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
5. SHIRO KOBAYASHI, SOO-IK-oh-ALTAN, T,Metal forming and Finite Element Method, Oxford University Press, 2001.
6. ALTAN.T, SOO-IK-oh, GEGEL, HL – Metal forming, fundamentals and Applications, American Society of Metals, Metals Park, Ohio, 1983.
7. Marciniak,Z., Duncan J.L., Hu S.J., „Mechanics of Sheet Metal Forming", Butterworth-Heinemann An Imprint of Elesevier, 2006
8. Proc. Of National Seminar on "Advances in Metal Forming" MIT, March 2000
9. SAE Transactions, Journal of Materials and Manufacturing Section 5, 1993-2007

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAMU
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

REFERENCES:

1. Product Design Techniques in Reverse Engineering and New Product Development, KEVIN OTTO & KRISTIN WOOD, Pearson Education (LPE), 2001.
2. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub:son south-western(www.swlearning.com)
3. Fundamentals of Quality control and improvement 2nd edition, AMITAVA MITRA, Pearson Education Asia, 2002.
4. Montgomery, D.C., Design and Analysis of experiments, John Wiley and Sons, 2003.
5. Phillip J.Rose, Taguchi techniques for quality engineering, McGraw Hill, 1996.

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DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech PRODUCTION DESIGN

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
3. Reverse Engineering, Katheryn, A. Ingle, McGraw-Hill, 1994
4. Data Reverse Engineering, Aiken, Peter, McGraw-Hill, 1996
5. Reverse Engineering, Linda Wills, Kluiver Academic Publishers, 1996
6. Co-ordinate Measurment and reverse engineering, Donald R. Honsa, ISBN 1555897, American Gear Manufacturers Association

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

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Course Structure of R21 Academic Regulations for M.Tech (Regular) Programs with effect from AY 2021-2022

DEPARTMENT OF MECHANICAL ENGINEERING

PRODUCT DESIGN

I SEMESTER

S.No.	Course Code	Subject Name	Cate Gory	Hours Per Week			Credits
				L	T	P	
1	21D34101	Computer Aided Engineering	PC	3	0	0	3
2	21D34102	Material Technology	PC	3	0	0	3
3	**Professional Elective – I**						
	21D34103	Rapid Prototyping Technologies	PE	3	0	0	3
	21D34104	Design of Material Handling Equipments					
	21D34105	Mechanical behavior of Materials					
4	**Professional Elective – II**						
	21D34106	Composite Materials and Mechanics	PE	3	0	0	3
	21D34107	Quality Concepts in Design					
	21D34108	Creativity and Innovations in Design					
5	21D11109	Research Methodology and IPR	MC	2	0	0	2
6	21D11110	English for Research Paper Writing	AC	2	0	0	0
	21D11111	Value Education					
	21D11112	Pedagogy Studies					
7	21D34109	Computer Aided Analysis & Design Lab	PC	0	0	4	2
8	21D34110	Material Testing Lab	PC	0	0	4	2
Total				**16**	**00**	**08**	**18**

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Course Structure of R21 Academic Regulations for M.Tech (Regular) Programs with effect from AY 2021-2022

DEPARTMENT OF MECHANICAL ENGINEERING

PRODUCT DESIGN

II SEMESTER

S.No.	Course Code	Subject Name	Cate Gory	Hours Per Week			Credits
				L	T	P	
1	21D34201	Design for Manufacturing	PC	3	0	0	3
2	21D34202	Robust Design	PC	3	0	0	3
3	**Professional Elective – III**						
	21D34203	Product Planning and Marketing	PE	3	0	0	3
	21D34204	Tribology in Design					
	21D34205	Design of Hydraulic and Pneumatic Systems					
4	**Professional Elective – IV**						
	21D34206	Advanced Metal Forming Techniques	PE	3	0	0	3
	21D34207	Quality Concepts in Product Development					
	21D34208	Reverse Engineering					
5	21D11209	Technical Seminar	PR	0	0	4	2
6	21D11210	Disaster Management	AC	2	0	0	0
	21D11211	Constitution of India					
	21D11212	Stress Management by Yoga					
7	21D34209	Simulation lab	PC	0	0	4	2
8	21D34210	Modeling and Analysis Laboratory	PC	0	0	4	2
Total				**14**	**00**	**12**	**18**

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Course Structure of R21 Academic Regulations for M.Tech (Regular) Programs with effect from AY 2021-2022

DEPARTMENT OF MECHANICAL ENGINEERING

PRODUCT DESIGN

III SEMESTER

S.No.	Course Code	Subject Name	Cate Gory	Hours Per Week			Credits
				L	T	P	
1	**Professional Elective – V**						
	21D33301	Fuel cell technology	PE	3	0	0	3
	21D33302	Specialty Engines					
	21D33303	Environmental Engineering and Pollution control					
2	**Open Elective**						
	21D30301	Mechatronics	OE	3	0	0	3
3	21D33304	Dissertation Phase – I	PR	0	0	20	10
4	21D00301	Co-Curricular Activities	PR				2
Total				**06**	**00**	**20**	**18**

IV SEMESTER

S.No.	Course Code	Subject Name	Cate Gory	Hours Per Week			Credits
				L	T	P	
1	21D33401	Dissertation Phase – II	PR	0	0	32	16
Total				**00**	**00**	**32**	**16**

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34101	COMPUTER AIDED ENGINEERING (21D34101)	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

1. Studentswilldemonstrateaptitudeinstandardnumericaltechniquesforsolvingvariousclasses ofproblems.
2. Studentswilllearnthetheoryunderlyingthe derivationofstandardnumericaltechniquesandthedevelopmentofalgorithms.
3. Modeling of engineering problems drawn from different disciplines of mechanicalengineering.

Course Outcomes (CO): Student will be able to

1. To enable students to formulate and solve engineering problems those are not amenable toanalyticalmethods.
2. Todemonstratetheapplicationof numericalmethodstodataanalysis andoptimaldesign.
3. To analyse and solve the axisymmetric problems
4. To analysethe heat transfer and fluid flow problems
5. To apply the problems on dynamic analysis for vibrations

UNIT – I — Lecture Hrs:

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

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

UNIT – II — Lecture Hrs:

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

UNIT – III — Lecture Hrs:

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

UNIT – IV — Lecture Hrs:

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 — Lecture Hrs:

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

Textbooks:

1. Tirupathi R. Chandrupatla, Ashok D Belegundu-“Introduction to FiniteElements in Engineering” (Third Edition) Prentice Hall India Pvt. Ltd., NewDelhi – 2003
2. Cook R.D, Malkus D.S &Plesha M.E-"Concepts and Applications of finiteElement 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 Edition,1984. 3. Bathe K .J-"Finite Element Procedures in Engineering Analysis", Prentice Hall,NewJersey, 1982. 4. Shames III &Dym C L- "Energy and Finite Element Methods in StructuralMechanics", Wiley Eastern Ltd, 1995,
Online Learning Resources:
https://nptel.ac.in/courses/112/104/112104031/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34102	MATERIALS TECHNOLOGY	L	T	P	C
Semester	I	(21D34102)	3	0	0	3

Course Objectives: The student will

- Learn the theory of the plasticity and elasticity
- Acquaint with various theories of fracture, crack deformation and propagation
- Learn the failure and fatigue aspects

Course Outcomes (CO): Student will be able to

- Understand the behavior of elastic and plastic property
- Apply the theory to fracture, fatigue and failure mechanisms
- Select the material for various applications
- Study the new metallic and non metallic materials

UNIT – I		Lecture Hrs:

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

UNIT – II		Lecture Hrs:

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

UNIT – III		Lecture Hrs:

Fatigue, Low and High cycle fatigue test, Crack Initiation and Propagation mechanism andparis 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		Lecture Hrs:

Motivation for selection, cost basis and service requirements, Selection for MechanicalProperties, 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 andNuclear Applications.

UNIT – V		Lecture Hrs:

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

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

Textbooks:

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.
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.
Online Learning Resources:
https://nptel.ac.in/courses/113/107/113107078/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34103	RAPID PROTOTYPING TECHNOLOGIES (21D34103) PE – I	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- To provide knowledge on different types of Rapid Prototyping systems and its applications in various fields

Course Outcomes (CO): Student will be able to

CO1: Describe product development, conceptual design and classify rapid prototyping systems; explain stereo lithography process and applications
CO2: Explain direct metal laser sintering, LOM and fusion deposition modeling processes
CO3: Demonstrate solid ground curing principle and process
CO4: Discuss LENS, BPM processes; point out the application of RP system in medical field define virtual prototyping and identify simulation components

UNIT - I		Lecture Hrs:

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, Datapreparation, Data files and machine details, Application.
Selective Laser Sintering: Type of machine, Principle of operation, Process parameters,Data preparation for SLS, Applications.

UNIT – II		Lecture Hrs:

Fusion Deposition Modelling: Principle, Process parameter,Path generation, Application
Solid Ground Curing: Principle of operation, Machine details, Applications.

UNIT – III		Lecture Hrs:

Laminated Object Manufacturing: Principle Of Operation, LOM materials.Process details, application.
Concepts Modelers: Principle, Thermal jet printer, Sander's model market, 3-D printer.GenisysXs printer HP system 5, Object Quadra systems.

UNIT – IV		Lecture Hrs:

LASER ENGINEERING NET SHAPING (LENS)
Rapid Tooling: Indirect Rapid tooling -Silicon rubber tooling –Aluminum filled epoxytooling Spray metal tooling, Cast kirksite, 3Q keltool, etc, Direct Rapid Tooling Direct.AIM, Quick cast process, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminatetooling soft, Tooling vs. hard tooling.

UNIT – V		Lecture Hrs:

Rapid Manufacturing Process Optimization: Factors influencing accuracy, Datapreparation errors, Part building errors, Error in finishing, Influence of build orientation.
Allied Processes: Vacuum casting, surface digitizing, Surface generation from pointcloud, Surface modification-data transfer to solid models.

Textbooks:

1. Rapid Prototyping and Tooling by Hari Prasad & K.S. Badhrinarayan/ PageTurners
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

Reference Books:
1. Flham D.T &Dinjoy S.S - "**Rapid Manufacturing**" Verlog London 2001. 2. Lament wood, "**Rapid automated",** Indus press New York
Online Learning Resources:
https://nptel.ac.in/courses/112/104/112104265/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34104	DESIGN OF MATERIAL HANDLING EQUIPMENTS (21D34104) PE – I	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- To develop competency for system visualization and design..
- To introduce student to optimum design and use optimization methods to design mechanical components.
- To enable student to design machine tool gearbox.
- To enable student to design material handling systems.

Course Outcomes (CO): Student will be able to

CO1: Understand the basic Fundamentals of Material Handling Equipment.
CO2: Design various hoisting elements like, chains, Hemp and wire ropes, Pulley systems, Sprockets & drums, forged hooks and eye hooks and Girders.
CO3: Design a Conveyors and Selection based on the Application.
CO4: Design of Bucket and Cage Elevator.

UNIT - I		Lecture Hrs:

MATERIALS HANDLING EQUIPMENT: Types, selection and applications

UNIT – II		Lecture Hrs:

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 hooksand eye hooks – crane grabs - lifting magnets - Grabbing attachments - Design of arresting gear -Brakes: shoe, band and cone types.

UNIT – III		Lecture Hrs:

DRIVES OF HOISTING GEAR: Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and monorailcranes - slewing, jib and luffing gear - cogwheel drive - selecting the motor ratings.

UNIT – IV		Lecture Hrs:

CONVEYORS: Types - description - design and applications of Belt conveyors, apron conveyors and escalatorsPneumatic conveyors, Screw conveyors and vibratory conveyors.

UNIT – V		Lecture Hrs:

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

Textbooks:

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.

Reference Books:

1. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.
2. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.
3. P.S.G. Tech., “Design Data Book”, KalaikathirAchchagam, Coimbatore, 2003.
4. Lingaiah. K. and NarayanaIyengar, “Machine Design Data Hand Book”, Vol. 1 & 2, SumaPublishers, Bangalore, 1983

R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Online Learning Resources:
https://nptel.ac.in/courses/112/107/112107142/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34105	MECHANICAL BEHAVIOR OF MATERIALS (21D34105)	L	T	P	C
Semester	I	PE – I	3	0	0	3

Course Objectives: Student will be able to

- Develop a working knowledge in deformation and fracture of materials and its relation to material microstructure.

Course Outcomes (CO): Student will be able to

CO1: Relate the mechanical properties of materials to their structure.
CO2: Select materials for structural applications
CO3: Solve realistic and/or fundamental problems relating to the mechanical behaviour of materials for individual solutions and tests.
CO4: Work in teams for the materials selection in design

UNIT - I		Lecture Hrs:

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

UNIT – II		Lecture Hrs:

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 nonmetallic materials – Failure analysis, sources of failure, procedure of failure analysis.

UNIT – III		Lecture Hrs:

SELECTION OF MATERIALS: Motivation for selection, cost basis and service requirements – Selection for mechanicalproperties, strength, toughness, fatigue and creep – Selection for surface durability corrosion andwear resistance – Relationship between materials selection and processing – Case studies inmaterials selection with relevance to aero, auto, marine, machinery and nuclear applications –Computer aided materials selection.

UNIT – IV		Lecture Hrs:

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		Lecture Hrs:

NON METALLIC MATERIALS: Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams,adhesives and coating – structure, properties and applications of engineering polymers – Advancedstructural ceramics, WC, TIC, TaC, Al2O3, SiC, Si3N4 CBN and diamond – properties, processingand applications.

Textbooks:

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, (3rd edition), Butterworth-Heiremann, 1997.

Reference Books:

1. Flinn, R.A., and Trojan, P.K., Engineering Materials and their Applications, (4th Edition) Jaico,1999.
2. Metals Hand book, Vol.10, Failure Analysis and Prevention, (10th Edition), Jaico, 1999.
3. Ashby M.F., materials selection in Mechanical Design 2nd Edition, Butter worth 1999. www.astm.org/labs/pages/131350.htm.

Online Learning Resources:

https://nptel.ac.in/courses/113/106/113106101/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34106	COMPOSITE MATERIALS AND MECHANICS (21D34106) PE – II	L	T	P	C
Semester	I		3	0	0	3

Course Objectives: Student will be able to

- Explain the behavior of constituents in the composite materials
- Enlighten the students in different types of reinforcement
- Develop the student's skills in understanding the different manufacturing methods available for composite material.
- Illuminate the knowledge and analysis skills in applying basic laws in mechanics to the composite materials.

Course Outcomes (CO): Student will be able to

CO1: Identify, describe and evaluate the properties of fibre reinforcements, polymer matrix materials and commercial composites.
CO2: Develop competency in one or more common composite manufacturing techniques, and be able to select the appropriate technique for manufacture of fibre-reinforced composite products.
CO3: Analyse the elastic properties and simulate the mechanical performance of composite laminates; and understand and predict the failure behaviour of fibre-reinforced composites
CO4: Apply knowledge of composite mechanical performance and manufacturing methods to a composites design project
CO5: Critique and synthesise literature and apply the knowledge gained from the course in the design and application of fibre-reinforced composites.

UNIT - I — Lecture Hrs:

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 andapplications of composites, Particulate-Reinforced composite Materials, Dispersion-Strengthenedcomposite, Fiber-reinforced composites Rule of mixtures-Characteristics of fiber-Reinforcedcomposites, Manufacturing fiber and composites.

UNIT – II — Lecture Hrs:

MANUFACTURING OF COMPOSITES

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

UNIT – III — Lecture Hrs:

INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS

Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint.Generalized Hooke‟s Law. Reduction to Homogeneous Orthotropic Lamina – Isotropiclimit case, Orthotropic Stiffness matrix (Qij), Definition of stress and Moment Resultants.Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates.Laminate

Constitutive Equations – Coupling Interactions, Balanced Laminates, SymmetricLaminates, 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		Lecture Hrs:

LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATEDFLAT PLATES

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion forIsotropic Materials. Generalized Hill‟s Criterion for Anisotropic materials. Tsai-Hill‟sFailure 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		Lecture Hrs:

THERMAL ANALYSIS

Assumption of Constant Co-efficient of Thermal Expansion (C.T.E.) - Modification ofHooke‟s Law. Modification of Laminate Constitutive Equations. Orthotropic LaminaC.T.E‟s. C.T.E‟s for special Laminate Configurations – Unidirectional, Off-axis,Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-IsotropicLaminates

Textbooks:

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 OriIshai, “Engineering Mechanics of Composite Materials”,Oxford University Press-2006, First Indian Edition - 2007

Reference Books:

1. Mallick, P.K., Fiber –”Reinforced Composites: Materials, Manufacturing and Design”, ManeelDekker Inc, 1993.
2. Halpin, J.C., “Primer on Composite Materials, Analysis”, Techomic Publishing Co., 1984.
3. Agarwal, B.D., and Broutman L.J., “Analysis and Performance of Fiber Composites”, John Wiley and Sons, New York, 1990.
4. Mallick, P.K. and Newman, S., (edition), “Composite Materials Technology: Processes and Properties”, Hansen Publisher, Munish, 1990.
5. MadhujitMukhopadhyay, “Mechanics of Composite Materials and Structures”, University Press(India) Pvt. Ltd., Hyderabad, 2004 (Reprinted 2008)
6. Chung, Deborah D.L., “Composite Materials: Science and Applications”, Ane Books Pvt.Ltd./Springer, New Delhi, 1st Indian Reprint, 2009

Online Learning Resources:

https://nptel.ac.in/courses/112/104/112104168/

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Ananthapuramu – 515 002, Andhra Pradesh, India

R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34107	QUALITY CONCEPTS IN DESIGN (21D34107) PE - II	L	T	P	C
Semester	I		3	0	0	3

Course Objectives: Student will be able

- To understand the concept of Quality
- To understand the Implication of Quality on Business
- To Implement Quality Implementation Programs
- To have exposure to challenges in Quality Improvement Programs

Course Outcomes (CO): Student will be able to

CO1. Adequate knowledge acquisition on how quality is a KPI in accomplishment of organizational objectives.
CO2. Ability to design quality frameworks exploring industrial applications to ensure quality towards operational excellence.
CO3. Examine the role of business process and assess the need for the quality metric of six sigma for quality control

UNIT - I		Lecture Hrs:

DESIGN FUNDAMENTALS, METHODS AND MATERIAL SELECTION

Morphology of Design – The Design Process – Computer Aided Engineering – ConcurrentEngineering – 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		Lecture Hrs:

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 conformingfactor-Set points-reflecting and repeating.

UNIT – III		Lecture Hrs:

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 selectionfor 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		Lecture Hrs:

DESIGN OF EXPERIMENTS

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

UNIT – V		Lecture Hrs:

STATISTICAL CONSIDERATION AND RELIABILITY

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

Textbooks:

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, TATAMcGRAW-HILL- 3rd Edition, 2003.

Reference Books:

1. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub:sonsouth-western(www.swlearning.com)
2. Fundamentals of Quality control and improvement 2nd edition, AMITAVA MITRA, PearsonEducation

Online Learning Resources:

https://nptel.ac.in/courses/112/106/112106249/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34108	CREATIVITY AND INNOVATIONS IN DESIGN (21D34108) PE - II	L	T	P	C
Semester	I		3	0	0	3

Course Objectives: Student will be able

- To define the strategic frames where the product/service innovation should be implemented, by using scenario and system analysis.
- To manage and lead design workgroups with multidisciplinary competences, a mandatory requirement to innovative design, with methods or approaches that ensures a harmonious convergence towards the customer final satisfaction.

Course Outcomes (CO): Student will be able to

CO1: Appreciate the imperative of innovation within society to dispel common misconceptions regarding innovation and creativity;
CO2: Critically analyse theories of innovation and creativity;
CO3: Use evidence to critically challenge innovation practices and communicate recommended behavioural changes;
CO4: Identify possible changes in established environments and routines to challenge status quo.

UNIT - I		Lecture Hrs:

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

UNIT – II		Lecture Hrs:

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

UNIT – III		Lecture Hrs:

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

UNIT – IV		Lecture Hrs:

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

UNIT – V		Lecture Hrs:

R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

INNOVATION: Achieving Creativity – Introduction to TRIZ methodology of Inventive Problem Solving – theessential factors – Innovator's solution – creating and sustaining successful growth – DisruptiveInnovation model – Segmentive Models – New market disruption - Commoditation and DEcommoditation– Managing the Strategy Development Process – The Role of Senior Executive inLeading New Growth – Passing the Baton
Textbooks:
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
Reference Books:
1. Clayton M. Christensen Michael E. Raynor," The Innovator's Solution", Harvard BusinessSchool Press Boston, USA, 2003 2. Semyon D. Savransky," Engineering of Creativity – TRIZ", CRC Press New YorkUSA," 2000
Online Learning Resources:
https://nptel.ac.in/courses/107/103/107103082/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34109	COMPUTER AIDED ANALYSIS & DESIGN LAB (21D34109)	L	T	P	C
Semester	I		0	0	4	2

Course Objectives:

Students gain and apply knowledge of advanced CAD concepts and techniques by using high-end CAD systems.

Course Outcomes (CO):

CO 1: Analyze different engineering problems using ansys software
CO 2 : Perform the stress analysis of 3D structure
CO 3 : Perform buckling analysis of column structure
CO 4 : Analyse the thermal problems

List of Experiments:

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 Number of Experiments: 12		

References:

Online learning resources/Virtual labs:

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34110	MATERIAL TESTING LAB (21D34110)	L	T	P	C
Semester	I		0	0	4	2

Course Objectives:

To test several properties of material like ductility, surface roughness, malleability, hardenability etc.

Course Outcomes (CO):

CO1: Ability to relate properties of microstructure.
CO2: Understand various crystal structures.
CO3: To study the thermosetting of ferrous and non ferrous materials.
CO4: To test magnetic defects of material.
CO5: To test the strength of material.

List of Experiments:

1. Preparation and study of the Micro Structure of pure metals like Iron, Cu and Al.
2. Preparation and study of the Microstructure of Mild steels, low carbon steels, high – C steels.
3. Hardenability of steels by Jominy End Quench Test.
4. To find out the hardness of various treated and untreated steels.
5. Study of the Micro Structures of Cast Irons.
6. Study of the Micro Structures of Non-Ferrous alloys.
7. Study of the Micro structures of Heat treated steels.

References:

Online learning resources/Virtual labs:

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34201	DESIGN FOR MANUFACTURING (21D34201)	L	T	P	C
Semester	II		3	0	0	3

Course Objectives:

- Design for assembly (DFA) seeks to simplify the product so that the cost of assembly is reduced. Consequently, applications of DFA principles to product design usually result in improved quality and reliability and a reduction in production equipment and part inventory.

Course Outcomes (CO): Student will be able to

CO1: Outline the appropriate design for economical production and select the materials.
CO2: Select between various machining and metal joining processes.
CO3: Apply a systematic understanding of knowledge in the field of metal casting and forging.
CO4: Fabricate basic parts and assemblies using powered and non – powered machine shop equipment in conjunction with mechanical documentation.
CO5: Integrate the knowledge of compliance analysis and interference analysis for assembly and also use visco-elastic and creep in plastics.

UNIT - I	Lecture Hrs:

System Concept-Elements of System- Types and Characteristics of System-System DesignApproach- System Development- Stages and phases of Development-Documentation andModels in System DevelopmentSystem Modelling and Theories, Modelling Process, System Theory, Black Box Approachand State Approach

UNIT – II	Lecture Hrs:

Mathematical Formulation in System design, LPP with Graphical solution, - Network FlowAnalysisSystem Evaluation, Evaluation Factors, Needs for Evaluation, Benefits, Types and Stagesin System Evaluation

UNIT – III	Lecture Hrs:

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

UNIT – IV	Lecture Hrs:

System simulation- Need for Simulation, Steps in simulation, Simulation Models.
System Approach to Project Management- Project Management Systems and Functionalmanagement System, Classification, Techniques and Objectives.

UNIT – V	Lecture Hrs:

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

Textbooks:

1. R.C.Mishra and Simant –"Mechanical System Design"
2. Arora.A.,and Bhatia A-"Management Information System". Excell Publication,New Delhi

Reference Books:

1. Gopal Krishna P., and P RamamoothyV.E.,"Text Book of ProjectManagement", Macmillian, New Delhi.

Online Learning Resources:

1. https://nptel.ac.in/courses/112/101/112101005/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34202	ROBUST DESIGN	L	T	P	C
Semester	II	(21D34202)	3	0	0	3

Course Objectives:

- Create designs that have a minimal sensitivity to input variation
- Reduce design costs
- Determine which design parameters have the largest impact on variation
- Optimize designs with multiple output

Course Outcomes (CO): Student will be able to

- Given a set process data, characterize the process behavior using descriptive statistics.
- Identify if the process is in-control. If not, identify special patterns that may exist. Given a measurement system, design a plan to identify if the measurement system is capable.
- Design experiments to identify the main effects, interaction effects and their significance.
- Design fractional factorial experiments to identify the main effects and confounding structures.

UNIT - I	Lecture Hrs:

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

UNIT – II	Lecture Hrs:

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

UNIT – III	Lecture Hrs:

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

UNIT – IV	Lecture Hrs:

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 implantationof variation in noise factors.

UNIT – V	Lecture Hrs:

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

R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Textbooks:
1. Robert H. Lochner and Joseph E. Matar – "Designing for Quality an Introduction, 2. best of Taguchi and western methods of statistical experimental design. 3. Madhav S. Phadke – "Quality Engineering using Robust Design" 4. D.c. Montgomery – "Design of Experiments".
Reference Books:
1. Philp J Ross – "Taguchi Techniques for Quality Engineering" 2. Taguchi G. Experimental design, "Maruzen Publishing Co", Tokyo 1981
Online Learning Resources:
1. https://nptel.ac.in/content/storage2/courses/110101010/downloads/mod3/Modue%20III-Lec4.pdf

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34203	PRODUCT PLANNING AND MARKETING (21D34203)	L	T	P	C
Semester	II	PE – III	3	0	0	3

Course Objectives:

- The students will learn about product planning and development from a strategic perspective.
- To enhance students' understanding of factors affecting the implementation of strategic plans, this course highlights methods for the management of new products in companies.

Course Outcomes (CO): Student will be able to

CO1: Identify and analyse the strategic elements of product development processes.
CO2: Develop a product innovation charter.
CO3: Apply idea generation techniques, and
CO4: Create and test viable product concepts using appropriate assessment techniques.
CO5: Assess the challenges and opportunities associated with the launch of new products.

UNIT - I Lecture Hrs:

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

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

UNIT – II Lecture Hrs:

Diffusion of Innovation and Adoption Process : Introduction, Adoption Process, FiveStage Process, Time of Adoption, Characteristics of Adopters, Characteristics AffectingAdoption Rate, Diffusion of Innovation, Product Life Cycle Introduction, Basics of PLC, 3Types of PLCs, Identification of Stages in a PLCSigma Method of Tracing the ProductLife 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 toLinguistic Differences, Branding Naming Strategies, Brand Naming Strategies, The Naming Process, The Dos and Don'ts While Naming Brands, Brand Names,Generalization.

UNIT – III Lecture Hrs:

Test Marketing: Introduction, Objectives of Test Marketing-What to look for?, Pros andCons 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 forProduct 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

forIdentifying the Brand Image, Brand Networking Techniques, Focus Groups, Constructive Techniques, Factor Analysis.		
UNIT – IV		Lecture Hrs:
Brand Personality: Introduction, Tools to Build/Understand Brand Personality, Brand personality Scale, Three Models to Build Brand Personality, Building Brand PersonalityVia the 4P's and Packaging, Building Brand Personality Bottom-up. Brand Positing andRepositioning 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		Lecture Hrs:
Line Extension: Introduction, Why Line Extension is so hard to resist? A GoodMarketing Strategy, Extension, Measuring the Line Extension Success Brand ExtensionIntroduction, Asker and Keller's Success Factors, Internal and External Factors AffectingFirm, Inter Brand Success Factors, Sequential Introduction of Brand Extension, Process ofBrand Extension, Brand Harvesting Introduction, Types of Harvesting, Activities Adoptedduring Harvesting Strategy, Planning the Harvesting Strategy Implementation.		
Textbooks:		
1. Gien L. Urban. John R. Hauser – "Design and Marketing of new products" 2. William L. Moore&Edgar – "Product Planning and Management", A. PessemierAGILE MANUFACTURIN 2. Dr.C. Anandan "Product Management". Tata McGraw Hill Education Pvt. Ltd.,		
Reference Books:		
1. Philip Kotler. "Marketing Management " Person EductionPvt Ltd., 2. Dr. VenuGopalRao. "Product and Brand Management" Himalaya Publications.		
Online Learning Resources:		
1. https://nptel.ac.in/courses/110/104/110104070/		

R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34204	TRIBOLOGY IN DESIGN (21D34204)	L	T	P	C
Semester	II	PE – III	3	0	0	3

Course Objectives:

- To provide the knowledge and importance of Tribology in Design, friction, wear and lubrication aspects of machine components.
- To understand the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques.

Course Outcomes (CO): Student will be able to

CO1: understanding of friction, lubrication, and wear processes.
CO2: familiar with common anti-friction and anti-wear components and the lubricants used therein.
CO3: describe the detailed operation of selected anti-friction or anti-wear components.
CO4: design a tribological system for optimal performance
CO5: develop technical project reports and technical presentations.

UNIT - I Lecture Hrs:

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-metallicmaterials – friction in extreme conditions –Thermal considerations in sliding contact

UNIT – II Lecture Hrs:

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 coatingsmethods- Surface Topography measurements –Laser methods – instrumentation – Internationalstandards in friction and wear measurements

UNIT – III Lecture Hrs:

LUBRICANTS AND LUBRICATION REGIMES

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

UNIT – IV Lecture Hrs:

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

UNIT – V		Lecture Hrs:

HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMICLUBRICATION

Rolling contacts of Elastic solids- contact stresses – Hertzian stress equation- Spherical andcylindrical contacts-Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubricationTheory-Soft and hard EHL-Reynolds equation for elasto hydrodynamic lubrication- Film shapewithin and outside contact zones-Film thickness and friction calculation- Rolling bearings- Stressesand deflections-Traction drives.

Textbooks:

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.

Reference Books:

1. S.K.Basu, S.N.Sengupta&B.B.Ahuja ,”Fundamentals of Tribology”, Prentice –Hall of India PvtLtd , New Delhi, 2005
2. G.W.Stachowiak& A.W .Batchelor , Engineering Tribology, Butterworth-Heinemann, UK,2005

Online Learning Resources:

1. https://nptel.ac.in/courses/112/102/112102015/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34205	DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS (21D34205) PE – III	L	T	P	C
Semester	II		3	0	0	3

Course Objectives: Student will be able

1. To provide fundamental knowledge of components forming pneumatic and hydraulic systems.
2. To analyze pneumatic and hydraulic circuits.
3. To learn graphical symbols conforming to international standards for various fluid power components.

Course Outcomes (CO): Student will be able to

CO1. Provide a knowledge base of the main components of the hydraulic and pneumatic systems and their functions and symbols.
CO2. Know the advantages and disadvantages of hydraulic/pneumatic systems, and be aware of the underlying principles.
CO3. Design and predict simple linear actuator and hydrostatic transmission circuits.
CO4. Select hydraulic fluids based on their classifications and properties.
CO5. Describe the construction, operation principles, and uses of auxiliary equipment, such as filters, oil coolers, oil heater and accumulators

UNIT - I Lecture Hrs:

OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS

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

UNIT – II Lecture Hrs:

CONTROL AND REGULATION ELEMENTS

Pressure - direction and flow control valves - relief valves, non-return and safety valves – actuationsystems.

UNIT – III Lecture Hrs:

HYDRAULIC CIRCUITS

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

UNIT – IV Lecture Hrs:

PNEUMATIC SYSTEMS AND CIRCUITS

Pneumatic fundamentals - control elements, position and pressure sensing - logic circuits switching circuits - fringe conditions modules and these integration - sequential circuits – cascademethods - mapping methods - step counter method - compound circuit design - combination circuitdesign.

UNIT – V Lecture Hrs:

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.

Textbooks:
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.
Reference Books:
1. Bolton. W., "Pneumatic and Hydraulic Systems ", Butterworth –Heinemann, 1997. 2. K.ShanmugaSundaram, "Hydraulic and Pneumatic Controls: Understanding made Easy"S.Chand& Co Book publishers, New Delhi, 2006 (Reprint 2009)
Online Learning Resources:
1. https://nptel.ac.in/content/storage2/courses/112106175/Module%201/Lecture%201.pdf

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34207	ADVANCED METAL FORMING TECHNIQUE (21D34207)	L	T	P	C
Semester	II	PE – IV	3	0	0	3

Course Objectives: student will be able to

- Learn the principles of metal forming for different types of materials
- understand tooling and equipments required for important metal forming processes

Course Outcomes (CO): Student will be able to

CO1. Determine major process/processes of manufacturing used for given application.
CO2. Explain when and why metal forming is chosen compared to other compatible methods.
CO3. Analyze effect of parameters influencing metal forming and compare hot working and cold working with applications.
CO4. Explain capabilities and applications of bulk metal forming processes and sheet metal work.

UNIT - I Lecture Hrs:

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 sphericalco-ordinate system – upper and lower bound solution methods – thermo elastic Elasto plasticity –elastovisco plasticity

UNIT – II Lecture Hrs:

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, equipmentused – Defects – applications – Recent advances in Forging, Rolling, Extrusion and Drawingprocesses – Design consideration in forming - Formability of laminated sheet - Overview of FEMapplications in Metal Forming analysis.

UNIT – III Lecture Hrs:

SHEET METAL FORMING

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

UNIT – IV Lecture Hrs:

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 – Hotand cold isostatic pressing – High speed extrusion – Rubber pad forming – Fine blanking – LASERbeam forming

UNIT – V Lecture Hrs:

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.

Textbooks:

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, Metalspark, 2003.

Reference Books:

1. ASM Hand book, Forming and Forging, Ninth edition, Vol – 14, 2003
2. SHIRO KOBAYASHI, SOO-IK-oh-ALTAN, T,Metal forming and Finite Element Method,Oxford University Press, 2001.
3. ALTAN.T, SOO-IK-oh, GEGEL, HL – Metal forming, fundamentals and Applications,American Society of Metals, Metals Park, Ohio, 1983.

Online Learning Resources:

1. https://nptel.ac.in/courses/112/107/112107250/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34207	QUALITY CONCEPTS IN PRODUCT DEVELOPMENT (21D34207) PE – IV	L	T	P	C
Semester	II		3	0	0	3

Course Objectives:

- The objective of product development is to cultivate, maintain and increase a company's market share by satisfying a consumer demand.

Course Outcomes (CO): Student will be able to

CO1: Learn the regulatory principles and requirements of drug discovery and developments
CO2: Understand the concept of pre-formulation studies for various formulations
CO3: Learn the concept of technology transfer from R&D to production plant
CO4: Discuss on the new era opportunities and challenges in the pharmaceutical market
CO5: Know the basics of stability studies during formulation development

UNIT - I Lecture Hrs:

DESIGN FOR QUALITY

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

UNIT – II Lecture Hrs:

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 Lecture Hrs:

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 SIGMAand services

UNIT – IV Lecture Hrs:

DESIGN OF EXPERIMENTS

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

UNIT – V Lecture Hrs:

STATISTICAL CONSIDERATION AND RELIABILITY

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

R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Textbooks:
1. Product Design Techniques in Reverse Engineering and New Product Development, KEVINOTTO & KRISTIN WOOD, Pearson Education (LPE), 2001. 2. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub:sonsouth-western(www.swlearning.com)
Reference Books:
1. Fundamentals of Quality control and improvement 2nd edition, AMITAVA MITRA, PearsonEducation Asia, 2002. 2. Montgomery, D.C., Design and Analysis of experiments, John Wiley and Sons, 2003. 3. Phillip J.Rose, Taguchi techniques for quality engineering, McGraw Hill, 1996.
Online Learning Resources:
1. https://nptel.ac.in/courses/112/104/112104230/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34208	REVERSE ENGINEERING (21D34208)	L	T	P	C
Semester	II	PE – IV	3	0	0	3

Course Objectives:

- The purpose of reverse engineering is to facilitate the maintenance work by improving the understandability of a system and to produce the necessary documents for a legacy system.

Course Outcomes (CO): Student will be able to

CO1. Understand the problem in the existing process.
CO2. Collect the large number of data/ information for the product
CO3. Depth analyze of the products and extraction of real time data
CO4. Understand the principles behind the design of the product, ways to redesign and improve the performance of the system

UNIT - I Lecture Hrs:

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

UNIT – II Lecture Hrs:

TOOLS FOR RE
Functionality- dimensional- developing technical data - digitizing techniques - construction ofsurface model - solid-part material- characteristics evaluation -software and applicationprototyping- verification

UNIT – III Lecture Hrs:

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 Lecture Hrs:

DATA MANAGEMENT
Data reverse engineering – Three data Reverse engineering strategies – Definition – organizationdata issues - Software application – Finding reusable software components – Recycling real-timeembedded software – Design experiments to evaluate a Reverse Engineering tool – Rule baseddetection for reverse Engineering user interfaces – Reverse Engineering of assembly programs: Amodel based approach and its logical basics

UNIT – V Lecture Hrs:

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

Textbooks:

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

3. Reverse Engineering, Katheryn, A. Ingle, McGraw-Hill, 1994
4. Data Reverse Engineering, Aiken, Peter, McGraw-Hill, 1996

Reference Books:

1. Reverse Engineering, Linda Wills, Kluiver Academic Publishers, 1996
2. Co-ordinate Measurement and reverse engineering, Donald R. Honsa, ISBN 1555897, AmericanGear Manufacturers Association

Online Learning Resources:

1. http://www.digimat.in/nptel/courses/video/112102101/L52.html

R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34209	SIMULATION LAB (21D34209)	L	T	P	C
Semester	II		0	0	4	2

Course Objectives: Student will be able to

- To impart the fundamental knowledge on using various analytical tools like ANSYS, FLUENT, etc., for Engineering Simulation. ..
- To impart knowledge on how these tools are ued in Industries by solving some real time problems using these tools..

Course Outcomes (CO): Student will be able to

CO1: Apply built-in functions in MATLAB/ SCILAB to solve numerical problems
CO 2: Develop code for solving problems involving different types of mathematical models and equations (ODE, PDE, Linear and nonlinear equations).
CO3: Solve simulation problems encountered in mechanical design, vibration analysis and CAD
CO4: Model a system and Develop a simulation code towards a mini project

LIST OF EXPERIMENTS:

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 Paretodiagram

References:

Online learning resources/Virtual labs:

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34210	MODELING AND ANALYSIS LABORATORY (21D34210)	L	T	P	C
Semester	II		0	0	4	2

Course Objectives: Student will be able to

- To acquire basic understanding of Modeling and Analysis software
- To understand the different kinds of analysis and apply the basic principles to find out the stress and other related parameters of bars, beams loaded with loading conditions

Course Outcomes (CO): Student will be able to

CO1: Develop programs for modeling the synthetic curves and surfaces.
CO 2: Develop finite element code to solve problems involving Trusses, Beams and Frames
CO3: Build 2D and 3D objects using a modeling software
CO4: Solve structural problems using finite element software
CO5: Execute mini project involving both modeling and analysis

LIST OF EXPERIMENTS:

1. Develop Programs for Transformations in CAD
2. Develop Programs for Synthetic Curves in CAD
3. Introduction to Pro/E and working with features like Extrude & Revolve in sketch mode
4. Model solids with features like Hole, Round, Chamfer and Rib
5. Model solids with features like Pattern, Copy, Rotate, Move and Mirror
6. Assembly modelling in Pro/E, Generating, editing and modifying drawings in Pro/E
7. Solution of Trusses problems using the developed code
8. Solution of Beams and Frames using the developed code
9. Solution of problems involving triangular element using the developed code
10. Solution of problems of Trusses using ANSYS
11. Solution of problems of Beams and Frames using ANSYS
12. Solution of problems involving triangular element etc. using ANSYS

References:

Online learning resources/Virtual labs:

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code		Program Elective Course – V	L	T	P	C
Semester	III	a. APPLIED ERGONOMICS	3	0	0	3

Course Objectives: Student will be able to

- to increase awareness of the need for and role of ergonomics in occupational health
- to obtain basic knowledge in the application of ergonomic principles to design of industrial workplaces and the prevention of occupational injuries
- to understand the breadth and scope of occupational ergonomics

Course Outcomes (CO): Student will be able to

CO1: Initiate or improve ergonomics programs to optimize system performance and well-being
CO2: Determine the roles and responsibilities of an installation Ergonomics Program
CO3: Develop work areas to accommodate a diverse work population
CO4:Perform work site analysis to identify, evaluate, and control risk factors that contribute to work-related musculoskeletal disorders

UNIT - I		Lecture Hrs:

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

UNIT – II		Lecture Hrs:

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		Lecture Hrs:

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		Lecture Hrs:

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		Lecture Hrs:

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

Textbooks:

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

Reference Books:

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
Online Learning Resources:
https://nptel.ac.in/courses/107/103/107103012/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code	21D34302	ADDITIVE MANUFACTURING (PE – V)	L	T	P	C
Semester	III		3	0	0	3

Course Objectives: Student will be able to

1. To introduce students the basics of additive manufacturing/rapid prototyping and its applications in various fields, reverse engineering techniques.
2. To teach students about mechanical properties and geometric issues relating to specific rapid prototyping applications.

Course Outcomes (CO): Student will be able to

CO1: describe additive manufacturing and explain its advantages and disadvantages
CO2: explain the processes used in additive manufacturing for a range of materials and applications
CO3: understand the role of additive manufacturing in the design process and the implications for design
CO4: describe the effects of surface finish and microstructural properties on behaviour for components produced using additive manufacturing
CO5: display an awareness of residual stresses that may occur during additive manufacturing and their effects.

UNIT - I **Lecture Hrs:**

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 **Lecture Hrs:**

REVERSE ENGINEERING AND CAD MODELING:
Basic concept- Digitization techniques – Model reconstruction – Data Processing for RapidPrototyping: CAD model preparation, Data requirements – Geometric modeling techniques:Wireframe, surface and solid modeling – data formats - Data interfacing, Part orientation and supportgeneration, Support structure design, Model Slicing, Tool path generation-Software for AM- Casestudies.

UNIT – III **Lecture Hrs:**

LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURINGSYSTEMS:
Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-buildprocesses, photo polymerization of SL resins, part quality and process planningrecoating 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 **Lecture Hrs:**

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

R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

UNIT – V		**Lecture Hrs:**

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.

Textbooks:

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: RapidPrototyping to Direct Digital Manufacturing", Springer, 2010.
2. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", secondedition, 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 forprototype development", CRC Press, 2011.

Reference Books:

1. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
2. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRCpress, 2005

Online Learning Resources:

https://nptel.ac.in/courses/112/103/112103306/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code		Program Elective Course – V	L	T	P	C
Semester	III	b. INDUSTRIAL DESIGN	3	0	0	3

Course Objectives:

1. Understanding the user-centred design process including form and colour theory.
2. Understanding product metamorphosis, and ergonomics.

Course Outcomes (CO): Student will be able to

CO1. Ability to carry out product design through proper observation.
CO2. Ability to generate design concepts for different types of users.
CO3. Understanding the cognitive, morphological process inherent in applying form analogies.
CO4. Ability to do implement sustainable design and to evaluate the prototype.

UNIT - I		Lecture Hrs:

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		Lecture Hrs:

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		Lecture Hrs:

ENVIRONMENTAL DESIGN

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

UNIT – IV		Lecture Hrs:

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		Lecture Hrs:

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.
Textbooks:
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.
Reference Books:
1. Martin Helander, A guide to Human Factors and Ergonomics, 2nd Edition, CRC, Taylor & Francis Group 2006.5. Kamrani, A.K. and Nasr, E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.
Online Learning Resources:
https://nptel.ac.in/courses/107/103/107103004/

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DEPARTMENT OF MECHANICAL ENGINEERING
(PRODUCT DESIGN)

Course Code		Open Elective	L	T	P	C
Semester	III	Mechatronics	3	0	0	3

Course Objectives:

To impart knowledge on

To impart knowledge on about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation.

Course Outcomes (CO): Student will be able to

1.Students can able to understand the concepts,need and importance of mechatronics.
2. They can able to know the concepts of 8085 microprocessor, 8051 microcontroller
3. They can able to understand the Programmable peripheral Interface
4. Students can able to know the structure, programming and selection of PLC
5. They can able to know the working principle and design concepts of actuators, mechatronic system.

UNIT – I	Lecture Hrs:

Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors.

UNIT – II	Lecture Hrs:

8085 MICROPROCESSOR AND 8051 MICROCONTROLLER
Introduction – Architecture of 8085– Pin Configuration – Addressing Modes –Instruction set, Timing diagram of 8085 – Concepts of 8051 microcontroller – Block diagram,.

UNIT – III	Lecture Hrs:

PROGRAMMABLE PERIPHERAL INTERFACE
Introduction – Architecture of 8255, Keyboard interfacing, LED display –interfacing, ADC and DAC interface, Temperature Control – Stepper Motor Control – Traffic Control interface.

UNIT – IV	Lecture Hrs:

PROGRAMMABLE LOGIC CONTROLLER
Introduction – Basic structure – Input and output processing – Programming – Mnemonics – Timers, counters and internal relays – Data handling – Selection of PLC.

UNIT – V	Lecture Hrs:

ACTUATORS AND MECHATRONIC SYSTEM DESIGN
Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages. Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Engine Management system – Automatic car park barrier.

Textbooks:

1.Bolton, “Mechatronics”, Printice Hall, 2008 2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, 5th Edition, Prentice Hall, 2008.

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Reference Books:

1. Michael B.Histand and Davis G.Alciatore, "Introduction to Mechatronics and Measurement systems", McGraw Hill International edition,2007.
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