JNTUACEA **R15**

2015-16

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAMU
DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech. (Product Design)

(4 SEMESTER COURSE STRUCTURE AND SYLLABUS)

EFFECTIVE FROM THE YEAR 2015-16

I- SEMESTER:

Subject Code	SUBJECT	L	P	C
15D34101	Creative Engineering Design-I	4	-	4
15D34102	Materials Technology	4	-	4
15D34103	Computer Aided Engineering	4	-	4
15D34104	Applied Ergonomics	4	-	4
	ELECTIVE-I	4	-	4
15D34105	Design of Material Handling Equipments			
15D32108	Rapid Prototyping Technologies			
15D34106	Mechanical Behaviour of Materials			
15D34107	Industrial Design			
	ELECTIVE-II	4	-	4
15D34108	Quality Concepts in Design			
15D34109	Composite Materials and Mechanics			
15D32111	Creativity and Innovations in Design			
15D34110	Enterprise Resource Planning			
15D34111	Computer Aided Analysis & Design Lab	0	4	2
TOTAL		**24**	**4**	**26**

II - SEMESTER:

Subject Code	SUBJECT	L	P	C
15D34201	Design for Manufacturing	4	-	4
15D34202	Optimization of Engineering Design	4	-	4
15D34203	Robust Design	4	-	4
15D34204	Creative Engineering Design-II	4	-	4
	ELECTIVE-III	4	-	4
15D32208	Product Planning and Marketing			
15D34205	Tribology in Design			
15D34206	Design of Hydraulic and Pneumatic Systems			
15D34207	Additive Manufacturing			
	ELECTIVE-IV	4	-	4
15D34208	Design for Manufacture Assembly and Environments			
15D34209	Advanced Metal Forming Techniques			
15D34210	Quality Concepts in Product Development			
15D32210	Reverse Engineering			
15D54201	Research Methodology (Audit Course)	3	-	-
15D34211	Simulation Lab	0	4	2
TOTAL		**24**	**4**	**26**

Code	Subject	T	P	C
15D34301	**III Semester Seminar - I**	**0**	**4**	**2**
15D34401	**IV Semester Seminar - II**	**0**	**4**	**2**
15D34302	**III & IV Semester Project Work**	**--**	**--**	**44**
	Total	**24**	**8**	**48**

Note : All End Examinations (Theory and Practical) are of Three Hours Duration.

T – Tutorial L – Theory P- Practical / Drawing C - Credits

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JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAMU
DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech : PRODUCT DESIGN

I- SEMESTER **L P C**

4 - 4

(4 SEMESTER COURSE STRUCTURE AND SYLLABUS)

EFFECTIVE FROM THE YEAR 2015-16

I- SEMESTER:

Subject Code	SUBJECT	L	P	C
15D34101	Creative Engineering Design-I	4	-	4
15D34102	Materials Technology	4	-	4
15D34103	Computer Aided Engineering	4	-	4
15D34104	Applied Ergonomics	4	-	4
	ELECTIVE-I	4	-	4
15D34105	Design of Material Handling Equipments			
15D32108	Rapid Prototyping Technologies			
15D34106	Mechanical Behaviour of Materials			
15D34107	Industrial Design			
	ELECTIVE-II	4	-	4
15D34108	Quality Concepts in Design			
15D34109	Composite Materials and Mechanics			
15D3212	Creativity and Innovations in Design			
15D34111	Enterprise Resource Planning			
15D34112	Computer Aided Analysis & Design Lab	0	4	2
TOTAL		**24**	**4**	**26**

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JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAMU

DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech – PRODUCT DESIGN

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

CREATIVE ENGINEERING DESIGN-I
(15D34101)

UNIT-I

Introduction to product design- Product development -Examples of product development process-theories and methodologies-Product development teams- Product development planning process-Technical and business concerns.

Understanding customer needs-Customer satisfaction -gathering customer needs-Organising and prioritizing customer needs.

UNIT-II

Establishing product function-Functional decomposition, Modeling process, Function trees, Creating function structure, Auguementation, Functional common basis.

UNIT-III

Product teardown and experimentation-Teardown process, Teardown methods, Post teardown reporting- Applications of product teardown.

UNIT-IV

Benchmarking and establishing engineering specifications- Benchmarking approach, examples, Support tools, Setting product specifications-Product portfolios architecture types, theory, platforms.

Product architecture - Types and examples, Product modularity, Modular design and methods.

UNIT-V

Generating, selection and embodiment of concepts: Concept generation process, methods-Basic and advanced-Morphological analysis, Concept selection process, Factors, Design evaluation, Information quality, Feasibility-Basic and advanced methods, Concept embodiment: General process, advanced methods

Modeling of product metrics: Model selection, Model preparation, Mathematical modeling, Construction of product models.

TEXT BOOKS:

1. Kevin N. Otto and Kristin L. Wood - **Product Design** Pearson Education 2001

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M.Tech – PRODUCT DESIGN

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

MATERIALS TECHNOLOGY
(15D34102)

UNIT I:

Elasticity in metals and polymers, mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening. Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behavior, super plasticity, deformation of non crystalline material

UNIT II:

Griffth's Theory, stress intensity factor and fracture Toughness, Toughening Mechanisms, Ductile and Brittle transition in steel, High Temperature Fracture, Creep, Larson – Miller parameter, Deformation and Fracture mechanism maps.

UNIT III:

Fatigue, Low and High cycle fatigue test, Crack Initiation and Propagation mechanism and paris Law, Effect of surface and metallurgical parameters on Fatigue, Fracture of non-metallic materials, fatigue analysis, Sources of failure, procedure of failure analysis.

UNIT IV:

Motivation for selection, cost basis and service requirements, Selection for Mechanical Properties, Strength, Toughness, Fatigue and Creep. Selection for Surface durability, Corrosion and Wear resistance, Relationship between Materials Selection and Processing, Case studies in Materials Selection with relevance to Aero, Auto , Marine, Machinery and Nuclear Applications.

UNIT V:

MODERN METALLIC MATERIALS: Dual Steels, Micro alloyed, High Strength Low alloy (HSLA) Steel, Transformation induced plasticity (TRIP) Steel, Maraging Steel, Intermetallics, Ni and Ti Aluminides, Smart Materials, Shape Memory alloys, Metallic Glass Quasi Crystal and Nano Crystalline Materials.

NONMETALLIC MATERIALS: Polymeric materials and their molecular structures, Production Techniques for Fibers, Foams, Adhesives and Coatings, structure, Properties and Applications of Engineering Polymers, Advanced Structural Ceramics WC, TiC, TaC, A12 O3, SiC, Si3 N4, CBN and Diamond – properties, Processing and applications.

REFERENCES:

1. Mechanical Behavior of Materials/Thomas H. Courtney/ 2 nd Edition, McGraw Hill, 2000
2. Mechanical Metallurgy/George E. Dicter/McGraw Hill, 1998.
3. Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann.

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M.Tech – PRODUCT DESIGN

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

COMPUTER AIDED ENGINEERING
(15D34103)

UNIT-I

Introduction: Equations of equilibrium, stress-strain relations for 2-D and 3-D, Potential energy and equilibrium, Boundary conditions, Von-Misses Stresses

FEM for 1-D Problems: General procedure for FEA, Raleigh Ritz method, Galerkin Approach, shape functions, stiffness matrix, load vectors, temperature effects, applications of boundary conditions using elimination, penalty and multi-constraint approaches, Application problems – 1-D bar element. Trusses and beams

UNIT-II

FEM for 2-D Problems: Shape functions, stiffness matrix, strain matrix, load vectors for CST Elements and application problems

UNIT-III

FEM for Axisymmetric Problems: Axisymmetric formulation, triangular elements, PE approach, Body force term, Rotating flywheel, Problem modeling and boundary conditions – Disks and Cylinders

UNIT-IV

FEM for Scalar Field Problems: 1-D and 2-D Steady state heat transfer, Torsion, potential flow and fluid flow in ducts and application problems

UNIT-V

Dynamic Analysis: Equations of motion for dynamic problems –Consistent and lumped mass matrices -Formulation of element mass matrices free vibration and forced vibration problems formulation.

TEXT BOOKS:

1. Tirupathi R. Chandrupatla, Ashok D Belegundu **-"Introduction to Finite Elements in Engineering"** (Third Edition) Prentice Hall India Pvt. Ltd., New Delhi – 2003
2. Cook R.D, Malkus D.S & Plesha M.E-**"Concepts and Applications of finite Element Analysis"**, John Wiley & Sons, 1989.

REFERENCE BOOKS:

1. Segerlind L .J.-"**Applied Finite Element Analysis**" John Wiley & Sons Edition, 1984.
2. Rao SS- "**The Finite Element Method in Engineering**", Pergomon Press, Oxford, 2nd
3. Edition,1984.
4. Bathe K .J-"**Finite Element Procedures in Engineering Analysis**", Prentice Hall, NewJersey, 1982.
5. Shames III & Dym C L- "**Energy and Finite Element Methods in Structural Mechanics**", Wiley Eastern Ltd, 1995,

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DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech – PRODUCT DESIGN

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

APPLIED ERGONOMICS
(15D34104)

UNIT I
INTRODUCTION:
Brief history of human factors engineering/Ergonomics – Interdisciplinary nature.

UNIT II
HUMAN PERFORMANCE:
Factors influencing performance – Information receiving and processing – Information theory and its application - Human response and errors – Signal detection theory – iostatic and Biodynamic Mechanics.

UNIT III
PHYSIOLOGICAL ASPECTS OF HUMAN AT WORK:
Metabolism – Physiological factors involved in muscular activity – Measurement of energy expenditure – Quantitative work load analysis - Physical work capacity and its evaluation – Physiological fatigue – Work and rest schedules – Physical fitness tests.

UNIT IV
WORK PLACE DESIGN:
Problems of body size, Anthropometry measures, Work posture - Work space layout and work station design – Design of displays, controls and VDT work stations - Hand tool design.illumination.

UNIT V
OCCUPATIONAL HEALTH AND SAFETY:
Industrial accidents, Personal Protective devices, Safety Management practices –
Effect of Environment – heat, cold & noise – NIOHS regulations and Factories Act

TEXT BOOK:

1. Bridger, R.S., Introduction to Ergonomics, McGraw Hill, 1995.

REFERENCES:

1. Martin Helander, A guide to Ergonomics of Manufacturing, TMH, 2006.
2. Mecormik, T.J., Human Factors Engineering, TMH, 1990.
3. John Grimaldi, Safety Management, A.I.B.S., 5th Edition, Hazard Control Technology 2003
4. Philips, Chandler A, Human Factors Engineering, John Wiley and Sons, Inc. 2000

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DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech – PRODUCT DESIGN

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

DESIGN OF MATERIAL HANDLING EQUIPMENTS (Elective – I)
(15D34105)

UNIT I MATERIALS HANDLING EQUIPMENT
Types, selection and applications

UNIT II DESIGN OF HOISTS
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
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
Types - description - design and applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors.

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

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

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DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech – PRODUCT DESIGN

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

RAPID PROTOTYPING TECHNOLOGIES (Elective – I)

(Common to Energy Systems & Product Design)

(15D32108)

UNIT-I

Introduction: Need for the compression in product development, History of RP systems, Survey of applications, Growth of RP industry and classification of RP systems.

Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, Data files and machine details, Application.

Selective Laser Sintering: Type of machine, Principle of operation, Process parameters, Data preparation for SLS, Applications.

UNIT-II

Fusion Deposition Modelling: Principle, Process parameter,Path generation, Application

Solid Ground Curing: Principle of operation, Machine details, Applications.

UNIT-III

Laminated Object Manufacturing: Principle Of Operation, LOM materials.
Process details, application.

Concepts Modelers: Principle, Thermal jet printer, Sander's model market, 3-D printer. Genisys Xs printer HP system 5, Object Quadra systems.

UNIT-IV

LASER ENGINEERING NET SHAPING (LENS)

Rapid Tooling: Indirect Rapid tooling -Silicon rubber tooling –Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite, 3Q keltool, etc, Direct Rapid Tooling Direct. AIM, Quick cast process, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft, Tooling vs. hard tooling.

UNIT-V

Rapid Manufacturing Process Optimization: Factors influencing accuracy, Data preparation errors, Part building errors, Error in finishing, Influence of build orientation.

Allied Processes: Vacuum casting, surface digitizing, Surface generation from point cloud, Surface modification-data transfer to solid models.

TEXT BOOKS:

1. Rapid Prototyping and Tooling by Hari Prasad & K.S. Badhrinarayan/ Page Turners
2. Paul F. Jacobs- "**Stereo lithography and other RP & M Technologies**", SME, NY 1996.
3. Flham D.T & Dinjoy S.S - "**Rapid Manufacturing**" Verlog London 2001.
4. Lament wood, "**Rapid automated",** Indus press New York

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M.Tech – PRODUCT DESIGN

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

MECHANICAL BEHAVIOR OF MATERIALS (Elective – I)
(15D34106)

UNIT I BASIC CONCEPTS OF MATERIAL BEHAVIOR

Elasticity in metals and polymers– Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity –. Griffith‟s theory,– Ductile, brittle transition in steel – High temperature fracture, creep – Larson Miller parameter – Deformation and fracture mechanism maps.

UNIT II BEHAVIOUR UNDER DYNAMIC LOADS AND DESIGN APPROACHES

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

UNIT III SELECTION OF MATERIALS

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

UNIT IV MODERN METALLIC MATERIALS

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

UNIT V NON METALLIC MATERIALS

Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TIC, TaC, Al_2O3, SiC, Si_3N_4 CBN and diamond – properties, processing and applications.

REFERENCES

1. George E.Dieter, Mechanical Metallurgy, McGraw Hill, 1988
2. Thomas H. Courtney, Mechanical Behavior of Materials, (2nd edition), McGraw Hill, 2000
3. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials, (34d edition), Butterworth-Heiremann, 1997.
4. Flinn, R.A., and Trojan, P.K., Engineering Materials and their Applications, (4th Edition) Jaico, 1999.
5. Metals Hand book, Vol.10, Failure Analysis and Prevention, (10th Edition), Jaico, 1999.
6. Ashby M.F., materials selection in Mechanical Design 2nd Edition, Butter worth 1999.
www.astm.org/labs/pages/131350.htm.

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M.Tech – PRODUCT DESIGN

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

INDUSTRIAL DESIGN (Elective – I)
(15D34107)

UNIT I INTRODUCTION

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

UNIT II WORK PLACE AND EQUIPMENT DESIGN

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

UNIT III ENVIRONMENTAL DESIGN

Vision and illumination design – Climate, Noise, Motion, Sound, Vibration.

UNIT IV BIOMECHANICS, BIOTHERMODYNAMICS, BIOENERGETICS

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

UNIT V COGNITIVE ERGONOMICS & HUMAN FACTOR APPLICATION

Information Theory Information processing, Signal detection theory, Human response, human errors, cognitive task analysis. Human factors applications : Human error, accidents, human factors and the automobile, organizational and social aspects, steps according to ISO.DIS6385, OSHA‟s approach, virtual environments.

REFERENCES

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

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DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech – PRODUCT DESIGN

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

QUALITY CONCEPTS IN DESIGN (Elective – II)
(15D34108)

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

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

UNIT IV DESIGN OF EXPERIMENTS
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, 2^K 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
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

REFERENCES

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

2. Product Design Techniques in Reverse Engineering and New Product Development, KEVIN OTTO & KRISTIN WOOD, Pearson Education (LPE), 2001.

3. Product Design And Development, KARL T. ULRICH, STEVEN D. EPPINGER, TATA McGRAW-HILL- 3rd Edition, 2003.

4. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub:son south-western(www.swlearning.com)

5. Fundamentals of Quality control and improvement 2nd edition, AMITAVA MITRA, Pearson Education Asia, 2002.

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M.Tech – PRODUCT DESIGN

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

COMPOSITE MATERIALS AND MECHANICS (Elective – II)
(15D34109)

UNIT I INTRODUCTION TO COMPOSITE MATERIALS

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

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

Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke‟s Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Q_{ij}), 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

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

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

REFERENCES

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

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DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech – PRODUCT DESIGN

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

CREATIVITY AND INNOVATIONS IN DESIGN (Elective – II)
(Common to Energy Systems & Product Design)
(15D3212)

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

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

UNIT III CREATIVITY
Methods and tools for Directed Creativity – Basic Principles – Tools of Directed Creativity – Tools that prepare the mind for creative thought – stimulation of new ideas – Development and Actions: - 16 Processes in creativity ICEDIP – Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation The Bridge between man creativity and the rewards of innovativeness – Applying Directed Creativity to the challenge of quality management

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

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

REFERENCES
1. Rousing Creativity: Think New NowFloydHurr, ISBN 1560525479, Crisp Publications Inc. 1999
2. Geoffrey Petty," how to be better at Creativity", The Industrial Society 1999

3. Donald A. Norman," Emotional Design", Perseus Books Group New York , 2004
4. Clayton M. Christensen Michael E. Raynor," The Innovator‟s Solution", Harvard Business School Press Boston, USA, 2003
5. Semyon D. Savransky," Engineering of Creativity – TRIZ", CRC Press New YorkUSA," 2000

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAMU
DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech – PRODUCT DESIGN

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

ENTERPRISE RESOURCE PLANNING (Elective – II)
(15D34110)

UNIT I ENTERPRISE RESOURCE PLANNING
Principle – ERP framework – BusinessBlue Print – Business Engineeringvs Business process Re-Engineering – Tools – Languages – Value chain – Supply and Demand chain – Extended supply chain management – Dynamic Models –Process Models

UNIT II TECHNOLOGY AND ARCHITECTURE
Client/Server architecture – Technology choices – Internet direction – Evaluation framework – CRM – CRM pricing – chain safety – Evaluation framework.

UNIT III ERP SYSTEM PACKAGES
SAP,.People soft, Baan and Oracle – Comparison – Integration of different ERP applications – ERP as sales force automation – Integration of ERP and Internet – ERP Implementation strategies – Organisational and social issues.

UNIT IV
Overview – Architecture – AIM – applications – Oracle SCM. SAP : Overview – Architecture – applications -Before and after Y2k – critical issues – Training on various modules of IBCS ERP Package-Oracle ERP and MAXIMO, including ERP on the NET

UNIT V ERP PROCUREMENT ISSUES
Market Trends – Outsourcing ERP – Economics – Hidden Cost Issues – ROI – Analysis of cases from five Indian Companies.

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

JNTUACEA **R15**

2015-16

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAMU
DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech – PRODUCT DESIGN

I- SEMESTER	**L**	**P**	**C**
	-	**4**	**2**

COMPUTER AIDED ANALYSIS & DESIGN LAB
(15D34111)

SNo.	**LIST of EXPERIMENTS:**	**No. of EXPTS**
1.	2D and 3D Solid Modelling of Components using Auto CAD/Pro-E	:04
2.	3D Modelling of Mechanical Components using IRON-CAD	:04
3.	Assembly of Machine Components	:02
4.	Analysis of typical Mechanical Systems using any analysis package	:02
	Total No. of Experiments	:12

JNTUACEA **R15**

2015-16

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAMU
DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech – PRODUCT DESIGN

(II SEMESTER COURSE STRUCTURE AND SYLLABUS)

EFFECTIVE FROM THE YEAR 2015-16

II - SEMESTER:

Subject Code	SUBJECT	L	P	C
15D34201	Design for Manufacturing	4	-	4
15D34202	Optimization of Engineering Design	4	-	4
15D34203	Robust Design	4	-	4
15D34204	Creative Engineering Design-II	4	-	4
	ELECTIVE-III	4	-	4
15D32208	Product Planning and Marketing			
15D34205	Tribology in Design			
15D34206	Design of Hydraulic and Pneumatic Systems			
15D34207	Additive Manufacturing			
	ELECTIVE-IV	4	-	4
15D34208	Design for Manufacture Assembly and Environments			
15D34209	Advanced Metal Forming Techniques			
15D34210	Quality Concepts in Product Development			
15D32210	Reverse Engineering			
15D54201	Research Methodology (Audit Course)	3	-	-
15D34211	Simulation Lab	0	4	2
TOTAL		**24**	**4**	**26**

JNTUACEA **R15**

2015-16

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAMU
DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech – PRODUCT DESIGN

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

DESIGN FOR MANUFACTURING
(15D34201)

UNIT-I

System Concept-Elements of System- Types and Characteristics of System-System Design Approach- System Development- Stages and phases of Development-Documentation and Models in System Development

System Modelling and Theories, Modelling Process, System Theory, Black Box Approach and State Approach

UNIT-II

Mathematical Formulation in System design, LPP with Graphical solution, - Network Flow Analysis

System Evaluation, Evaluation Factors, Needs for Evaluation, Benefits, Types and Stages in System Evaluation

UNIT-III

System Reliability, Block diagram, Block Failure, Definition of Reliability, Reliability and Probability, Failure Rate, Estimation, Reliability Indices. Reliability Tests.

UNIT-IV

System simulation- Need for Simulation, Steps in simulation, Simulation Models.

System Approach to Project Management- Project Management Systems and Functional management System, Classification, Techniques and Objectives.

UNIT-V

Manufacturing Systems-Classifications, Introduction to FMS and Computer Integrated Manufacturing System - Concepts of Group Technology

TEXT BOOKS:

1. R.C.Mishra and Simant –"**Mechanical System Design"**
2. Arora.A.,and Bhatia A-**"Management Information System"**. Excell Publication, New Delhi
3. Gopal Krishna P., and P RamamoothyV.E., -"**Text Book of Project Management**", Macmillian, New Delhi.

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAMU
DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech – PRODUCT DESIGN

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

OPTIMIZATION OF ENGINEERING DESIGN
(15D34202)

UNIT I
Introduction: Optimal Problem formulation, engineering optimization problems- optimal design of a truss structure, an Ammonia reactor a transit schedule and a car suspension, Optimization Algorithms.

Single- variable optimization algorithms: Optimality criteria, bracketing methods, Region – elimination method, Point estimation method, Gradient –based method, Root- Finding using optimization technique.

UNIT II
Multivariable optimization algorithms: Optimality criteria unidirectional search, direct search methods-evolutionary optimization method, simplex search method, Hooke - Jeeves pattern search method, Powell's conjugate direction method. Gradient- based method – Cauchy's (steepest descent) method, Newton's method, Marquardt's method, Conjugate gradient method, Variable- metric method (DFP method)

UNIT III
Constrained Optimization Algorithms: Kuhn-Tucker conditions, Transformation methods-Penalty function method, method of multipliers, sensitivity analysis.

Direct search for constrained minimization: Variable elimination, complex search and random search methods, Linear search techniques-Frank-wolfe and cutting plane methods. Feasible direction, generalized reduced gradient and gradient projection methods.

UNIT IV
Specialized algorithms: Integer programming, Penalty function method, branch and bound method, Geometric programming

UNIT V
Nontraditional optimization algorithms: Genetic algorithm-working principle, Difference between GAs and traditional methods, Similarities between GAs and traditional methods, GAs for constrained optimization, other GA operators, real coded GAs, advanced Gas

Simulated Annealing, Global optimization-steepest descent method, Genetic algorithms and simulated annealing

TEXT BOOKS:

1. Kalyanmoy Deb- "**Optimization for Engineering Design"**

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M.Tech – PRODUCT DESIGN

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

ROBUST DESIGN
(15D34203)

UNIT – I

What is quality Fundamental principle, Tools used in robust design, Applications and benefits of robust design, Quality loss function – the fraction defective fallacy, noise factors- causes of variation, average quality loss, Exploiting Nonlinearity, classification of parameters: P Diagram, Optimization of product and process design.

UNIT – II

Matrix Experiment for a CVD process, Estimation of factor Effects, additive model ofr factor effects, Analysis of variance, prediction of Diagnosis, Steps in robust design. Temperature control circuit and its function, problem formulation.

UNIT – III

Optimization of polysilicon layer thickness uniformity, evaluation of sensitivity to noise, S/N Ratios for static problems, S/N Ratios for dynamic problems, analysis of ordered categorical data.

Quality characteristics and S/N Ratio, optimization of the design, tolerance design, reducing the simulation efforts, analysis of nonlinearity, selecting an appropriate S/N Ratio.

UNIT – IV

Guidelines for selecting Quality characteristics, Examples of Qaulity characteristics. Examples of S/N Ratios, selection of control factors, role of orthogonal arrays.

Computer aided robust design: Differential op-amp circuit, Description of noise factors, methods of simulating the variation in noise factors, orthogonal array based implantation of variation in noise factors.

UNIT – V

Counting degrees of freedom, selecting a standard orthogonal array, dummy level technique, compound factor method, linear graphs and interaction assignment, modification of linear graphs, column merging method, branching design, strategy for constructing an orthogonal array, comparison with the classical statistical experiment design.

REFERENCE BOOKS:

1. Robert H. Lochner and Joseph E. Matar – "Designing for Quality an Introduction, best of Taguchi and western methods of statistical experimental design.
2. Madhav S. Phadke – "Quality Engineering using Robust Design"
3. D.c. Montgomery – "Design of Experiments".
4. Philp J Ross – "Taguchi Techniques for Quality Engineering"
5. Taguchi G. Experimental design, "Maruzen Publishing Co", Tokyo 1981

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DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech – PRODUCT DESIGN

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

CREATIVE ENGINEERING DESIGN-II
(15D34204)

UNIT –I

Introduction: Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development.

Development Processes and Organizations: A generic development process, concept development: the front-end process, adopting the generic product development process, the AMF development process, product development organizations, the AMF organization.

UNIT-II

Product Planning: The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

Identifying Customer Needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.

UNIT-III

Product Specifications: What are specifications, when are specifications established, establishing target specifications, setting the final specifications.

Concept Generation: The activity of concept generation clarify the problem, search externally, search internally, explore systematically, reflect on the results and the process.

Concept Selection: Overview of methodology, concept screening, and concept scoring,

Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.

Product Architecture: What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.

UNIT-IV

INDUSTRIAL DESIGN: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assessing the quality of industrial design.

Design for Manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

Prototyping: Prototyping basics, principles of prototyping, technologies,
planning for prototypes.

UNIT-V

Product Development Economics: Elements of economic analysis, base case financial mode,. Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.

Managing Projects: Understanding and representing task, baseline project planning, accelerating projects, project execution, postmortem project evaluation.

TEXT BOOKS:

1. Karl.T.Ulrich, Steven D Eppinger, "**Product Design and Development"** Irwin McGrawHill-2000.

REFERENCE BOOKS:

1. A C Chitale and R C Gupta, PH1- **"Product Design and Manufacturing"**
2. Timjones. Butterworth Heinmann-"**New Product Development**" Oxford. UCI. 1997
3. Geoffery Boothroyd, Peter Dewhurst and Winston Knight- "**Product Design for Manufacture and Assembly"**

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M.Tech – PRODUCT DESIGN

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

PRODUCT PLANNING AND MARKETING (Elective-III)

(Common to Energy Systems & Product Design)
(15D32208)

UNIT-I

Classification of New Products: New products success and failure. Definition of success and failure, the latent Factors Behind the Marketing Success of New Products, Failure of New product, Factors Influencing Failure, Failures preventing new product Failure, New Product Development process and models, Model 1-The Cyclical Approach, Model 11-New product process Management

Concept Development and Statistical Tools Used : Introduction Common Sources for Product Ideas, Concept Development Methods, Idea Screening, idea Screening Approaches, Concept Testing, Definition, Methodology of Data Collection for Concept Testing, Data Analysis Techniques for Concept Testing, Concept Screen Test Method, Weighted Scoring Method, Concept Screening Matrix

UNIT-II

Diffusion of Innovation and Adoption Process : Introduction, Adoption Process, Five Stage Process, Time of Adoption, Characteristics of Adopters, Characteristics Affecting Adoption Rate, Diffusion of Innovation, Product Life Cycle Introduction, Basics of PLC, 3 Types of PLCs, Identification of Stages in a PLCSigma Method of Tracing the Product Life Cycle and Stages Identification.,

Product Mix : Introduction, Width, Length, Depth, And Consistency of Product mix, Product Lines, Product Strategies, Introduction, Types of Naming, Problem Faced due to Linguistic Differences, Branding Naming Strategies, Brand Naming Strategies, The Naming Process, The Dos and Don'ts While Naming Brands, Brand Names, Generalization.

UNIT-III

Test Marketing: Introduction, Objectives of Test Marketing-What to look for?, Pros and Cons of test Marketing, Decision Variables for Test Markets, Test Marketing Approaches, Types of Test Marketing Producers, Statistical Models for Analyzing Test Market Data, Data Project Method, Product Launch and Commercialization, The Product Launch Cycle,

The Launch Mix, Issues in Launch, The Product Launch Process, Effective Plan for Product Launch, Product Launch Mistakes

Brand Identity: Introduction, What Identity is not ? Dimensions and Identity, Inner and Outer Identity, The Six Sided Prism, How to find Identity? Multiple Identities, Conclusion, Brand Image, Brand Images of Some of the Indian Brands, Techniques Used for Identifying the Brand Image, Brand Networking Techniques, Focus Groups, Constructive Techniques, Factor Analysis.

UNIT-IV

Brand Personality: Introduction, Tools to Build/Understand Brand Personality, Brand personality Scale, Three Models to Build Brand Personality, Building Brand Personality Via the 4P's and Packaging, Building Brand Personality Bottom-up. Brand Positing and Repositioning Introduction, Grabbing the Mind Space, Positioning Statement, Determine the Positioning, The MDS Way, Image and Profile Analysis, Positioning through Correspondence Analysis, By factor Analysis, Positioning Analysis, by Discriminate Mapping, Repositioning, Brand Loyalty, Definition, Brand Loyalty Measurement Models, Preference Behavior Model, Purchase Probability Model, Brand Loyalty Analysis with Markov Chains, Strategies to Build Brand Loyalty, Building Loyalty Through Strategic Differentiation

UNIT-V

Line Extension: Introduction, Why Line Extension is so hard to resist ? A Good Marketing Strategy, Extension, Measuring the Line Extension Success Brand Extension Introduction, Asker and Keller's Success Factors, Internal and External Factors Affecting Firm, Inter Brand Success Factors, Sequential Introduction of Brand Extension, Process of Brand Extension, Brand Harvesting Introduction, Types of Harvesting, Activities Adopted during Harvesting Strategy, Planning the Harvesting Strategy Implementation.

TEXT BOOKS :

1. Gien L. Urban. John R. Hauser – "Design and Marketing of new products"
2. William L. Moore&Edgar – "Product Planning and Management", A. Pessemier AGILE MANUFACTURIN
3. Dr.C. Anandan "Product Management". Tata Mc Graw Hill Education Pvt. Ltd.,
4. Philip Kotler. "Marketing Management " Person Eduction Pvt Ltd.,
5. Dr. Venu Gopal Rao. "Product and Brand Management" Himalaya Publications.

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAMU
DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech - PRODUCTION DESIGN

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

TRIBOLOGY IN DESIGN (Elective-III)
(15D34205)

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

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

UNIT V HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION
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.

REFERENCES

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

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M.Tech PRODUCTION DESIGN

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS (Elective-III)
(15D34206)

UNIT I OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS
Hydraulic Power Generators – Selection and specification of pumps, pump characteristics. Linear and Rotary Actuators – selection, specification and characteristics.

UNIT II CONTROL AND REGULATION ELEMENTS
Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems.

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

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)

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M.Tech PRODUCTION DESIGN

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

ADDITIVE MANUFACTURING (Elective-III)
(15D34207)

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

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

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

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

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

REFERENCES

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.

2. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.

3. Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.

4. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications : A tool box for prototype development", CRC Press, 2011.

5. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.

6. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.

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DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech PRODUCTION DESIGN

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS
(Elective-IV)
(15D34208)

UNIT I INTRODUCTION

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

UNIT II FACTORS INFLUENCING FORM DESIGN

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

UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION

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

UNIT IV COMPONENT DESIGN – CASTING CONSIDERATION

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

UNIT V DESIGN FOR THE ENVIRONMENT

Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T‟s environmentally responsible product assessment - Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for remanufacture – Design for energy efficiency – Design to regulations and standards.

REFERENCES

1. Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker.
2. Bralla, Design for Manufacture handbook, McGraw hill, 1999.
3. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994. 4. Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.
5. Fixel, J. Design for the Environment McGraw hill., 1996.
6. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
7. Kevien Otto and Kristin Wood, Product Design. Pearson Publication, 2004.

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M.Tech PRODUCTION DESIGN

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

ADVANCED METAL FORMING TECHNIQUE (Elective-IV)
(15D34209)

UNIT I INTRODUCTION TO THEORY OF PLASTICITY AND FORMING

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

UNIT II THEORY AND PRACTICE OF BULK FORMING PROCESSES

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

UNIT III SHEET METAL FORMING

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

UNIT IV POWDER METALLURGY AND SPECIAL FORMING PROCESSES

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

UNIT V ELECTROMAGNETIC FORMING AND ITS APPLICATIONS

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

REFERENCES

1. Dieter G.E., Mechanical Metallurgy (Revised Edition II) McGraw Hill Co., 2004
2. Proceedings of International Workshop on EMFT 2010, Anna University
3. Altan T., Metal forming – Fundamentals and applications – American Society of Metals, Metals park, 2003.
4. ASM Hand book, Forming and Forging, Ninth edition, Vol – 14, 2003
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DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech PRODUCTION DESIGN

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

QUALITY CONCEPTS IN PRODUCT DEVELOPMENT (Elective-IV)
(15D34210)

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

UNIT II FAILURE MODES & EFFECT ANALYSIS
Basic methods: Refining geometry and layout, general process of product embodiment - Embodiment checklist- Advanced methods: systems modeling, mechanical embodiment principles-FMEA method- linking fault states to systems modeling

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

UNIT IV DESIGN OF EXPERIMENTS
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, 2^K 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
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

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II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

REVERSE ENGINEERING (Elective-IV)
(Common to Energy Systems & Product Design)
(15D32210)

UNIT I INTRODUCTION
Scope and tasks of RE - Domain analysis- process of duplicating

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

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

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

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

REFERENCES
1. Design Recovery for Maintenance and Reuse, T J Biggerstaff, IEEE Corpn. July 1991
2. White paper on RE, S. Rugaban, Technical Report, Georgia Instt. of Technology, 1994
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6. Co-ordinate Measurment and reverse engineering, Donald R. Honsa, ISBN 1555897, American Gear Manufacturers Association

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M.Tech – PRODUCT DESIGN

II- SEMESTER	**L**	**P**	**C**
	-	**4**	**2**

SIMULATION LAB
(15D34211)

CYCLE-I: DEMO EXPERIMENTS

1. MATLAB Commands and Examples
2. Built-in functions

RELIABILITY SOFTWARE MODULES

3. SPARE Software package
4. Failure Mode Software Package
5. FMEA-RPN Software package
6. SPC Software package

CYCLE-II: TESTING PROGRAMS

1. Characteristics of Binomial and Poisson distributions
2. Characteristics of Exponential and Weibull distributions
3. Characteristics of Normal and Log-Normal distributions
4. Determination of MTTF for series and parallel systems
5. Evaluation of Limiting State Probabilities (LSPs)
6. Evaluation of basic probability indices for series and parallel systems
7. Parametric Boot-Strap estimation and finding best parameters
8. Chi-Square Goodness of Fit
9. Determination of Covariance, Correlation and Cross-Correlation coefficients
10. Neural Network design to Block box models
11. Testing of sampling methods
12. Characteristics of Histogram, Scatter diagram, Process Flow diagram and Pareto diagram