Curriculum & Syllabus

of

M.E. Engineering Design

(For the batches admitted in 2008-09 and 2009-10)

K.S.RANGASAMY COLLEGE OF TECHNOLOGY
TIRUCHENGODE – 637 215

(An Autonomous Institution affiliated to Anna University of Technology Coimbatore and approved by AICTE New Delhi)

K.S.Rangasamy College of Technology - Autonomous Regulation	R 2008
Department	Mechanical Engineering
Programme Code & Name	31 : M.E. Engineering Design

K.S.Rangasamy College of Technology, Tiruchengode - 637 215								
Curriculum for the Programmes under Autonomous Scheme								
Regulation	R 2008							
Department	Department of Mechanical Engineering							
Program Code & Name	31 : M.E. Engineering Design							
Semester I								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
	THEORY							
08310101S	Advanced Mathematics	3	1	0	4	50	50	100
08310102S	Computer Application in Design	3	0	0	3	50	50	100
08310103S	Finite Element Analysis	3	1	0	4	50	50	100
08310104C	Concepts of Engineering Design	3	0	0	3	50	50	100
08310105C	Micro Electro Mechanical Systems Design	3	1	0	4	50	50	100
083101**E	Elective I	3	0	0	3	50	50	100
	PRACTICAL							
08310107P	CAD Laboratory	0	0	3	2	50	50	100
	Total	18	3	3	23	700		
Semester II								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
	THEORY							
08310201S	Mechanical Vibrations	3	1	0	4	50	50	100
08310202C	Product Design and Development	3	0	0	3	50	50	100
08310203C	Advanced Mechanisms and Robot Kinematics	3	1	0	4	50	50	100
08310204C	Design for Manufacture and Assembly	3	0	0	3	50	50	100
083102**E	Elective II	3	0	0	3	50	50	100
083102**E	Elective III	3	0	0	3	50	50	100
	PRACTICAL							
08310207P	Analysis and Simulation laboratory	0	0	3	2	50	50	100
08310208P	Technical Report Preparation and Presentation I	0	0	2	0	100	00	100
	Total	18	2	5	22	800		

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Curriculum for the Programmes under Autonomous Scheme								
Regulation	R 2008							
Department	Department of Mechanical Engineering							
Program Code & Name	31 : M.E. Engineering Design							
Semester III								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
	THEORY							
083103**E	Elective IV	3	0	0	3	50	50	100
083103**E	Elective V	3	0	0	3	50	50	100
083103**E	Elective VI	3	0	0	3	50	50	100
	PRACTICAL							
08310304P	Project Work - Phase I	0	0	12	6	100	00	100
08310305P	Technical Report Preparation and Presentation II	0	0	2	0	100	00	100
	Total	9	0	14	15	500		
Semester IV								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310401P	Project Work - Phase II	0	0	40	20	50	50	100
	Total	0	0	40	20	100		

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Curriculum for the programmes under Autonomous Scheme								
Regulation	R 2008							
Department	Department of Mechanical Engineering							
Programme Code & Name	31 : M.E. Engineering Design							
List of Electives								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
Electives I								
08310141E	Rapid Prototyping and Tooling	3	0	0	3	50	50	100
08310142E	Tribology in Design	3	0	0	3	50	50	100
08310143E	Optimization Techniques in Design	3	0	0	3	50	50	100
08310144E	Advanced Strength of Materials	3	0	0	3	50	50	100
08310145E	Product Data Management	3	0	0	3	50	50	100
Electives II								
08310251E	Design of Hydraulic and Pneumatic Systems	3	0	0	3	50	50	100
08310252E	Applied Engineering Acoustics	3	0	0	3	50	50	100
08310253E	Advanced Tool Design	3	0	0	3	50	50	100
Electives III								
08310261E	Mechanics of Composite Materials	3	0	0	3	50	50	100
08310262E	Applied Finite Element Analysis	3	0	0	3	50	50	100
08310263E	Mechanics of Fracture	3	0	0	3	50	50	100
08310264E	Applied Object Oriented Programming	3	0	0	3	50	50	100
Electives IV								
08310371E	Design of Material Handling Equipments	3	0	0	3	50	50	100
08310372E	Experimental Stress Analysis	3	0	0	3	50	50	100
08310373E	Vibration Control And Condition Monitoring	3	0	0	3	50	50	100
Electives V								
08310381E	Integrated Manufacturing Systems	3	0	0	3	50	50	100
08310382E	Theory of Plates And Shells	3	0	0	3	50	50	100
08310383E	Design of Heat Exchangers	3	0	0	3	50	50	100
Electives VI								
08310391E	Productivity Management And Re-Engineering	3	0	0	3	50	50	100
08310392E	Mechatronics in Manufacturing Systems	3	0	0	3	50	50	100

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Department	Mechanical Engineering	Programme Code & Name			31 : M.E. Engineering Design			
Semester I								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310101S	ADVANCED MATHEMATICS	3	1	0	4	50	50	100
Objective(s)	At the end of the study of the paper Advanced Mathematics, the student will be able to solve linear systems by methods of elimination, triangularisation and iteration, method of finite differences and Rayleigh Ritz methods, Solve numerically partial differential equations of parabolic, elliptic and hyperbolic types with appropriate boundary and initial conditions encountered in engineering design.							
1	SIMULTANEOUS EQUATIONS AND NUMERICAL INTEGRATION				Total Hrs	9		
Simultaneous Equations: Gauss elimination method-Choleski scheme-Gauss seidel method-Relaxation method- Numerical Integration- Trapezoidal rule and Simpson's 1/3 and 3/8 th rules- Weddle's rule.								
2	BOUNDARY & CHARACTERISTIC VALUE PROBLEMS				Total Hrs	9		
BVP Solution through finite differences of second order BVP o Derivative boundary conditions - Rayleigh Ritz method. CVP Finding eigen values / vectors by characteristic polynomial method – Jacobi method – Power method.								
3	CALCULUS OF VARIATIONS				Total Hrs	9		
Extremum of functional involving one unknown function- Several unknown functions-Functional dependant on higher order derivatives- Several independent variables- Isoperimetric problems.								
4	ELLIPTIC PARTIAL DIFFERENTIAL EQUATIONS				Total Hrs	9		
Finite difference expressions for partial derivatives – Laplace's equation – Liebmann method – Derivative boundary conditions- Poisson equation – Relaxation method.								
5	PARABOLIC AND HYPERBOLIC PARTIAL DIFFERENTIAL EQUATIONS				Total Hrs	9		
Parabolic Pole- Explicit method – Crank- Nichlson method – ADI method for equation of higher order- Hyperbolic Pole - Solution by finite differences, Several types of Boundary conditions Explicit method.								
Total hours to be taught						45		
Text book (s) :								
1	Rajasekaran.S "Numerical method in Science and Engineering" – Wheeler Publishing, 1999, Second edition.							
Reference(s) :								
1	Douglas J Faires and Riched Burden, "Numerical Methods" Brooks / Cole Publishing Company, 1998, second edition.							
2	M.K.Venkatraman, Higher mathematics for engineering and Science; National Publishing company,2000							
3	John H Mathews and Kurtis D Fink, "Numerical Methods using MATLAB", Prentice Hall, 1998.							
4	Ward Cheney and David Kincaid, "Numerical Mathematics and Computing", Brooks/Cole Publishing Company, Fourth Edition, 1999.							

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Semester I								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310102S	COMPUTER APPLICATION IN DESIGN	3	0	0	3	50	50	100
Objective(s)	To Impart knowledge on parametric sketching and data exchange formats. To Impart knowledge on use of computers in design. To develop the students to learn softwares like Lisp, visual basic in designing mechanical components. To develop the students the ability to utilize the computers in managing product design data.							
1	INTRODUCTION TO COMPUTER APPLICATIONS IN NEW PRODUCT DESIGN				Total Hrs	9		
Concept design – Parametric sketching – Constraints – Computer graphics principles-2D transformation, Scaling, Rotation – Windowing, View ports – Clipping – Data exchange formats.								
2	COMPUTERS IN DESIGN				Total Hrs	9		
Solid modeling of Mechanical components – Associative features – Sheet metal components, Nesting and development – Plastic parts with draft and shrinkage allowance – Reverse engineering of components – Assembly of parts – Tolerance analysis – Mass property calculations.								
3	COMPUTERS IN TOOLING DESIGN				Total Hrs	9		
Mould design – Jigs and fixtures design – Check for interferences – Mechanism design and analysis – Rapid tooling								
4	COMPUTERS IN DESIGN PRODUCTIVITY				Total Hrs	9		
Customizing various software by using visual basic, pro/program, script, LISP etc to write applications like design of shafts, gears etc.,								
5	MANAGING PRODUCT DESIGN DATA				Total Hrs	9		
Version control – Library creation – Catalog making – Standardization for design –Collaborative design among peer groups – Design optimization for geometry – Design check, approval and validation.								
Total hours to be taught						45		
Text book (s) :								
1	William M. Neumann and Robert Sproul “Principles of Computer Graphics” McGraw Hill Book Co. Singapore 1989.							
2	Ibrahim Zeid “CAD/CAM – Theory and Practice” – McGraw Hill, International Edition 1998.							
Reference(s) :								
1	P N Rao “CAD/CAM: Principles and Applications” Tata McGraw Hill, Second Edition. 2004.							
2	Schlechtendahl, E. G, CAD – Data transfer for Solid Models, Springer Verlag,Berlin, 1989.							
3	Donald Hearn and M Pauline Baker “Computer Graphics” Prentice Hall Inc1992.							

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Department	Mechanical Engineering	Programme Code & Name			31 : M.E. Engineering Design			
Semester I								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310103S	FINITE ELEMENT ANALYSIS	3	1	0	4	50	50	100
Objective(s)	To teach students the concepts in finite element method as related to solving engineering problems and working knowledge of computer-aided engineering analysis tools and their use in design.							

1	INTRODUCTION & ONE-DIMENSIONAL PROBLEMS	Total Hrs	9
Relevance of finite element analysis in design - Variational principles and methods –Weighted-Integral statements – Weak formulations – Ritz method – Method of weighted residuals Applications of FEA - Finite element modeling – Co-ordinates and shape functions - Potential energy approach – Galerkin's approach – One-dimensional finite element models in Solid mechanics and Heat transfer – Finite element model for beams			
2	TWO-DIMENSIONAL PROBLEMS	Total Hrs	9
Poisson equation – Laplace equation – Weak form – Element matrices for triangular and rectangular elements – Evaluation of integrals – Assembly – Axi-symmetric problems – Applications – Conduction and convection heat transfer – Torsional cylindrical member – Transient analysis - Theory of elasticity – Plane strain – Plane stress – Axi-symmetric problems – Principle of virtual displacement			
3	ISOPARAMETRIC ELEMENTS	Total Hrs	9
Introduction – Bilinear quadrilateral elements – Quadratic quadrilaterals –Hexahedral elements - Numerical integration – Gauss quadrature – Static condensation – Load considerations – Stress calculations – Examples of 2D and 3D applications			
4	STRUCTURAL DYNAMICS APPLICATIONS	Total Hrs	9
Dynamic equations – Mass and damping matrices – Natural frequencies and modes– Reduction of number of DOF-response history – Model methods – Ritz vectors –Component mode synthesis – Harmonic response – Direct integration techniques –Explicit and implicit methods – Analysis by response spectra – Example problems			
5	NON-LINEAR PROBLEMS & ERROR ESTIMATES	Total Hrs	9
Introduction – Material non-linearity – Elasto Plasticity – Plasticity – Visco plasticity –Geometric non-linearity – Large displacement – Error norms and convergence rates– H-refinement with adaptivity – adaptive refinement			
Total hours to be taught			45

Text book (s) :

1	Reddy J.N., "An Introduction to the Finite Element Method", McGraw Hill, International Edition, 1993.
2	Logan D.L, "A First Course in the Finite Element Method", Third Edition, Thomson Learning, 2002.

Reference(s) :

1	Cook, Robert Davis et al "Concepts and Applications of Finite Element Analysis", Wiley, John & Sons, 1999.
2	Segerlind L.J., "Applied Finite Element Analysis", John Wiley, 1984.
3	S.S.Rao, "Finite Element Analysis", 2002 Edition.
4	Zienkiewicz, O.C. and Taylor, R.L., "The Finite Element Method", Fourth Edition, Volumes 1 & 2, McGraw Hill International Edition, Physics Services, 1991.
5	Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall, 1990.

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Semester I								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310104C	CONCEPTS OF ENGINEERING DESIGN	3	0	0	3	50	50	100
Objective(s)	To impart knowledge on design process, and its requirements, mathematical modeling, geometric modeling, material selection for design process, material processing, Environmental and safety issues.							
1	THE DESIGN PROCESS				Total Hrs	9		
The Design Process - need identification – Design requirements – Product Life Cycle– Morphology of Design steps of Product Design – Conceptual Design, Embodiment Design, Detailed Design – Concurrent Engineering – CAD & CAM, Human factors in Design.								
2	TOOLS IN ENGINEERING DESIGN				Total Hrs	9		
Creativity and problem solving, Decision Theory, Modeling – Role of models in Engineering Design, Mathematical modeling, Geometric modeling, Finite element modeling, Rapid Prototyping – Simulation Finite Difference method, Monte Carlo method – Optimization – Search methods, Geometric programming, Structural and Shape Optimization.								
3	MATERIAL SELECTION AND MATERIALS IN DESIGN				Total Hrs	9		
The Classification and properties of Engineering materials- Material standards and Specifications – Methods of material selection – Ashby Chart and Method of Weight factors- Derivation of material indices- Use of material selection Chart-Pugh selection method- Selection with computed aided databases – Design for brittle fracture-Design for fatigue failure- Design for corrosion resistance- Designing with plastics.								
4	MATERIAL PROCESSING AND DESIGN				Total Hrs	9		
Classification of manufacturing processes and their role in design- Factors determining the process selection-use of process selection chart and computerized database – Design for manufacturing- Design for forging and sheet metal forming-Design for casting-Design for Machining, Welding and Assembly- Design for residual stresses and heat treatment.								
5	LEGAL, ETHICAL ENVIRONMENTAL AND SAFETY ISSUES IN DESIGN AND QUALITY ENGINEERING				Total Hrs	9		
The origin of laws- Contracts - Liability – Tort Law- Product Liability – Design aspects of product liability- Codes of ethics- Solving ethical conflicts- Design for environment – Life Cycle assessment – Material recycling and remanufacture- Design for safety – Potential Dangers and Guidelines for design for safety-Design for reliability failure mode effect analysis-robust Design.								
Total hours to be taught						45		
Text book (s) :								
1	Dieter, George E, Engineering Design –"A materials and processing Approach, ".Mc Graw Hill, International Edition, Singapore 2000.							
2	Karl T. Vlrich and Steven D. Eppinger "Product design and Development", McGraw Hill, International Edition, 2000.							
Reference(s) :								
1	Pahlgand Beitz W "Engineering Design" Springer – Verlag NY- 1984.							
2	Ray M.S. "Elements of Engineering Design", Printice Hall Inc. 1985.							
3	Suh. N. P. "The principles of design",. Oxford University, Press NY 1990.							

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Semester I									
Course Code	Course Name	Hours / Week			Credit	Maximum Marks			
		L	T	P	C	CA	ES	Total	
08310105C	MICRO ELECTRO MECHANICAL SYSTEMS DESIGN	3	1	0	4	50	50	100	
Objective(s)	To Impart knowledge on micro actuation techniques, scaling laws and scaling in mechanical applications, materials and fabrication process, micro mechanics, micro system manufacturing and micro system design.								
1	INTRODUCTION				Total Hrs	9			
Overview-Microsystems and microelectronics - Working principle of Microsystems -Micro actuation techniques-Micro sensors-Types-microactuators-Types-Micropumpmicromotors-Micro-Valves-Microgrippers-Scaling laws-Scaling in geometry-Scaling in rigid body dynamics- Scaling in electrostatic forces- Scaling in electricity-Scaling in fluid mechanics- Scaling in heat transfer.									
2	MATERIALS AND FABRICATION PROCESS				Total Hrs	9			
Substrates and wafer-single crystal silicon wafer formation-ideal substrates mechanical properties-silicon compounds - Sio2, SiC, Si3N4 and polycrystalline silicon - Silicon piezo resistors - Gallium are senside, Quartz-piezoelectric crystals polymers for MEMS -conductive polymers – Photolithography - Ion implantation -Diffusion – Oxidation –CVD - Physical vapor deposition - Deposition by epitaxy - Etching process.									
3	MICROMECHANICS				Total Hrs	12			
Introduction-static bending of thin plates-circular plates with edge fixed – Rectangular plate with all edges fixed and square plate with all edges fixed – Mechanical vibration-resonant vibration- Micro accelerometers-design theory and damping coefficients- Thermo mechanics-Thermal stresses-fracture mechanics-Stress intensity factors, Fracture toughness and interfacial fracture mechanics.									
4	MICRO SYSTEM MANUFACTURING				Total Hrs	9			
Clean room technology-Bulk Micro manufacturing- Surface micro machining –LIGASLIGA-Micro system packaging-materials-Die level-device level-System level packaging techniques-Die preparation-Surface bonding-Wire bonding-sealing.									
5	MICRO SYSTEM DESIGN				Total Hrs	9			
Design considerations-Process design-Mask layout design- Mechanical design applications of micro system in -Automotive industry-Bio medical –Aero space telecommunications.									
Total hours to be taught						45			
Text book (s) :									
1	Mohamed Gad-el-Hak, The MEMS Hand book, CRC press 2002.								
2	Julian W.Gardner,Vijay K.Varadan, Osama O.Awadel Karim, Microsensors MEMS and Smart Devices, John Wiby & sons Ltd.,2001.								
Reference(s) :									
1	S.Fatikow, U.Rembold, Microsystem Technology and Microrobotics, Springer-Verlag Berlin Heidelberg, 1997.								
2	Tai-Ran Hsu, MEMS & Microsystems Design and Manufacture, Tata McGraw-Hill, 2006.								
3	Francis E.H Tay and W.O Choong, Microfludics and BioMEMS Applications, Springer, 2002.								

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Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310107 P	CAD LABORATORY	0	0	3	2	50	50	100
Objective(s)	To develop the students to work in solid modeling, sheet metal and mechanism design of mechanical components and feature based packages like pro-E, solid works etc.							
Exercises in Sketching, Solid Modeling, Surface modeling, Sheet metal and mechanism design of Mechanical Components and assembly using Parametric and Feature Based Packages like PRO-E / SOLID WORKS /SOLID EDGE/CATIA / NX / ANSYS / NASTRAN etc.								

<table>
<tr><td colspan="6">K.S.Rangasamy College of Technology - Autonomous Regulation</td><td colspan="3">R 2008</td></tr>
<tr><td>Department</td><td>Mechanical Engineering</td><td colspan="2">Programme Code & Name</td><td colspan="4">31 : M.E. Engineering Design</td></tr>
<tr><td colspan="9">Semester II</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ES</td><td>Total</td></tr>
<tr><td>08310201S</td><td>MECHANICAL VIBRATIONS</td><td>3</td><td>1</td><td>0</td><td>4</td><td>50</td><td>50</td><td>100</td></tr>
<tr><td>Objective(s)</td><td colspan="8">To impart knowledge on mechanical vibrations of single, multiple degrees of freedom and continuous systems, design systems to achieve the vibratory response, analyze and predict vibratory behavior of mechanical systems.</td></tr>
<tr><td>1</td><td colspan="5">FUNDAMENTALS OF VIBRATION</td><td>Total Hrs</td><td colspan="2">9</td></tr>
<tr><td colspan="9">Introduction – Single degree freedom free vibration systems – Damped vibrations – Single degree freedom forced vibration with elastically coupled viscous dampers, System Identification from frequency response, Support motion, Duhamel’s Integral – Impulse Response function – Virtual work – Lagrange’s equation-– Transient Vibration.</td></tr>
<tr><td>2</td><td colspan="5">TWO DEGREE FREEDOM SYSTEM</td><td>Total Hrs</td><td colspan="2">9</td></tr>
<tr><td colspan="9">Free vibration of spring-coupled system – Mass coupled system – Vibration of two degree freedom system – Forced vibration – Vibration Absorber – Vibration isolation</td></tr>
<tr><td>3</td><td colspan="5">MULTI-DEGREE FREEDOM SYSTEM</td><td>Total Hrs</td><td colspan="2">9</td></tr>
<tr><td colspan="9">Normal mode of vibration – Flexibility Matrix and Stiffness matrix – Eigen values and eigen vectors – orthogonal properties – Modal matrix-Modal Analysis – Forced Vibration by matrix inversion – Modal damping in forced vibration – Numerical methods for fundamental frequencies.</td></tr>
<tr><td>4</td><td colspan="5">VIBRATION OF CONTINUOUS SYSTEMS</td><td>Total Hrs</td><td colspan="2">9</td></tr>
<tr><td colspan="9">Systems governed by wave equations – Vibration of strings – vibration of rods – Euler Equation for Beams – Effect of Rotary inertia and shear deformation – Vibration of plates.</td></tr>
<tr><td>5</td><td colspan="5">EXPERIMENTAL METHODS IN VIBRATION ANALYSIS</td><td>Total Hrs</td><td colspan="2">9</td></tr>
<tr><td colspan="9">Vibration instruments – Vibration exciters Measuring Devices – Analysis – Vibration Tests – Free and Forced Vibration tests. Examples of Vibration tests – Industrial, case studies.</td></tr>
<tr><td colspan="7">Total hours to be taught</td><td colspan="2">45</td></tr>
<tr><td colspan="9">Text book (s) :</td></tr>
<tr><td>1</td><td colspan="8">Thomson, W.T., “Theory of Vibration with Applications”, CBS Publishers and Distributors, New Delhi, 1990.</td></tr>
<tr><td>2</td><td colspan="8">Rao, J.S. and Gupta, K., “Introductory Course on Theory and Practice Mechanical Vibration”, New Age International (P) Ltd., New Delhi, 1999.</td></tr>
<tr><td colspan="9">Reference(s) :</td></tr>
<tr><td>1</td><td colspan="8">Den Hartog, J.P, “Mechanical Vibrations,” Dover Publications, New York, 1990.</td></tr>
<tr><td>2</td><td colspan="8">Rao, S.S., “Mechanical Vibrations”, Addison Wesley Longman, New York, 1995.</td></tr>
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Department	Mechanical Engineering	Programme Code & Name			31 : M.E. Engineering Design			
Semester II								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310202C	PRODUCT DESIGN AND DEVELOPMENT	3	0	0	3	50	50	100
Objective(s)	To Impart knowledge on product development process and challenges in product development, product planning, product specifications, concept selection and product architecture.							
1	INTRODUCTION				Total Hrs	9		
Characteristics of Successful Product Development-Interdisciplinary activity-Duration and Costs of Product Development- Challenges of Product Development –Development Processes and Organizations-A Generic Development Process-Concept Development: The Front-End Process Adapting the Generic Product Development Process- The AMF Development Process-Product Development Organizations-The AMF Organization.								
2	PRODUCT PLANNING				Total Hrs	9		
Product Planning Process- Identifying Opportunities- Evaluating and Prioritizing Projects- Allocating Resources and Timing- Pre-Project Planning-Reflect on the Results and the Process-Identifying Customer Needs- Raw Data from Customers- Interpreting Raw Data in Terms of Customer Needs-Organizing the Needs into a Hierarchy- Establishing the Relative Importance of the Needs-Reflecting on the Results and the Process.								
3	PRODUCT SPECIFICATIONS				Total Hrs	9		
Product specifications- Stages of Specifications -Establishing Target Specifications- Setting the Final Specifications-Concept Generation-The Activity of Concept Generation-The steps in concept generation method.								
4	CONCEPT SELECTION				Total Hrs	9		
Concept Selection- Overview of Methodology-Concept Screening-Concept Testing- Defining the Purpose of the Concept Test- Choosing a Survey Population- Choosing a Survey Format- Communicating the Concept-Measuring Customer Response- Interpreting the Results- Reflecting on the Results and the Process.								
5	PRODUCT ARCHITECTURE				Total Hrs	9		
Product Architecture-Implications of the Architecture-Establishing the Architecture- Delayed Differentiation-Platform Planning-Related System-Level Design Issues.								
Total hours to be taught						45		
Text book (s) :								
1	Ulrich, Karl T. and Eppinger, Steven D., “Product Design and Development”, McGraw–Hill, New York, 1999.							
2	Otto, Kevien and Wood, Kristin, “Product Design” Pearson Publication, New Delhi, 2004.							
Reference(s) :								
1	Rosenthal, Stephen, “Effective Product Design and Development”, Business One Orwin, Homewood, 1992.							
2	Stuart Pugh., “Tool Design – Integrated Methods for successful Product Engineering”, Addison Wesley Publishing, New York, 1991.							
3	Kemnneth Crow., “Concurrent Engineering / Integrated Product Development”, DRM Associates, 26/3,Via Olivera, Palos Verdes, Workshop Book.							

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Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310203C	ADVANCED MECHANISMS AND ROBOT KINEMATICS	3	1	0	4	50	50	100
Objective(s)	To Impart knowledge on kinematics analysis path curvature theory, synthesis of mechanisms, static force analysis, dynamic force analysis and robot kinematics.							
1	INTRODUCTION				Total Hrs	9		
Review of fundamentals of kinematics – Mobility analysis – Formation of one D.O.F. Multi loop kinematic chains, Network formula – Gross motion concepts.								
2	KINEMATIC ANALYSIS				Total Hrs	9		
Displacement- Velocity and acceleration analysis of simple mechanisms- Instant centers kinematics analysis of complex mechanisms- Goodman analysis- Auxiliary point method.								
3	PATH CURVATURE THEORY				Total Hrs	9		
Inflection point and inflection circles. Euler – Savary equation- Bobilliers constructions- Hartmann's construction-The cubic of stationary curvature or Burmester's circle point and center point curves for four infinitesimally close positions of the moving plane.								
4	SYNTHESIS OF MECHANISMS				Total Hrs	9		
Type synthesis – Number synthesis – Associated Linkage Concept. Dimensional synthesis – Function generation- Path generation- Motion generation- Graphical methods- Cognate linkages -Coupler curve synthesis- Design of six-bar mechanisms- Algebraic methods- Application of instant center in linkage design- Cam Mechanisms – Determination of optimum size of Cams.								
5	DYNAMICS OF MECHANISMS AND SPATIAL MECHANISMS AND ROBOTICS				Total Hrs	9		
Static force analysis with friction – Inertia force analysis – Combined static and inertia force analysis- Shaking force- Kinetostatic analysis- Introduction to force and moment balancing of linkages- Kinematic Analysis of Spatial RSSR mechanism – Denavit – Hartenberg Parameters- Forward and inverse Kinematics of Robotic Manipulators- Study and use of Mechanism using Simulation Software packages.								
Total hours to be taught						45		
Text book (s) :								
1	Sandor G.N., and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Prentice Hall, 1984.							
2	Shigley, J.E., and Uicker, J.J., "Theory of Machines and Mechanisms", McGraw Hill, 1995.							
Reference(s) :								
1	Ghosh, Amitabha and Mallik, Asok Kumar., "Theory of Mechanism and Machines", EWLP, Delhi, 1999.							
2	Nortron, R.L., "Design of Machinery", Tata McGraw-Hill, New Delhi, 2005.							
3	Waldron, Kenneth J, and Kinzel, Gary L., "Kinematics, Dynamics and Design of Machinery", John Wiley & Sons, New York. 1999.							

K.S.Rangasamy College of Technology - Autonomous Regulation								R 2008
Department	Mechanical Engineering	Programme Code & Name			31 : M.E. Engineering Design			
Semester II								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310204C	DESIGN FOR MANUFACTURE AND ASSEMBLY	3	0	0	3	50	50	100
Objective(s)	To Impart knowledge on process capability and tolerances, form design, component design machining consideration, casting consideration in component design and design for the environment.							
1	PROCESS CAPABILITY AND TOLERANCES				Total Hrs	9		
General design principles for manufacturability - Strength and mechanical factors- Mechanisms selection- Evaluation method - Process capability - Feature tolerances - Geometric tolerances –Worst case method - Assembly limits -Datum features – Tolerance stacks.								
2	FACTORS INFLUENCING FORM DESIGN				Total Hrs	9		
Influence of materials on form design - Form design of grey iron- Malleable iron-Steel and Aluminum castings - Form design of welded members and forgings.								
3	COMPONENT DESIGN - MACHINING CONSIDERATION				Total Hrs	9		
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.								
4	COMPONENT DESIGN - CASTING CONSIDERATION				Total Hrs	9		
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								
5	DESIGN FOR THE ENVIRONMENT				Total Hrs	9		
Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T's environmentally responsible product assessment - Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for remanufacture – Design for energy efficiency – Design to regulations and standards.								
Total hours to be taught						45		
Text book (s) :								
1	Peck, Harry, "Designing for Manufacture", Pitman Publications, 1983.							
2	Bralla., "Design for Manufacture Handbook", McGraw-Hill, New York, 1999.							
Reference(s) :								
1	Boothroyd, G, Heartz and Nike, "Product Design for Manufacture", Second Edition, Marcel Dekker Inc., London, 2002.							
2	Otto, Kevien and Wood, Kristin, "Product Design", Pearson Publication, New Delhi, 2004.							
3	Matousek, "Engineering Design- A Systematic Approach", Blackie & Son Ltd., London, 1974.							
4	Allen, Graedel T., "Design for the Environment", Prentice Hall, New Jersey, 1996.							
5	Fixel, J., "Design for the Environment", McGraw-Hill, New Delhi, 1996.							

<table>
<tr><td colspan="8">K.S.Rangasamy College of Technology - Autonomous Regulation</td><td>R 2008</td></tr>
<tr><td>Department</td><td colspan="2">Mechanical Engineering</td><td colspan="2">Programme Code & Name</td><td colspan="4">31 : M.E. Engineering Design</td></tr>
<tr><td colspan="9">Semester II</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2" colspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ES</td><td>Total</td></tr>
<tr><td>08310207P</td><td colspan="2">ANALYSIS AND SIMULATION LABORATORY</td><td>0</td><td>0</td><td>3</td><td>2</td><td>50</td><td>50</td><td>100</td></tr>
<tr><td>Objective(s)</td><td colspan="8">-To develop the students to perform Analysis of beams, trusses and fins using analysis software.</td></tr>
<tr><td colspan="9">Analysis of mechanical machine components using analysis software
Introduction of CAE software, Structural Analysis: Static analysis 2D, 3D, Beam, Truss. Thermal Analysis: 2D Conduction, 3D Convection. Dynamics Analysis: Modal analysis, Transient analysis.</td></tr>
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<table>
<tr><td colspan="6">K.S.Rangasamy College of Technology - Autonomous Regulation</td><td colspan="3">R 2008</td></tr>
<tr><td>Department</td><td colspan="2">Mechanical Engineering</td><td colspan="2">Programme Code & Name</td><td colspan="3">31 : M.E. Engineering Design</td></tr>
<tr><td colspan="8">Semester II</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="2">Maximum Marks</td><td></td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ES</td><td>Total</td></tr>
<tr><td>08310208P</td><td>TECHNICAL REPORT PREPARATION AND PRESENTATION I</td><td>0</td><td>0</td><td>2</td><td>0</td><td>100</td><td>00</td><td>100</td></tr>
<tr><td>Objective(s)</td><td colspan="8">To provide exposure to the students to refer, read and review the research articles in referred journals and conference proceedings.
To Improve the technical report writing and presentation skills of the students.</td></tr>
<tr><td>Methodology</td><td colspan="8">• Each student is allotted to a faculty of the department by the HOD
• By mutual discussions, the faculty guide will assign a topic in the general / subject area to the student.
• The students have to refer the Journals and Conference proceedings and collect the published literature.
• The student is expected to collect at least 20 such Research Papers published in the last 5 years.
• Using OHP/Power Point, the student has to make presentation for 15-20 minutes followed by 10 minutes discussion.
• The student has make two presentations, one at the middle and the other near the end of the semester.
• The student has to write a Technical Report for about 30-50 pages (Title page, One page Abstract, Review of Research paper under various subheadings, Concluding Remarks and List of References). The technical report has to be submitted to the HOD one week before the final presentation, after the approval of the faculty guide.</td></tr>
<tr><td rowspan="9">Execution</td><td>Week</td><td colspan="7">Activity</td></tr>
<tr><td>I</td><td colspan="7">Allotment of Faculty Guide by the HoD</td></tr>
<tr><td>II</td><td colspan="7">Finalizing the topic with the approval of Faculty Guide</td></tr>
<tr><td>III-IV</td><td colspan="7">Collection of Technical papers</td></tr>
<tr><td>V-VI</td><td colspan="7">Mid semester presentation</td></tr>
<tr><td>VII-VIII</td><td colspan="7">Report writing</td></tr>
<tr><td>IX</td><td colspan="7">Report submission</td></tr>
<tr><td>X-XI</td><td colspan="7">Final presentation</td></tr>
<tr><td rowspan="6">Evaluation</td><td colspan="8">❖ 100% by Continuous Assessment
❖ 3 Hrs/week and 2 credits</td></tr>
<tr><td colspan="6">Component</td><td colspan="2">Weightage</td></tr>
<tr><td colspan="6">Phase -I Presentation</td><td colspan="2">25 %</td></tr>
<tr><td colspan="6">Phase - II Presentation</td><td colspan="2">25 %</td></tr>
<tr><td colspan="6">Report Preparation and Submission</td><td colspan="2">30 %</td></tr>
<tr><td colspan="6">Final Presentation</td><td colspan="2">20 %</td></tr>
<tr><td colspan="6">Total</td><td colspan="2">100 %</td></tr>
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<tr><td colspan="7">K.S.Rangasamy College of Technology - Autonomous Regulation</td><td>R 2008</td></tr>
<tr><td>Department</td><td colspan="2">Mechanical Engineering</td><td colspan="2">Programme Code & Name</td><td colspan="3">31 : M.E. Engineering Design</td></tr>
<tr><td colspan="8">Semester III</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ES</td><td>Total</td></tr>
<tr><td>08310304P</td><td>PROJECT WORK - PHASE I</td><td>0</td><td>0</td><td>12</td><td>6</td><td>100</td><td>00</td><td>100</td></tr>
<tr><td>Objective(s)</td><td colspan="7">To import the practical knowledge to the students and also to make them to carry out the technical procedures in their project work. To provide an exposure to the students to refer, read and review the research articles, journals and conference proceedings relevant to their project work and placing this as their beginning stage for their final presentation.</td></tr>
<tr><td>Methodology</td><td colspan="7">• Three reviews have to be conducted by the committee of minimum of three members one of which should be the guide.
• Problem should be selected
• Students have to collect about 20 papers related to their work
• Report has to be prepared by the students as per the format as given below
• Preliminary implementation can be done if possible
• Internal evaluation has to be done for 100marks</td></tr>
</table>

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<tr><td colspan="6">K.S.Rangasamy College of Technology - Autonomous Regulation</td><td colspan="3">R 2008</td></tr>
<tr><td>Department</td><td colspan="2">Mechanical Engineering</td><td colspan="2">Programme Code & Name</td><td colspan="3">31 : M.E. Engineering Design</td></tr>
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<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="2">Maximum Marks</td><td></td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ES</td><td>Total</td></tr>
<tr><td>08310305P</td><td>TECHNICAL REPORT PREPARATION AND PRESENTATION II</td><td>0</td><td>0</td><td>2</td><td>0</td><td>100</td><td>00</td><td>100</td></tr>
<tr><td>Objective(s)</td><td colspan="8">To provide exposure to the students to refer, read and review the research articles in referred journals and conference proceedings.
To Improve the technical report writing and presentation skills of the students.</td></tr>
<tr><td>Methodology</td><td colspan="8">• Each student is allotted to a faculty of the department by the HOD
• By mutual discussions, the faculty guide will assign a topic in the general / subject area to the student.
• The students have to refer the Journals and Conference proceedings and collect the published literature.
• The student is expected to collect atleast 20 such Research Papers published in the last 5 years.
• Using OHP/Power Point, the student has to make presentation for 15-20 minutes followed by 10 minutes discussion.
• The student has make two presentations, one at the middle and the other near the end of the semester.
• The student has to write a Technical Report for about 30-50 pages (Title page, One page Abstract, Review of Research paper under various subheadings, Concluding Remarks and List of References). The technical report has to be submitted to the HOD one week before the final presentation, after the approval of the faculty guide.</td></tr>
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<tr><td>X-XI</td><td colspan="7">Final presentation</td></tr>
<tr><td rowspan="7">Evaluation</td><td colspan="8">❖ 100% by Continuous Assessment
❖ 3 Hrs/week and 2 credits</td></tr>
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<tr><td colspan="6">Phase -I presentation</td><td colspan="2">25%</td></tr>
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<tr><td colspan="6">Report Preparation and Submission</td><td colspan="2">30%</td></tr>
<tr><td colspan="6">Final Presentation</td><td colspan="2">20%</td></tr>
<tr><td colspan="6">Total</td><td colspan="2">100%</td></tr>
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<tr><td>Department</td><td>Mechanical Engineering</td><td colspan="3">Programme Code & Name</td><td colspan="3">31 : M.E. Engineering Design</td></tr>
<tr><td colspan="8">Semester IV</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ES</td><td>Total</td></tr>
<tr><td>08310401P</td><td>PROJECT WORK - PHASE II</td><td>0</td><td>0</td><td>40</td><td>20</td><td>50</td><td>50</td><td>100</td></tr>
<tr><td>Objective(s)</td><td colspan="7">This enables and strengthens the students to carryout the project on their own and to implement their innovative ideas to forefront the risk issues and to retrieve the hazards by adopting suitable assessment methodologies and staring it to global.</td></tr>
<tr><td>Methodology</td><td colspan="7">Three reviews have to be conducted by the committee of minimum of three members one of which should be the guide.
Each review has to be evaluated fro 100 marks
Attendance is compulsory for all reviews. If a student fails to attend review for some valid reason, one or more chance may be given
They should publish the paper preferably in the journals/conferences
Final review will be done by the committee that consists of minimum of three members one of which should be the guide(If possible include one external expert examiner with in the college)
The report should be submitted by the students around at the end of may</td></tr>
</table>

K.S.Rangasamy College of Technology - Autonomous Regulation								R 2008
Department	Mechanical Engineering	Programme Code & Name			31 : M.E. Engineering Design			
Semester I								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310141E	RAPID PROTOTYPING AND TOOLING	3	0	0	3	50	50	100
Objective(s)	To Understand the Rapid tooling software for Rapid Prototyping and rapid prototyping in manufacturing industries.							
1	INTRODUCTION				Total Hrs	4		
Need for the compression in product development - History of RP systems - Survey of applications - Growth of RP industry and classification of RP systems.								
2	STEREOLITHOGRAPHY SYSTEMS				Total Hrs	5		
Principle - Process parameters - Process details - Data preparation - Data files and Machine details - Applications. SELECTIVE LASER SINTERING - Types of machines - Principle of operation - Process parameters - Data preparation for SLS - Applications.								
3	FUSION DEPOSITION MODELING				Total Hrs	9		
Principle - Process parameters - Path generation - Applications. Solid Ground Curing - Principle of operation - Machine details - Applications.								
4	LAMINATED OBJECT MANUFACTURING				Total Hrs	9		
Principle of operation - LOM materials - Process details - Applications. Concept Modelers – Principle - Thermo jet printer - Sander's model market - 3-D printer - Genisys Xs printer - JP system 5 - Object Quadra System. Laser Engineered Net Shaping (LENS) – Principle –Applications.								
5	RAPID TOOLING				Total Hrs	9		
Indirect Rapid Tooling - Silicone rubber tooling - Aluminum filled epoxy tooling - Spray metal tooling etc. Direct Rapid Tooling - Direct AIM - Quick cast process - Copper polyamide - Rapid Tool – DMILS – ProMetal - Sand casting tooling - Laminate tooling - Soft tooling Vs Hard tooling.								
6	SOFTWARE FOR RAPID PROTOTYPING				Total Hrs	9		
STL files - Overview of Solid view - Magics, mimics, magics communicator, etc.- Internet based soft wares - Collaboration tools - Rapid Manufacturing Process Optimization - Factors influencing accuracy - Data preparation errors - Part building errors - Errors in finishing - Influence of part build orientation. Allied Processes - Vacuum Casting - Surface Digitizing - Surface Generation from point cloud -Surface modification and data transfer to solid models.								
Total hours to be taught						45		
Text book (s) :								
1	Paul. F. Jacobs, "Stereo lithography and other RP & M Technologies", SME, NY, 1996.							
2	Pham. D. T. & Dimov. S. S., "Rapid Manufacturing", Verlag, London, 2001.							
Reference(s) :								
1	Terry Wohlers, "Wohlers Report 2006", Wohlers Associates, 2006.							

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Department	Mechanical Engineering	Programme Code & Name			31 : M.E. Engineering Design			
Semester I								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310142E	TRIBOLOGY IN DESIGN	3	0	0	3	50	50	100
Objective(s)	To create awareness of the importance of Tribology in design and selection of machine elements.							

1	SURFACES, FRICTION AND WEAR	Total Hrs	9

Topography of surfaces – Surfaces features – Experimental Determinations of surface structure – Chemical analysis of surface – Surface effects in Tribology – Analysis of surface roughness – Measurement of surface roughness. Friction – Mechanism of friction, measuring friction, equations and models of friction – Friction.
Properties of metallic and non metallic materials- friction in extreme conditions- Wear – Types, mechanism, mapping, measurements, wear resistance materials – surface treatment, surface modifications and surface coatings- Computer Simulations of friction, Lubrication and wear.

2	LUBRICATION THEORY	Total Hrs	9

Lubricants – Selection criteria – Lubrication regimes – Hydrodynamic, elasto and plasto hydrodynamic lubrication - Basic equations - Reynold's equation - Energy equation, boundary lubrication, boundary lubricating films and its properties- Hydrostatic lubrication – Gas lubrication

3	DESIGN OF FLUID FILM BEARINGS	Total Hrs	9

Dynamic analysis of hydrodynamic bearing performance, trust and journal bearings– Full, partial, fixed and pivoted – Mass flow rate, friction, power loss, heat and temperature difference, dynamic loads, oil film thickness, stiffness of squeeze film and dynamic co-efficient – Hydrostatic bearing design.

4	INDUSTRIAL COMPONENTS AND SYSTEMS	Total Hrs	9

Slider bearings – Self acting finite bearings, failure modes, materials rolling element bearings – Types, contact mechanics, bearing internal load distribution, lubrication – Bearing geometry and kinematics, load ratings and life prediction, torque calculation, temperature analysis, endurance testing and failure analysis.

5	SPACE AND AUTOMOTIVE TRIBOLOGY	Total Hrs	9

Introduction – Mechanism, components, liquid and solid lubricants, accelerated testing and life testing of space mechanism. Principles of Aerospace eccentric bearing test mechanism. Engine Tribology –Importance, lubrication regimes, engine bearings, wheel bearings, tire- Mechanics of load transfer – Contact area and normal pressure distribution, brakes, effects of service on engine oil properties. Tribology in manufacturing – Macro and micro tribology of MEMS materials -Technologies for machinery diagnosis and prognosis.

Total hours to be taught	45

Text book (s) :

1	Cameron, A. "Basic Lubrication Theory", Ellis Herward Ltd., UK, 1981.
2	Hulling, J.(Editor) – " Principles of Tribology", MacMillan, 1984.

Reference(s) :

1	Williams, J.A. "Engineering Tribology", Oxford University Press, 1994.
2	Neale, M.J. "Tribology Handbook", Butterworth Heinemann, 1995.
3	Bharat Bhushan, "Modern Tribology Handbook" Vol. – I & II.

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<tr><td colspan="8">Semester I</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2" colspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="2">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ES</td><td>Total</td></tr>
<tr><td>08310143E</td><td colspan="2">OPTIMIZATION TECHNIQUES IN DESIGN</td><td>3</td><td>0</td><td>0</td><td>3</td><td>50</td><td>50</td><td>100</td></tr>
<tr><td>Objective(s)</td><td colspan="7">To Impart knowledge on static, dynamic constrained and unconstrained optimization techniques in design.</td></tr>
<tr><td>1</td><td colspan="4">INTRODUCTION</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="8">General Characteristics of mechanical elements - Adequate and Optimum design - Principles of optimization - Formulation of objective function - Design constraints – Classification of optimization problem.</td></tr>
<tr><td>2</td><td colspan="4">UNCONSTRAINED OPTIMIZATION</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="8">Single variable and Multivariable optimization- Techniques of unconstrained minimization – Golden section, Pattern and Gradient search methods – Interpolation methods.</td></tr>
<tr><td>3</td><td colspan="4">CONSTRAINED OPTIMIZATION</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="8">Optimization with equality and inequality constraints - Indirect methods using penalty functions - Lagrange multipliers - Geometric programming - Constrained, mixed inequality and unconstrained minimization - Genetic algorithms.</td></tr>
<tr><td>4</td><td colspan="4">STATIC APPLICATIONS</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="8">Structural applications – Design of simple truss members - Design applications – Design of simple axial, transverse loaded members for minimum cost, maximum weight – Design of shafts and torsionally loaded members – Design of springs.</td></tr>
<tr><td>5</td><td colspan="4">DYNAMIC APPLICATIONS</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="8">Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms – Optimum design of simple linkage mechanisms.</td></tr>
<tr><td colspan="7">Total hours to be taught</td><td>45</td></tr>
<tr><td colspan="8">Text book (s) :</td></tr>
<tr><td>1</td><td colspan="7">Singiresu S.Rao., “Engineering Optimization Theory and Practice”, New Age International (P) Limited, Publishers 1996.</td></tr>
<tr><td>2</td><td colspan="7">Johnson Ray, C., “Optimum design of mechanical elements”, Wiley, John & Sons, 1990.</td></tr>
<tr><td colspan="8">Reference(s) :</td></tr>
<tr><td>1</td><td colspan="7">Kalyanamoy Deb, “Optimization for Engineering design algorithms and Examples”, Prentice Hall of India Pvt. 1995.</td></tr>
<tr><td>2</td><td colspan="7">Goldberg, D.E., “Genetic algorithms in search, optimization and machine”, Barnen, Addison-Wesley, New York, 1989.</td></tr>
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Department	Mechanical Engineering		Programme Code & Name		31 : M.E. Engineering Design			
Semester I								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
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08310144E	ADVANCED STRENGTH OF MATERIALS	3	0	0	3	50	50	100
Objective(s)	To Analyze, understand and predict the mechanical behavior of deformable solid bodies using techniques from engineering mechanics and applied mathematics, basic concepts in mechanics of materials to more advanced topics and advanced mechanics of materials topics such as unsymmetrical beam bending.							
1	ELASTICITY				Total Hrs	9		
Stress – Strain relation and General equation of elasticity in Cartesian, Polar and Spherical coordinates- Differential equation of equilibrium – Compact ability – Boundary conditions - Representations of three dimensional stress of a tension – Generalized Hooke's law – St.Vennant's principle – Plane strain - Plane stress –-Shear Centre - Location of shear centre for various sections – Shear flow.								
2	UNSYMMETRICAL BENDING				Total Hrs	9		
Stresses and Deflection in beams subjected to unsymmetrical loading – Kern of a section - Curved flexural members - Circumferential and Radial stresses – Deflection and radial curved beam with re-strained ends – Closed ring subjected to concentrated load and uniform load – Chain link and crane hooks.								
3	THICK CYLINDERS AND ROTATING DISKS				Total Hrs	9		
Thick walled cylinder subjected to internal and external pressures – Shrink fit joints – Stresses due to rotation – Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness – Allowable speed. – Rotating shafts and cylinders.								
4	TORSION OF NON CIRCULAR SECTIONS				Total Hrs	9		
Torsion of rectangular cross section – St.Vennant Theory – Elastic membrane analogy – Prandtl's stress function – Torsional stresses in hollow thin walled tubes.								
5	STRESSES IN FLAT PLATES				Total Hrs	9		
Stresses in circular and rectangular plates due to various types of loading and end conditions – Buckling of plates - Theory of contact stresses – Methods of computing contact stresses – Deflection of bodies in point and line contact – Applications.								
Total hours to be taught						45		
Text book (s) :								
1	Arthur P.Boresi and Omar M.Siseborttom, "Advanced Mechanics of Materials", John, Willey International Education, 1985.							
2	Robert,D.Cook, Wareen.C.Yound, "Advanced Mechanics of Materials", Macmillan Publishers Company, 1985.							
Reference(s) :								
1	Robert,D.Cook, Wareen.C.Yound, "Advanced Mechanics of Materials", Macmillan Publishers Company, 1985.							
2	Srinath.L.S., Advanced Mechanics of Solids, Tata McGraw Hill Publishing Company Limited, 2003							
3	KrishnaRaju, N., Gururaja,D.R., Advanced Mechanics of Solids and Structures, Narosa Publishing House, 1997.							
4	U.C.Jindal, "Advanced Topics of Strength of materials", Galgotia Publications, First edition, 1997.							

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Department	Mechanical Engineering	Programme Code & Name			31 : M.E. Engineering Design			
Semester I								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310145E	PRODUCT DATA MANAGEMENT	3	0	0	3	50	50	100
Objective(s)	To Impart knowledge on change management, configuration management, components on product data, projects and variants.							
1	INTRODUCTION				Total Hrs	9		
Introduction to PDM - Present market constraints - Need for collaboration - Internet and developments in server - Client computing.								
2	COMPONENTS OF PDM				Total Hrs	9		
Components of a typical PDM setup - Hardware and software-document management - Creation and viewing of documents - Creating parts - Versions and version control of parts and documents - Case studies.								
3	CONFIGURATION MANAGEMENT				Total Hrs	9		
Base lines - Product structure - Configuration management - Case studies.								
4	PROJECTS AND ROLES				Total Hrs	4		
Creation of projects and roles - Life cycle of a product - Life cycle management automating information flow - Work flows - Creation of work flow templates - Life cycle work flow integration - Case studies.								
5	CHANGE MANAGEMENT				Total Hrs	5		
Change issue - Change request - Change investigation - Change proposal – Change activity - Case studies.								
6	GENERIC PRODUCTS AND VARIANTS				Total Hrs	9		
Data Management Systems for FEA data - Product configuration – Comparison between sales configuration and product configuration - Generic product modeling in configuration modeler - Use of order generator for variant creation - Registering of variants in product register - Case studies								
Total hours to be taught						45		
Text book (s) :								
1	Kevin Otto, Kristin Wood, “Product Design”, Pearson, 2001.							
2	Daniel Amor, “The E-Business Revolution”, Prentice-Hall, 2000.							
Reference(s) :								
1	David Bed worth. Mark Henderson & Phillip Wolfe. “Computer Integrated Design and Manufacturing “. McGraw Hill Inc...1991.							
2	Terry Quatrain. “Visual Modeling with Rational Rose and UML “. Addison Wesley...1998.							
3	Wind-Chill R5.0 Reference Manuals 2000.							

K.S.Rangasamy College of Technology - Autonomous Regulation								R 2008
Department	Mechanical Engineering	Programme Code & Name			31 : M.E. Engineering Design			
Semester II								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310251E	DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS	3	0	0	3	50	50	100
Objective(s)	To Impart knowledge on design of Hydraulic and pneumatic systems, oil hydraulic systems, Hydraulic & pneumatic actuators, their control and regulation elements, hydraulic & pneumatic circuits and their installation and maintenance.							
1	OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS				Total Hrs	9		
Hydraulic Power Generators – Selection and specification of pumps - Pump characteristics - Determination of volumetric, mechanical and overall efficiencies of positive displacement pumps - Linear and Rotary Actuators – Selection, specification and characteristics.								
2	CONTROL AND REGULATION ELEMENTS				Total Hrs	9		
Pressure - Direction and flow control valves - Relief valves, non-return and safety valves - Actuation systems. Electrical control solenoid valves, relays - Electro hydraulic servo valves.								
3	HYDRAULIC CIRCUITS				Total Hrs	9		
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.								
4	PNEUMATIC SYSTEMS AND CIRCUITS				Total Hrs	9		
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.								
5	INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS				Total Hrs	9		
Pneumatic equipments - Selection of components - Design calculations – Application –Fault finding - Hydro pneumatic circuits - Use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.								
Total hours to be taught						45		
Text book (s) :								
1	Espossito, Antony., “Fluid Power with Applications”, Prentice Hall, New York, 1980.							
2	Pease, Dudleyt, A. and Pippenger, John J., “Industrial Hydraulics”, Tata McGraw-Hill, New Delhi, 1985.							
Reference(s) :								
1	Parr, Andrew, “Hydraulic and Pneumatics”, Jaico Publishing House, New Delhi, 2004.							
2	Bolton. W., “Pneumatic and Hydraulic Systems”, Butterworth –Heinemann, 1997.							

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Semester II								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310252E	APPLIED ENGINEERING ACOUSTICS	3	0	0	3	50	50	100
Objective(s)	To Impart knowledge on basic concepts of acoustics, characterization of sound and their transmission phenomena and concepts of noise control							
1	BASIC CONCEPTS OF ACOUSTICS				Total Hrs	9		
Scope of Acoustics – Sound pressure – Sound intensity – Sound power level Sound power– Wave motion – Alteration of wave paths –Measurement of sound waves – sound spectra– Sound fields – Interference – Standing waves – Acoustic energy density and intensity –Specific acoustic impedance.								
2	CHARACTERISTICS OF SOUND				Total Hrs	9		
The one dimensional wave equation – Solution of 1D wave equation – Velocity in gaseous medium – Velocity of plane progressive sound wave through a thin solid rod – Velocity of plane wave in a bulk of solid – Transverse wave propagation along a string stretched under tension – Wave equation in two dimension.								
3	TRANSMISSION PHENOMENA				Total Hrs	9		
Changes in media – Transmission from one fluid medium to another, normal incidence, oblique incidence - Reflection at the surface of a solid, normal incidence, oblique incidence– Standing wave pattern – Transmission through three media.								
4	AN INTRODUCTION TO THE ASSESSMENT AND MEASUREMENT OF SOUND				Total Hrs	9		
Introduction – The decibel scale for the measurement of sound power – Sound level meter –Weighted sound pressure level – Equal Loudness contours – Perceived noisiness –Loudness, Loudness level, perceived noise, perceived noise level – Equivalent sound level– Identified level – Frequency and Amplitude measurement.								
5	BASIC CONCEPTS OF NOISE CONTROL				Total Hrs	9		
Noise Control at source, path, and receiver – Noise control by acoustical treatment – Machinery noise – Types of machinery involved – Determination of sound power and sound power level – Noise reduction procedures – Acoustic enclosures.								
Total hours to be taught						45		
Text book (s) :								
1	Kinsler, Lawrence E. and Frey, Austin R., “Fundamentals of Acoustics”, John Wiley & Sons New York, 1986.							
2	Bies, David A. and Hansen, Colin H., “Engineering Noise Control: Theory and Practice”, Second Edition, Chapman-Hall, London, 1996.							
Reference(s) :								
1	Hansen, C.H. and Snyder, S.D., “Active Control of Sound and Vibration”, E and FN Spon, London, 1996.							

<table>
<tr><td colspan="6">K.S.Rangasamy College of Technology - Autonomous Regulation</td><td colspan="3">R 2008</td></tr>
<tr><td>Department</td><td colspan="2">Mechanical Engineering</td><td colspan="2">Programme Code & Name</td><td colspan="3">31 : M.E. Engineering Design</td></tr>
<tr><td colspan="9">Semester II</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2" colspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="2">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ES</td><td>Total</td></tr>
<tr><td>08310253E</td><td colspan="2">ADVANCED TOOL DESIGN</td><td>3</td><td>0</td><td>0</td><td>3</td><td>50</td><td>50</td><td>100</td></tr>
<tr><td>Objective(s)</td><td colspan="8">To Impart knowledge on Tool design methods, Tooling materials and Heat Treatment design of drill jigs, design of fixtures and dies and tool design for NC machine.</td></tr>
<tr><td>1</td><td colspan="5">TOOL-DESIGN METHODS</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="9">Introduction – The Design Procedure – Statement of the problem – The Needs Analysis –Research and Ideation – Tentative Design Solutions – The Finished Design – Drafting and Design Techniques in Tooling drawings – Screws and Dowels – Hole location – Jig-boring practice – Installation of Drill Bushings – Punch and Die Manufacture – Electro-discharge machining – Electro-discharge machining for cavity.</td></tr>
<tr><td>2</td><td colspan="5">TOOLING MATERIALS AND HEAT TREATMENT</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="9">Introduction – Properties of Materials – Ferrous Tooling Materials – Tool steels – Cast Iron– Mild, or low-carbon Steel – Nonmetallic Tooling Materials – Nonferrous Tooling Materials – Metal cutting Tools – Single-point cutting tools – Milling cutters – Drills and Drilling – Reamer classification – Taps – Tap classification- the selection of carbide cutting tools – Determining the insert thickness for carbide tools</td></tr>
<tr><td>3</td><td colspan="5">DESIGN OF DRILL JIGS</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="9">Introduction – Fixed Gages – Gage Tolerances – The selection of material for Gages –Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – Chip formation in drilling – General considerations in the design of drill jigs – Drill bushings – Methods of construction – Drill jigs and modern manufacturing</td></tr>
<tr><td>4</td><td colspan="5">DESIGN OF FIXTURES AND DIES</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="9">Introduction – Fixtures and economics – Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures –Types of Die construction – Die-design fundamentals – Blanking and Piercing die construction – Pilots – Strippers and pressure pads- Presswork materials – Strip layout –Short-run tooling for Piercing – Bending dies – Forming dies – Drawing operations.</td></tr>
<tr><td>5</td><td colspan="5">TOOL DESIGN FOR NUMERICALLY CONTROLLED MACHINE</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="9">Introduction – The need for numerical control – A basic explanation of numeric control –Numerical control systems in use today – Fixture design for numerically controlled machine tools – Cutting tools for numerical control – Tool holding methods for numerical control – Automatic tool changers and tool positioners – Tool presetting – Introduction – General explanation of the Brown and sharp machine – Tooling for Automatic screw Machines</td></tr>
<tr><td colspan="8">Total hours to be taught</td><td>45</td></tr>
<tr><td colspan="9">Text book (s) :</td></tr>
<tr><td>1</td><td colspan="8">Donaldson, Cyrll., LeCain, George H. and Goold, V.C., “Tool Design”, Tata McGraw- Hill, New York, 2000.</td></tr>
<tr><td>2</td><td colspan="8">Joshi, Prakash Hiralal., “Tooling Data”, Wheeler Publishing, Allagabad, 2000.</td></tr>
<tr><td colspan="9">Reference(s) :</td></tr>
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<tr><td colspan="2">Department</td><td>Mechanical Engineering</td><td colspan="3">Programme Code & Name</td><td colspan="2">31 : M.E. Engineering Design</td></tr>
<tr><td colspan="8">Semester II</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ES</td><td>Total</td></tr>
<tr><td>08310261E</td><td>MECHANICS OF COMPOSITE MATERIALS</td><td>3</td><td>0</td><td>0</td><td>3</td><td>50</td><td>50</td><td>100</td></tr>
<tr><td>Objective(s)</td><td colspan="7">To Impart knowledge on Principles of Composite Material Mechanics, mechanics of composite materials their design structure and its manufacturing.</td></tr>
<tr><td>1</td><td colspan="4">INTRODUCTION</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="8">Definition – Need – General Characteristics - Applications - Fibers – Glass, Carbon, Ceramic and Aramid fibers - Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices - Fiber surface treatments - Fillers and additives - Fiber content, density and void content.</td></tr>
<tr><td>2</td><td colspan="4">MECHANICS</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="8">Rule of mixture - Volume and mass fractions – Density - Void content - Evaluation of four elastic moduli based on strength of materials approach and Semi - Empirical model - Longitudinal Young’s modulus - transverse Young’s modulus – major Poisson’s ratio - In-plane shear modulus, Ultimate strengths of a unidirectional lamina - Characteristics of Fiber -Reinforced lamina – Laminates –Lamination theory, Interlaminar stresses</td></tr>
<tr><td>3</td><td colspan="4">PERFORMANCE</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="8">Static Mechanical Properties – Fatigue and Impact Properties – Environmental effects – Long term properties, Fracture Behavior and Damage Tolerance.</td></tr>
<tr><td>4</td><td colspan="4">MANUFACTURING</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="8">Bag Moulding – Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes – Quality Inspection methods - Processing of MMC – Diffusion bonding – Stir casting – Squeeze casting.</td></tr>
<tr><td>5</td><td colspan="4">DESIGN OF STRUCTURES</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="8">Failure Predictions - Laminate Design Consideration -Design criteria - Design allowable - Design guidelines - Joint design-Bolted and Bonded Joints - Design Examples - Design of a tension member – Design of a compression member – Design of a beam-design of a torsional member - Application of FEM for design and analysis of laminated composites.</td></tr>
<tr><td colspan="6">Total hours to be taught</td><td colspan="2">45</td></tr>
<tr><td colspan="8">Text book (s) :</td></tr>
<tr><td>1</td><td colspan="7">Mallick, P.K., “Fiber Reinforced Composites: Materials, Manufacturing and Design”, Marcel Dekker Inc, 1993.</td></tr>
<tr><td>2</td><td colspan="7">Autar K. Kaw, “Mechanics of Composite Materials” CRC Press, 2006.</td></tr>
<tr><td colspan="8">Reference(s) :</td></tr>
<tr><td>1</td><td colspan="7">Agarwal, B.D., and Broutman L.J., “Analysis and Performance of Fiber Composites”, John Wiley and Sons, New York, 1990.</td></tr>
<tr><td>2</td><td colspan="7">Ronald Gibson, “Principles of Composite Material Mechanics", Tata McGraw Hill, 1994.</td></tr>
<tr><td>3</td><td colspan="7">Chawla K.K., “Composite materials”, Springer – Verlag, 1987.</td></tr>
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Department	Mechanical Engineering		Programme Code & Name			31 : M.E. Engineering Design		
Semester II								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310262E	APPLIED FINITE ELEMENT ANALYSIS	3	0	0	3	50	50	100
Objective(s)	To Teach students the concepts in finite element method as related to solving engineering problems involving fluid mechanics, linear and non-linear. To provide students with a working knowledge of computer-aided engineering analysis tools and their use in design.							
1	BENDING OF PLATES AND SHELLS				Total Hrs	9		
Review of Elasticity Equations – Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements - Conforming and Non Conforming Elements – C_0 and C_1 Continuity Elements – Application and Examples.								
2	NON-LINEAR PROBLEMS				Total Hrs	9		
Introduction – Iterative Techniques – Material non-linearity – Elasto Plasticity – Plasticity –Visco Plasticity – Geometric Non linearity – large displacement Formulation – Application in Metal Forming Process and Contact Problems.								
3	DYNAMIC PROBLEM				Total Hrs	9		
Direct Formulation – Free, Transient and Forced Response – Solution Procedures –Subspace Iterative Technique – Houbolt, Wilson, Newmark – Methods – Examples.								
4	FLUID MECHANICS AND HEAT TRANSFER				Total Hrs	9		
Governing Equations of Fluid Mechanics – Inviscid and Incompressible Flow – Potential Formulations – Slow Non-Newtonian Flow – Metal and Polymer Forming – Navier Stokes Equation – Steady and Transient Solution.								
5	ERROR ESTIMATES AND ADAPTIVE REFINEMENT				Total Hrs	9		
Error norms and Convergence rates – h-refinement with adaptivity – Adaptive refinement.								
Total hours to be taught						45		
Text book (s) :								
1	Cook, R.D., “Concepts and Applications of Finite Element Analysis”, John Wiley & Sons Inc., New York, 1989.							
2	Bathe, K.J., “Finite Element Procedures in Engineering Analysis”, Prentice Hall, New Jersey, 1990.							
Reference(s) :								
1	-							

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Department	Mechanical Engineering	Programme Code & Name			31 : M.E. Engineering Design			
Semester II								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310263E	MECHANICS OF FRACTURE	3	0	0	3	50	50	100
Objective(s)	To prove in depth study on stationary crack, crack growth and Fatigue crack growth. To analyse crack Growth for cyclic loading and crack initiation under large scale.							
1	ELEMENTS OF SOLID MECHANICS				Total Hrs	9		
The geometry of stress and strain - Elastic deformation - Plastic and elasto-plastic deformation - Limit analysis.								
2	STATIONARY CRACK UNDER STATIC LOADING				Total Hrs	9		
Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation - Plastic zone size – Dugdaale model – J integral and its relation to crack opening displacement.								
3	ENERGY BALANCE AND CRACK GROWTH				Total Hrs	9		
Griffith analysis – Linear Fracture Mechanics - Crack Opening displacement – Dynamic energy balance – Crack arrest.								
4	FATIGUE CRACK GROWTH CURVE				Total Hrs	9		
Empirical Relation describing crack growth by fatigue – Life calculations for a given load amplitude – Effects of changing the load spectrum – Effects of Environment.								
5	ELEMENTS OF APPLIED FRACTURE MECHANICS				Total Hrs	9		
Examples of crack-growth Analysis for cyclic loading - Leak before break – Crack Initiation under large scale yielding – Thickness as a Design parameter – Crack instability in Thermal or Residual – Stress fields.								
Total hours to be taught						45		
Text book (s) :								
1	Broek, David. "Elementary Engineering Fracture Mechanics", Fifthoff & Noerdhoff International Publisher, 1978.							
2	Hellan, Kare., "Introduction of Fracture Mechanics", McGraw-Hill, New York, 1985.							
Reference(s) :								
1	Preshant Kumar., "Elements of Fracture Mechanics", Wheeler Publishing, Allahabad, 1999.							

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<tr><td colspan="2">Department</td><td colspan="2">Mechanical Engineering</td><td colspan="2">Programme Code & Name</td><td colspan="3">31 : M.E. Engineering Design</td></tr>
<tr><td colspan="9">Semester II</td></tr>
<tr><td colspan="2" rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ES</td><td>Total</td></tr>
<tr><td colspan="2">08310264E</td><td>APPLIED OBJECT ORIENTED PROGRAMMING</td><td>3</td><td>0</td><td>0</td><td>3</td><td>50</td><td>50</td><td>100</td></tr>
<tr><td colspan="2">Objective(s)</td><td colspan="7">To Impart some fundamentals of object oriented programming, C++ data types, C++ classes, class derivation and applications of all</td></tr>
<tr><td>1</td><td colspan="4">FUNDAMENTALS OF OBJECT ORIENTED PROGRAMMING</td><td colspan="2">Total Hrs</td><td colspan="2">9</td></tr>
<tr><td colspan="9">Elements of OOP, classes, subjects, messaging, inheritance, polymorphism, OOP paradigm versus Procedural paradigm, object-oriented design.</td></tr>
<tr><td>2</td><td colspan="4">C++ DATA TYPES</td><td colspan="2">Total Hrs</td><td colspan="2">9</td></tr>
<tr><td colspan="9">Expression and statements, operators, precedence, type conversion, flow control, Arrays structures, argument passing, reference argument, overloaded function.</td></tr>
<tr><td>3</td><td colspan="4">C++ CLASS</td><td colspan="2">Total Hrs</td><td colspan="2">9</td></tr>
<tr><td colspan="9">Definition, class objects, member functions, pointer friends, class member pointer, scope, unions, bit-fields, class argument and ellises - Class member functions, initialization, operator overloading, user defined conversions.</td></tr>
<tr><td>4</td><td colspan="4">CLASS DERIVATION</td><td colspan="2">Total Hrs</td><td colspan="2">9</td></tr>
<tr><td colspan="9">Derivation specification, Information hiding under derivation public and private base classes, standard conventions under derivation, class scope, Initialization and assignment under derivation.</td></tr>
<tr><td>5</td><td colspan="4">APPLICATION</td><td colspan="2">Total Hrs</td><td colspan="2">9</td></tr>
<tr><td colspan="9">OOP’s applications in linear programming, integer programming, simulation, etc.</td></tr>
<tr><td colspan="7">Total hours to be taught</td><td colspan="2">45</td></tr>
<tr><td colspan="9">Text book (s) :</td></tr>
<tr><td>1</td><td colspan="8">Wiener, Richard, S. and Pinson, Lewis, J. “An introduction to objective oriented programming and C++ ", 1999.</td></tr>
<tr><td>2</td><td colspan="8">Stanley B.Lippman, “C++ primer ", Addison - Wesley Pub. Co., 1989.</td></tr>
<tr><td colspan="9">Reference(s) :</td></tr>
<tr><td>1</td><td colspan="8">Robert Lafore, “Object Oriented programming in Turbo C++ ", Galgotia Publication, 1992.</td></tr>
<tr><td>2</td><td colspan="8">Strousstrup, Bjarne, The “C++ programming languages ", Addison Wesley, 1986.</td></tr>
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<tr><td colspan="9">Semester III</td></tr>
<tr><td colspan="2" rowspan="2">Course Code</td><td colspan="2" rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ES</td><td>Total</td></tr>
<tr><td colspan="2">08310371E</td><td colspan="2">DESIGN OF MATERIAL HANDLING EQUIPMENTS</td><td>3</td><td>0</td><td>0</td><td>3</td><td>50</td><td>50</td><td>100</td></tr>
<tr><td colspan="2">Objective(s)</td><td colspan="7">To give a comprehensive insight on design of hoists, Hoisting gear, conveyors and Elevators.</td></tr>
<tr><td>1</td><td colspan="5">MATERIALS HANDLING EQUIPMENT</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="8">Types of material handling equipments - Selection and applications.</td></tr>
<tr><td>2</td><td colspan="5">DESIGN OF HOISTS</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td>3</td><td colspan="5">DRIVES OF HOISTING GEAR</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="8">Hand and power drives - Traveling gear - Rail traveling mechanism - Cantilever and monorail cranes - Slewing, jib and luffing gear - Cogwheel drive - Selecting the motor ratings.</td></tr>
<tr><td>4</td><td colspan="5">CONVEYORS</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="8">Types - Description - Design and applications of Belt conveyors, apron conveyors and escalators - Pneumatic conveyors - Screw conveyors - Vibratory conveyors.</td></tr>
<tr><td>5</td><td colspan="5">ELEVATORS</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="8">Bucket elevators: design - Loading and bucket arrangements - Cage elevators - Shaft way, guides, counter weights, hoisting machine, safety devices - Design of form lift trucks.</td></tr>
<tr><td colspan="7">Total hours to be taught</td><td>45</td></tr>
<tr><td colspan="8">Text book (s) :</td></tr>
<tr><td>1</td><td colspan="7">Rudenko, N., Materials handling equipment, ELnvee Publishers, 1970.</td></tr>
<tr><td>2</td><td colspan="7">Spivakovsy, A.O. and Dyachkov, V.K., LConveying Machines, Volumes I and II, MIR Publishers, 1985.</td></tr>
<tr><td colspan="8">Reference(s) :</td></tr>
<tr><td>1</td><td colspan="7">Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.</td></tr>
<tr><td>2</td><td colspan="7">Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.</td></tr>
<tr><td>3</td><td colspan="7">P.S.G. Tech, “Design Data Book”, Kalaikathir Achchagam, Coimbatore, 2003.</td></tr>
<tr><td>4</td><td colspan="7">Lingaiah. K. and Narayana Iyengar, “Machine Design Data Hand Book”, Vol. 1 & 2, Suma Publishers, Bangalore, 1983.</td></tr>
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Semester III								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310372E	EXPERIMENTAL STRESS ANALYSIS	3	0	0	3	50	50	100
Objective(s)	To prove in depth study on forces and strain measurement and vibration measurements, principles of Acoustics and distress measurements and non- destructive testing methods.							
1	FORCES AND STRAIN MEASUREMENT				Total Hrs	9		
Strain gauge, principle, types, performance and uses. Photo elasticity – principle and applications - Moire Fringe - Hydraulic jacks and pressure gauges – Electronic load cells – Proving Rings – Calibration of Testing Machines								
2	VIBRATION MEASUREMENTS				Total Hrs	9		
Characteristics of Structural Vibrations – Linear Variable Differential Transformer (LVDT) – Transducers for velocity and acceleration measurements. Vibration meter – Seismographs – Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter – Chart Plotters – Digital data Acquisition systems.								
3	ACOUSTICS AND WIND FLOW MEASURES				Total Hrs	9		
Principles of Pressure and flow measurements – Pressure transducers – Sound level meter – Venturimeter and flow meters – Wind tunnel and its use in structural analysis – Structural modeling – Direct and indirect model analysis.								
4	DISTRESS MEASUREMENTS				Total Hrs	9		
Diagnosis of distress in structures – Crack observation and measurements – Corrosion of reinforcement in concrete – Half-cell, construction and use – Damage assessment – Controlled blasting for demolition.								
5	NON DESTRUCTIVE TESTING METHODS				Total Hrs	9		
Load testing on structures, buildings, bridges and towers – Rebound Hammer – Acoustic emission – Ultrasonic testing principles and application – Holography – Use of laser for structural testing – Brittle coating								
Total hours to be taught						45		
Text book (s) :								
1	JW Dalley and WF Riley, Experimental Stress Analysis, McGraw Hill Book Company, N.Y. 1991.							
2	L.S.Srinath et al, Experimental Stress Analysis, Tata McGraw Hill Company, New Delhi, 1984.							
Reference(s) :								
1	Sadhu Singh – Experimental Stress Analysis, Khanna Publishers, New Delhi, 1996.							
2	R.S.Sirohi, HC Radhakrishna, Mechanical Measurements, New Age International (P) Ltd. 1997.							
3	F.K Garas, J.L. Clarke and GST Armer, Structural assessment, Butterworths, London, 1987.							
4	D.E. Bray & R. K.Stanley, Non-destructive Evaluation, McGraw Hill Publishing Company, N.Y.1989.							

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Department	Mechanical Engineering	Programme Code & Name			31 : M.E. Engineering Design			
Semester III								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310373E	VIBRATION CONTROL AND CONDITION MONITORING	3	0	0	3	50	50	100
Objective(s)	At the end of the course, the student should be able to understand the vibration control in design and principles & applications, dynamic balancing and alignment of machinery.							
1	INTRODUCTION				Total Hrs	9		
Review of Fundamentals of Single Degree Freedom Systems – Two Degree Freedom Systems - Multi Degree Freedom System - Continuous system - Determination of Natural frequencies and mode shapes - Numerical methods in Vibration Analysis.								
2	VIBRATION CONTROL				Total Hrs	9		
Introduction – Reduction of Vibration at the Source - Control of Vibration – by Structural design – Material Selection – Localized additions – Artificial damping – Resilient isolation - Vibration isolation - Vibration absorbers.								
3	ACTIVE VIBRATION CONTROL				Total Hrs	9		
Introduction – Concepts and applications - Review of smart materials – Types and Characteristics - Review of smart structures – Characteristics Active vibration control in smart structures.								
4	CONDITION BASED MAINTENANCE PRINCIPLES AND APPLICATIONS				Total Hrs	9		
Introduction - Condition Monitoring Methods - The Design of Information system -Selecting methods of monitoring - Machine condition monitoring and diagnosis – Vibration severity criteria – Machine maintenance techniques – Machine condition monitoring techniques – Vibration monitoring techniques – Instrumentation systems – Choice of monitoring parameter.								
5	DYNAMIC BALANCING AND ALIGNMENT OF MACHINERY				Total Hrs	9		
Introduction - Dynamic Balancing of Rotors - Field Balancing in one Plane, two Planes and in several Planes- Machinery Alignment - “Rough” Alignment Methods -The Face - Peripheral Dial Indicator Method - Reverse Indicator Method - Shaft-to-coupling spool method.								
Total hours to be taught						45		
Text book (s) :								
1	Bathe K.J. and Wilson, F.I., “Numerical Methods in Finite Element Analysis”, Prentice Hall of India, New Delhi, 1978.							
2	Hartog, J.O. Den., “Mechanical Vibrations”, McGraw-Hill, New York, 1985.							
Reference(s) :								
1	Rao, J.S., “Vibratory Condition Monitoring of Machines”, CRC Press, London, 2000.							
2	Science Elsevier, “Hand Book of Condition Monitoring”, Elsevier Science, Amsterdam, 1996.							

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Department	Mechanical Engineering	Programme Code & Name			31 : M.E. Engineering Design			
Semester III								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310381E	INTEGRATED MANUFACTURING SYSTEMS	3	0	0	3	50	50	100
Objective(s)	To enlighten the basic concepts of group technology and computer aided process planning, computer aided planning and control, ways and means of computer monitoring and integrated manufacturing system.							
1	INTRODUCTION				Total Hrs	9		
Objectives of a manufacturing system-identifying business opportunities and problems classification production systems-linking manufacturing strategy and systems analysis of manufacturing operations.								
2	GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING				Total Hrs	9		
Introduction-part families-parts classification and cooling - group technology machine cells-benefits of group technology. Process planning function CAPP - Computer generated time standards.								
3	COMPUTER AIDED PLANNING AND CONTROL				Total Hrs	9		
Production planning and control-cost planning and control-inventory management-Material requirements planning (MRP)-shop floor control-Factory data collection system-Automatic identification system-barcode technology- automated data collection system.								
4	COMPUTER MONITORING				Total Hrs	9		
Types of production monitoring systems-structure model of manufacturing process-process control & strategies- direct digital control-supervisory computer control-computer in QC - contact inspection methods non-contact inspection method - computer-aided testing - integration of CAQC with CAD/CAM.								
5	INTEGRATED MANUFACTURING SYSTEM				Total Hrs	9		
Definition - application - features - types of manufacturing systems-machine tools-materials handling system-computer control system - DNC systems manufacturing cell. Flexible manufacturing systems (FMS) - the FMS concept-transfer systems - head changing FMS - variable mission manufacturing system - CAD/CAM system - human labor in the manufacturing system-computer integrated manufacturing system benefits. Rapid prototyping - Artificial Intelligence and Expert system in CIM.								
Total hours to be taught						45		
Text book (s) :								
1	Groover, M.P., "Automation, Production System and CIM", Prentice-Hall of India, 1998.							
2	David Bedworth, "Computer Integrated Design and Manufacturing", TMH, New Delhi, 1998							
Reference(s) :								
1	Yorem Koren, "Computer Integrated Manufacturing Systems", McGraw Hill, 1983.							
2	Ranky, Paul G., "Computer Integrated Manufacturing", Prentice Hall International 1986.							
3	R.W. Yeomamas, A. Choudry and P.J.W. Ten Hagen, "Design rules for a CIM system", North Holland Amsterdam, 1985.							

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Semester III								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310382E	THEORY OF PLATES AND SHELLS	3	0	0	3	50	50	100
Objective(s)	To Impart some fundamentals knowledge on thin plates and governing differential equations, Energy methods, finite difference and finite element methods, shells and space frames.							
1	THIN PLATES & GOVERNING DIFFERENTIAL EQUATION				Total Hrs	9		
Thin Plates with small deflection - Laterally loaded thin plates - Governing differential equation - Various boundary conditions.								
2	BENDING OF RECTANGULAR & CIRCULAR PLATES				Total Hrs	9		
Rectangular plates - Simply supported rectangular plates - Navier solution and Levy's method - Rectangular plates with various edge conditions - Plates on elastic foundation - Symmetrical bending of circular plates.								
3	ANALYSIS OF PLATES				Total Hrs	9		
Energy methods - Finite difference and Finite element methods.								
4	SHELLS & FOLDED PLATES STRUCTURE				Total Hrs	9		
Classification of shells - Types of shells, structural action - Membrane theory - Shells of revolution and shells of translation, examples, and limitations of membrane theory - Folded Plate structures - Structural behavior, types, design by ACI - ASCE Task Committee method								
5	SPACE FRAMES				Total Hrs	9		
Space frames - Configuration - Types of nodes - General principles of design Philosophy - Behavior.								
Total hours to be taught						45		
Text book (s) :								
1	Szilard, R., Theory and Analysis of Plates, Prentice Hall Inc., 1995.							
2	Timoshenko, S. and Krieger S.W. Theory of Plates and Shells, McGraw Hill Book Company, New York 1990.							
Reference(s) :								
1	Wilhelm Flügge, stresses in shells, Springer – Verlag.							
2	Timoshenko, S. Theory of Plates and Shells, McGraw Hill, 1990.							
3	Ramasamy, G.S., Design and Construction of Concrete Shells Roofs, CBS Publishers, 1986.							
4	Dr.N.Subramanian, Principles of Space Structures , Wheeler Publishing Co. 1999.							
5	Proceedings of International Conference on Space Structures, Anna University, November 1997.							

<table>
<tr><td colspan="7">K.S.Rangasamy College of Technology - Autonomous Regulation</td><td>R 2008</td></tr>
<tr><td colspan="2">Department</td><td colspan="2">Mechanical Engineering</td><td colspan="2">Programme Code & Name</td><td colspan="2">31 : M.E. Engineering Design</td></tr>
<tr><td colspan="9">Semester III</td></tr>
<tr><td rowspan="2" colspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="2">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ES</td><td>Total</td></tr>
<tr><td colspan="2">08310383E</td><td>DESIGN OF HEAT EXCHANGERS</td><td>3</td><td>0</td><td>0</td><td>3</td><td>50</td><td>50</td><td>100</td></tr>
<tr><td colspan="2">Objective(s)</td><td colspan="7">To educate the ways and means of flow distribution and stress analysis, constructional details of Heat Exchangers, Design aspects of heat exchangers, condensers, evaporators and cooling towers.</td></tr>
<tr><td>1</td><td colspan="5">CONSTRUCTIONAL DETAILS AND HEAT TRANSFER</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="9">Types - Shell and Tube Heat Exchangers - Regenerators and Recuperates Industrial Applications Temperature Distribution and its Implications - LMTD - Effectiveness</td></tr>
<tr><td>2</td><td colspan="5">FLOW DISTRIBUTION AND STRESS ANALYSIS</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="9">Effect of Turbulence - Friction Factor - Pressure Loss - Channel Divergence Stresses in Tubes - Heater sheets and Pressure Vessels - Thermal Stresses - Shear Stresses - Types of Failures</td></tr>
<tr><td>3</td><td colspan="5">DESIGN ASPECTS</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="9">Heat Transfer and Pressure Loss - Flow Configuration - Effect of Baffles - Effect of Deviations from Ideality - Design of Typical Liquid - Gas-Gas-Liquid Heat Exchangers</td></tr>
<tr><td>4</td><td colspan="5">CONDENSERS AND EVAPORATORS DESIGN</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="9">Design of Surface and Evaporative Condensers - Design of Shell and Tube - Plate Type Evaporators</td></tr>
<tr><td>5</td><td colspan="5">COOLING TOWERS</td><td colspan="2">Total Hrs</td><td>9</td></tr>
<tr><td colspan="9">Packing - Spray Design - Selection of Pumps - Fans and Pipes - Testing and Maintenance – Experimental Methods.</td></tr>
<tr><td colspan="7">Total hours to be taught</td><td colspan="2">45</td></tr>
<tr><td colspan="9">Text book (s) :</td></tr>
<tr><td>1</td><td colspan="8">T. Taborek, G.F. Hewitt and N.Afgan, Heat Exchangers, Theory and Practice, McGraw Hill Book Co., 1980.</td></tr>
<tr><td>2</td><td colspan="8">Walker, Industrial Heat Exchangers - A Basic Guide, McGraw Hill Book Co., 1980.</td></tr>
<tr><td colspan="9">Reference(s) :</td></tr>
<tr><td>1</td><td colspan="8">Nicholas Cheremisioff, Cooling Tower, Ann Arbor Science Pub 1981.</td></tr>
<tr><td>2</td><td colspan="8">Arthur P. Fraas, Heat Exchanger Design, John Wiley & Sons, 1988.</td></tr>
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Semester III								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310391E	PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING	3	0	0	3	50	50	100
Objective(s)	To Integrate the concepts of productivity models, organizational transformation, Re-engineering process, Re-engineering tools and Implementation.							
1	INTRODUCTION				Total Hrs	9		
Productivity concepts - Macro and Micro factors of productivity, Productivity benefit model, productivity cycle.								
2	PRODUCTIVITY MODELS				Total Hrs	9		
Productivity measurement at International, National and Organizational level, Total productivity models. Productivity management in manufacturing and service sector. Productivity evaluation models, Productivity improvement models and techniques.								
3	ORGANIZATIONAL TRANSFORMATION				Total Hrs	9		
Principles of organizational transformation and re-engineering, fundamentals of process reengineering, preparing the workforce for transformation and reengineering, methodology, guidelines, DSMCQ and PMP model								
4	RE-ENGINEERING PROCESS IMPROVEMENT MODELS				Total Hrs	9		
PMI models, Edosomwan model, Moen and Nolan strategy for process improvement, LMICIP model, NPRDC model.								
5	RE-ENGINEERING TOOLS AND IMPLEMENTATION				Total Hrs	9		
Analytical and process tools and techniques - Information and communication technology - Enabling role of IT, RE-opportunities, process redesign - cases. Software methods in BPR - specification of BP, case study - Order, processing, user interfaces, maintainability and reusability								
Total hours to be taught						45		
Text book (s) :								
1	Sumanth, D.J., " Productivity engineering and management ", TMH, New Delhi, 1990.							
2	Edosomwan, J.A., “Organizational transformation and process re-engineering ", British Library cataloging in pub. Data, 1996.							
Reference(s) :								
1	Rastogi, P.N. “Re-Engineering and Re-inventing the enterprise ", Wheeler pub. New Delhi, 1995.							
2	Premvrat, Sardana, G.D. and Sahay, B.S, “Productivity Management - A systems approach ", Narosa Pub. New Delhi, 1998.							

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Semester III								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ES	Total
08310392E	MECHATRONICS IN MANUFACTURING SYSTEMS	3	0	0	3	50	50	100
Objective(s)	To understand the functions of mechatronic systems, sensors and transducers, microprocessor in mechatronics, programmable logic controllers and design.							
1	INTRODUCTION				Total Hrs	9		
Introduction to Mechatronics - Systems - Mechatronics in Products - Measurement Systems - Control Systems - Traditional design and Mechatronics Design.								
2	SENSORS AND TRANSDUCERS				Total Hrs	9		
Introduction - Performance Terminology - Displacement, Position and Proximity - Velocity and Motion - Fluid pressure - Temperature sensors - Light sensors - Selection of sensors - Signal processing - Servo systems.								
3	MICROPROCESSORS IN MECHATRONICS				Total Hrs	9		
Introduction - Architecture - Pin configuration - Instruction set - Programming of Microprocessors using 8085 instructions - Interfacing input and output devices - Interfacing D/A converters and A/D converters –Applications - Temperature control - Stepper motor control - Traffic light controller.								
4	PROGRAMMABLE LOGIC CONTROLLERS				Total Hrs	9		
Introduction - Basic structure - Input / Output processing - Programming -Mnemonics Timers, Internal relays and counters - Data handling - Analog input / output - Selection of PLC								
5	DESIGN AND MECHATRONICS				Total Hrs	9		
Designing - Possible design solutions - Case studies of Mechatronics systems.								
Total hours to be taught						45		
Text book (s) :								
1	Michael B.Histand and David G. Alciatore, " Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 1999.							
2	Bradley, D.A., Dawson, D, Buru, N.C. and Loader, AJ., " Mechatronics ", Chapman and Hall, 1993.							
Reference(s) :								
1	Ramesh.S, Gaonkar, " Microprocessor Architecture, Programming and Applications "Wiley Eastern, 1998.							
2	Lawrence J.Kamm, “Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics ", Prentice-Hall, 2000.							
3	Ghosh, P.K. and Sridhar, P.R., 0000 to 8085, “Introduction to Microprocessors for Engineers and Scientists ", Second Edition, Prentice Hall, 1995.							