I SEMESTER

15PD01 COMPUTATIONAL MATHEMATICS

2 2 0 3

I**NTRODUCTION TO COMPUTATIONAL METHODS:** Solving set of equations - Gauss elimination method, LU-Choleski method, Gauss Jacobi method, Gauss Siedel method, successive over relaxation method, system of non-linear equations – Newton's method. (6+6)

INTERPOLATION: (Revision – Forward, Backward, divided difference interpolation) - Cubic spline interpolation, Bezier curves and B-spline curves, polynomial approximation of surfaces, least square approximations. (4+4)

NUMERICAL INTEGRATION: Numerical integration - Gaussian quadrature, trapezoidal rule and Simpson's one third rule, multiple integrals, multiple integration with variable limits, application of cubic splines. (4+4)

NUMERICAL SOLUTION OF ODE: Taylor series method, Euler and Modified Euler method (Heun's method), Runge Kutta method, Milne's method, Adams - Moulton method. (3+3)

NUMERICAL SOLUTION OF PDE: Classification of partial differential equations of second order, Liebmann's method for Laplace equation and Poisson equation, explicit method and Crank-Nicolson method for parabolic equations, explicit method for hyperbolic equations. (4+4)

FINITE ELEMENT METHOD: The Rayleigh-Ritz method, Collocation and Galerkin method, finite element method – ordinary differential equations, elliptic, parabolic, hyperbolic partial differential equations. (6+6)

SIMULATION MODELLING: Introduction, simulating deterministic behaviour, area under a curve, generating random numbers, simulating probabilistic behaviour, inventory model: gasoline and consumer demand. (3+3)

Note: Exposure to software. Design problems can be given to the students and they have to submit assignments / term papers using programs.

Total L: 30 + T: 30 = 60

REFERENCES:

1. Curtis F Gerald and Patrick O Wheatly, "Applied Numerical Analysis", Pearson Education, New Delhi, 2011.
2. Steven C Chapra and Raymond P Canale, "Numerical Methods for Engineers with software and Programming Applications", Tata McGraw Hill, New Delhi, 2006.
3. John H Mathews and Kurtis D Fink, "Numerical Methods using MATLAB", Prentice Hall, New Delhi. 2004.
4. Douglas J Faires and Richard Burden, "Numerical Methods", Cengage Learning, New Delhi, 2005.
5. Ward Cheney and David Kincaid, "Numerical Mathematics and Computing", Cengage Learning, New Delhi, 2013.

15PD02 FAILURE THEORIES IN DESIGN

3 0 0 3

STRESSES IN A BODY: Two dimensional and three dimensional state of stress, Mohr's circle two and three dimensions, hydrostatic stress, Von-mises, maximum shear stress (Tresca), octahedral shear stress, torsional stresses for large plastic strain.(3)

STATIC FAILURE THEORIES: Failure of ductile materials under static loading - distortion energy theory, maximum shear stress theory maximum normal stress theory; failure of brittle materials under static loading - Coulomb-Mohr theory, modified - Mohr theory. (7)

FRACTURE: Types of fracture, Griffith crack theory, metallographic aspects of fracture. Brittle, ductile fractures, notch effects, fracture curve, strain energy release rate, Stress intensity factor, fracture toughness, J Integral, R curve, fracture under combined stresses, effect of hydrostatic pressure on fracture, probabilistic aspects of fracture mechanics. (9)

FATIGUE FAILURE THEORIES: Mechanism of fatigue failure, fatigue failure models - stress life approach, strain life approach, fatigue loads, S-N curve; theoretical estimation of fatigue strength, correction factors, Soderberg, modified Goodmann and Gerber equations - stress concentration factor, notch sensitivity factor - finite life - variable amplitude loading - fatigue damage - damage summing methods for initiation - cycle counting - crack propagation under variable amplitude loading - designing for multiaxial stresses in fatigue, cumulative damage in fatigue, Miner's rule. (12)

SURFACE FAILURE: Surface geometry, mating surfaces – Friction, Adhesive wear, Abrasive wear, Corrosion wear – Surface fatigue. Spherical contact, cylindrical contact, general contact, dynamic contact stresses, surface fatigue failure models, surface fatigue strength. (7)

CREEP FAILURE: High temperature material properties, time dependent mechanical behavior, Creep curve, stress rupture test -

structural changes during creep, mechanism of creep deformation, deformation mechanism maps, activation energy for steady state creeps - fracture at elevated temperature, prediction of long term properties – creep under combined stresses, creep fatigue interaction (7)

Total L: 45

REFERENCES:

1. Robert L Norton, "Machine Design an Integrated Approach", Pearson Education, New Delhi, 2005.
2. Joseph E Shigley and Charles R Mischke, "Mechanical Engineering Design", Tata McGraw Hill, New Delhi, 2004.
3. Ralph I Stephens, Ali Fatemi, Robert R Stephens and Henry O Fuchs, "Metal Fatigue in Engineering", John Wiley & Sons, 2001.
4. Richard W Hertzberg, "Deformation and Fracture Mechanism of Engineering Materials", John Wiley & Sons, Inc., 1995.
5. Julie A Bannantine, Jess J Comer and James L Handrock, "Fundamentals of Metal Fatigue Analysis", Prentice Hall, 1989.
6. George E Dieter, "Mechanical Metallurgy", McGraw Hill Book Company, 1988.
7. Boyle J T and Spence J, "Stress Analysis for Creep", Butterworth & Co., 1983

15PD03 MATERIALS SELECTION AND METALLURGY

vide Manufacturing Engineering 15PP03

15PD04 / 15PM05 GEOMETRIC MODELING AND COMPUTER AIDED DESIGN

3 2 0 4

COMPUTER GRAPHICS AND GRAPHICS SYSTEMS: Origin, history, goals and applications. 3D graph essentials, 3D world, Graphics API's and software, graphics input and output devices, Raster devices. (6)

OUTPUT PRIMITIVES AND ATTRIBUTES: DDA, Bresenham algorithm for straight lines, Midpoint algorithm for conics and curves, Filled area – scan line, boundary and flood fill. Primitive attributes. (4)

TRANSFORMATIONS AND GRAPHICS PIPELINE: Coordinate system, Graphics pipeline, Translation, scaling, rotation, reflection and shear transformations. Combined, modeling and co-ordinate transformation. (4)

VIEWING AND CLIPPING: 3D viewing pipeline, Co-ordinates and volume, Parallel and perspective projections, Projection and view-port transformation, clipping. Camera, normalized view volume. (4)

CURVES: Lagrange, hermite and spline interpolation, cubic, Bezier and b-spline curves, composite curves and geometric continuity, non-linear splines, curve fairing, recursive subdivision of curves. (6)

SURFACES: Implicit and quadric surfaces, surface of revolution, sweep, ruled, bilinear and coons surfaces. Bicubic patch. Bezier, b-spline and cyclide surfaces. Surface fairing, recursive subdivision of surfaces. (6)

SOLID MODELING: Solid Modeling and their representation. (7)

GRAPHICS FILE STANDARDS: Data exchange format, shake based format, product based format, GKS, PHIGS, IGES, PDES, DXF, CGM, STL, VRML, XML files. (5)

INTERACTIVE COMPUTER PROGRAMMING: Introduction to elementary level - on screen menu - high level - database level - device level and object oriented programming. (3)

TUTORIAL COMPONENT: (30)

Total L: 45 + T: 30 = 75

REFERENCES:

1. Donald Hearn and Pauline Baker, "Computer Graphics C Version", Pearson Education, 2004.
2. Michael E Mortenson, "Geometric Modeling", John Wiley and Sons, Inc., 2004.
3. David F Rogers and Alan Adams J, "Mathematical Elements in Computer Graphics", Tata McGraw Hill, 2002.
4. James D Foley, Andries Van Dam, Steven K Feiner and John F Hughes, "Computer Graphics Principles and Practice", Addison-Wesley Publishing Company, 2000.
5. Martti Mantyla, "An Introduction to Solid Modeling", Springer Verlag, 1987.

15PD05 DESIGN FOR MANUFACTURE AND ASSEMBLY

vide Manufacturing Engineering 15PP05

15PD55 / 15PM55 OBJECT COMPUTING AND DATA STRUCTURES LABORATORY

vide Manufacturing Engineering 15PP55

0 0 4 2

15PD61 INDUSTRY VISIT & TECHNICAL SEMINAR

0 0 2 1

Every candidate shall make a technical presentation on an appropriate topic allotted by the department and submit a report on dates announced by the department. The seminar and the report will be evaluated by a review committee constituted by the HoD.

A minimum of two industrial visits are to be arranged as part of the course and the candidates are expected to make a presentation of their learnings in the industrial visit. There will be a viva-voce examination on the dates announced by th department to verify the depth of understanding of the candidate in both the industrial visits and the technical topic.

Total P: 30

II SEMESTER

15PD06 / 15PM08 PRODUCT LIFECYCLE MANAGEMENT

3 0 0 3

MOTIVATION AND INTRODUCTION: e-commerce, B to B, B to C forms of business, extended enterprise, concepts in PDM - product life cycle, business objects, work flows, versions, views, product structure, change processes, work list, information flow model in product development, engineering bill of materials and manufacturing bill of materials. (10)

COMPONENTS OF PLM SOLUTIONS: Object oriented approach in product development solutions, phase gate process in product design - disparate databases and connectivity, use of EAI technology (middleware) - cases for preparation of combined BoM and other reports. Component supplier management and sourcing. (10)

PRODUCT VISUALISATION: CAD neutral environment and visualisation of products, standard softwares, use of visualisation in several stages of lifecycle, reviews, mark up - case studies. (8)

ROLE OF PLM IN INDUSTRIES: (like auto, aero, electronic) - other possible sectors, ten step approach to PLM, benefits of PLM.(7)

DETAILS OF MODULES IN A PDM/PLM SOFTWARE: Examples (4)

BASICS ON CUSTOMISATION OF PDM/PLM SOFTWARE (6)

Total L: 45

REFERENCES:

1. Lihui Wang and Andrew Y C Nee, “Collaborative Design and Planning for Digital Manufacturing”, Springer-Verlag London Limited, 2009.
2. John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.
3. Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.
4. John Stark, “Product Lifecycle Management: 21 Century Paradigm for Product Realisation”, Springer Publisher, 2005.
5. Cortada and James W, “The Digital Hand : How Computers Changed the Work of American Manufacturing, Transportation and Retail Industries, Oxford University Press Inc., 2004.
6. Leon Alexis, “Enterprise Resource Planning”, Tata McGraw Hill, 2002.
7. Kevin N Otto and Kristin L Wood, “Product Design”, Pearson, 2001.
8. David Ferris and Larry Whipple, “Building an Intelligent E-Business”, Premier Press, 2001.
9. Damer Amer, “The E-business Revolution”, Prentice Hall, 2000.
10. Faisal Hoque and David Orchard, “e-Enterprise: Business Models, Architecture and Components (Breakthroughs in Application Development)”, Cambridge University Press, 2000.

15PD07 FINITE ELEMENT ANALYSIS

3 2 0 4

FORMULATION OF SOLID AND STRUCTURAL MECHANICS PROBLEMS: Generalized Hooke's law, Strain Energy density function, Elastic symmetry, Stress strain relationship, strain displacement relationship, boundary conditions, compatibility equations, Equilibrium equations. First law of thermodynamics and energy Equation. (7)

ENERGY AND VARIATIONAL PRINCIPLE: Calculus of variations: The variational operator, Extremum of functional, Natural and essential boundary conditions, Principle of virtual displacements, Principle of total potential energy, Principle of virtual forces and complimentary potential energy, Hamilton principle, Castigliano's theorems. (8)

BASIC PROCEDURE OF FEM: Discretization of the domain, basic element shapes, discretization process, node numbering scheme, assemblage of element equations and incorporation of boundary conditions. (8)

INTERPOLATION MODELS: Polynomial form of interpolation functions, selection of the order of the interpolation polynomial, simplex, complex and multiplex elements, interpolation polynomial in terms of nodal degrees of freedom, convergence requirements, linear interpolation polynomials in terms of global coordinates and for vector quantities, coordinate transformation. (8)

STATIC ANALYSIS OF SOLID MECHANICS PROBLEMS: Analysis of bar, space truss, beam, plates - triangular membrane, rectangular, isoparametric formulation and axisymmetric formulation. case studies. (7)

DYNAMIC ANALYSIS OF SOLID MECHANICS PROBLEMS: Dynamic equations of motion, consistent and lumped mass matrices, free vibration analysis, dynamic response using finite element method, case studies. (7)

TUTORIAL COMPONENT: (30)

Total L: 45 + T: 30 = 75

REFERENCES:

1. Singerasu S Rao, “The Finite Element Method in Engineering”, Butterworth Heinemann, 2010.
2. Reddy J N, “An Introduction to the Finite Element Method”, Tata McGraw Hill, 2012.
3. Klaus Jurgen Bathe, “Finite Element Procedures”, Prentice Hall Inc. 2012.
4. Reddy J N, “Energy Principles and Variational Methods in Applied Mechanics”,John Wiley & Sons, 2002.

15PD08 ENGINEERING ECONOMICS

vide Manufacturing Engineering 15PP06

15PD09 PRODUCT RELIABILITY

3 0 0 3

INTRODUCTION: Definitions, stage gate approach, reliability mathematics, reliability models, parametric and catastrophic methods, reliability predictive modelling. (10)

FAILURE MODES AND EFFECT ANALYSIS: Goal and vision, concepts and types of FMEA evaluations, fault tree model. (9)

EVALUATING PRODUCT RISK: Test design by failure modes and aging stresses. Aging due to cyclic force, Miner’s rule. (6)

CONCEPTS IN ACCELERATED TESTING: Time acceleration factor, influence of acceleration factor in test planning, application to acceleration test, high temperature operating life acceleration model, temperature humidity bias acceleration model, temperature cycle acceleration model, vibration accelerator model, failure free accelerated test planning. Accelerated reliability growth. (10)

PRODUCT MAINTAINABILITY: Maintainability concepts and analysis measures of maintainability, design for serviceability, supportability and maintainability preventive maintenance scheduling. (6)

INTRODUCTION TO SOFTWARE RELIABILITY: Definitions, waterfall lifecycle, techniques to improve software reliability, software reliability models. (4)

Total L: 45

REFERENCES:

1. Naikan V N A, “Reliability Engineering and Life Testing”, PHI Learning Private Limited, 2009.
2. Prabhakar Murthy D N and Marvin Rausand, “Product Reliability”, Springer-Verlag London Limited, 2008.
3. Wayne Nelson and John A, “Accelerated Testing Statistical Models, Test Plans and Data Analyses”, John Wiley & Sons Inc., 2004.
4. Pham and Hoang, “System Software Reliability (Springer Series in Reliability Engineering) 1. Systems Software 2. Computer Software – Reliability”, Springer-Verlag London Limited, 2006.
5. Alex Porter, “Accelerated Testing and Validation Testing, Engineering and Management Tools for Lean Development”, Elsevier Inc., 2004.
6. Dana Crowe and Alec Feinberg, “Design for Reliability”, CRC Press, 2001.
7. John W Priest and Jose M Sanchez, “Product Development and Design for Manufacturing – A Collaborative Approach to Producibility and Reliability”, Marcel Dekker, 2001.
8. Michael Pecht, “Product Reliability, Maintainability and Supportability Handbook”, CRC Press, 1995.

15PD10 HUMAN FACTORS FOR PRODUCT DESIGN

3 2 0 4

INTRODUCTION: Definition, human technological system, multidisciplinary engineering approach, human - machine system, manual, mechanical, automated system. (6)

HUMAN INPUT DESIGN: Input and processing, text, graphics, symbols, codes, visual display of dynamic information, auditory, tactual, olfactory displays. (6)

HUMAN ABILTIES: Human abilities and limits, physical capacity, motor skill, design of controls, devices and hand tools. Biomechanics - biostatic mechanics, statics of rigid bodies, upper extremity of hand, lower extremity and foot, bending, lifting and carrying, biodynamic mechanics, human body kinematics (8)

ANTHROPOMETRY: Measuring human dimensions, Anthropometers, procedure for anthropometric design, three - dimensional models for anthropometric design, anthropometry standards. (7)

WORKPLACE DESIGN: Posture design, RULA,REBA, arrangement of controls/components, design of static and dynamic tasks - repetitive task, manual handling task, physical and mental tasks, work-rest cycle, stress, fatigue, interpersonal aspects. (7)

ENVIRONMENTAL CONSIDERATIONS: Illumination, climate, bio-thermal fundamentals, human operator heat transfer, human system bioenergetics, thermoregulatory physiology, human operator thermo regularity, passive operator, active operator, heat stress, noise, motion, sound, vibration. (6)

HUMAN FACTORS APPLICATIONS: Human error, accidents, human factors and the automobile, organizational and social aspects, steps according to ISO/DIS6385, OSHA's approach, virtual environments. (5)

TUTORIAL COMPONENT: (30)

Total L: 45 + T: 30 = 75

REFERENCES:

1. Waldemar Karwowski, "Human Factors and Ergonomics in Consumer Product Design", Taylor and Francis, 2011.
2. Nemeth C P, "Human Factors Methods for Design", Taylor and Francis, 2004.
3. Bridger R S, "Introduction to Ergonomics", Taylor and Francis, 2003.
4. Chandler Allen Phillips, "Human Factors Engineering", John Wiley & Sons, 2000.
5. Martin Helandar, "A Guide to Ergonomics of Manufacturing", Taylor and Francis, 1996.
6. Mark S Sanders, "Human Factors in Engineering and Design", McGraw Hill, 1993.

15PD51 PRODUCT DESIGN AND DEVELOPMENT LABORATORY

0 0 2 1

PROJECT

Identify a consumer product as needed by the market, develop concept, develop CAD model, simulate in CAE environment, optimize, develop tooling and make a physical prototype. Prepare a detailed report.
(The fabricated models may be in the form of RP models, clay models, sheet metal models or card-board models etc…)

DEMONSTRATION EXERCISE:

1. Study of reverse engineering concepts
2. Demonstration of 3D scanning
3. Study of rapid prototyping machines
4. Demonstration of Fusion Deposition Modeling
5. Demonstration of Selective Laser Sintering
6. Demonstration of Vacuum casting
7. Demonstration of Virtual Reality

Total P: 30

REFERENCES:

1. Kevin N Otto and Kristin L Wood, "Product Design : Techniques in Reverse Engineering and New Product Development", Pearson Education, 2006.
2. Karl T Ulrich and Steven D Eppinger, Product Design and Development, Tata McGraw Hill Publishing Company Private Limited, 2004.

III SEMESTER

15PD52 ENGINEERING DESIGN LABORATORY

0 0 4 2

In this course, students will be provided with an orientation programme on the following equipment/software for a duration of 20 hours. After this orientation, each student is expected to formulate and complete an activity of interest which has to be derived from the orientation programme under the guidance of a faculty. The details like background, problem definition, state of technology/knowledge in that area by a good literature review (5 latest papers), objectives, methodology, equipment that can be used (from the orientation programme), results from the experiments and their interpretation with respect to the assumptions/background and a formal conclusion are expected in the report which is to be submitted at the end of the semester. This work is evaluated for the credit assigned. Expected hours needed for this work is 40 hours.

Topics for orientation programme

1. Static analysis of an automotive component
2. Modal analysis and design optimisation to improve natural frequencies using FEA.
3. Random vibration analysis of a automotive component and estimation of fatigue life using FEA
4. Steady state thermal analysis
5. Unsteady state thermal analysis
6. Steady state fluid flow analysis
7. Mold flow analysis of a injection molded component
8. Casting process analysis using software
9. Harmonic analysis of aircraft structure
10. Stress analysis of an electronic component under thermal cycling/shock loads and estimation of fatigue life.

Total P: 60

15PD71 PROJECT WORK - I

0 0 6 3

1. Identification of a real life problem in thrust areas
2. Developing a mathematical model for solving the above problem
3. Finalisation of system requirements and specification
4. Proposing different solutions for the problem based on literature survey
5. Future trends in providing alternate solutions
6. Consolidated report preparation

IV SEMESTER

15PD72 PROJECT WORK – II

0 0 28 14

The project work involves the following:

I. Preparing a project - brief proposal including

1. Problem Identification
2. A statement of system / process specifications proposed to be developed (Block Diagram / Concept tree)
3. List of possible solutions including alternatives and constraints
4. Cost benefit analysis
5. Time Line of activities

II. A report highlighting the design finalization [based on functional requirements and standards (if any)]

III. A presentation includes the following:

1. Implementation Phase (Hardware / Software / both)
2. Testing and Validation of the developed system
3. Learning in the Project

IV. Consolidated report preparation

ELECTIVE THEORY COURSES

15PD21 / 15PM25 DATABASE MANAGEMENT SYSTEMS

3 2 0 4

BASIC CONCEPTS: Introduction to databases - Conventional file Processing - Purpose of Database system - Characteristics of database approach - Advantages of using DBMS - Database concept and architecture - Data Abstraction - Data Models Instances and schema - Data independence - schema architecture- Components of a DBMS - Database Languages - Database Manager - Database Administrator - Database Users. (7)

DATA MODELING: Introduction - Data Associations - entities, attributes, relationships - Type role and structural constraints Weak and Strong entity types - Design of Entity relationship data models (ERD) - Generalization - Aggregation - Conversion of ERD into tables - Applications - Introduction to Network data model and Hierarchical data model. (7)

FILE ORGANIZATION: Storage Device Characteristics - Constituents of a file - Operations on file - Serial Files - Sequential Files - Index Sequential Files - Direct Files - Data Retrieval - Indexing using Tree Structures. (7)

RELATIONAL MODEL: Introduction to Relational Data Model - Basic Concepts - Enforcing Data Integrity Constraints - Relational Algebra Operations - Extended Relational Algebra Operations - Triggers - Introduction to views. (4)

RELATIONAL DATABASE MANIPULATION: Introduction to Structured Query Language (SQL) - SQL Commands for Defining Database, Constructing Database, Manipulations on Database - Basic Data Retrieval Operations - Advanced Queries in SQL - Functions in SQL - Aggregation - Categorization - Updates in SQL - Views in SQL. (7)

DATA BASE DESIGN THEORY: Data base design process - Relational Database Design - Relation Schema - Anomalies in a database - Functional dependencies - Axioms - Normal forms based on primary keys - Second Normal form, Third Normal form, Boyce - Codd Normal form - Examples - Multi-valued dependencies - Fourth Normal form - Reduction of an E-R schema to Tables - Converting ER Diagrams to relations - Practical database design tuning. (8)

DATABASE SECURITY, INTEGRITY CONTROL: Security and Integrity threats - Defense mechanisms - Transaction and concurrency control mechanisms. (5)

TUTORIAL COMPONENT: (30)

Total L: 45 + T: 30 = 75

REFERENCES:

1. Date C J, "An Introduction to Database Systems", Pearson Education Asia, 2005.
2. Elmasri Rand Navathe S B, "Fundamentals of Database Systems", Pearson Education, 2004.
3. Raghu Ramakrishnan and Johannes Gehrke, "Database Management System", McGraw Hill, 2004.
4. Silberschatz A and Korth Hand Sudarshan S, "Database System Concepts", McGraw Hill, 2003.
5. Thomas Condly and Carolyn Begg, "Database System", Pearson Education, 2003.
6. Graeme C Simsion, "Data Modeling Essentials", Dreamtech, 2001.

15PD22 PRODUCT DEVELOPMENT STRATEGIES

vide Manufacturing Engineering 15PP28

15PD23 / 15PM26 ENTERPRISE COMPUTING

3 0 0 3

ENTERPRISE FOUNDATIONS: Enterprise Architectural overview - object oriented software development for enterprise Component Based software development for enterprise. Java Enterprise System. (5)

ENTERPRISE DATA ENABLING: Enterprise Data - Basis of JDBC, Drivers, Connection, Statement, Result Set, Advanced JDBC features. (8)

JAVA WEB SERVICES: Web Service standards, Describing and publishing, JAX-WS, WSDL, SOAP, XML processing API. (6)

ASYNCHRONOUS COMMUNICATION: Java Message Service, Point to Point Messaging, Publish Subscribe Messaging, Java Script, AJAX (6)

ENTERPRISE WEB ENABLING: Web Browsers and Web Servers in Enterprise. Web Programming, Java Servlets - Java Server pages, JavaServer Faces. (10)

MULTITIER ENTERPRISE COMPUTING: Java Beans, Enterprise Java Beans, Stateless Session Beans, Stateful Session Beans, Message Driven Beans, Entity, Accessing EJB in web services. (10)

Total L: 45

REFERENCES:

1. George Reese, "Database programming with JDBC and Java", O'Reily, 2012.
2. Bill Burke and Richard Monson Haefel, "Enterprise Java Beans 3.0", O'Reily, 2006.
3. Raghu R Kodali, Jonathan R Wetherbee and Peter Zadrozny, "Beginning EJB 3 Application Development", Apress, 2006.
4. Dave Crane, Eric Pascarello and Darren Jame, "Ajax in Action", Manning, 2006.
5. Eric Jendrock, Jennifer Ball, Debbie Carson, Ian Evans, Scott Fordin and Kim Haase, "The Java EE 5 Tutorial", Addison Wesley, 2006.
6. Kito D Mann, "JavaServer Faces in Action", Manning, 2005.

15PD24 RAPID PROTOTYPING

vide Manufacturing Engineering 15PP24

15PD25 / 15PM23 OBJECT ORIENTED ANALYSIS AND DESIGN

3 2 0 4

INTRODUCTION: Introduction to Software Engineering, Best Practices in Software Development. (2+0)

OBJECT TECHNOLOGY: Object and classes - Abstraction and encapsulation - Methods and Message - Interfaces, Inheritance and Polymorphism - Access Control. (2+0)

UNIFIED PROCESS: Four Phases of the Unified Process, Introduction to UML, UML History. (10+6)

SOFTWARE ARCHITECTURE: "4+1" View Model, Views and UML Diagrams, Patterns, Framework. (10+6)

WORKFLOW: Requirement Workflow – Use Case Model, Analysis Workflow – Analysis Model, Use case Realization, Data Dictionary, Design Workflow – Design Model, Design Subsystem, Implementation Workflow – Component Model, Deployment Model, Test Workflow – Test Plan, Types of Testing. (21+18)

TUTORIAL COMPONENT: (30)

Total L: 45 + T: 30 = 75

REFERENCES:

1. Philippe Krucheten, "The Rational Unified Process – An Introduction", Pearson Education, 2004.
2. Grady Booch, James Rumbaugh and Ivar Jacobson, "The Unified Modelling Language User Guide", Pearson Education, 2009.
3. Craig Larman , "Applying UML and Patterns", Prentice Hall, 2004.
4. Martin Fowler, "UML Distilled", Pearson Education, 2009.
5. John Hunt, "The Unified Process for Practitioners", Springer, 2001.
6. Grady Booch, Robert A. Maksimchuk, "Object-Oriented Analysis and Design with Applications", Addison-Wesley Professional, 2007.

15PD26 COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER

3 0 0 3

INTRODUCTION: Basics of fluid flow, derivation of the governing equations - conservation of mass, momentum and energy. (5)

GRID GENERATION: Choice of grid, grid oriented velocity components, cartesian velocity components, staggered and collocated arrangements, adaptive grids. (4)

DISCRETISATION: Finite difference method, forward, backward and central difference schemes, explicit and implicit methods. Properties of numerical solution methods, stability analysis, error estimation. (5)

CFD TECHNIQUES: Mathematical classification of flow, hyperbolic, parabolic, elliptic and mixed flow types, Lax - Wendroff technique, MacCormack's technique, relaxation technique, artificial viscosity, ADI technique, pressure correction technique, SIMPLE algorithm, upwind schemes, flux vector splitting. (14)

FINITE VOLUME METHOD: Introduction, difference between FDM and FVM, approximation of surface integrals, approximation of volume integrals, interpolation practices, implementation of boundary conditions. (3)

TURBULENCE MODELING: Turbulence energy equation - one-equation model, the k-ω model, the k- ε model. (3)

APPLICATIONS: Fluid dynamics and heat transfer problems. (11)

Total L: 45

REFERENCES:

1. Muralidhar K and Sundararajan T, "Computational Fluid Flow and Heat Transfer", Narosa Publications, 2003.
2. Chung T J, "Computational Fluid Dynamics", Cambridge University Press, 2002.
3. Joel H Freziger and Milovan Peric, "Computational Methods for Fluid Dynamics", Springer Publications, 1999.
4. John D Anderson, "Computational Fluid Dynamics - The Basics with Applications", McGraw Hill, 1995.
5. Versteeg H K and Malalasekara W, "An Introduction to Computational Fluid Dynamics - The Finite Volume Method', Longman, 1995.

15PD27 COMPOSITE MATERIALS

3 0 0 3

INTRODUCTION: Characteristics of composite materials, classification of composites, advantages, applications. Matrix and their role, principal types of fibre and matrix materials, basic principles of production of composite materials and products, advantages and limitations of different processes. (7)

MICRO MECHANICAL BEHAVIOUR OF A LAMINA: Volume and mass fractions, evaluation of elastic moduli, strength of unidirectional lamina, multiaxial strength criteria, analysis of discontinuous fiber lamina. (8)

MACRO MECHANICAL BEHAVIOUR OF A LAMINA: Hooke's law for different types of materials, engineering constants for orthotropic materials. Stress, strain relations for plane stress in an orthotropic materials and in a lamina of arbitrary orientation, strength of an orthotropic lamina, basic strength theories, determinations of engineering constants, mechanics of materials approach. (8)

MACRO MECHANICAL BEHAVIOUR OF A LAMINATE: Classical lamination theory, lamina stress, strain behaviour, resultant forces and moments in a laminate, types of laminates, strength and stiffness of laminates, interlaminar stresses in laminates. (7)

LAMINATED PLATES AND BEAMS: Types of laminated plates and beams, elementary mechanical behaviour, bending and buckling of laminated plates, forces and moments, stresses and deflections under different boundary conditions. (7)

MANUFACTURE OF COMPOSITE COMPONENTS: Layup and curing, open and closed mould processes, hand layup techniques, bag moulding, filament winding, pultrusion, pulforming, thermoforming, injections moulding, blow moulding. Manufacture of metal matrix composites and ceramic matrix composites. (8)

Total L: 45

REFERENCES:

1. Sanjay K Mazumdar, "Composites Manufacturing", CRC Press, 2003.
2. Autar K Kaw, "Mechanics of Composite Materials", CRC Press, 1997.
3. Matthews F L and Rawlings R D, "Composite Materials: Engineering and Science", Chapman and Hall, 1994.
4. Ronald F Gibson, "Principles of Composite Material Mechanics", McGraw Hill Book Co, 1994.
5. Agarwal B D and Broutman L J, "Analysis and Performance of Fibre Composites", John Wiley and Sons Inc, 1990.
6. Terry Richardson, "Composites - A Design Guide", Industrial Press Inc, 1987.
7. Robert M Jones, "Mechanics of Composite Materials", McGraw Hill Book Co, 1970.

15PD28 OPTIMIZATION TECHNIQUES

vide Manufacturing Engineering 15PP26

15PD29 ANALYSIS OF METALLURGICAL FAILURES

3 0 0 3

STRESSES IN A BODY: Two dimensional and three dimensional state of stress, Mohr's circle two and three dimensions, hydrostatic stress, Von-mises, maximum shear stress (Tresca), octahedral shear stress. (4)

FRACTURE: Types of fracture, Griffith crack theory, stress analysis of cracks, metallographic aspects of fracture. Brittle, ductile fractures, notch effects, fracture curve, R curve, fracture under combined stresses, effect of hydrostatic pressure on fracture, probabilistic aspects of fracture mechanics, toughness of materials. (8)

FATIGUE: Statistical nature of fatigue, S-N curve, low cycle fatigue, strain life equations, structural feature of fatigue, fatigue crack propagation, effect of stress concentration, size, surface properties, metallurgical variables on fatigue, case studies, designing against fatigue, detail design, improvements after failure and service, fatigue of bolts, welded and adhesive joints. (13)

WEAR FAILURES: Type of wear, role of friction in wear, lubricated and non-lubricated wear, analysing wear failures. (4)

CORROSION FAILURES: Factors influencing corrosion failures, analysis of corrosion failures, overview of various types of corrosion, stress corrosion cracking - sources, characteristics of stress corrosion cracking, procedure of analysing stress corrosion cracking, various types of hydrogen damage failures, corrective and preventive action. (5)

ELEVATED TEMPERATURE FAILURES: Creep, stress rupture, elevated temperature fatigue, metallurgical instabilities, environment induced failure, tests for analysis of failure at elevated temperatures. (7)

FMEA: Definition - analysis causes of failure - modes - ranks of failure modes - fault tree analysis - case studies. (4)

Total L: 45

REFERENCES:

1. Jaap Schijve, “Fatigue of Structures and Materials”, Kluwer Academic Publishers, 2001.
2. ASM Metals Handbook, “Failure Analysis and Prevention”, ASM Metals Park, USA, Vol. 10, 1995.
3. Richard W Hertzberg, “Deformation and Fracture Mechanism of Engineering Materials”, John Wiley & Sons, Inc., 1995.
4. George E Dieter, “Mechanical Metallurgy”, McGraw Hill Book Company, 1988.

15PD30 PRODUCTION AND OPERATIONS MANAGEMENT

vide Manufacturing Engineering 15PP21

15PD31 TOTAL QUALITY MANAGEMENT

vide Manufacturing Engineering 15PP34

15PD32 MECHANICAL VIBRATIONS

3 0 0 3

INTRODUCTION: Relevance of and need for vibrational analysis. Mathematical modeling of vibrating systems - discrete and continuous systems - single degree of freedom systems - free and forced vibrations, various damping models - Transient Vibration - Impulse and arbitrary excitation, base excitation, Laplace transform formulation, response spectrum. (10)

TWO DEGREES OF FREEDOM SYSTEMS: Generalized co-ordinates, principal co-ordinates, derivation of equations of motion, co-ordinate coupling, Lagrange’s equation. (6)

MULTI DEGREES OF FREEDOM SYSTEMS: Derivation of equations of motion, influence coefficients, orthogonality principle, calculation of natural frequencies by Raleigh, Stodala, Dunkerley, Holzer and matrix iteration methods, branched system, geared system. (8)

VIBRATION MEASUREMENT: Transducers for vibration measurement – Mechanical Exciters, Electrodynamic Shaker – Signal analysis, Spectrum Analyzer, Bandpass Filter – Dynamic Testing of Machines and Structure – Experimental Modal Analysis, Determination of Modal Data, Measurement of mode shapes (12)

VIBRATION CONTROL: Methods of vibration control - excitation reduction at source, balancing of rigid, flexible and variable mass rotors. Dynamic properties and selection of structural materials-viscoelastic polymers, vibration absorbers- tuned absorber, tuned and damped absorber (qualitative treatment only), untuned viscous damper, vibration isolation. (9)

. **Total L: 45**

REFERENCES:

1. Rao S S, "Mechanical Vibrations", Pearson Education, New Delhi, 2012.
2. Thomson W T, "Theory of Vibration with Applications", Pearson Education, New Delhi, 2013.
3. Ashok Kumar Mallik, “Principles of Vibration Control”, Affiliated East-West Press (P) Ltd., New Delhi, 1990.
4. Seto, “Mechanical Vibrations", Schaum Outline Series, McGraw Hill Book Company, New York, 1990.
5. Grover G K, "Mechanical Vibrations ", New Chand and Brothers, Roorkey, 1989.
6. Tse Morse and Hinkle, “Mechanical Vibration”, Prentice Hall of India Ltd., New Delhi, 1987.

15PD33 MECHANICS OF POLYMER MATRIX COMPOSITES

3 0 0 3

INTRODUCTION: Modern materials in design, types, metals, polymers, ceramics, composites, Classification of composites, advantages, applications and limitations, Matrix and reinforcement-their roles, principal types of fibre and matrix materials. (8)

MANUFACTURE OF COMPOSITE COMPONENTS: Lay up and curing, open and closed mould processes, bag moulding, filament winding, pultrusion, pulforming, thermoforming, injection moulding, blow moulding,an overview of metal matrix composite processing and ceramic matrix composite processing. (8)

MICRO MECHANICAL BEHAVIOUR OF A LAMINA: Volume and mass fractions, evaluation of elastic moduli, strength of unidirectional lamina. (9)

MACRO MECHANICAL BEHAVIOUR OF A LAMINA: Hooke's law for different types of materials, engineering constants for orthotropic materials. Stress, strain relations for plane stress in an orthotropic materials and in a lamina of arbitrary orientation, strength of an orthotropic lamina, basic strength theories. (10)

MACRO MECHANICAL BEHAVIOUR OF A LAMINATE: Classical lamination theory - lamina stress - strain behaviour - resultant forces and moments in a laminate - types of laminates - strength and stiffness of laminates – inter laminar stresses in laminates.(10)

Total L: 45

REFERENCES:

1. Autar K Kaw, "Mechanics of Composite Materials", CRC Press, NY, 2006.
2. Matthews F L and Rawlings R D, “Composite Materials: Engineering and Science”, Woodhead Publishing, 1999.
3. Ronald F Gibson, “Principles of Composite Material Mechanics", McGraw Hill Book Co, 2007.
4. Robert M Jones, "Mechanics of Composite Materials", Taylor and Francis, 1999.

ONE CREDIT COURSES

For the detailed Syllabi of all the one credit courses offered by Production Engineering department which are listed in this programme scheme refer to the syllabi of M.E Manufacturing Engineering programme.

For the detailed syllabi of the electives and one credit courses offered by other departments refer to the syllabi of M.E- Automotive Engineering offered by Automobile Engineering Department.