ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

M.E. ENGINEERING DESIGN

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

Enable the students **:**

I. to develop an aptitude to use engineering principles to conceptualize, create, model, test and evaluate designs within the context of local and global needs.

II. to become effective and excellent collaborators and innovators, participating in efforts to address and provide solutions to social and technical challenges.

III. to develop innovative technologies and find solutions to contemporary issues in Engineering Design using fundamental principles in combination with modern engineering tools and methods.

IV. to pursue advanced education, research and development and other creative/ innovative efforts in their professional career.

PROGRAMME OUTCOMES (POs):

On successful completion of the programme,

1. Graduates will demonstrate knowledge of mathematics, science and engineering.

2. Graduates will demonstrate an ability to identify, formulate and solve engineering design problems by using computer aided tools.

3. Graduate will demonstrate an ability to design and conduct experiments, analyze and interpret data in the area of design engineering though software.

4. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

5. Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze multidisciplinary problems.

6. Graduates will demonstrate knowledge of professional and ethical responsibilities in the field of mechanical design.

7. Graduate will communicate their technical knowledge.

8. Graduate will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.

9. Graduate will develop confidence for self-education and ability for life-long learning and research.

Mapping of PEOs with POs

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

		Subjects	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
YEAR 1	SEM 1	Engineering Fracture Mechanics	√	√	√	√					√
		Computer Applications in Design	√	√	√		√				
		Concepts of Engineering Design				√		√	√	√	
		Vibration Analysis and Control	√	√	√	√	√			√	√
		Advanced Numerical Methods	√		√					√	√
		Finite Element Methods in Mechanical Design	√	√	√		√			√	√
		Modelling and Simulation Lab			√		√		√	√	√
	SEM 2	Engineering Materials and their Applications				√		√		√	√
		Integrated Mechanical Design	√	√	√	√	√			√	
		Mechanisms Design and Simulation	√	√	√	√	√			√	
		Professional Elective I**									
		Professional Elective II**									
		Professional Elective III**									
		DFMA and Prototyping Lab		√	√				√	√	
		Technical Seminar							√	√	√
YEAR 2	SEM 3	Professional Elective IV**									
		Professional Elective V**									
		Professional Elective VI**									
		Project Work Phase I	√	√	√	√	√	√	√	√	√
	SEM 4	Project Work Phase II	√	√	√	√	√	√	√	√	√

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

ELECTIVES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
Advanced metal forming techniques		√						√	√
Plates and shell	√			√	√			√	
Surface Engineering								√	√

Additive Manufacturing			√		√			√	√
Bearing Design and Rotor Dynamics	√	√	√	√					
Composite Materials and Mechanics	√	√	√	√	√			√	√
Design for Manufacture Assembly and Environments		√	√	√	√			√	√
Design of Hydraulic and Pneumatic systems			√	√				√	√
Design of Material Handling Equipments	√			√				√	√
Design of Pressure Vessels and Piping	√			√					√
Modal Analysis of Mechanical Systems	√	√	√	√	√			√	
Optimization Techniques in Design	√			√				√	√
Tribology in Design			√	√				√	√
Computational Fluid Dynamics	√	√	√	√	√			√	√
Tool Design	√			√	√			√	√
Integrated Product and Process Design		√		√		√		√	√
Quality Concepts in Design			√			√		√	√
Advanced Mechanics of Materials	√			√					√

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI

M.E. ENGINEERING DESIGN

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.	ED7152	Concepts of Engineering Design	FC	3	3	0	0	3
3.	ED7153	Engineering Fracture Mechanics	PC	3	3	0	0	3
4.	ED7154	Finite Element Methods in Mechanical Design	PC	4	4	0	0	4
5.	ED7156	Vibration Analysis and Control	PC	5	3	0	2	4
6.	MA7154	Advanced Numerical Methods	FC	4	4	0	0	4
PRACTICALS								
7	ED7111	Modelling and Simulation Lab	PC	4	0	0	4	2
			TOTAL	**26**	**20**	**0**	**6**	**23**

SEMESTER II

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	ED7201	Engineering Materials and their Applications	PC	3	3	0	0	3
2.	ED7251	Integrated Mechanical Design	PC	4	4	0	0	4
3.	ED7252	Mechanisms Design and Simulation	PC	4	4	0	0	4
4.		Elective I	PE	3	3	0	0	3
5.		Elective II	PE	3	3	0	0	3
6.		Elective III	PE	3	3	0	0	3
PRACTICALS								
7.	ED7211	Design for Manufacture Assembly and Environment and Prototyping Lab	PC	4	0	0	4	2
8.	ED7212	Technical Seminar	EEC	2	0	0	2	1
			TOTAL	**26**	**20**	**0**	**6**	**23**

SEMESTER III

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Elective IV	PE	3	3	0	0	3
2.		Elective V	PE	3	3	0	0	3
3.		Elective VI	PE	3	3	0	0	3
PRACTICALS								
4.	ED7311	Project Work Phase I	EEC	12	0	0	12	6
			TOTAL	**21**	**9**	**0**	**12**	**15**

SEMESTER IV

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1.	ED7411	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 = 73

FOUNDATION COURSES (FC)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Advanced Numerical Methods	FC	5	3	2	0	4
2.		Concepts of Engineering Design	FC	3	3	0	0	3

PROFESSIONAL CORE (PC)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Engineering Materials and their Applications	PC	3	3	0	0	3
2.		Computer Applications in Design	PC	3	3	0	0	3
3.		Vibration Analysis and Control	PC	5	3	0	2	4
4.		Finite Element Methods in Mechanical Design	PC	4	4	0	0	4
5.		Engineering Fracture Mechanics	PC	3	3	0	0	3
6.		Integrated Mechanical Design	PC	4	4	0	0	4
7.		Mechanisms Design and Simulation	PC	4	4	0	0	4
8.		Analysis and Simulation Lab	PC	4	0	0	4	2
9.		Design for Manufacture Assembly and Environment and Prototyping Lab	PC	4	0	0	4	2

PROFESSIONAL ELECTIVES (PE)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CI7251	Additive Manufacturing	PE	3	3	0	0	3
2.	ED7001	Advanced Metal Forming Techniques	PE	3	3	0	0	3
3.	ED7002	Plates and shell	PE	3	3	0	0	3
4.	ED7071	Advanced Mechanics of Materials	PE	3	3	0	0	3
5.	ED7072	Bearing Design and Rotor Dynamics	PE	3	3	0	0	3
6.	ED7073	Composite Materials and Mechanics	PE	3	3	0	0	3
7.	ED7074	Concepts of Design for Manufacture and Assembly	PE	3	3	0	0	3
8.	ED7075	Design of Hydraulic and Pneumatic systems	PE	3	3	0	0	3
9.	ED7076	Design of Material Handling Equipments	PE	3	3	0	0	3
10.	ED7077	Modal Analysis of Mechanical Systems	PE	3	3	0	0	3
11.	ED7078	Optimization Techniques in Design	PE	3	3	0	0	3
12.	ED7079	Quality Concepts in Design	PE	3	3	0	0	3
13.	ED7080	Surface Engineering	PE	3	3	0	0	3
14.	ED7081	Tool Design	PE	3	3	0	0	3
15.	ED7082	Tribology in Design	PE	3	3	0	0	3
16.	ED7155	Integrated Product Design and Process Development	PE	3	3	0	0	3
17.	ED7351	Design of Pressure Vessels and Piping	PE	3	3	0	0	3
18.	IC7071	Computational Fluid Dynamics	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Technical Seminar	EEC	2	0	0	2	1
2.		Project Work Phase I	EEC	12	0	0	12	6
3.		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

ED7152 CONCEPTS OF ENGINEERING DESIGN L T P C
3 0 0 3

OBJECTIVES:

- To impart the importance of design in today's context of global competition, environmental awareness and customer oriented market.
- To impart the basic concepts and various aspects of design using simple examples and case studies.

UNIT I DESIGN FUNDAMENTALS 9

Importance of design- The design process-Considerations of Good Design – Morphology of Design –Organization for design– Computer Aided Engineering – Designing to codes and standards – Concurrent Engineering – Product and process cycles – Technological Forecasting – Market Identification – Competition Bench marking.

UNIT II CUSTOMER ORIENTED DESIGN & SOCIETAL CONSIDERATIONS 9

Identification of customer needs- customer requirements- Quality Function Deployment- Product Design Specifications- Human Factors in Design – Ergonomics and Aesthetics.Societal consideration - Contracts – Product liability – Protecting intellectual property – Legal and ethical domains – Codes of ethics - Ethical conflicts – Environment responsible design-future trends in interaction of engineering with society.

UNIT III DESIGN METHODS 9

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

UNIT IV MATERIAL SELECTION PROCESSING AND DESIGN 9

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

UNIT V PROBABILITY CONCEPTS IN DESIGN FOR RELIABILITY 9

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

TOTAL :45 PERIODS

OUTCOME:

- At the end of this course, the students will be able to appreciate the aspects of need for design, design process, materials and processes used for designing various components .
- Students will be acquainted with the knowledge of designing creative components and legal, human and marketing factors during the design of products.
- Students will be equipped with tools for improving quality, reliability and performance of a product.
- Students will thus be self-assured of the technique to promote innovative and successful designs.

TEXT BOOKS:

1. Dieter, George E., "Engineering Design - A Materials and Processing Approach", McGraw Hill, International Editions, Singapore, 2000.

REFERENCES:

1. Pahl, G, Beitz, W, Feldhusen, J, Grote, K.-H," Engineering Design- A systematic approach", Springer – Verlag, NY. 2007.

2. Ray, M.S., “Elements of Engg. Design”, Prentice Hall Inc. 1985.
3. Suh, N.P., “The principles of Design”, Oxford University Press, NY.1990.
4. Karl T. Ulrich and Steven D. Eppinger “Product Design and Development” McGraw Hill Edition 2008.

ED7153 ENGINEERING FRACTURE MECHANICS L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on mechanics of cracked components of different modes by which these components fail under static load conditions.
- To impart knowledge on mechanics of cracked components of different modes by which these components fail under fatigue load conditions.

UNIT I ELEMENTS OF SOLID MECHANICS 9

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

UNIT II STATIONARY CRACK UNDER STATIC LOADING 9

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

UNIT III ENERGY BALANCE AND CRACK GROWTH 9

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

UNIT IV FATIGUE CRACK GROWTH CURVE 9

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

UNIT V APPLICATIONS OF FRACTURE MECHANICS 9

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

TOTAL: 45 PERIODS

OUTCOME:

- It helps the engineers to get familiarized with the design of components that contain crack under static load condition.
- It helps the engineers to get familiarized with the design of components that contain crack and its growth under fatigue load condition.

REFERENCES:

1. David Broek, ”Elementary Engineering Fracture Mechanics “, Fifthoff and Noerdhoff International Publisher, 1978.
2. Kare Hellan, “Introduction of Fracture Mechanics”, McGraw-Hill Book Company, 1985.
3. Preshant Kumar, “Elements of Fracture Mechanics”, Wheeler Publishing, 1999.
4. John M.Barson and Stanely T.Rolfe Fatigue and fracture control in structures Prentice hall Inc. Englewood cliffs. 1977
5. Tribikram Kundu, “Fundamentals of Fracture Mechanics”, Ane Books Pvt. Ltd. New Delhi/ CRC Press, 1st Indian Reprint, 2012

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,

ED7156 VIBRATION ANALYSIS AND CONTROL L T P C
3 0 2 4

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 15

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 15

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 15

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 15

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 15

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 = 45+30 =75PERIODS

OUTCOME:

- This course will help the students to understand the basics of vibration and its importance in engineering field.
- The students are equipped with the working operations of various vibration measuring instruments, vibration control and analysis techniques.
- The laboratory classes helps the students to reinforce the knowledge learnt in the theory classes.

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.

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, Eigenvalue 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 which 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.

ED7111 MODELLING AND SIMULATION LAB L T P C
0 0 4 2

OBJECTIVE:

- To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modeling software’s
- At the end of this course the students would have developed a thorough understanding of the Computer Aided Finite Element Analysis packages with an ability to effectively use the tools of the analysis for solving practical problems arising in engineering design

- **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
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
Use of kinematics and dynamics simulation software like ADAMS, MATLAB. Analysis of velocity and acceleration for mechanical linkages of different mechanisms.

TOTAL : 60 PERIODS

OUTCOME:

- The laboratory classes will help the students to get familiarized with the computer applications in design and preparing drawings for various mechanical components.
- It helps the students to get familiarized with the Computer Aided Finite Element Analysis packages which are necessary to solve the engineering problems numerically.

ED7201 ENGINEERING MATERIALS AND THEIR APPLICATIONS L T P C
3 0 0 3

OBJECTIVE:

- To know the mechanical behaviour of both metallic and non-metallic materials under different loading and temperature conditions.

UNIT I BASIC CONCEPTS OF MATERIAL BEHAVIOR 12

Elasticity in metals and polymers– Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion

strengthening. Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity – . Griffith's theory,– Ductile, brittle transition in steel – High temperature fracture, creep – Larson Miller parameter – Deformation and fracture mechanism maps.

UNIT II BEHAVIOUR UNDER DYNAMIC LOADS AND DESIGN APPROACHES 10

Stress intensity factor and fracture toughness – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law.- Safe life, Stress-life, strain-life and fail - safe design approaches -Effect of surface and metallurgical parameters on fatigue – Fracture of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

UNIT III SELECTION OF MATERIALS 8

Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Computer aided materials selection.

UNIT IV MODERN METALLIC MATERIALS 8

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

UNIT V NON METALLIC MATERIALS 7

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

TOTAL:45 PERIODS

OUTCOME:

- To familiarize the researchers in the area of material behaviour under different loading and selection of materials for the design of engineering structures.

REFERENCES:

1. George E.Dieter, Mechanical Metallurgy, McGraw Hill, 1988
2. Thomas H. Courtney, Mechanical Behavior of Materials, (2nd edition), McGraw Hill, 2000
3. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials, (34d edition), Butterworth-Heiremann, 1997.
4. Flinn, R.A., and Trojan, P.K., Engineering Materials and their Applications, (4th Edition) Jaico, 1999.
5. Metals Hand book, Vol.10, Failure Analysis and Prevention, (10th Edition), Jaico, 1999.
6. Ashby M.F., Materials Selection in Mechanical Design 2nd Edition, Butter worth 1999.

ED7251 INTEGRATED MECHANICAL DESIGN L T P C
(Use of Approved Data Book Is Permitted) 4 0 0 4

OBJECTIVE:

- To know the integrated design procedure of different machine elements for mechanical applications.

UNIT I FUNDAMENTALS AND DESIGN OF SHAFTS 10

Phases of design – Standardization and interchangeability of machine elements - Process and Function Tolerances – Individual and group tolerances – Selection of fits for different design

situations – Design for assembly and modular constructions – Concepts of integration –BIS, ISO, DIN, BS, ASTM Standards. Oblique stresses – Transformation Matrix – Principal stresses – Maximum shear stress - Theories of Failure – Ductile vs. brittle component design - Analysis and Design of shafts for different applications – integrated design of shaft, bearing and casing – Design for rigidity

UNIT II DESIGN OF GEARS AND GEAR BOXES 15

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

UNIT III BRAKES & CLUTCHES 10

Dynamics and thermal aspects of brakes and clutches – Integrated design of brakes and clutches for machine tools, automobiles and mechanical handling equipments.

UNIT IV INTEGRATED DESIGN 25

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

TOTAL: =60 PERIODS

The Pattern of Question Paper will consist of one Question from Unit – 4 for 50% of total marks.

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

OUTCOME:

- This will familiarize the students with the concepts of integration of design of machines and structures.

REFERENCES:

1. Norton L. R., “Machine Design – An Integrated Approach” Pearson Education, 2005
2. Newcomb, T.P. and Spur, R.T., “Automobile Brakes and Braking Systems”, Chapman and Hall, 2nd Edition, 1975.
3. Maitra G.M., “Hand Book of Gear Design”, Tata McGraw Hill, 1985.
4. Shigley, J.E., “Mechanical Engineering Design”, McGraw Hill, 1986.
5. Prasad. L. V., “Machine Design”, Tata McGraw Hill, New Delhi, 1992.
8. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.
9. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.

APPROVED DATA BOOKS

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

ED7252 MECHANISMS DESIGN AND SIMULATION L T P C
4 0 0 4

OBJECTIVE:

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

UNIT I INTRODUCTION 12

Review of fundamentals of kinematics-classifications of mechanisms-components of mechanisms – mobility analysis – formation of one D.O.F. multi loop kinematic chains, Network formula – Gross

motion concepts-Basic kinematic structures of serial and parallel robot manipulators-Compliant mechanisms-Equivalent mechanisms.

UNIT II KINEMATIC ANALYSIS 12

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

UNIT III PATH CURVATURE THEORY, COUPLER CURVE 12

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

UNIT IV SYNTHESIS OF FOUR BAR MECHANISMS 12

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

UNIT V SYNTHESIS OF COUPLER CURVE BASED MECHANISMS & CAM MECHANISMS 12

Cognate Lingages-parallel motion Linkages. Design of six bar mechanisms-single dwell-double dwell-double stroke. Geared five bar mechanism-multi-dwell. Cam Mechanisms- determination of optimum size of cams. Mechanism defects.

Study and use of Mechanism using Simulation Soft-ware packages. Students should design and fabricate a mechanism model as term project.

TOTAL = 60 PERIODS

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

OUTCOME:

- It helps the students to get familiarized with the advanced mechanisms which are necessary to design and simulate mechanisms.

REFERENCES:

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

ED7211 DESIGN FOR MANUFACTURE ASSEMBLY AND ENVIRONMENT AND PROTOTYPING LAB **L T P C 0 0 4 2**

OBJECTIVE:

- To understand the manufacturability of designed product in the DFMA software through product simplification.
- To explore alternatives in processes and materials, and immediately see the cost impact.
- To understand how the digital model could be transformed into a physical prototype using additive manufacturing technique.

Introduction to Design for Assembly and Manufacturability (DFA/DFM)- The New Product Design (NPD) Process-Design for Assembly –Assembly Method Selection-Design for Assembly - Boothroyd-Dewhurst Method-Cost Estimation Using DFM.
Introduction to product prototyping-prototypes in a product design process-design parameters-manufacturing materials & processes- impacts of design decisions-Using product design software-3D graphic design software- prototyping technologies- Fused deposition modeling.
The students will be given training on the use and application of the following
1. DFMA software
2. Rapid Prototyping Machine.

TOTAL : 60 PERIODS

OUTCOME:

- The laboratory classes will help the students to get familiarized with DFMA package which is necessary for cost estimation and evaluating the product design.
- The laboratory classes will help the students to get familiarized with the additive manufacturing processes which are necessary for making prototypes

ED7212 TECHNICAL SEMINAR **L T P C 0 0 2 1**

OBJECTIVES:

- To work on a specific technical topic in Engineering design related topics in order to acquire the skills of oral presentation.
- To acquire technical writing abilities for seminars and conferences.

SYLLABUS:

The students will work for two hours per week guided by a group of staff members. They will be asked to talk on any topic of their choice related to Engineering design topics and to engage in dialogue with the audience. A brief copy of their talk also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic. They will also answer the queries on the topic. The students as audience also should interact. Evaluation will be based on the technical presentation and the report and also on the interaction during the seminar.

TOTAL: 30 PERIODS

OUTCOME:

Students comprehend concepts and methods adequate to understand inductive and deductive reasoning, and increase their general problem solving skills. Students develop communicative skills (e.g. speaking, listening, reading, and/or writing).

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ED7311 **PROJECT WORK (PHASE I)** **L T P C**
0 0 12 6

OBJECTIVES:

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

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

TOTAL: 180 PERIODS

OUTCOME:

- At the end of the course the students will have a clear idea of their area of work and they will be in a position to carry out the remaining phase II work in a systematic way.

ED7411 **PROJECT WORK (PHASE II)** **L T P C**
0 0 24 12

OBJECTIVES:

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

SYLLABUS:

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

TOTAL: 360 PERIODS

OUTCOME:

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

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.

ED7001 ADVANCED METAL FORMING TECHNIQUES L T P C
3 0 0 3

OBJECTIVES:

- To study the concepts of latest metal forming techniques and their applications in metal forming industry.
- To study the thermo mechanical regimes and its requirements of metal forming

UNIT I INTRODUCTION TO THEORY OF PLASTICITY AND FORMING 9

Theory of plastic deformation – Yield criteria – Tresca and Von-mises – Distortion energy – Stress strain relation – Mohr's circle representation of a state of stress – cylindrical and spherical coordinate system – upper and lower bound solution methods – thermo elastic Elasto plasticity – elasto visco plasticity.

UNIT II THEORY AND PRACTICE OF BULK FORMING PROCESSES 9

Analysis of plastic deformation in Forging, Rolling, Extrusion, rod/wire drawing and tube drawing – Effect of friction – calculation of forces, work done – Process parameters, equipment used – Defects – applications – Recent advances in Forging, Rolling, Extrusion and Drawing processes – Design consideration in forming - Formability of laminated sheet - Overview of FEM applications in Metal Forming analysis.

UNIT III SHEET METAL FORMING 9

Formability studies – Conventional processes – H E R F techniques – Superplastic forming techniques – Hydro forming – Stretch forming – Water hammer forming – Principles and process parameters – Advantage, Limitations and application

UNIT IV POWDER METALLURGY AND SPECIAL FORMING PROCESSES 9

Overview of P/M technique – Advantages – applications – Powder preform forging – powder rolling – Tooling, process parameters and applications. - Orbital forging – Isothermal forging – Hot and cold isostatic pressing – High speed extrusion – Rubber pad forming – Fine blanking – LASER beam forming.

UNIT V ELECTROMAGNETIC FORMING AND ITS APPLICATIONS 9

Electromagnetic Forming Process – Electro – Magnetic Forming Machines – Process Variables – Coils and Dies – Effect of Resistivity and Geometry – EM tube and sheet forming, stamping, shearing and welding – Applications – Finite Element Analysis of EM forming.

TOTAL: 45 PERIODS

OUTCOME:

- The course would familiarize the students on the latest metal forming techniques and help them decide on the suitable method to form the metals for various industrial applications.

REFERENCES:

1. Dieter G.E., Mechanical Metallurgy (Revised Edition II) McGraw Hill Co., 2004
2. Proceedings of International Workshop on EMFT 2010, Anna University
3. Altan T., Metal forming – Fundamentals and applications – American Society of Metals, Metals park, 2003.
4. ASM Hand book, Forming and Forging, Ninth edition, Vol – 14, 2003
5. Shiro Kobayashi, Soo-Ik-Oh-Altan, T,Metal forming and Finite Element Method, Oxford University Press, 2001.
6. Altan.T, Soo-Ik-Oh, Gegel, HL – Metal forming, fundamentals and Applications, American Society of Metals, Metals Park, Ohio, 1983.
7. Marciniak,Z., Duncan J.L., Hu S.J., 'Mechanics of Sheet Metal Forming', Butterworth-Heinemann An Imprint of Elesevier, 2006
8. Proc. Of National Seminar on "Advances in Metal Forming" MIT, March 2000
9. SAE Transactions, Journal of Materials and Manufacturing Section 5, 1993-2007

ED7002 PLATES AND SHELLS L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on the behavior of plates and shell elements, their places of utility and of course the design procedure of such elements in practical applications.

UNIT I GENERAL INTRODUCTION 7

Review of equations of elasticity- kinematics, compatibility equations, stress measures- equations of motions- constitutive relations- transformation of stresses, strains and stiffness-energy principles and variational methods in elasticity- virtual work-external and internal virtual workvariational operator- functionals- Euler Lagrange equations- energy principles- Hamilton's principle- principle of minimum total potential- applications

UNIT II CLASSICAL THEORY OF PLATES 10

Plates as structural elements- stress and moment resultants- assumptions made in the classical theory- displacement fields and strains- equations of equilibrium in Cartesian coordinates and in polar coordinates- boundary conditions – bending of rectangular plates with various boundary conditions and loading- symmetrical and asymmetrical bending of circular plates-limitations of classical theory- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)

UNIT III BUCKLING ANALYSIS OF RECTANGULAR PLATES 10

Buckling of simply supported plates under compressive forces- governing equations- the Navier solution- biaxial compression of a plate- uniaxial compression of a plate- buckling of plates simply supported on two opposite edges- Levy's solution- buckling of plates with various boundary conditions- general formulation- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)

UNIT IV VIBRATION OF PLATES 9

Governing equations for natural flexural vibrations of rectangular plates- natural vibrations of plates simply supported on all edges- vibration of plates with two parallel sides simply supported- Levy's solution- vibration of plates with different boundary conditions- Rayleigh-Ritz method- Natural vibration of plates with general boundary conditions- transient analysis of rectangular plates- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)

UNIT V ANALYSIS OF THIN ELASTIC SHELLS OF REVOLUTION 9

Classification of shell surfaces- geometric properties of shells of revolution- general strain displacement relations for shells of revolution- stress resultants- equations of motion of thin shells analytical solution for thin cylindrical shells- membrane theory- flexure under axisymmetric loadsshells with double curvature- geometric considerations- equations of equilibrium- bending of spherical shells- vibration of cylindrical shells- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)

TOTAL: 45 PERIODS

OUTCOME:

- After undergoing this course, the students would be in a position to understand the behaviour of these commonly occurring structural elements in engineering design and would have developed the capability to design and analyse them in their normal design practice.

REFERENCES:

1. Reddy,J.N., "Theory and Analysis of Elastic Plates & Shells", C.R.C.Press,NY,USA, 2nd Edition 2002
2. Szilard, R., Theory and Analysis of Plates, Prentice Hall Inc., 1995
3. Timoshenko, S. and Krieger S.W. Theory of Plates and Shells, McGraw Hill Book Company, New York 1990.
4. Wilhelm Flügge, Stresses in Shells, Springer – Verlag, 1962

5. Timoshenko, S. Theory of Plates and Shells, McGraw Hill, 1990
6. Ramasamy, G.S., Design and Construction of Concrete Shells Roofs,CBS Publishers, 1986
7. Dr.N.Subramanian, Principles of Space Structures , Wheeler Publishing Co. 1999
8. K. Baskar and T.K. Varadan, “Plates- Theories and Applications”, Ane Books Pvt. Ltd., New Delhi, 2013

ED7071 ADVANCED MECHANICS OF MATERIALS L T P C
3 0 0 3

OBJECTIVE:

- To know the fundamentals of mechanics of materials under various loading conditions.

UNIT I ELASTICITY 9

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

UNIT II SHEAR CENTER AND UNSYMMETRICAL BENDING 10

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

UNIT III STRESSES IN FLAT PLATES AND CURVED MEMBERS 10

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

UNIT IV TORSION OF NON-CIRCULAR SECTIONS 7

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

UNIT V STRESSES IN ROTATING MEMBERS AND CONTACT STRESSES 9

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

TOTAL : 45 PERIODS

OUTCOME:

- It helps the students to be familiarized with the stresses under different loading conditions.

REFERENCES:

1. Arthur P Boresi, Richard J. Schmidt, “Advanced mechanics of materials”,John Wiley, 2002.
2. Timoshenko and Goodier, "Theory of Elasticity", McGraw Hill.1951
3. Robert D. Cook, Warren C. Young, "Advanced Mechanics of Materials", Mc- millan pub. Co., 1985.
4. Srinath. L.S., “Advanced Mechanics of solids”, Tata McGraw Hill, 1992.
5. G H Ryder Strength of Materials Macmillan, India Ltd, 2007.
6. Allan F. Bower, “Applied Mechanics of Solids”, CRC press – Special Indian Edition -2012, 2010
7. K. Baskar and T.K. Varadan, “Theory of Isotropic/Orthotropic Elasticity”, Ane Books Pvt. Ltd., New Delhi, 2009

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

OUTCOME:

- 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

ED7073 COMPOSITE MATERIALS AND MECHANICS L T P C
3 0 0 3

OBJECTIVE

- To understand the fundamentals of composite material strength and its mechanical behavior
- Understanding the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
- Thermo-mechanical behavior and study of residual stresses in Laminates during processing.
- Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.

UNIT I INTRODUCTION TO COMPOSITE MATERIALS 10

Definition-Matrix materials-polymers-metals-ceramics - Reinforcements: Particles, whiskers, inorganic fibers, metal filaments- ceramic fibers- fiber fabrication- natural composite wood, Jute - Advantages and drawbacks of composites over monolithic materials. Mechanical properties and applications of composites, Particulate-Reinforced composite Materials, Dispersion-Strengthened composite, Fiber-reinforced composites Rule of mixtures-Characteristics of fiber-Reinforced composites, Manufacturing fiber and composites,

UNIT II MANUFACTURING OF COMPOSITES 10

Manufacturing of Polymer Matrix Composites (PMCs)-handlay-up, spray technique, filament winding, Pultrusion, Resin Transfer Moulding (RTM)-, bag moulding, injection moulding, Sandwich Mould Composites (SMC) - Manufacturing of Metal Matrix Composites (MMCs) - Solid state, liquid state,vapour state processing, Manufacturing of Ceramic Matrix Composites (CMCs) –hot pressing-reaction bonding process-infiltration technique, direct oxidation- interfaces

UNIT III INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS 12

Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

UNIT IV LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES 8

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies

UNIT V THERMAL ANALYSIS 5

Assumption of Constant Co-efficient of Thermal Expansion (C.T.E.) - Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E's. C.T.E's for special Laminate Configurations – Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates

TOTAL: 45 PERIODS

OUTCOME

- At the end of the course the students will be in position to understand the mechanics and design related to layered components such as fiber reinforced polymer composites, isotropic layered structures (example electronic chips) etc and its manufacturing methodologies

REFERENCES:
1. Gibson, R.F., Principles of Composite Material Mechanics, McGraw-Hill, 1994,
Second Edition - CRC press in progress.
2. Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw-Hill, 1998
3. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials",
Oxford University Press-2006, First Indian Edition - 2007
4. Mallick, P.K., Fiber –"Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc, 1993.
5. Halpin, J.C., "Primer on Composite Materials, Analysis", Techomic Publishing Co., 1984.
6. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990.
7. Mallick, P.K. and Newman, S., (edition), "Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 1990.
8. Madhujit Mukhopadhyay, "Mechanics of Composite Materials and Structures", University Press (India) Pvt. Ltd., Hyderabad, 2004 (Reprinted 2008)
9. Chung, Deborah D.L., "Composite Materials: Science and Applications", Ane Books Pvt. Ltd./Springer, New Delhi, 1st Indian Reprint, 2009

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)

ED7076 DESIGN OF MATERIAL HANDLING EQUIPMENTS L T P C
(Use of Approved Data Book Is Permitted) 3 0 0 3

OBJECTIVES:

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

UNIT I MATERIALS HANDLING EQUIPMENT 5

Types, selection and applications

UNIT II DESIGN OF HOISTS 10

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

UNIT III DRIVES OF HOISTING GEAR 10

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

UNIT IV CONVEYORS 10

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

UNIT V ELEVATORS 10

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

TOTAL: 45 PERIODS

OUTCOME:

- The course would familiarize the student on the technique to select suitable material handling equipment and design them based on the need.

REFERENCES

1. Rudenko, N., Materials handling equipment, ELnvee Publishers, 1970.
2. Spivakovsy, A.O. and Dyachkov, V.K., Conveying Machines, Volumes I and II, MIR Publishers, 1985.
3. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.
4. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.
5. P.S.G. Tech., “Design Data Book”, Kalaikathir Achchagam, Coimbatore, 2003.
6. Lingaiah. K. and Narayana Iyengar, “Machine Design Data Hand Book”, Vol. 1 & 2, Suma Publishers, Bangalore, 1983

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

OBJECTIVE:

- To impart knowledge on modal testing and 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:

- The students will become exposed to modal testing and techniques used for measurement of modal parameters.

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.

ED7079 QUALITY CONCEPTS IN DESIGN L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on various concepts in engineering design and 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 FUNDAMENTALS, METHODS AND MATERIAL SELECTION 9

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

UNIT II DESIGN FOR QUALITY 9

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

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

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

UNIT IV DESIGN OF EXPERIMENTS 9

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

UNIT V STATISTICAL CONSIDERATION AND RELIABILITY 9

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

TOTAL: 45 PERIODS

OUTCOME:

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

REFERENCES:

1. Dieter, George E., "Engineering Design - A Materials and Processing Approach", McGraw Hill, International Editions, Singapore, 2000.
2. Product Design Techniques in Reverse Engineering and New Product Development, Kevin Otto & Kristin Wood, Pearson Education (LPE), 2001.
3. Product Design And Development, Karl t. Ulrich, Steven D. Eppinger,Tata Mcgraw-Hill- 3rd Edition, 2003.
4. Fundamentals of Quality control and improvement 2nd edition, Amitava Mitra, Pearson Education Asia, 2002.
5. Montgomery, D.C., Design and Analysis of experiments, John Wiley and Sons, 2003.
6. Phillip J.Rose, Taguchi techniques for quality engineering, McGraw Hill, 1996.

ED7080 SURFACE ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on surface engineering and surface modification methods that will come in handy to solve the industrial problems. This will also serve as a precursor for future research in the same field.

UNIT I 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 6

Introduction – Abrasive wear, Erosive, Cavitation, Adhesion, Fatigue wear and Fretting Wear-Laws of wear – Theoretical wear models – Wear of metals and non metals - International standards in friction and wear measurements

UNIT III CORROSION 10

Introduction – Principle of corrosion – Classification of corrosion – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Evaluation of corrosion – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors

UNIT IV SURFACE TREATMENTS 12

Introduction – Surface properties, Superficial layer – Changing surface metallurgy – Wear resistant coatings and Surface treatments – Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying, Applications of coatings and surface treatments in wear and friction control – Characteristics of Wear resistant coatings – New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coatings

UNIT V ENGINEERING MATERIALS 10

Introduction – Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Applications – Bio Tribology Nano Tribology.

TOTAL: 45 PERIODS

OUTCOME:

- It helps the students to get familiarized with the various theories and practice on surface engineering and surface modification methods which are necessary to solve the industrial practical problems that arise and also for the research.

REFERENCES

1. G.W.Stachowiak & A.W .Batchelor , “Engineering Tribology”, Butterworth-Heinemann, UK,2005
2. Rabinowicz.E, “Friction and Wear of materials”, John Willey &Sons,UK,1995
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. Fontana G., “Corrosion Engineering”, McGraw Hill, 1985

ED7081 TOOL DESIGN L T P C
3 0 0 3

OBJECTIVES

- To understand the importance, functions and design of cutting tools, Jigs, Fixtures and press tools.
- To gain proficiency in the development of required toolings.

UNIT I INTRODUCTION TO TOOL DESIGN 8

Introduction –Tool Engineering – Tool Classifications– Tool Design Objectives – Tool Design in anufacturing- Challenges and requirements- Standards in tool design-Tool drawings -Surface finish – Fits and Tolerances - Tooling Materials- Ferrous and Non ferrous Tooling Materials-Carbides, Ceramics and Diamond -Non metallic tool materials-Designing with relation to heat treatment

UNIT II DESIGN OF CUTTING TOOLS 9

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

UNIT III DESIGN OF JIGS AND FIXTURES 10

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

UNIT IV DESIGN OF PRESS TOOL DIES 10

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

UNIT V TOOL DESIGN FOR CNC MACHINE TOOLS 8

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

TOTAL: 45 PERIODS

OUTCOME

- On successful completion of this course the students can design cutting tools, Jigs, fixtures and Press tools and give the assembly drawing with dimensions and part list.
- Use the above knowledge to design tools and dies which can later be used to simulate the machining and forming processes to verify the design.

REFERENCES:

1. Cyrll Donaldson, George H.LeCain, V.C. Goold, “Tool Design”, Tata McGraw Hill Publishing Company Ltd., 2000.
2. E.G.Hoffman,” Jig and Fixture Design”, Thomson Asia Pvt Ltd, Singapore, 2004
3. Prakash Hiralal Joshi, “Tooling data”, Wheeler Publishing, 2000
4. Venkataraman K., “Design of Jigs, Fixtures and Presstools”, TMH, 2005
5. Haslehurst M., “Manufacturing Technology”, The ELBS, 1978

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

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

ED7351 DESIGN OF PRESSURE VESSELS AND PIPING L T P C
3 0 0 3

OBJECTIVE

- The main objective is to present the industrial related problems, procedures and design principles for pressure vessels and enhance the understanding of design procedure of pressure vessel and Design of piping layout.

UNIT I INTRODUCTION 3

Methods for determining stresses – Terminology and Ligament Efficiency – Applications.

UNIT II STRESSES IN PRESSURE VESSELS 15

Introduction – Stresses in a circular ring, cylinder – Membrane stress Analysis of Vessel Shell components – Cylindrical shells, spherical Heads, conical heads – Thermal Stresses – Discontinuity stresses in pressure vessels.

UNIT III DESIGN OF VESSELS 15

Design of Tall cylindrical self supporting process columns – Supports for short, vertical and horizontal vessels – stress concentration – at a variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of Reinforcement – pressure vessel Design. Introduction to ASME pressure vessel codes

UNIT IV BUCKLING OF VESSELS 8

Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

UNIT V PIPING 4

Introduction – Flow diagram – piping layout and piping stress Analysis.

TOTAL: 45 PERIODS

OUTCOME

- It helps the student to get familiarized with the various theories and practice on pressure vessel and piping design and procedures which are necessary to solve the industrial practical problems that arise and also for the research in the field of pressure vessel design.

REFERENCES

1. John F. Harvey, Theory and Design of Pressure Vessels, CBS Publishers and Distributors, 1987.
2. Henry H. Bedner, “Pressure Vessels, Design Hand Book, CBS publishers and Distributors,1987.
3. Stanley, M. Wales, “Chemical process equipment, selection and Design. Buterworths series in Chemical Engineering, 1988.
4. William. J., Bees, “Approximate Methods in the Design and Analysis of Pressure Vessels and Piping”, Pre ASME Pressure Vessels and Piping Conference, 1997.

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:

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