen and Michael E. Raynor, “The Innovator’s Solution”, Harvard Business School Press, Boston, USA, 2003.
6. Semyon D. Savransky, “Engineering of Creativity – TRIZ”, CRC Press, New York, USA, 2000.

PD7202 MATERIALS FOR PRODUCT DESIGN L T P C
4 0 0 4

OBJECTIVES

To expose the students to the material aspects of Product design, Process modeling, design for assembly and new material processing techniques.

UNIT I MATERIAL BEHAVIOR AND SELECTION 12

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- Superplasticity-Deformation of non-crystalline materials- Material selection- Cost and service requirement- Recycling-Selection of materials 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 behavior – Tooling in product design- Case studies in material selection.

UNIT II PROCESS MODELING AND PRODUCT DESIGN 12

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 12

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 12

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 12

Micro fabrication technologies- Tool for micro fabrication- Diamond and high speed machining- LIGA micro fabrication process- Multilayer X-ray lithography- Wire bonding packaging- Etching- Wet and dry etching techniques- Typical application

TOTAL 60 PERIODS

OUTCOMES:

On completion of the course the student will be able to

- understand the behavior of various metals and non-metals
- Learn about the selection of materials for different applications
- Appreciate design for assembly
- Get exposure to the manufacturing processes in micro fabrication

TEXT BOOK

1. Serope Kalpakjian and Schmid- Manufacturing process for Engineering materials Pearson-Prentice Hall, 2008.

REFERENCES

1. Paul Degarmo, Black and Kohsher- Materials and processes in Manufacturing- Wiley Student Edition - 9th Edition- 2005
2. Sami Franssile- Introduction to Micro Fabrication- John Wiley and Sons-UK 2004
3. Harfold Belofsky- Plastic design and processing hand book, Hanser publication- 2005
4. Beck- Plastic Product Design- van Nostrand Reignhold 2nd Edition
5. Asbhy, Selection of Materials, Elsevier Publications, 2006

PD7211 MULTI BODY DYNAMICS LAB L T P C
0 0 2 1

OBJECTIVE:

- To expose the students to understand the forces and torques that come into action in various kinds of mechanical systems

Exercise for this lab

1. Free fall of rigid body
2. Projectile motion
3. Simulation of simple & Compound Pendulum
4. Kinematic & Dynamic Analysis four bar and slider crack mechanism and its inversions
5. Design of cam Profile for various follower output motion
6. Kinematic & Dynamic Analysis of Gear Tracks
7. Vibration Analysis SDOF and MDOF
8. Project on virtual product design using ADAMS

TOTAL: 30 PERIODS

OUTCOME:

- The students get familiarized with modeling different systems and importing them into the multi body dynamic software.
- The students will be trained to obtain required dynamic properties by conducting multi body dynamic tests.
- The students will learn how to use this data in additional stress analysis software.

ED7154 FINITE ELEMENT METHODS IN MECHANICAL DESIGN L T P C
4 0 0 4

OBJECTIVE:

- To develop a thorough understanding of the basic principles of the 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 FINITE ELEMENT ANALYSIS OF ONE DIMENSIONAL PROBLEMS 12

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

UNIT II FINITE ELEMENT ANALYSIS OF TWO DIMENSIONAL PROBLEMS 12

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

UNIT III ISO-PARAMETRIC FORMULATION 12

Natural Co-ordinate Systems – Lagrangian Interpolation Polynomials – Isoparametric Elements – Formulation – Numerical Integration – Gauss quadrature – one-, two- and three-dimensional triangular elements formulation – rectangular elements – Serendipity elements - Illustrative Examples.

UNIT IV SOLUTION TECHNIQUES 12

Inversion Method, LU decomposition, Cholesky Decomposition, Banded Solver method, Skyline procedure method, Band width reduction Techniques, Front width Methods, Free meshing and Mapped Meshing

UNIT V SPECIAL TOPICS 12

Dynamic Analysis – Equations of Motion – Mass & damping matrices – Free Vibration analysis – Natural frequencies of Longitudinal, Transverse and torsional vibration – Introduction to transient field problems - Solution techniques – Explicit & Implicit methods

Non-linear analysis, Solution Techniques – Case studies – h & p elements – special element formulation

TOTAL = 60 PERIODS

OUTCOMES:

Upon completion of this course the students will be able to

- Understand how to mathematically model physical systems and solve using numerical techniques.
- Select appropriate element and boundary conditions for various 1D & 2D Boundary value problems.
- Apply various solution techniques to solve Boundary value problems and Eigen value problems

REFERENCES:

1. Rao, S.S., "The Finite Element Method in Engineering", Butterworth-Heinemann (An imprint of Elsevier), reprint 2012, Published by Elsevier India Pvt. Ltd., New Delhi,
2. Reddy, J.N., "Introduction to Non-Linear Finite Element Analysis", Oxford University Press, 2008
3. Zienkiewicz.O.C, Taylor.R.L,& Zhu,J.Z "The Finite Element Method: Its Basis & Fundamentals", Butterworth-Heinemann (An imprint of Elsevier), 2007, India
4. Cook, R.D., Malkus, D. S., Plesha,M.E., and Witt,R.J " Concepts and Applications of Finite Element Analysis", Wiley Student Edition, 4th Edition, First Reprint 2007, Authorized reprint by Wiley India(P) Ltd., New Delhi,
5. Zienkiewicz.O.C, Taylor.R.L "The Finite Element Method" McGraw Hill International Editions, Fourth Edition, 1991, Volume 2 (Chapters 7&8)
6. Huebner,K.H., Dewhirst,D.L.,Smith,D.E & Byron,T.G., "The Finite Element Method for Engineers", Wiley Student Edition, Fourth Edition 2004,John Wiley & Sons(Asia)Pvt. Ltd.,
7. Ramamurthi, V., "Finite Element Method in Machine Design", Narosa Publishing House, January 2009.

PD7301 **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, 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.

TOTAL: 60 PERIODS

OUTCOME:

Upon completion of this course the students will be able to

- Understand the human aspects to be considered in the design of equipments, work spaces and various OSHA standards

REFERENCES:

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

PD7311 ANALYSIS AND SIMULATION LAB FOR PRODUCT DESIGN AND DEVELOPMENT **L T P C 0 0 2 1**

OBJECTIVE:

To impart knowledge on the use of Finite Element Analysis software to solve various field problems in mechanical engineering to optimize and verify the design of machine elements and also fabricate a physical prototype.

Analysis of Mechanical Components – Use of FEA Packages like ANSYS/ NASTRAN etc.,
Exercises shall include analysis of
i) Machine elements under Static loads
ii) Thermal Analysis of mechanical systems
iii) Modal Analysis
iv) Machine elements under Dynamic loads
v) Non-linear systems
Rapid Prototyping – Making RP component – Study on RP tooling

TOTAL: 30 PERIODS

OUTCOME:

Upon conclusion of this course the student will be able to

- Model and analyze various physical problems
- Select appropriate elements and give boundary conditions
- Solve structural, thermal, modal and dynamics problems.
- Generate physical prototypes direct from the CAD model using additive manufacturing.

PD7401 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 and various 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-Objectives and functions-Targets- 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 MODES AND EFFECTS 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

UNIT III DESIGN FOR SIX SIGMA **8**

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

UNIT IV DESIGN OF EXPERIMENTS 10

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

UNIT V STATISTICAL 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 distribution

TOTAL: 45 PERIODS

OUTCOME:

It helps the design cum quality engineer to get familiarized with various concepts in quality and reliability principles in the design of an engineering product or a service.

REFERENCES:

1. Kevin Otto & Kristin Wood, Product Design Techniques in Reverse Engineering and New Product Development, Pearson Education (LPE), 2001.
2. Amitava Mitra, Fundamentals of Quality control and improvement 2nd edition,Pearson Education Asia, 2002.
3. Montgomery, D.C., Design and Analysis of experiments, John Wiley and Sons, 2003.
4. Phillip J.Ross, Taguchi techniques for quality engineering, McGraw Hill, 1996.

PD7411 PRODUCT DESIGN LAB 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

PD7501 ENGINEERING ECONOMICS AND 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 in marketing research and its application in the front end of product development.

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 – nonprobability 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- Chisquare 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

TOTAL: 45 PERIODS

OUTCOME:
- Shall serve the students with a prerequisite knowledge for use of any of the relevant software packages like SPSS, SAS, etc.

REFERENCES

1. Naresh K.Malhotra, Satyabhushan Dash, “Marketing Research: An Applied Orientation”,6th Edition, Pearson, 2007
2. Donald S.Tull, Del I.Hawkins, “Marketing Research: Measurement and Method”,5th Edition, Eastern Economy Edition, Prentice Hall India,1990
3. Paul E. Green and Donald S. Tull, Research for Marketing Decisions,‖ Prentice- Hall of India Private Limited,. New Delhi(2003),

PD7511 **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 are in a position to carry out the remaining phase II work in a systematic way.

PD7611 **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 problems in the field of engineering design and find better solutions to it.

CD7071 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 PLANNING 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. Groover, M.P., "Automation, Production System and CIM", Prentice-Hall of India, 4th Edition 2014.
2. David Bedworth, "Computer Integrated Design and Manufacturing", TMH, New Delhi, 1998.
3. Yoram Koren, "Computer Integrated Manufacturing Systems", McGraw Hill, 1983.
4. Paul G. Ranky, "Computer Integrated Manufacturing", Prentice Hall International 1986.
5. R.W. Yeomamas, A. Choudry and P.J.W. Ten Hagen, "Design rules for a CIM system", North Holland Amsterdam, 1985.

CD7072 PRODUCT DESIGN FOR ENERGY AND ENVIRONMENT L T P C
3 0 0 3

OBJECTIVE:
To expose the students to the design and development of sustainable products using emerging renewable sources of energy such as solar, wind and bio energy

UNIT I INTRODUCTION 9
Energy and Environment - Scenario – Global and Indian perspectives – Necessity for promotion of Energy generation and Environment friendly products – Creativity and Innovation.

UNIT II SOLAR PRODUCTS – DESIGN AND DEVELOPMENT 9
Solar energy Conversion – Types, Solar Products – Solar water heater, Solar Lantern, Solar Cooker & storage devices (Solar PV modules, Battery, Charge Controller, Investors), Existing Designs, Avenues for Improvements, Creativity and Innovation – Eco-friendly concepts.

UNIT III BIO ENERGY PRODUCTS – DESIGN 9
Bio energy conversion – Types, Processes and Equipments, Existing Designs, Avenues for Improvements, Creativity and Innovation – Eco-friendly concepts.

UNIT IV TESTING 9
Standards and Procedures for Solar and Bio products - Design and Testing, Testing of Equipments, Safety standards, International standards and Indian scenario.

UNIT V ECONOMICS 9
Barriers involved in commercialization of Energy products, Factors under considerations - cost, payback, reliability, comfort factors, technical factors, Policy affairs. Economics of solar and bio power generation, Quantitative and Qualitative Approach

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of the course, the students will be able
- To appreciate the need for energy efficient and environmental friendly products
- To use new and renewable energy sources for new product development
- To gain the knowledge about the standards and testing procedures

TEXT BOOKS:
1. Garg H P., Prakash J, Solar Energy: Fundamentals & Applications, Tata McGraw Hill, 2000.
2. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Hooknood Chichester, 1984.

REFERENCES:
1. Duffie J.A and Beckman W.A., Solar Engineering of Thermal Processes, John Wiley & sons, 1991.
2. Roger Messenger and Jerry Vnetre, Photovoltaic Systems Engineering, CRC Press, 2004.
3. Khandelwal KC, Mahdi SS, Biogas Technology – A Practical Handbook, Tat McGraw Hill, 1986.

CI7072 INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS L T P C
3 0 0 3

OBJECTIVE:

- 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.

TEXT BOOK:

1. K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill, 1987.

REFERENCES:

1. Koren,Y., “Robotics for Engineers”, McGraw-Hill, 1987.
2. Kozyrey, Yu. “Industrial Robots”, MIR Publishers Moscow, 1985.
3. Klafter,R.D., Chmielewski, T.A. and Negin,M., “Robotics Engineering – An Integrated Approach”, Prentice-Hall of India Pvt. Ltd., 1984.
4. Deb, S.R.” Robotics Technology and Flexible Automation”, Tata Mc Graw-Hill, 1994.
5. Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., “Industrial Robotics Technology, Programming and Applications”, Mc Graw-Hill, Int., 1986.
6. Jordanides,T. and Torby,B.J., ,”Expert Systems and Robotics“, Springer –Verlag, New York, May 1991.

CI7075 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. Hsu, T.R., “MEMS & Microsystems Design and Manufacture”, Tata McGraw Hill, 2002,ISBN: 9780070487093.
2. Franssila, S., “Introduction to Micro Fabrication” John Wiley & sons Ltd, 2004.ISBN:470-85106-6
3. Jain, V.K., “Introduction to Micromachining” Narosa Publishing House, 2010.
4. Jackson, M.J., “Microfabrication and Nanomanufacturing” Taylor and Francis 2006.
5. McGeough, J.A., “Micromachining of Engineering Materials”, CRC Press, ISBN: 0824706447, 2001.
6. Hak M.G., “MEMS Handbook”, CRC Press, ISBN: 8493-9138-5, 2006.

ED7072 BEARING DESIGN AND ROTOR DYNAMICS L T P C
3 0 0 3

OBJECTIVE:

- To know about different types of bearings available for machine design and their operating principles
- To design hydrodynamic/ hydrostatic / rolling bearing for given specifications and analyze the bearings for their performance
- To understand the bearing behavior under dynamic conditions

UNIT I CLASSIFICATION AND SELECTION OF BEARINGS 6

Selection criteria-Dry and Boundary Lubrication Bearings-Hydrodynamic and Hydrostatic bearings-Electro Magnetic bearings-Dry bearings-Rolling Element bearings- Bearings for Precision.
Applications-Foil Bearings-Special bearings- Selection of plain Bearing materials –Metallic and Non metallic bearings.

UNIT II DESIGN OF FLUID FILM BEARINGS 10

Design and performance analysis of Thrust and Journal bearings – Full, partial, fixed and pivoted journal bearings design procedure-Minimum film thickness – lubricant flow and delivery – power loss, Heat and temperature distribution calculations- Design based on Charts & Tables and Experimental curves-Design of Foil bearings-Air Bearings- Design of Hydrostatic bearings-Thrust and Journal bearings- Stiffness consideration - flow regulators and pump design

UNIT III SELECTION AND DESIGN OF ROLLING BEARINGS 10

Contact Stresses in Rolling bearings- Centrifugal stresses-Elasto hydrodynamic lubrication- Fatique life calculations- Bearing operating temperature- Lubrication- Selection of lubricants- Internal clearance – Shaft and housing fit- -Mounting arrangements-Materials for rolling bearings-Manufacturing methods- Ceramic bearings-Rolling bearing cages-bearing seals selection

UNIT IV DYNAMICS OF HYDRODYNAMIC BEARINGS 10

Hydrodynamic Lubrication equation for dynamic loadings-Squeeze film effects in journal bearings and thrust bearings -Rotating loads , alternating and impulse loads in journal bearings – Journal centre Trajectory- Analysis of short bearings under dynamic conditions- Finite difference solution for dynamic conditions

UNIT V ROTOR DYNAMICS 9

Rotor vibration and Rotor critical speeds- support stiffness on critical speeds- Stiffness and damping coefficients of journal bearings-computation and measurements of journal bearing coefficients - Mechanics of Hydro dynamic Instability- Half frequency whirl and Resonance whip- Design configurations of stable journal bearings

TOTAL: 45 PERIODS

OUTCOMES:

- Acquisition of knowledge in the analysis of all types of bearings.
- Ability to make specifications of all types of bearings
- Skill for conducting dynamic / vibration analysis and trouble shooting of bearings

REFERENCES:

1. Neale, M.J. “Tribology Hand Book”, Butterworth Heinemann, United Kingdom 2001.
2. Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981
3. Halling, J. (Editor) – “Principles of Tribology “, Macmillian – 1984.
4. Williams J.A. “ Engineering Tribology”, Oxford Univ. Press, 1994.
5. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,”Fundamentals of Tribology”, Prentice –Hall of India Pvt Ltd , New Delhi, 2005
6. G.W.Stachowiak & A.W .Batchelor , Engineering Tribology, Butterworth-Heinemann, UK, 2005

ED7074 CONCEPTS OF DESIGN FOR MANUFACTURE AND ASSEMBLY 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. Bralla, Design for Manufacture handbook, McGraw hill, 1999.
3. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.
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. Kevin Otto and Kristin Wood, Product Design. Pearson Publication, (Fourth Impression) 2009.
8. Harry Peck , Designing for manufacture, Pitman– 1973

ED7075 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS L T P C
3 0 0 3

OBJECTIVE:

- To impart students on the science, use and application of hydraulics and pneumatics as fluid power in Industry. Also to impart knowledge on the methodology of basic and advanced design of pneumatics and hydraulics systems.

UNIT I OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS 7

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

UNIT II CONTROL AND REGULATION ELEMENTS 10

Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems, Proportional Electro hydraulic servo valves.

UNIT III HYDRAULIC CIRCUITS 8

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

UNIT IV PNEUMATIC SYSTEMS AND CIRCUITS 10

Pneumatic fundamentals - control elements, position and pressure sensing, Pneumatic equipments-selection of components - design calculations - logic circuits - switching circuits - fringe conditions modules and these integration - sequential circuits - cascade methods - mapping methods - step counter method - compound circuit design - combination circuit design- Karnaugh - Veitch map.

UNIT V ELECTROMAGNETIC & ELECTRONIC CONTROL OF HYDRAULIC & PNEUMATIC CIRCUIT 10

Electrical control of pneumatic circuits – use of relays, counters, timers, ladder diagrams, use of microprocessor in circuit design – use of PLC in hydraulic and pneumatic circuits – Fault finding– application -fault finding - hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

TOTAL : 45 PERIODS

OUTCOME:

- It helps students to get knowledge on the need, use and application of fluid power and make them familiar to industrial design that lead to automation.

REFERENCES:

1. Antony Espossito, “Fluid Power with Applications”, Prentice Hall, 1980.
2. Dudleyt, A. Pease and John J. Pippenger, “Basic fluid power”, Prentice Hall, 1987.
3. Andrew Parr, “Hydraulic and Pneumatics” (HB), Jaico Publishing House, 1999.
4. Bolton. W., “Pneumatic and Hydraulic Systems “, Butterworth –Heinemann, 1997.
5. K.Shanmuga Sundaram, “Hydraulic and Pneumatic Controls: Understanding made Easy" S.Chand & Co Book publishers, New Delhi, 2006 (Reprint 2009)

ED7077 MODAL ANALYSIS OF MECHANICAL SYSTEMS L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on modal testing, modal analysis of single and multi- degree of freedom systems.

UNIT I INTRODUCTION 6

Introduction to Modal Testing – Applications of Modal Testing – Philosophy of Modal Testing – Summary of Theory – Summary of Measurement Methods – Summary of Analysis – Review of Test Procedure.

UNIT II VIBRATIONS 12

Introduction – Single Degree of Freedom (SDOF) System Theory – Presentation and Properties of FRF Data for SDOP System – Undamped Multi-degree of freedom (MDOF) system – Proportional Damping – Hysteretic Damping – General Case – Viscous Damping – General Case – Characteristics and presentation of MDOF – FRF Data – Complete and incomplete models - Nonsinusoidal vibration and FRF Properties – Analysis of Weakly Nonlinear Structures.

UNIT III MOBILITY MEASUREMENT TECHNIQUES 10

Introduction – Basic Measurement System – Structure preparation – Excitation of the Structure – Transducers and Amplifiers – Analyzers – Digital Signal Processing – Use of Different Excitation types – Calibration – Mass Cancellation – Rotational Mobility Measurement – Measurement on Non linear structures – Multi point excitation methods.

UNIT IV MODAL PARAMETER EXTRACTION METHODS 11

Introduction – Preliminary checks of FRF Data – SDOF Modal Analysis-I – Peak-amplitude –SDOF Modal Analysis-II – Circle Fit Method – SDOF Modal Analysis III – Inverse Method –Residuals – MDOF curve-fitting procedures – MDOF curve fitting in the Time Domain – Global or Multi-Curve fitting – Non linear systems.

UNIT V MATHEMATICAL MODELS 6

Introduction – Modal Models – Display of Modal Model – Response Models – Spatial Models –Mobility Skeletons and System Models.

TOTAL: 45 PERIODS

OUTCOME:

- It helps the students to get familiarized with the modal testing, modal analysis of single and multi- degree of freedom systems.

REFERENCES:

1. Ewins D J, “Modal Testing: Theory and Practice “, John Wiley & Sons Inc., 1988
2. Nuno Manuel Mendes Maia et al,” Theoretical and Experimental Modal Analysis”, Wiley John & sons, 1997.

ED7078 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. Rao, Singaresu, S., “Engineering Optimization – Theory & Practice”, New Age International (P) Limited, New Delhi, 2000.
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. Goldberg, D.E., “Genetic Algorithms in Search, Optimization and Machine Learning”, Pearson, 2008.

ED7082 TRIBOLOGY IN DESIGN L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge in the friction , wear and lubrication aspects of machine components
- To understand the material properties which influence the tribological characteristics of surfaces.
- To understand the analytical behavior of different types bearings and design of bearings based on analytical /theoretical approach

UNIT I SURFACE INTERACTION AND FRICTION 7

Topography of Surfaces – Surface features-Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction –Rolling Friction-Friction properties of metallic and non-metallic materials – friction in extreme conditions –Thermal considerations in sliding contact

UNIT II WEAR AND SURFACE TREATMENT 8

Types of wear – Mechanism of various types of wear – Laws of wear –Theoretical wear models- Wear of Metals and Non metals – Surface treatments – Surface modifications – surface coatings methods-Surface Topography measurements –Laser methods – instrumentation - International standards in friction and wear measurements

UNIT III LUBRICANTS AND LUBRICATION REGIMES 8

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

UNIT IV THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION 12

Reynolds Equation,-Assumptions and limitations-One and two dimensional Reynolds Equation-Reynolds and Sommerfeld boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings-Squeeze film effects-Thermal considerations-Hydrostatic lubrication of Pad bearing- Pressure , flow , load and friction calculations-Stiffness considerations- Various types of flow restrictors in hydrostatic bearings

UNIT V HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION 10

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

TOTAL: 45 PERIODS

OUTCOME:

- Ability to select material / surface properties based on the tribological requirements
- Methodology for deciding lubricants and lubrication regimes for different operating conditions
- Analysis ability of different types of bearings for given load/ speed conditions.

REFERENCES:

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

IC 7071 **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 MODELLING 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.Versteeg and Malalasekera, N, "An Introduction to computational Fluid Dynamics The Finite Volume Method," Pearson Education, Ltd., Second Edition, 2014.

2.Ghoshdastidar, P.S., "Computer Simulation of Flow and Heat Transfer", Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998.

3. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.

4. Subas and V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation,1980

5. Jiyuan Tu, Guan Heng Yeoh, Chaogun Liu, "Computational Fluid Dynamics A Practical Approach" Butterworth – Heinemann An Imprint of Elsevier, Madison, U.S.A., 2008

6. John D. Anderson . JR. "Computational Fluid Dynamics The Basics with Applications" McGraw-Hill International Editions, 1995.

MS7251 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. Sadagopan.S , ERP-A Managerial Perspective, Tata Mc Graw Hill, 1999.
2. Jose Antonio Fernandez, The SAP R/3 Handbook, Tata Mc Graw Hill, 1998.
3. Vinod Kumar Garg and N.K.Venkitakrishnan, Enterprise Resource Planning –Concepts and Practice, Prentice Hall of India, 2004.
4. Garg & Venkitakrishnan, ERPWARE , ERP Implementation Framework, Prentice Hall, 2004.
5. Thomas E Vollmann and Bery Whybark, Manufacturing and Control Systems, Galgothia Publications, 1998.

PD7001 **DESIGN PARADIGM** **L T P C**
3 0 0 3

OBJECTIVE:

- To impart knowledge on the various design methodologies for manufacture and assembly, value engineering and the economics of product development

UNIT I DESIGN FOR MANUFACTURE 8

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 FORM DESIGN OF CASTINGS AND WELDMENTS 9

Redesign of castings based on parting line considerations - Minimizing core requirements - Redesigning weldments to cast members -factors influencing form design-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 DESIGN FOR ASSEMBLY 6

Assembly processes-Handling and insertion process-Manual, automatic and robotic assembly- Cost of Assembly-Number of Parts-DFA guidelines

UNIT IV VALUE ENGINEERING 12

Value –types –functional –operational –aesthetic –cost- –material – Design process – value and worthiness –procedure -brainstorming sessions –evaluation –case studies –value estimation- Value analysis - Design for value - Selection of alternatives - optimization – Implementation

UNIT V PRODUCT DEVELOPMENT ECONOMICS 10

Elements of Economics analysis-Quantitative and qualitative analysis-Economic Analysis process-Estimating magnitude and time of future cash inflows and out flows-Sensitivity analysis-Project trade-offs-Trade-offs rules-Limitation of quantitative analysis-Influence of qualitative factors on project success

TOTAL :45 PERIODS

OUTCOMES:

Upon completion of the course, the students will be able

- To gain an exposure to the interrelation between design and manufacture.
- To understand the various design aspects to be considered for manufacturing the products using different processes.

TEXT BOOK:

1. Harry Peck, Designing for Manufacture, Pitman Publications, 1983.
2. George E Dieter, Engineering Design, McGraw-Hill Int Editions, 2000

REFERENCES:

1. S.S.Iyer ,Value Engineering, New Age International, 2000
2. Charles E. Ebeling, Reliability and Maintainability Engineering, , TMH, 2000
3. Karl T.Ulrich and Steven D.Eppinger, "Product Design and Development", McGraw – Hill International Edns.2012

PD7002 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.

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 Practitioners – Role of Managers – IP Commercialisation – IP Audit and its Importance

TOTAL: 45 PERIODS

OUTCOMES:

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

TEXT BOOKS:

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

REFERENCES:

1. N.R.Subbaram, "Patent law – Practices and Procedures", Wadhwa, Second Edition, 2007
2. N.S.Gopalakrishnan & T.G.Agitha, 'Principles of Intellectual Property", Eastern Book Company, First Edition, 2009

PD7003 **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.

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

OUTCOMES:
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

TEXT BOOK:
1. "Maintenance Engineering and Management": K.Venkataraman-PHI Learning - 2007

REFERENCES:

1. Kelly. A and Harris, M. J, “Management of Industrial maintenance”, Butter worth & Co., 1978
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

PD7004 VIBRATION ANALYSIS L T P C
3 0 0 3

OBJECTIVE:

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

UNIT I FUNDAMENTALS OF VIBRATION 9

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

UNIT II TWO DEGREE FREEDOM SYSTEM 9

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

UNIT III MULTI-DEGREE FREEDOM SYSTEM AND CONTINUOUS SYSTEM 9

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

UNIT IV VIBRATION CONTROL 9

Specification of Vibration Limits –Vibration severity standards- Vibration as condition Monitoring tool-Vibration Isolation methods- -Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber-Damped Vibration absorbers-Static and Dynamic Balancing-Balancing machines-Field balancing – Vibration Control by Design Modification- - Active Vibration Control

UNIT V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS 9

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

TOTAL = 45PERIODS

OUTCOME:

- To make the students understand the basics of vibration, its importance in engineering field. Since vibration is a critical problem today in engineering industries, the students are equipped with the working operations of various vibration measuring instruments, vibration control and analysis techniques in the engineering field.

REFERENCES:
1. Rao, S.S.," Mechanical Vibrations," Prentice Hall, 2011.
2. Thomson, W.T. – "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 1990
3. Ramamurti. V, "Mechanical Vibration Practice with Basic Theory", Narosa, New Delhi, 2000.
4. S. Graham Kelly & Shashidar K. Kudari, "Mechanical Vibrations", Tata McGraw –Hill Publishing Com. Ltd New Delhi,2007.

PD7071 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 – C_0 and C_1 Continuity Elements – Degenerated shell elements- Application and Examples.

UNIT II NON-LINEAR PROBLEMS 10

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

UNIT III DYNAMIC PROBLEMS 8

Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Eigen solution-Subspace Iterative Technique – Response analysis-Houbolt, Wilson, Newmark – Methods – Explicit &Implict Methods- Lanczos, 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.

TOTAL : 45 PERIODS

OUTCOME:

• It helps the students to get a better insight into advanced concepts used in finite element analysis to solve practical engineering problems.

REFERENCES:

1. Zienkiewicz, O.C. and Taylor, R.L., "The Finite Element Method", Fourth Edition, Volumes 1&2 McGraw Hill International Edition, Physics Services, 1991.
2. Robert D. Cook, David S. Malkus, Michael E. Plesha and Robert J. Witt "Concepts and Applications of Finite Element Analysis", John Wiley and Sons Inc., Newyork, 2001
3. Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall,1996.

PD7072 **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 REVERSE ENGINEERING **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 OF REVERSE ENGINEERING **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 OF REVERSE ENGINEERING **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

OUTCOMES:

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

PD7005 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.