SRI VENKATESWARA COLLEGE OF ENGINEERING
(An Autonomous Institution, Affiliated to Anna University, Chennai)
SRIPERUMBUDUR TK.- 602 117
REGULATION – 2016
M.E. COMPUTER AIDED DESIGN
CURRICULUM AND SYLLABUS

SEMESTER I

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	MA16183	Advanced Numerical Methods	3	1	0	4
2	CD16101	Advanced Mechanics of Materials	3	0	0	3
3	CD16102	Computer Applications in Design	3	0	2	4
4	CD16103	Quality Concepts in Design	3	0	0	3
5	CD16104	Vibration Analysis and Control	3	0	2	4
6		Elective I	3	0	0	3
PRACTICALS						
7	CD16111	CAD Laboratory	0	0	2	1
		TOTAL	**18**	**1**	**6**	**22**

SEMESTER II

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	CD16201	Finite Element Methods in Mechanical Design	3	1	0	4
2	CD16202	Mechanisms Design and Simulation	3	0	2	4
3	CD16203	Computer Aided Tools	3	0	0	3
4	CD16204	Integrated Mechanical Design	3	1	0	4
5		Elective II	3	0	0	3
6		Elective III	3	0	0	3
PRACTICALS						
7	CD16211	Analysis and Simulation Laboratory	0	0	2	1
8	CD16212	Design Project	0	0	3	2
		TOTAL	**18**	**2**	**7**	**24**

SEMESTER III

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1		Elective IV	3	0	0	3
2		Elective V	3	0	0	3
3		Elective VI	3	0	0	3
PRACTICALS						
4	CD16311	Project Work (Phase I)	0	0	12	6
		TOTAL	**9**	**0**	**12**	**15**

SEMESTER IV

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICALS						
4	CD16411	Project Work (Phase II)	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

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

M.E. COMPUTER AIDED DESIGN

ELECTIVE I

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	CD16001	Rapid Prototyping and Tooling	3	0	0	3
2	CD16002	Design of Material Handling Equipments	3	0	0	3
3	CD16003	Engineering Fracture Mechanics	3	0	0	3
4	CD16004	Composite Materials and Mechanics	3	0	0	3
5	CD16005	Design of Hydraulic and Pneumatic Systems	3	0	0	3

ELECTIVE II & III

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	CD16006	Applied Engineering Acoustics	3	0	0	3
2	CD16007	Advanced Tool Design	3	0	0	3
3	CD16008	Industrial Robotics and Expert Systems	3	0	0	3
4	CD16009	Design of Pressure Vessel and Piping	3	0	0	3
5	IC16016	Computational Fluid Dynamics	3	0	0	3

ELECTIVE IV, V & VI

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	CD16010	Plasticity and Metal Forming	3	0	0	3
2	CD16011	Experimental Methods in Stress Analysis	3	0	0	3
3	CD16012	Integrated Manufacturing Systems	3	0	0	3
4	CD16013	Tribology in Design	3	0	0	3
5	CD16014	Advanced Finite Element Analysis	3	0	0	3

MA16183 ADVANCED NUMERICAL METHODS

L	T	P	C
3	1	0	4

OBJECTIVES:

- 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 (9+3)

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

UNIT II ORDINARY DIFFERENTIAL EQUATIONS (9+3)

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 elementmethod.

UNIT III FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATION (9+3)

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-Stabilityof above schemes.

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS (9+3)

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 (9+3)

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

TOTAL: 60 PERIODS

OUTCOMES:

- Developes the skill to solve linear system of equations using direct and iterative methods and also acquire the knowledge of solving Eigen Value problems.
- Acquire the skill to solve ordinary differential equations using single step, multistep methods and finite element method.
- Apply numerical technique to solve parabolic and hyperbolic PDE using finite difference methods
- Apply numerical technique to solve elliptic PDE using finite difference technique.
- Acquire the skill to solve PDE using finite element method.

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.

CD16101 ADVANCED MECHANICS OF MATERIALS

L	T	P	C
3	0	0	3

OBJECTIVES:

- 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

OUTCOMES:

- Students will be able to analyse the fundamental concepts of stress and strain and the relationship between both through the strain stress equations in order to solve problems for simple tridimensional elastic solids.
- Students will be able to develop pure and non-uniform bending of beams and other simple structures.
- Students will be able to design bars and other simple tridimensional Structures under torsional deformation.
- Students will be able to analyse and compute the torsion and stresses on various mechanical components.

REFERENCES:

1. Arthur P Boresi, Richard J. Schmidt, “Advanced mechanics of materials”,John Wiley, 2009.
2. Timoshenko and Goodier, "Theory of Elasticity", McGraw Hill, 2010.
3. Robert D. Cook, Warren C. Young, "Advanced Mechanics of Materials", Mc-Millan pub. Co., 1998.
4. Srinath. L.S., “Advanced Mechanics of solids”, Tata McGraw Hill, 2010.
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.
7. K. Baskar and T.K. Varadan, "Theory of Isotropic/Orthotropic Elasticity", Ane Books Pvt. Ltd., New Delhi, 2015.

CD16102 COMPUTER APPLICATIONS IN DESIGN

L	T	P	C
3	0	2	4

OBJECTIVES:

- 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 8

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 10

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.

T=30; TOTAL: 75 PERIODS

Laboratory session: Writing interactive programs generate graphics and to solve design problems - using any languages like Auto LISP/ C / FORTRAN etc. Each assessment should contain a component of Laboratory session.

OUTCOMES:

- Students will understand the 2D and 3D transformations in CAD tools.
- Students will select suitable curves and surfaces for modelling components in engineering applications and apply suitable algorithms for hidden line, hidden surface and hidden solid.
- Students will understand the principles of visualization and apply it to simple models.
- Students will understand data exchange standards in CAD tools,also to implement the assembly modelling approaches for various mechanical components.

REFERENCES:

1. Donald Hearn and M. Pauline Baker "Computer Graphics with open GL", 4th Edition, Prentice Hall, Inc., 2014.
2. Ibrahim Zeid and Sivasubramanian R, CAD/CAM Theory and Practice – Tata McGraw Hill, publication, 2009.
3. Foley, Wan Dam, Feiner and Hughes – Computer graphics principles & practices, Pearson Education – 2003.
4. David F. Rogers, James Alan Adams "Mathematical elements for computer graphics" second edition, Tata McGraw-Hill edition, 1989.
5. Chesava R. Alavalannake "CAD/CAM: Concepts And Applications" PHI Learning Pvt. Ltd., 2008.
6. Jayanta Sarkar "Computer Aided Design: A Conceptual Approach" CRC Press, 2014.
7. Dr. Sadhu Singh "Computer Aided Design" S.K.Kataria and Sons, 2011.

CD16103 **QUALITY CONCEPTS IN DESIGN** **L T P C**

3 0 0 3

OBJECTIVES:

- 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.

AIM

- To gather knowledge on fundamentals of design and its methods, robust design,embodiment principles, various methods in design of experiments, reliability, statistical tools and six sigma techniques.

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-StakeholdersMeasures 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 EFFECT 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 embodimentprinciples-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 andsmall organizations - SIX SIGMA and lean production –Lean SIX SIGMA and services.

UNIT IV DESIGN OF EXPERIMENTS 9

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

UNIT V STATISTICAL CONSIDERATION AND RELIABILITY 9

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

TOTAL: 45 PERIODS

OUTCOMES:

- Students will understand the various concepts in engineering design and principles of implementing quality in a product.
- Students will design the quality product using the tools like Quality function deployment, design of experiments and etc.,
- Students will able to implement the FMEA analysis in design a product and implement the six sigma concepts to ensure defect free products.
- Students will apply the Design of experiments concepts and able to apply in required applications.
- Students will apply the statistical tools in the application of product design and manufacture.

REFERENCES:

1. Dieter, George E., "Engineering Design - A Materials and Processing Approach", McGraw Hill, International Editions, 5th Edition, 2012.
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- 5th Edition, 2011.
4. The Management and control of Quality-8th edition, James R. Evens, William M Lindsay Pub: son south-western (www.swlearning.com), 2011.
5. Fundamentals of Quality control and improvement 4th edition, AMITAVA MITRA, Pearson Education Asia, 2016.
6. Montgomery, D.C., Design and Analysis of experiments, John Wiley and Sons, 8th edition, 2012.
7. Phillip J.Rose, Taguchi techniques for quality engineering, McGraw Hill, 1996.
8. R.Pannerselvam, Design and analysis of experiments, PHI, 2012.
9. K. Krishnaiah & P. Shahabudeen,Applied Design of Experiments and Taguchi Methods, International edition.PHI, 2011.

CD16104 **VIBRATION ANALYSIS AND CONTROL****

L	T	P	C
3	0	2	4

OBJECTIVES:

- 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 10

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 7

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

UNIT III MULTI-DEGREE FREEDOM SYSTEM AND CONTINUOUS SYSTEM 9

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

UNIT IV VIBRATION CONTROL 9

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

UNIT V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS 10

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.

T=30, TOTAL: 75 PERIODS

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

OUTCOMES:

- Students will apply the basics of vibration and damping conceptsin real time engineering applications.
- Students will Solve the in field dynamic problems by applying the control techniques
- Students will utilize the vibration instruments to measure and analyse the vibration.
- Students will determine the response of forced mechanical systems.

REFERENCES:

1. Rao, S.S.," Mechanical Vibrations," 5th Edition, Pearson Education, 2011.
2. Thomson, W.T. Marie Dillon Dahleh – "Theory of Vibration with Applications", Pearson Education, 1997.
3. J.P. Den hartog, , "Mechanical Vibrations", Dover Publications, Inc, 2013.
4. Singh, V.P., "Mechanical Vibrations", Danpatrai Publication, 2016.
5. Ramamurti. V, "Mechanical Vibration Practice with Basic Theory", Narosa, New Delhi, 2012.
6. S. Graham Kelly & Shashidar K. Kudari, "Mechanical Vibrations Mechanical Vibrations: Theory and Applications, Cengage Learning; 1 edition, 2011.
7. G.K.Groover, "Mechanical Vibrations", Nem Chand & Bros, 2009.
8. J.S.Rao., "Introductory Course on Theory and Practice of Mechanical Vibrations", 1999.
9. Elements of Vibrations Analysis: Leonard Meirovitch, McGraw-Hill Education (ISE Editions); International 2 edition, 1986.
10. Sujatha.C, Vibration and Acoustics: Measurement and Signal Analysis, McGraw Hill Education, 2009.

CD16111 **CAD LABORATORY** **L T P C**
0 0 2 1

OBJECTIVES:

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

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

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

TOTAL: 30 PERIODS

OUTCOMES:

- The students will be able to apply the CAD software for drafting and modelling of machine components.
- The students will be able to apply the concept of various tolerances and fits used for component design.
- The students will be able to sketch the assembly, orthographic and sectional views of various machine components.

REFERENCES:

1. Randy Shih, "Parametric Modeling with Creo Parametric 3.0", SDC Publications, 2014.
2. Michael Rider, "Designing with Creo Parametric 3.0", SDC Publications, 2015.
3. Sadhu Singh, P. L. Sah, "Fundamentals of Machine Drawing", PHI learning Pvt. Ltd., 2012.
4. Ibrahim Zeid and Sivasubramanian R, CAD/CAM Theory and Practice – Tata McGraw Hill, publication, 2009.

CD16201 FINITE ELEMENT METHODS IN MECHANICAL DESIGN

L	T	P	C
3	1	0	4

OBJECTIVES:

- 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 11+3

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 10+3

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 8+3

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 8+3

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

UNIT V SPECIAL TOPICS 8+3

Dynamic Analysis – Equation of Motion – Mass & damping matrices – Free Vibration analysis – Natural frequencies of Longitudinal, Transverse and torsional vibration – Introduction to transient field problems. Non-linear analysis. Use of softwares – h & p elements – special element formulation – Solution techniques – Explicit & Implicit methods.

T=15; TOTAL: 75 PERIODS

NOTE:

At the post-graduate level of instruction the contact hours are to be supplemented by self study by students. As for the examination, modelling considerations, choice of elements, boundary conditions, loading conditions, and basic procedures only need to be emphasized without expecting a complete numerical solution to practical problems.

OUTCOMES:

- The students will apply the principles involved in the finite element approach on mechanical systems related to One-dimensional elements.
- The students will apply the concept of 2D plane elasticity and analyze the stresses in structural members.
- The students will differentiate the shape functions and stiffness matrix for Isoparametric elements.
- The Students will apply the concepts of Free mesh and Mapped mesh and different solver methods based on Engineering applications.
- Students will solve Non-Linear, Vibrational problems based on time dependent variables

REFERENCES:

1. Zienkiewicz.O.C, Taylor.R.L,& Zhu,J.Z "The Finite Element Method: Its Basis & Fundamentals", Butterworth-Heinemann, 2013.
2. 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.
3. Reddy, J.N., "Introduction to Non-Linear Finite Element Analysis", Oxford UniiversityPress, 2015.
4. Rao,S.S., "The Finite Element Method in Engineering", Butterworth-Heinemann(An imprint of Elsevier), reprinted 2006,2007, Published by Elsevier Pvt. Ltd.,
5. 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.,
6. Thomas J. R. Hughes, The Finite Element Method: Linear Static and Dynamic Finite Element Analysis, Dover Publications, 2000.
7. Ramamurthi, V., "Finite Element Method in Machine Design", Narosa PublishingHouse, January, 2009.

CD16202	MECHANISMS DESIGN AND SIMULATION**	L	T	P	C
		3	0	2	4

OBJECTIVES:

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

UNIT I INTRODUCTION 9

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 9

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 RSSRmechanism-Denavit-Hartenberg Parameters – Forward and inverse kinematics of robot manipulators.

UNIT III PATH CURVATURE THEORY, COUPLER CURVE 9

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 9

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 9

Cognate Lingages-parallel motion Linkages. Design of six bar mechanisms-single dwell-doubledwell-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.

T=30;TOTAL: 75 PERIODS

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

OUTCOMES:

- Students will be able to Develop analytical equations describing the relative position, velocity and acceleration.
- Students will be able to Select, configure, and synthesize mechanical components into complete systems.
- Students will be able to Use kinematic geometry to formulate and solve constraint equations to design linkages for specified tasks.
- Students will be able to Formulate and solve four position synthesis problems for planar and spherical four-bar linkages by graphical and analytical methods.

REFERENCES:

1. Arthur G. Erdman, George N. Sandor, Sridhar Kota, Mechanism Design: Analysis and Synthesis: 1, Prentice Hall; 4th edition, 2001.
2. Arthur G. Erdman, George N. Sandor, Mechanism Design: Analysis and Synthesis: 2, Prentice Hall; 1984.
3. Robert L.Norton., “Design of Machinery”, McGraw Hill, 5th edition, 2011.
4. Uicker, J.J., Pennock, G. R. and Shigley, J.E., “Theory of Machines and Mechanisms”, Oxford University Press, 2016.
5. Amitabha Ghosh and Asok Kumar Mallik, “Theory of Mechanism and Machines”, T&F India, 2016.
6. Kenneth J, Waldron, Gary L. Kinzel, “Kinematics, Dynamics and Design of Machinery”, John Wiley-sons, 2003.
7. Ramamurti, V., “Mechanics of Machines”, 3rd Edition, Narosa, 2009.
8. J. S. Rao, R. V. Dukkipati, Mechanism And Machine Theory, New Age Publishers, 2008.
9. Amitabha Ghosh and Asok Kumar Mallik, Kinematic Analysis and Synthesis of Mechanisms, CRC Press, 1994.

CD16203 COMPUTER AIDED TOOLS

L	T	P	C
3	0	0	3

OBJECTIVES:

- The purpose of this course is to make the students to get familiarized with various computer aided tools that can be implemented in various industrial applications

UNIT I COMPUTER AIDED MANUFACTURING 9

Manufacturing Processes – Removing, Forming, Deforming and joining – Integration Requirements. Integrating CAD, NC and CAM – Machine tools – Point to point and continuous path machining, NC, CNC and DNC – NC Programming – Basics, Languages, G Code, M Code, APT – Tool path generation and verification – CAD/CAM NC Programming – Production Control – Cellular Manufacturing.

UNIT II COMPUTER AIDED PROCESS PLANNING 9

Role of process planning in CAD/CAM Integration – Computer Aided Process Planning – Development, Benefits, Model and Architecture – CAPP Approaches – Variant, Generative and Hybrid – Process and Planning systems – CAM-I, D-CLASS and CMPP – Criteria in selecting a CAPP System.

UNIT III COMPUTER AIDED INSPECTION 9

Engineering Tolerances – Need for Tolerances – Conventional Tolerances – FITS and LIMITS – Tolerance Accumulation and Surface quality – Geometric Tolerances – Tolerances Practices in design, Drafting and manufacturing – Tolerance Analysis – Tolerance synthesis – Computer Aided Quality control – Contact Inspection Methods – Non Contact Inspection Methods - Non optical.

UNIT IV REVERSE ENGINEERING 9

Scope and tasks of Reverse Engineering – Domain Analysis – Process Duplicating – Tools for RE – Developing Technical data – Digitizing techniques – Construction of surface model – Solid part model – Characteristic evaluation – Software's and its application – CMM and its feature capturing – surface and solid modeling.

UNIT V DATA MANAGEMENT 9

Strategies for Reverse Engineering Data management – Software application – Finding renewable software components – Recycling real time embedded software – Design experiments to evaluate a RE tools – Rule based detection for RE user interface – RE of assembly programs.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will be able to get familiarized with computer aided tools for various industrial applications in manufacturing.
- Students will be able to get familiarized with computer aided tools for various industrial applications in process planning.
- Students will be able to get familiarized with computer aided tools for various industrial applications in inspection.
- Students will be able to get familiarized with computer aided tools for various industrial applications in data management and reverse engineering.
- Students will be able to get familiarized with computer aided tools for various industrial applications in reverse engineering.

REFERENCES:

1. Ibrahim Zeid and R. Sivasubramanian, "CAD/CAM Theory and Practice", Revised First special Indian Edition, Tata Mc Graw Hill Publication, 2009.
2. Catherine A. Ingle, "Reverse Engineering", Tata Mc Graw Hill Publication, 1994.
3. Ibrahim Zeid, "Mastering CAD/CAM", special Indian Edition, Tata Mc Graw Hill Publication, 2007.
4. David D. Bedworth, Mark R. Henderson, Philp M. Wolfe, "Computer Integrated Design and manufacturing", Mc Graw Hill International series, 1991.
5. Linda Wills, "Reverse Engineering" Kluwer Academic Press, 2013.

CD16204	INTEGRATED MECHANICAL DESIGN** (Use of Approved Data Book is Permitted)	L	T	P	C
		3	1	0	4

OBJECTIVES:

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

UNIT I FUNDAMENTALS AND DESIGN OF SHAFTS 8

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 12

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 7

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 18

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)**

OUTCOMES:

- Students will be able to design mechanical components by selecting a suitable material and failure criteria.
- Students will be able to analyze and predict the fracture strength of mechanical components under different fracture modes.
- Students will be able to design mechanical components involving contacts avoiding the surface failures.
- Students will be able to apply the design procedures on different types of integrated mechanical systems.

REFERENCES:

1. Norton L. R., “Machine Design – An Integrated Approach” 5th Edition Pearson Education, 2013.
2. Maitra G.M., “Hand Book of Gear Design”, Tata McGraw Hill publication, 2001.
3. Shigley, J.E., “Mechanical Engineering Design”, McGraw Hill publication, 2015.

4. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.
5. Raymond A. Kulweic, Materials Handling Handbook, Wiley India Pvt. Ltd., 2009.

Approved Data Books:

1. P.S.G. Tech., “Design Data Book”, Kalaikathir Achchagam, Coimbatore, 2015.
2. Lingaiah. K., “Machine Design Data Hand Book”, Vol. 1 & 2, 2nd Edition, Mcgraw Hill, 2010.

CD16211 ANALYSIS AND SIMULATION LABORATORY

L	T	P	C
0	0	2	1

OBJECTIVES:

- 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.

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 system.
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: 30 PERIODS

OUTCOMES:

- Students will be able to Model complex Engineering problem and solving through the relationship between theoretical, mathematical, and computational modelling for predicting and optimizing performance and objective.
- Students will be able to Develop solutions and extract results from the information generated in the context of the engineering domain to assist engineering decision making.
- Students will be able to Interpret the model and apply the results to resolve critical issues in a real-world environment.

REFERENCES:

1. Finite Element Analysis- Theory and Applications with ANSYS-Third Edition-Pearson Publications-Saeed Moaveni, 2011.
2. Klee, Harold “Simulation of Dynamic Systems with Matlab and Simulink” CRC Press Inc, Taylor &Francis Group: Boca Raton London New York, 2007.
3. Michael R. Hatch “Vibration Simulation Using MATLAB and ANSYS” Chapman and Hall/CRC, 2000.
4. http://www.mece.ualberta.ca/tutorials/ansys

CD16212 **DESIGN PROJECT**

L	T	P	C
0	0	3	2

OBJECTIVES:

- The main objective is to give an opportunity to the student to achieve integrated mechanical design of a product through parts design assembly preparation of manufacturing drawings.

GUIDELINE FOR REVIEW AND EVALUATION:

Each student works under a project supervisor. The product system /component(s) to be designed may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the student which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will apply design standards, design calculations and analysis in designing of mechanical component or a system.
- Students will Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design, and justify their design.
- Students will able to present the findings of their technical solution in a written report and making an oral presentation before an evaluation committee.

CD16001 RAPID PROTOTYPING AND TOOLING

	L	T	P	C
	3	0	0	3

OBJECTIVES:

- At the end of this course the students would have developed a thorough understanding of the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Rapid Prototyping Technologies.

UNIT I INTRODUCTION 7

Need - Development of RP systems – RP process chain - Impact of Rapid Prototyping and Tooling on Product Development – Benefits- Applications – Digital prototyping - Virtual prototyping.

UNIT II LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS 10

Stereolithography Apparatus, Fused deposition Modeling, Laminated object manufacturing, Three dimensional printing: Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT III POWDER BASED RAPID PROTOTYPING SYSTEMS 10

Selective Laser Sintering, Direct Metal Laser Sintering, Three Dimensional Printing, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations – Case Studies.

UNIT IV 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 and contour data organization, direct and adaptive slicing, Tool path generation.

UNIT V RAPID TOOLING 8

Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect – Fabrication processes, Applications. Case studies - automotive, aerospace and electronic industries.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will be able to Apply the reverse engineering concepts for design and product development.
- Students will apply appropriate additive manufacturing methodology to develop products.
- Students will analyse the cases relevant to mass customization and some of the important research challenges associated with AM and its data processing tools

REFERENCES:

1. Rapid prototyping: Principles and applications, second edition, Chua C.K., Leong K.F., and Lim C.S., World Scientific Publishers, 2003.
2. Rapid Tooling: Technologies and Industrial Applications, Peter D.Hilton, Hilton/Jacobs, Paul F.Jacobs, CRC press, 2000.
3. Rapid prototyping, Andreas Gebhardt, Hanser Gardener Publications, 2003.
4. Rapid Prototyping and Engineering applications: A tool box for prototype development, Liou W.Liou, Frank W.Liou, CRC Press, 2007.

5. Rapid Prototyping: Theory and practice, Ali K. Kamrani, Emad Abouel Nasr, Springer, 2006.

CD16002 DESIGN OF MATERIAL HANDLING EQUIPMENTS
(Use of Approved Data Book is Permitted)

L	T	P	C
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

OUTCOMES:

- Students will be able to determine the effect of product, process, and schedule design parameters on plant layout and materials handling systems design.
- Students will be able to Identify the characteristics of product and process layouts and their needs in terms of materials handling.
- Students will be able to Develop and analyze plant layouts using manual and computer aided software methodologies.
- Students will be able to Identify and select various types of material handling equipment.
- Students will be able to Design material handling systems for a variety of scenarios pertaining to manufacturing and service industry.

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, 2015.
6. Lingaiah. K. and Narayana Iyengar, “Machine Design Data Hand Book”, Vol.1 & 2, Suma Publishers, Bangalore, 2010.
7. Manufacturing Facilities Designm and Material Handling(Fifth Edition)" by Fred E.Meyer

and Matthew P Stephens, 2013.
8. Materials Handling Handbook- Vol 1 & 2" by Kulweic, Aug 2009.
9. Aspects of Material Handling K.C.Arora, Vikas V.Shinde, First Edition, 2015.

CD16003 ENGINEERING FRACTURE MECHANICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- 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

OUTCOMES:

- Students will remember and Use any one of the four parameters for finding out damage tolerance: stress intensity factor, energy release rate, J integral, Crack tip opening displacement.
- Students will manage singularity at crack tip using complex variable
- Students will analyze the Energy balance and crack growth.
- Students will be able to identify the fatigue life of a component with or without crack in it.
- Students will apply the Fracture concepts in different application through experimental techniques.

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 StanelyT.Rolfe Fatigueand fracture control in structures Prentice hall Inc. Englewood cliffs, 1977.
5. Deformation and Fracture Mechanics of Engineering Materials, Richard W. Hertzberg, Richard P. Vinci, Jason L. Hertzberg, Wiley, 2012.
6. Fracture Mechanics Fundamentals and Applications,Ted L..Anderson, CRC Press, 2005.

7. Tribikram Kundu, “Fundamentals of Fracture Mechanics”, Ane Books Pvt. Ltd. New Delhi/ CRC Press, 1st Indian Reprint, 2012.

CD16004 COMPOSITE MATERIALS AND MECHANICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- 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

OUTCOMES:

- Students will identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.
- Students will have the ability to predict the elastic properties of both long and short fiber composites based on the constituent properties.
- Students will correlate stress, strain and stiffness tensors using ideas from matrix algebra.
- Students will analyze a laminated plate in bending, including finding laminate properties from lamina properties.
- Students will be able to predict the failure strength of a laminated composite plate.

REFERENCES:

1. Gibson, R.F., Principles of Composite Material Mechanics, Thired Edition - RC Press, 2011.
2. Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw-Hill, 2008.
3. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press, 2013.
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., 1992.
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.
10. Robert M. Jones,Mechanics of Composite Materials (Materials Science & Engineering Series)Second edition , Taylor & Francis, 2015.

CD16005 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

- 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 5

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

UNIT II CONTROL AND REGULATION ELEMENTS 12

Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems.

UNIT III HYDRAULIC CIRCUITS 5

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

UNIT IV PNEUMATIC SYSTEMS AND CIRCUITS 16

Pneumatic fundamentals - control elements, position and pressure sensing - 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.

UNIT V INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS 7

Pneumatic equipments- selection of components - design calculations – application -fault finding - hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will understand about oil hydraulic systems and Actuators.
- Students will learn and able to implement flow control and regulation elements in the required applications.
- Students will remember about Hydraulic circuits and can able to apply in the various applications.
- Students will apply the Pneumatic systems, circuits concepts into the various applications.
- Students will able to install and maintain the Hydraulic and Pneumatic systems

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).

CD16006 **APPLIED ENGINEERING ACOUSTICS** **L T P C**
3 0 0 3

OBJECTIVES:

- To impart knowledge on the fundamentals of acoustics, its characteristics, its transmission in different media, usage of sound measuring instruments and the various sound control methods.

UNIT I BASIC CONCEPTS OF ACOUSTICS 9

Scope of Acoustics – Sound pressure – Sound intensity – Sound power level Sound power – Wave motion – Alteration of wave paths –Measurement of sound waves – sound spectra – Sound fields – Interference – Standing waves – Acoustic energy density and intensity – Specific acoustic impedance.

UNIT II CHARACTERISTICS OF SOUND 10

One dimensional wave equation – Solution of 1D wave equation – Velocity in gaseous medium – Velocity of plane progressive sound wave through a thin solid rod – Velocity of plane wave in a bulk of solid – Transverse wave propagation along a string stretched under tension – Wave equation in two dimension.

UNIT III TRANSMISSION PHENOMENA 6

Changes in media – Transmission from one fluid medium to another, normal incidence, oblique incidence - Reflection at the surface of a solid, normal incidence, oblique incidence – Standing wave pattern – Transmission through three media.

UNIT IV INTRODUCTION TO THE ASSESSMENT AND MEASUREMENT OF SOUND 10

Introduction – Decibel scale for the measurement of sound power – Sound level meter – Weighted sound pressure level – Equal Loudness contours – Perceived noisiness – Loudness, Loudness level, perceived noise, perceived noise level – Equivalent sound level – Identified level – Frequency and Amplitude measurement.

UNIT V BASICS OF NOISE CONTROL 10

Noise Control at source, path, receiver – Noise control by acoustical treatment – Machinery noise – Types of machinery involved – Determination of sound power and sound power level – Noise reduction procedures – Acoustic enclosures.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will understand and remember the concepts of Acoustics.
- Students will able to analyze the characterization of sound.
- Students will analyze the sound transmission medium and pattern.
- Students will able to assess and measure the sound using various methods.
- Students will apply the noise control methods to various applications

REFERENCES:

1. Lawrence E. Kinsler, Austin R. Frey, “Fundamentals of Acoustics “– John Wiley and Sons Inc., 1999.
2. Bies, David, A. and Hansen, Colin H., “Engineering Noise Control – Theory and Practice”, E and FN Spon, Chapman-Hall, Second Edition, 2003.
3. Hansen C.H. and Snyder, S.D., “Active Control of Sound and Vibration”, E and FN Spon, London 2013.
4. Gerhard Muller, Michael Mose, “Handbook of Engineering Acoustics”, Springer, 2013.
5. Robert D. Finch , Introduction to Acoustics, Pearson Education; First edition,2016.
6. F. Alton Everest , Ken C Pohlmann , Master Handbook of Acoustics, Sixth Edition , McGraw-Hill Education TAB; 2015.

CD16007 **ADVANCED TOOL DESIGN**

L	T	P	C
3	0	0	3

OBJECTIVES:

- The purpose of this course is to make the students to get familiarized with the design of various tools that can be implemented for different mechanical operations.

UNIT I INTRODUCTION TO TOOL DESIGN 8

Introduction –Tool Engineering – Tool Classifications– Tool Design Objectives – Tool Design in manufacturing- 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 - Designof 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

OUTCOMES:

- Students will understand the tool engineering, materials and heat treatments used in making of tools.
- Students will have the ability design single and multiple point cutting tools for manufacturing various components.
- Students will be able to recommend design of fixtures for various machine tools.
- Students will be able to design tools involving forming processes.
- Students will be able to design fixtures for CNC machines for performing various operations

REFERENCES:

1. Cyrll Donaldson, George H.LeCain, V.C. Goold, “Tool Design”, Tata McGraw Hill Publishing Company Ltd., 4th edition, 2012.
2. E.G.Hoffman,” Jig and Fixture Design”, Thomson Asia Pvt Ltd, Singapore, 2008.
3. Prakash Hiralal Joshi, Jigs and fixture, McGraw Hill Education, 2010.
4. Venkataraman K., “Design of Jigs, Fixtures and Press tools”, Wiley-Blackwell; 2nd Edition, 2015.
5. Eric Henriksen , Jig & Fixture Design Manual Industrial Press Inc.,U.S,2012.
6. John Nee, Fundamentals of Tool Design, Society of Manufacturing Engineers; 6th Revised edition, 2010.

CD16008	INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT I INTRODUCTION AND ROBOT KINEMATICS 10

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors.

Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT II ROBOT DRIVES AND CONTROL 9

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

UNIT III ROBOT SENSORS 9

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.

UNIT IV ROBOT CELL DESIGN AND APPLICATION 9

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

UNIT V ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS 8

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

TOTAL: 45 PERIODS

OUTCOMES:

- Students will be able to define the basic terminologies and concepts associated with Robotics and Automation.
- Students will be able to describe the various Robotic sub-systems.
- Students will be able to explain the kinematics, dynamics and exact working pattern of robots.
- Students will be able to discuss the associated recent updates in Robotics.

REFERENCES:

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

CD16009 DESIGN OF PRESSURE VESSEL AND PIPING

L	T	P	C
3	0	0	3

OBJECTIVES:

- 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

OUTCOMES:

- Students will identify the methods of stress analysis in pressure vessels
- Students will analyze the stresses of the vessels in different heads.
- Students will able to design shells, end closures and nozzles of pressure vessels using ASME codes.
- Students will analyze buckling effect in vessels and piping.
- Students will understand the piping layout concepts and able to design the piping layout for different applications

REFERENCES:

1. John F. Harvey, Theory and Design of Pressure Vessels, CBS Publishers and Distributors, 2001.
2. Henry H. Bedner, "Pressure Vessels, Design Hand Book, CBS publishers and Distributors, 1991.
3. Stanley, M. Wales, "Chemical process equipment, selection and Design. Buterworths series in Chemical Engineering, 1988.
4. Eugene Megyesy, Pressure Vessel Handbook, 14th Edition,P V Publishing inc, 2008.
5. J. Phillip Ellenberger Pressure Vessels: ASME Code Simplified 8th Edition, McGraw-Hill Education, 2004.
6. Dennis R.Moss,"Pressure Vessel Design Manual" 4th Edition, Butterworth-Heinemann, 2013.

IC16016 COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	0	0	3

AIM:

This course aims to introduce numerical modeling and its role in the field of heat and fluid flow, it will enable the students to understand the various discrimination methods and solving methodologies and to create confidence to solve complex problems in the field of heat transfer and fluid dynamics.

OBJECTIVES:

- To develop finite difference and finite volume discredited forms of the CFD equations.
- To formulate explicit & implicit algorithms for solving the Euler Eqns & Navier Stokes Eqns.

UNIT I GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD 10

Classification, Initial and Boundary conditions, Initial and Boundary value problems. Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT II CONDUCTION HEAT TRANSFER 10

Steady one-dimensional conduction, Two and Three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

UNIT III INCOMPRESSIBLE FLUID FLOW 10

Governing Equations, Stream Function – Verticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and spalding, Computation of Boundary layer flow, Finite difference approach.

UNIT IV CONVECTION HEAT TRANSFER AND FEM 10

Steady One-Dimensional and Two-Dimensional Convection – Diffusion, Unsteady onedimensional convection – Diffusion, Unsteady two-dimensional convection – Diffusion – Introduction to finite element method – Solution of steady heat conduction by FEM – Incompressible flow – Simulation by FEM.

UNIT V TURBULENCE MODELS 5

Algebraic Models – One equation model, K - Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

TOTAL: 45 PERIODS

OUTCOMES:

- The student will appraise the knowledge of CFD techniques, basic aspects of discretization and grid generation.
- The students will deduce the suitable governing equations to formulate numerical solutions for conduction problems using finite volume method.
- The students will establish the mathematical representation of the governing equations for incompressible flow models.
- The students will prioritize different schemes used for convection problems using finite volume methods.
- The students will deduce the turbulence models and the prediction of systems.

REFERENCES:

1. Muralidhar, K., and Sundararajan, T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 1995.
2. Ghoshdasdidar, P.S., “Computer Simulation of flow and heat transfer” Tata McGraw Hill Publishing Company Ltd., 1998.
3. Subas, V.Patankar “Numerical heat transfer fluid flow”, Hemisphere Publishing Corporation, 1980.
4. Taylor, C and Hughes, J.B. “Finite Element Programming of the Navier Stock Equation”, Pineridge Press Limited, U.K., 1981.
5. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., “Computational fluid Mechanic and Heat Transfer “ Hemisphere Publishing Corporation, Newyork, USA, 1984.
6. Fletcher, C.A.J. “Computational Techniques for Fluid Dynamics 1” Fundamental and General Techniques, Springer – Verlag, 1987.
7. Fletcher, C.A.J. “Computational Techniques for Fluid Dynamics 2” Specific Techniques for Different Flow Categories, Springer – Verlag, 1987.
8. Bose, T.X., “Numerical Fluid Dynamics” Narosa Publishing House, 1997.

CD16010 **PLASTICITY AND METAL FORMING** **L T P C**

3 0 0 3

OBJECTIVES:

- To impart knowledge on theory of plasticity, analysis of various metal forming processes that arise in engineering applications.

UNIT I THEORY OF PLASTICITY 9

Theory of plastic deformation - Engineering stress and strain relationship Stress tensor - Strain tensor - - Plastic stress strain relationship Plastic work - Equilibrium conditions - Incremental plastic strain.

UNIT II CONSTITUTIVE RELATIONSHIPS AND INSTABILITY 7

Uniaxial tension test - Mechanical properties - Work hardening, Compression test, bulge test, plane strain compression stress, plastic instability in uniaxial tension stress, plastic instability in biaxial tension stress.

UNIT III ANALYSIS OF METAL FORMING PROBLEMS 12

Slab analysis - Slip line method, upper bound solutions, statistically admissible stress field, numerical methods, contact problems, effect of friction, thermo elastic Elasto plasticity, elasto visco plasticity - Thermo mechanical coupling Analysis of forging, rolling, extrusion and wire drawing processes - Experimental techniques of the evaluation of metal forming.

UNIT IV ANALYSIS OF SHEET METAL FORMING 8

Bending theory - Cold rolling theory - Hill's anisotropic theory, Hill's general yield theory - Sheet metal forming - Elements used - Mesh generation and formulation Equilibrium equations - Consistent full set algorithm - Numerical solutions procedures - examples of simulation of simple parts - Bench mark tests Forming limit diagrams.

UNIT V ADVANCES IN METAL FORMING 9

Orbital forging, Isothermal forging, Warm forging, Hot and Cold isotropic pressing, high speed extrusion, rubber pad forming, micro blanking Superplastic forming - Overview of Powder Metal techniques - Powder rolling - Tooling and process parameters – Overview of Severe plastic deformation techniques such as ECAP, Twist Extrusion, High Pressure Torsion, Accumulated Roll Bonding.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will understand plasticity and be able to relate the stress and strain.
- Students will be to perform various tests to determine the tension stress developed.
- Students will have the ability to analyze stresses involved in various thermo-mechanical manufacturing processes.
- Students will be able to predict the stresses devleoped during sheet metal forming by applying various theories.
- Students will get exposed variuos advancements in metal forming techniques

REFERENCES:

1. Wagoner. R H., and Chenot. J.J., Metal Forming analysis, Cambridge University Press, 2002.
2. Slater. R A. C., Engineering Plasticity - Theory & Applications to Metal Forming, John Wiely and Sons, 1987.
3. George Dieter, Mechanical Metallurgy, 3rd Edition, McGraw Hill Publications, 2013.
4. Shiro Kobayashi, Altan. T, Metal Forming and Finite Element Method, Oxford University Press, 1989.

5. Narayanaswamy. R, Theory of Metal Forming Plasticity, Narosa Publishers, 1999.
6. Hosford. W. F and Caddell. RM., Metal Forming Mechanics and Metallurgy, Prentice Hall Eaglewood Cliffs, 2011.
7. Surender Kumar, "Technology of Metal Forming Processes", Prentice Hall of India, New Delhi, 2008.

CD16011 EXPERIMENTAL METHODS IN STRESS ANALYSIS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart the principles of measurement, its need, within the field of production, vibration, acoustics, fluid mechanics, fracture mechanics & NDT.

UNIT I FORCES AND STRAIN MEASUREMENT 9

Strain gauge, principle, types, performance and uses. Photo elasticity – Principle and applications - Moire Fringe - Hydraulic jacks and pressure gauges – Electronic load cells – Proving Rings – Calibration of Testing Machines.

UNIT II VIBRATION MEASUREMENTS 9

Characteristics of Structural Vibrations – Linear Variable Differential Transformer (LVDT) – Transducers for velocity and acceleration measurements. Vibration meter – Seismographs – Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter – Chart Plotters – Digital data Acquisition systems.

UNIT III ACOUSTICS AND WIND FLOW MEASURES 9

Principles of Pressure and flow measurements – pressure transducers – sound level meter – venturimeter and flow meters – wind tunnel and its use in structural analysis – structural modeling – direct and indirect model analysis.

UNIT IV DISTRESS MEASUREMENTS 9

Diagnosis of distress in structures – crack observation and measurements – corrosion of reinforcement in concrete – Half-cell, construction and use – damage assessment – controlled blasting for demolition.

UNIT V NON DESTRUCTIVE TESTING METHODS 9

Load testing on structures, buildings, bridges and towers – Rebound Hammer – acoustic emission – ultrasonic testing principles and application – Holography – use of laser for structural testing – Brittle coating.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will Understand and design strain gage-based transducers for measuring specific loads.
- Students will apply the methods to measure the Vibrations ·
- Students will analyze the acoustics and wind flow by appropriate measuring methods.
- Students will implement distress measurement methods in required applications.
- Students will apply the non-destructive testing methods and concepts in different applications.

REFERENCES:

1. Sadhu Singh Experimental Stress Analysis, Khanna Publishers, New Delhi, 2009.
2. JW Dalley and WF Riley, Experimental Stress Analysis, McGraw Hill Book Company, N.Y. 1991.
3. L.S. Srinath et al, Experimental Stress Analysis, Tata McGraw Hill Company, New Delhi, 2004.
4. R.S.Sirohi, HC Radhakrishna, Mechanical Measurements, New Age International (P) Ltd., 1997.
5. F.K Garas, J.L. Clarke and GST Armer, Structural assessment, Butterworths, London, 1987.
6. D.E. Bray & R. K.Stanley, Non-destructive Evaluation, McGraw Hill Publishing Company, N.Y.1989.

CD16012 INTEGRATED MANUFACTURING SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

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

UNIT I INTRODUCTION 5

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

UNIT II GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING 5

Introduction-part families-parts classification and cooling - group technology machine cells- benefits of group technology. Process planning function CAPP - Computer generated time standards.

UNIT III COMPUTER AIDED PLANNING AND CONTROL 10

Production planning and control-cost planning and control-inventory management-Material requirements planning (MRP)-shop floor control-Factory data collection system-Automatic identification system-barcode technology- automated data collection system.

UNIT IV COMPUTER MONITORING 10

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

UNIT V INTEGRATED MANUFACTURING SYSTEM 15

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

TOTAL: 45 PERIODS

OUTCOMES:

- Students will be able to discuss the computer aided processes planning.
- Students will be able to explain the group technology systems.
- Students will be able to describe the production process planning control.
- Students will be able to define and recognize computer integrated manfacturing systems

REFERENCES:

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

CD16013 **TRIBOLOGY IN DESIGN**

L	T	P	C
3	0	0	3

OBJECTIVES:

- 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 Wear Maps - 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 10

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 Journalbearings-Squeeze film effects-Thermal considerations-Hydrostatic lubrication of Pad bearing- Pressure , flow , load and friction calculations-Stiffness considerations- Various types of flowrestrictors in hydrostatic bearings.

UNIT V HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION 12

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- Bearing performance measurement - Bearing Vibration Measurement.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will be able to select material / surface properties based on the tribological requirements.
- Students will acquire the Methodology for deciding lubricants and lubrication regimes for different operating conditions.
- Students will analysis for the different types of bearings for given load/speed conditions

REFERENCES:

1. Rabinowicz.E, “Friction and Wear of materials”, John Willey &Sons ,UK, 2008.
2. Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981.
3. Halling, J. (Editor) – “Principles of Tribology “, Macmillian ,1991.
4. Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 2005.
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.
7. T.A.Stolarsk, Tribology in Machine Design, Butterworth- Heinemann, UK, 2013.
8. Giovanni Straffelini, Friction and Wear: Methodologies for Design and Control, Springer 2015.
9. Michael M.Khonsari, Applied Tribology: Bearing Design and Lubrication, Wiley-Blackwell; 2nd Revised edition, 2008.
10. Avraham Harnoy, Bearing Deign in Machinery: Engineering Tribology and Lubrication, Dekker 2007.

CD16014	ADVANCED FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT I BENDING OF PLATES AND SHELLS 9

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

UNIT II NON-LINEAR PROBLEMS 10

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

UNIT III DYNAMIC PROBLEM 8

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

UNIT IV FLUID MECHANICS AND HEAT TRANSFER 9

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

UNIT V ERROR ESTIMATES AND ADAPTIVE REFINEMENT 9

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

TOTAL: 45 PERIODS

OUTCOMES:

- Students will understand and apply the concepts on conformal and Non-conformal elements in Engineering applications related to plates and shells.
- Students will solve non-linear problems related to contact and metal forming applications.
- Students will deduce suitable methods related to dynamic problems in engineering applications.
- Students will interpret the solution problems in application in fluid and heat transfer problems.
- Students will understand the concepts of refinements and convergence in the model

REFERENCES:

1. Zienkiewicz, O.C. and Taylor, R.L., “The Finite Element Method”, Fourth Edition, Volumes 1 & 2, McGraw Hill International Edition, Physics Services, 2013.
2. Cook R.D., “Concepts and Applications of Finite Element Analysis”, John Wiley and Sons Inc., Newyork, 2007.
3. Bathe K.J., “Finite Element Procedures in Engineering Analysis”, Prentice Hall, 1995.