VASAVI COLLEGE OF ENGINEERING (Autonomous)

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(Sponsored by Vasavi Academy of Education)

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DEPARTMENT OF MECHANICAL ENGINEERING

Minutes of the fifth meeting of Board of Studies, Mechanical Engineering Department, held at 3.00 PM on 14.09.2016 (Wednesday) at the Department of Mechanical Engineering, Vasavi College of Engineering, Ibrahimbagh, Hyderabad.

Members Presents

Prof. G.V. Ramana Murthy	Chairman & Head
Dr. Jeevan Jaidi	OU nominee (BITS Hyderabad)
Prof. Sriram Venkatesh	Subject expert (OU Hyderabad)
Dr. B. Venkatesham	Subject expert (IIT Hyderabad)
Dr. N.K. Singh	Industry representative (BHEL R&D)
Dr. K. Kishore	Faculty member
Dr. T. Ramamohan Rao	Faculty member
Mr. K. Srinivasa Rao	Faculty member
Mr. P.V.Gopal Krishna	Faculty member
Mr. K.Veladri	Faculty member
Mr. V.B.S. Rajendra Prasad	Faculty member
Mr. B.Radha Krishna	Faculty member
Mr. J. Anjaneyulu	Faculty Member
Mr. S. Sreekrishna	Faculty member
Mrs. P.V.S. Subhashini	Faculty member
Mr. K.I. Spurgeon	Faculty member
Mr. D. Govinda Rao	Faculty member
Mr. B. Naga Manohar	Faculty member
Dr. A. Srinivas	Faculty member
Mr. S.Venkataiah	Faculty member
Mr. P. Venkateswara Rao	Faculty member
Mr. M. Sudhakar	Faculty member
Mr. B. Sandeep	Faculty Member
Mr. N.B. Samba Murthy	Faculty member
Mr. S. Venkateswarulu	Faculty member

The following members of Board of Studies could not attend the meeting

1. Mr. K. Pratap Singh Naik, PG Alumnus

Contd...2

Chairman welcomed the members and readout the agenda points for discussion.

1. **Finalisation of scheme of instruction for ME 1st & 2nd Years under Choice Based Credit System (CBCS)**

   Chairman readout the scheme of instruction proposed for M.E. 1st year to be implimented w.e.f. A.Y. 2016-17 under choice based credit system.

   1.1 The scheme consists of three core and three elective courses in the first semester and second semester respectively. The students will be required to register for elective courses after choosing from a list of courses. The list of courses for electives have been grouped under three categories namely Design, Manufacturing and Analysis. Each student need to complete two elective courses from each category. The scheme also includes course on Finishing School: Soft Skills in first and second semester respectively in order to improve the communication skills of the students.

   1.2 It is suggested that the course on Mechanical Behaviour of Materials under Analysis Group to be shifted to Manufacturing Group and accordingly same has been accepted. It has been suggested that an additional course on numerical analysis and modelling be included in the analysis group which has been agreed to.

   The scheme of instruction and examination with the above modifications has been approved.

2. Approval of syllabus for ME 1st & 2nd Years under Choice Based Credit System (CBCS)

   The members went through the syllabus framed for core courses and elective courses. The following suggestions have been suggested.

   2.1 Title (Design for Assembly) has been assigned to unit-5 of course "Design for Manufacture and Assembly".

   2.2 No prerequisite is needed for unit-5 of Computer Aided Mechanical Design and Analysis.

   2.3 A topic on introduction to compliant mechanisms has been added in unit-5 of Advanced Kinematics.

   2.4 The course content for unit-3 of Mechanical Vibrations has been revised based on the discussions.

   2.5 The contents of unit-1 in Design of Pressure Vessels and Piping have been enlarged.

The course contents and syllabus with the above modifications has been approved.

Prof. Sriram Venkatesh Subject Expert-1	SVenu	Dr. N.K. Singh Industry Expert	[illegible]
Dr. B. Venkatesham Subject Expert-2	B. Venkatesham	Dr. Jeevan Jaidi OU Nominee	[illegible]
Dr. G.V. Ramana Murty Chairman, BOS	GRamanamurty 14/9		

SCHEME OF INSTRUCTION AND EXAMINATION FOR
M.E. (Advanced Design and Manufacturing)
With effect from Academic year 2016-17
Choice Based Credit System

Sl. No.	Category	Subject code	Subject Title	Scheme of Instruction L	T	P	Scheme of Examination Duration in Hrs	CIE	Sem end Exam	Total	Credits
I – SEMESTER											
1	PC	MA5110	Mathematical methods for Engineers	3	1	0	3	30	70	100	3
2	PC	ME5120	Metal cutting and forming	3	0	0	3	30	70	100	3
3	PC	ME5130	Computer Integrated Design and manufacturing	3	1	0	3	30	70	100	3
4	PE	ME5010	Professional Elective - 1	3	1	0	3	30	70	100	3
5	PE	ME5020	Professional Elective - 2	3	0	0	3	30	70	100	3
6	PE	ME5030	Professional Elective - 3	3	0	0	3	30	70	100	3
7.	EEC	HSxxxx	Finishing School: Soft Skills	2	0	0	1.5	15	35	50	1
Laboratory											
7	PC	ME5111	CAD/CAM Laboratory	0	0	3	3	25	50	75	2
8	EEC	ME5112	Seminar - I	0	0	2	0	25	0	25	1
				20	3	5	-	245	505	750	**22**
II - SEMESTER											
1	PC	ME5250	Design for Manufacture and assembly	3	1	0	3	30	70	100	3
2	PC	ME5260	Metallurgy of Metal Casting and welding processes	3	1	0	3	30	70	100	3
3	PC	ME5270	Computer Aided Mechanical Design and Analysis	3	0	0	3	30	70	100	3
4	PE	ME5040	Professional Elective – 4	3	1	0	3	30	70	100	3
5	PE	ME5050	Professional Elective – 5	3	0	0	3	30	70	100	3
6	PE	ME5060	Professional Elective – 6	3	0	0	3	30	70	100	3
7.	EEC	HS xxxx	Finishing School: Soft Skills	2	0	0	1.5	15	35	50	1
Laboratory											
7	PC	ME5211	Modelling & Simulation Laboratory	0	0	3	3	25	50	75	2
8	EEC	ME5212	Seminar -II	0	0	2	0	25	0	25	1
				20	3	5	-	245	505	750	**22**
III - SEMESTER											
1.	EEC	ME6112	Dissertation seminar	**0**	**0**	**4**	**0**	**50**	**0**	**50**	**2**
2.	EEC	ME6115	Dissertation – Phase I	**0**	**0**	**16**	**0**	**100**	**0**	**100**	**8**
				0	**0**	**20**	**-**	**150**	**0**	**150**	**10**
IV - SEMESTER											
1.	EEC	ME6215	Dissertation – Phase II	**0**	**0**	**30**	**-**	**Viva-voce (Grade)**			**15**
											69

The student shall select at least **two courses** from each group of Professional Electives to be eligible to receive the degree.

Professional Electives

Sl. No.	Code No.	Design Group (D)	Code No	Manufacturing Group (M)	Code No	Analysis Group (A)
1	ME50x0	Advanced Kinematics	ME50x0	Flexible Manufacturing systems	ME50x0	Finite Element Techniques
2	ME50x0	Mechanical Vibrations	ME50x0	Advanced Non Destructive Evaluation Techniques	ME50x0	Engineering Research Methodology
3	ME50x0	Advanced Mechanics of solids	ME50x0	Additive Manufacturing	ME50x0	Optimisation Techniques
4	ME50x0	Theory of Elasticity and Plasticity	ME50x0	An Introduction to Nano Science and Technology	ME50x0	Computational Fluid Dynamics
5	ME50x0	Mechanics of Composite materials	ME50x0	Product Design and Process Planning	ME50x0	Advanced Finite Element Analysis
6	ME50x0	Robotic Engineering	ME50x0	Quality and Reliability Engineering	ME50x0	Experimental Techniques and Data Analysis
7	ME50x0	Gear Design and Engineering	ME50x0	Value Engineering	ME50x0	Fracture Mechanics
8.	ME50x0	Design of Pressure Vessels and Piping	ME50x0	Mechatronics	-	-
9.	-	-	ME50x0	Mechanical behaviour of engineering materials	-	-

X in Code No. will be replaced by 1,2,3 in I semester and 4,5,6 in II semester.

SIGNATURES:

(Dr. Jeevan Jaidi)
1) OU Nominee

(Prof. Sriram Venkatesh)
2) Subject Expert-1

B. Venkatesham
(Dr. B. Venkatesham)
3) Subject Expert-2

(Dr. N.K. Singh)
4) Industry Expert

Ramana Murty
(Dr. G.V. Ramana Murty) 14/9
5)Chairman, BOS

CORE SUBJECTS

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

MATHEMATICAL METHODS FOR ENGINEERS		
Instruction: 3 Hours/ week	Semester End Exam Marks: 70	Subject Reference Code: **MA 5110**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

COURSE OBJECTIVES	COURSE OUTCOMES
The course will enable the students to:	*At the end of the course students shall be able to:*
1 Understand the basic operations of vector operators to prove vector Identities	1. Solve the problems by applying the basic operations of vectors to prove vector identities
2 Understand the basics of tensors to prove vector identities in tensor form	2. Solve the basics of tensors to prove vector identities in tensor form and related problems
3 Understand the basics of matrices to solve linear algebraic equations	3. Solve the linear algebraic equations by using methods of matrices.
4. Understand the concepts of Laplace transforms to solve ordinary differential Equations.	4. Solve differential equations by using the Laplace Transforms. Verify the orthogonality of Functions.
5. Classify the PDEs and study the application of PDEs for engineering problems	5. Solve the PDEs and apply the knowledge for solving engineering problems

UNIT-I : (11 Periods)
Vectors: Definition of Scalar–Vector –Scalar point function–Vector point function – Gradient – Divergence – Curl – related problems – Vector Identities – related problems.

UNIT-II : (12 Periods)
Tensors:(Cartesian system): Definition – notation – transformation matrix – order of a tensor – Addition, outer product, inner product, contraction and quotient rule on tensors – Kronecker Delta – Definition of Contra variant, Covariant and Mixed tensors –Definition of permutation tensor – Tensor notation of Gradient – Curl and Divergence of vector operators – Tensor notation of Vector identities.

UNIT-III : (12 Periods)
Linear algebraic equations: Representation of linear equations in matrix form-Cramer's rule– Inverse of a matrix – Consistence/In–Consistence of equations – Gauss elimination – Gauss-Seidal – LU Decomposition – General solution for under determined system – Least square solutions for over determined systems – Eigen values and Eigen vectors – Singular value decomposition.

UNIT-IV : (10 Periods)
Laplace Transforms and Its Applications: Laplace transforms – Properties of Laplace transforms –Inverse Laplace transforms – Convolution theorem – Applications of Laplace transforms to ordinary differential equations – Orthogonal functions – Gram-Schmidt Orthogonalization of vectors.

UNIT-V : (11 Periods)
Partial Differential Equations and It Applications : Classification of PDEs – Transformation between different coordinate system – Fourier series – Application of Fourier series to one dimensional wave equation-One dimensional heat equation – Laplace's equation

Suggested Reading:

1 Higher Engineering Mathematics, B.S.Grewal, Khanna Publications
2 Advanced Engineering Mathematics, RK Jain, SRK Iyengar, Narosa Publications
3 Advanced Engineering Mathematics, Kreyszig,8th Edition, John Wiley and Sons Ltd.,2006
4 A Text Book of Engineering Mathematics, N.P.Bali and Manish Goyal, Laxmi Publications
5 Numerical Methods IN Engineering and Science, Dr.B.S Grewal, Khanna Publishers.

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(Dr. G.V. Ramana Murty) 1/4/9
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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

METAL CUTTING AND FORMING		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: **ME 5120**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • Explain the principles of metal cutting • Discuss various shear angle relations • Discuss effects of temperature and forces in metal cutting • Describe various plastic deformation theories • Identify and differentiate various non conventional forming methods	On completion of the course the student will be able to: • **Analyse** various metal cutting processes. • **Formulate** equations of temperature distribution and forces in metal cutting. • **Appreciate** methods of improving cutting efficiency and economics. • **Evaluate** different metal forming methods. • **Analyze** various non conventional forming methods.

UNIT-I

Tool Materials: Tool material properties – HSS, Carbides, coated carbides, ceramic and CBN and diamonds, sialons, powder coatings – Relative advantages. Tool Geometry: Various methods of tool nomenclature and their inter relationship. Theoretical Determination of shear angle and cutting forces: Shear plane theory–Merchants models, Lee and Shofers model. Velocity relations. Estimation of shear·angle experimentally. Metal cutting friction. Real area of contact-Rules of dry sliding, stress distribution of tool face-variation of co-efficient of tool face friction with the rake angle.

UNIT-II

Dynamometry: Theoretical and empirical estimation of force and power in turning, drilling, milling and grinding processes optimization in cutting forces – Dynamometer requirements – Force measurements – Electric transducers. Lathe, drilling and milling dynamometers. Cutting Temperatures: Shear Plane temperature – Average chip-tool interface temperature-interface temperature by dimensional analysis – Distribution of shear plane temperature-Measurement of temperature by radiation pyrometer – Moving thermo couple – Photo cell – Photographic method.

UNIT-III

Tool Wear, Tool life and Machinability: Mechanism of tool wear – Adhesive, Abrasive, Diffusive and Chemical wear – Taylor"s tool life equation. Cutting Fluids – Carbon tetrachloride – Direction of fluid application – Chip curl-economics of machining – Comparison of machinability of different metals. Recent development in metal cutting: Hot machining. Rotary machining – High speed machining, rapid proto typing.

UNIT-IV

Plastic Deformation: Mechanism of plastic deformation, Factors affecting plastic deformation, Strain hardening behavior. Recovery, Recrystallization and grain growth. Variables affecting stress-strain curves, Ideal & Practical stress-strain curves. Cold working, warm working and hot working. Plasticity cycle. Plane stress & Plane strain condition. Rolling: Principle of rolling, process parameters. Estimation of rolling loads. Principles of roll pass design for various product shapes. Principles of ring rolling.

UNIT-V

Unconventional Methods In Metal Forming: High energy rate forming. Merits and limitations of HERF Processes. Principle, merits, limitations and applications of pneumatic-mechanical systems. Explosive forming, electro-magnetic forming, electro-hydraulic forming and water hammer forming. Forming with rubber pads – Guerin, Marform & Wheelon forming techniques.

Learning Resources:

1. M.C. Shaw. *Metal cutting principles* – CBS Publications, New Delhi, 1992.
2. BhattaCharya, *Metal cutting* – Central book publishers, Calcutta – 1996.
3. Heinrich Makelt, *Mechanical presses*, Edward Arnold (Pvt) Ltd., London, 1968.
4. Bary. Donald.F and Reads. Edward A., *Techniques of press working sheet metal*, Prentice Hall Publ., 1974.
5. Kameschikov, *Forming Practice*, Mir Publishers, Moscow, 1970.
6. *High Velocity Forming methods*, ASTME, Michigan, 1968.

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

COMPUTER INTEGRATED DESIGN AND MANUFACTURING		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: **ME 5130**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • understand the present trends of the product cycle. • learn the modern manufacturing methods and its programming part. • introduce the concepts of modern prototype manufacturing RPT • introduce the present shop floor control methods • Learn the network methods of the digital devices.	On completion of the course the student will be able to: • **understand** the modern methods of design and manufacturing • **Distinguish** production planning and control methods in shop floor • **Classify** the different additive manufacturing methods • **Describe** the modern machining processes • **Integrate** the CAD/CAM operations

UNIT-I
Product Design and CAD/CAM in the Production Systems - Product development through CAD and CAE: Geometric modeling techniques using wireframe, surface and solid modeling-graphic standards, Advanced modeling for curves, surfaces, NURBS- Advanced assembly – assembly constraints – subassembly – modification - concepts of engineering analysis and optimization using CAE techniques.

UNIT-II
Advanced Manufacturing Technology – Design drafting interface, Graphic libraries, Computer aided manufacturing technologies using Numerical Control, CNC and DNC, process interface hardware, programming languages, direct digital control, supervisory compiler controls and optical control, adoptive control – Agile and lean manufacturing.

UNIT-III
Rapid proto typing: Various techniques & mathematical background. Automated inspection & RE-engineering techniques: Point cloud data acquisition & analysis.

UNIT-IV
Concepts of Production Planning, Material Requirement Planning, up to down planning and bottom up replanning – Master production scheduling, PPC, Material Handling Requirements, Technology Planning.

UNIT-V
Communication aspects in CIM – Issues in Implementation of Advanced Manufacturing Technology – configuration management, database systems, networking concepts, LAN, MAN, SQL, CIM Models, Economics of CIM.

Learning Resources:

1. MP Groover, "Automation, Production Systems and Computer Integrated Manufacturing", - Pearson Education, 2nd Edition, 2001.
2. Ibrahim Zeid, "CAD/CAM Theory and Practice", - Tata McGraw Hill, 1991.
3. FH Mitchell, "CIM Systems - An Introduction", - Prentice Hall, 1986.
4. Eric Teicholz & JN, "CIM Handbook", - McGraw Hill, 1986.
5. P.N. Rao, "CAD/CAM Principles and Applications", Tata McGraw Hill, 3rd Ed, 2010

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

DESIGN FOR MANUFACTURE & ASSEMBLY		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: **ME 5250**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • Learn design principles, mechanical properties, geometrical tolerances and economic use of raw materials • design metallic components • design different casting processes • design non-metallic components and study ergonomical aspects • design assembled parts	On completion of the course the student will be able to: • **select** materials for design • **apply** principles for manufacturability for metallic components • **describe** design considerations for castings • **apply** principles for manufacturability for non metallic components • **assemble** the designed parts.

Unit-I
Introduction: General design principles for manufacturability, Introduction to design for manufacturing concepts, mechanical behavior of materials. Materials and design, evolution of engineering materials and their properties. Materials selection charts, selection of engineering materials and their shape. Importance of product specification and standardization.
Economic Use of Raw Materials: Ferrous steel, hot rolled steel, cold finished steel, stainless steel, non ferrous materials aluminium, copper, brass, non metallic materials, plastics, rubber and composites.

Unit-II
Metallic Components Design: Metal extrusion, metal stamping, fine blanking, spun metal parts, cold headed parts, extruded parts, rolled formed parts, specialized forming methods, turned parts, drilled parts, milled parts.

Unit-III
Metallic Components Design: Planned and shaped parts, internal ground parts, center less ground, electrical discharged, electro chemical parts. Sand cast, die cast and investment cast.

Unit-IV
Non Metallic Components Design: Thermosetting plastic, injection moulded and rotational moulded parts, blow moulded, ceramics. Thermoformed plastic parts, plastic welding, rubber parts, design for ergonomics, design for quality and reliability, design for X concepts.

Unit-V
Design for assembly: Design for assembly, design for reassembly, design for automated assembly, Assembled Parts Design: Welded parts, arc, resistance, brazed and soldered parts, gear box assembly, bearing assembly. Retention, bolted connection, screwed connections, press fitted connections, heat treated parts, product design requirements.
Case Studies: Identification of economical design and redesign for manufacture.

Learning Resources:
1. James G. Bralla, "*Hand book of product design for manufacturing*" McGraw Hill Co., 1999
2. K.G. Swift "*Knowledge based design for Manufacture*", Kogan page Limited, 1987.
3. Ashby. Materials selection in Mechanical Design fourth edition Elsevier, 2011
4. Boothroyd, Geoffrey, Peter Dewhurst, and Winston A. Knight. "Product Design for Manufacture and Assembly", 3rd edition, Fl: Standards media, 2010
5. Swift, K.G., and J.D. Booker. Manufacturing Process Selection Handbook, Butterworth-Heinemann, 2013.

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

METALLURGY OF METAL CASTING AND WELDING PROCESSES		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: **ME 5260**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • familiarize the concepts of $Fe\text{-}Fe_3C$ equilibrium diagram. • impart knowledge about metallurgy of ferrous and no ferrous castings. • familiarize the concepts of various heat treatment processes. • study the welding aspects of various ferrous and non-ferrous alloys. • study about the defects in welding process.	On completion of the course the student will be able to: • **interpret** metallurgy of casting for ferrous and non ferrous alloys and their heat treatment process. • **distinguish** various processes in Welding and related heat treatment processes. • **demonstrate** various aspects of welding of alloys of iron, aluminium, magnesium and titanium. • **predict** stresses in welding and their relief. • **analyse** the defects in welding processes

UNIT-I

Solidification of pure metals and alloys, phase diagrams.
Metallurgy of Steel and Cast Iron: Iron-Carbon constitutional equilibrium diagram, Solidification microstructure, effect of cooling rate, carbon content. Types of cast irons.

Solidification of Castings: solidification rate and directional solidification, microstructure of cast metals, shrinkage, gases in cast metals, degasification methods.

UNIT-II

Foundry Refractories, malleabilisation. Heat treatment of cast steel, cast iron, age hardening of castings.
Metallurgy of non-ferrous cast alloys: copper base alloys, Aluminium alloys, Magnesium alloys
Zinc based die casting alloys, Nickel chromium high temperature alloys.

UNIT-III

Welding metallurgy – Weld zone, Fusion boundary zone, Heat affected Zone. Heat treatment and related processes in Fusion welding – Annealing, Normalizing, Austempering, martempering stress relieving, Solution treatment.

UNIT-IV

Micro structural products in weldments – Schaeffer diagram, Delta Ferrite, Austenite, pearlite, Martensite. Effect of Alloying elements on weldments. Welding stresses – Residual stresses, effects, methods of relieving.

UNIT-V

Weldability aspects of low alloy steels, stainless steels, aluminium alloys, Magnesium and Titanium alloys.
Weld cracks – cold and hot cracks; Liquation cracks, Hydrogen Induced cracks, Lamellar cracks.

Learning Resources:

1. Taylor, Flemings & Wulff, "Foundry Engineering", N.Y,Wiley & Song Inc, 1993
2. Heine, Richard.W, and others, "Principles of metal casting", Tata McHill, New York, 1983.
3. Udin Funk & Wulff, "Welding for Engineers", N.Y.John Wiley,1954.
4. J.F. Lancaster, "Metallurgy of welding", London, George Allen & Unwio, 1999.
5. R.S. Parmar, "Welding Engineering & Technology", Delhi, Khanna Publishers, 2007.

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14/9

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

COMPUTER AIDED MECHANICAL DESIGN AND ANALYSIS		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: **ME 5270**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • Explain the design procedure for pressure vessels • Discuss the plate bending theories and equations • Demonstrate the concept of fracture mechanics • Describe the Eigen value problems • Identify various methods to perform dynamic analysis	On completion of the course the student will be able to: • **analyse** the pressure vessels • **formulate** the plate bending equations • **interpret** the behaviour of crack and crack propagation • **formulate** an Eigen value problem and **develop** its solution • **apply** various methods to obtain solutions in Dynamic analysis

UNIT-I
Design of pressure Vessels: Introduction and constructional features of pressure vessels, stresses in pressure vessels, shrink fit stresses in built up cylinders, autofrettage of thick cylinders, thermal stresses and their significance.

UNIT-II
Stresses in flat plates: Introduction, Bending of plate in one direction, Bending of plate in two perpendicular directions, Thermal stresses in plates, Bending of circular plates of constant thickness, Bending of uniformly loaded plates of constant thickness.

UNIT-III
Fracture Mechanics: Introduction, Modes of fracture failure Griffith Analysis, Energy release rate, Energy release rate of DCB specimen; Stress Intensity Factor: SIF"s for edge and centre line crack, Fracture toughness, Elastic plastic analysis through J-integral method: Relevance and scope, Definition of J-integral, Path independence, stress strain relation, Strain Energy Release Rate Vs J-integral.

UNIT-IV
Eigen Value Problems: Properties of Eigen values and Eigen Vectors, Torsional, Longitudinal vibration, lateral vibration, Sturm sequence. Subspace iteration and Lanczo"s method, Component mode synthesis, Eigen value problems applied to stepped beams and bars.

UNIT-V
Dynamic Analysis: Direct integration method, Central difference method, Wilson- method, Newmark method, Mode superposition, Single degree of freedom system response, Multi degree of freedom system response, Rayleigh damping, Condition for stability. (Note: The related algorithms and codes to be practiced by students)

Learning Resources:

1. John, V. Harvey, "Pressure Vessel Design: Nuclear and Chemical Applications", Affiliated East West Press Pvt. Ltd., 1969.
2. Prasanth Kumar, "Elements of Fracture Mechanics", Wheeler Publishing, New Delhi-1999.
3. V. Rammurti, "Computer Aided Mechanical Design and Analysis", Tata Mc Graw Hill-1992.
4. Bathe, J., " Finite Element Procedures", Prentice Hall of India-1996.

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ELECTIVES – DESIGN GROUP

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

ADVANCED KINEMATICS (ELECTIVE)		
Instruction: 3 Hours/ week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • **study** the graphical and analytical methods to perform kinematic analysis • **asses** number and dimensional synthesis of different linkages • **learn** D-H convention and transformations to do kinematic analysis of RGGR spatial mechanism • **evaluate** the cam and follower mechanism for different motion requirements and their design. • **analyze** the methods for kinematic analysis of Two degree of freedom Robot.	On completion of the course the student will be able to: • **perform** kinematic analysis of complex mechanisms • **demonstrate** principles of kinematic synthesis • **analyze** spatial mechanism • **design** the cam profile for given required motion of the follower. • **perform** kinematic analysis for two degree of freedom Robot manipulator.

Unit-I
Kinematic analysis of plane mechanism: Analytical method of kinematic analysis of four bar mechanisms. Acceleration analysis of complex mechanisms by auxiliary point method. Good man's indirect method.

Unit-II
Kinematic synthesis of linkages: Number synthesis, associated linkage or equivalent linkage concept, dimensional synthesis by analytical and graphical methods.

Unit-III
Kinematic analysis of four link RGGR spatial mechanism, D-H parameters, Transformations matrix method for position velocity and acceleration analysis of special mechanisms.

Unit-IV
Cams: Forces in rigid systems, Mathematical models, Response of a uniform - Motion undamped cam mechanism - Analytical method, Follower response by phase - Plane method - Position error, Jump, Crossover shock - Johnson's numerical analysis

Unit-V
Kinematic analysis of two-degree freedom of Robot, introduction to compliant mechanisms.

Learning Resources:

1. Amitabh Gosh and Ashok Kumar Mallik, '*Theory of Mechanisms and Machines*', Affiliated East-West Press Pvt. Ltd., New Delhi, 1998.
2. Artur, G.Erdman and George.N.Sandor, '*Mechanism Design*', Volume-I and -II, Prentice Hall of India, 1984.
3. Joseph Edward. Shigley and J.Joseph Uicker, '*Theory of Mechanisms and Machines*', McGraw-Hill Company, 1995.
4. RL Norton 'Kinematics and Dynamics of Machines' by McGraw-Hill Company, 1st Ed., 2012
5. Charles E Wilson "Kinematics and Dynamics of Machinery", Pearson, 3rd Edition .

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1) OU Nominee	2) Subject Expert-1	3) Subject Expert-2	4) Industry Expert

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

MECHANICAL VIBRATIONS (ELECTIVE)		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • Explain the concept of vibrations, with single and multi-degree freedom • Discuss the numerical methods involved in vibrations • Demonstrate the concept of Transient vibrations and Random vibrations • Identify various methods of vibration control. • Describe the concept of Non-Linear vibrations Identify various methods of vibration control.	On completion of the course the student will be able to: • **analyse** the multi degree of freedom systems vibrations • **formulate** vibration problem using various numerical methods • **interpret** the concept of the Random and Transient vibrations • **apply** various methods for vibration control • **interpre**t the non-linear phenomenon of vibrations and their formulation

Unit-I

(A) Multi Degree Freedom System:-Free Vibration equation of motion. Influence Coefficient i)Stiffness Coeff. (ii) Flexibility Coeff. Generalized co ordinates, and Coordinate couplings. Langranges Equations Matrix Method Eigen Values Eigen Vector problems. Modal Analysis. Forced Vibrations of undamped system and modal analysis.

(B) Multi Degree System Numerical Methods:-(i)Rayleigh`s Method, (ii)Rayleigh-Ritz Method (iii)Holzer`s Method (iv)Methods of Matrix iterations (v) Transfer Matrix Method, Impulse response and frequency response functions.

Unit-II

Continuous System:- Vibrations of String, Bars, Shafts and beams, free and forced vibration of continuous systems.

Unit-III

MODAL PARAMETER EXTRACTION METHODS Introduction – Preliminary checks of FRF Data – SDOF Modal Analysis-I – Peak-amplitude – SDOF Modal Analysis-II – Circle Fit Method – SDOF Modal Analysis III – Inverse Method – Residuals – MDOF curve-fitting procedures – MDOF curve fitting in the Time Domain – Global or Multi-Curve fitting – Non linear systems.

Unit-IV

Vibration Control:-Balancing of rotating machine, In-situ balancing of rotors, control of natural frequency introduction of damping, vibration isolation & vibration absorbers..Vibration Measurement:- FFT analyzer, vibration exciters, signal analysis. Time domain & Frequency domain analysis of signals. Experimental modal analysis, Machine Conditioning and Monitoring, fault diagnosis.

Unit-V

Random Vibrations:- Expected values auto and cross correlation function, Spectral density, response of linear systems, analysis of narrow band systems.

Non Linear Vibrations:-Systems with non-linear elastic properties, free vibrations of system with non-linear elasticity and damping, phase-plane technique, Duffing's equation, jump phenomenon, Limit cycle, perturbation method.

Learning Resources:

1. W T Thomson., " Theory of Vibrations with Applications", CBS Publishers
2. S S Rao, " Mechanical Vibrations", Addison-Wesley Publishing Co.
3. Leonard Meirovitch, " Fundamentals of Vibration", McGraw Hill International Edison.
4. J P Den Hartog, "Mechanical Vibrations", Mc Graw Hill.
5. Srinivasan, " Mechanical Vibration Analysis", Mc Graw Hill.
6. Nuno Manuel Mendes Maia et al," Theoretical and Experimental Modal Analysis", Wiley John & sons, 1999

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

ADVANCED MECHANICS OF SOLIDS (ELECTIVE)		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • make the students understand the concepts of elasticity and equip them with the knowledge to independently handle the problems of elasticity. • enhance the competency level and develop the self confidence through quality assignments in theory of Elasticity. • inculcate the habit of researching and practicing in the field of elasticity.	On completion of the course the student will be able to: • **solve** the problems of 3-D elasticity with confidence. • **develop** the problems of 2-D elasticity in Cartesian/Polar Coordinates. • **apply** airy's stress function in 2-D problems of elasticity in Cartesian/Polar Coordinates. • **relate** various theories of torsion of prismatic bars of various cross sections and can solve the problems of torsion. • **apply** the theory of elasticity to practical problems of Structural engineering.

Unit – I
Definition and notation of stress. Components of stress and stain. Generalized Hooke's law. Stress and strain in three dimensions. Stress components on an oblique plane. Transformation of stress components under change of co-ordinate system.
Principal stresses and principal planes. Stress invariants. Mean and deviator stress. Strain energy per unit volume. Octahedral shear stress. Strain of a line element. Principle strains. Volume strain.
Unit – II
Two dimensional problems in elasticity: Plane stress and plane strain situations. Equilibrium equations. Compatibility equations. St. Venant's principle. Uniqueness of solution. Stress components in terms of Airy's stress functions. Applications to cantilever. Simply supported and fixed beams with sample loading.
Unit – III
Solutions of problems in polar co-ordinates. Equilibrium equations. Stress Strain Components. Compatibility equation. Applications using Airy's stress functions in polar co-ordinates for stress distributions symmetric about an axis. Effect of hole on stress distribution in a plate in tension. Stresses due to load at a point on a semi-infinite straight boundary. Stresses in a circular disc under diametrical loading
Unit -IV
Torsion – Torsion of various shapes of bars, Stress function method of solution applied to circular and elliptical bars. Prandtl's membrane analogy, Solution of torsion of rectangular bars by (i) Raleigh Ritz method and (ii) Finite difference method
Unit-V
Bending of curved beams:
Winkler-Bach Formula, Elasticity solution for : pure bending of curved beams, curved cantilever under end loading

Learning Resources:

1. S. Timoshenko & N. Goodier, "Theory of Elasticity", Mc Graw Hill., 1951
2. Valiappan, "Theory of Elasticity", Mc. Graw Hill, 2010
3. L.S. Srinath, "Advanced Mechanics of Solids" Tata McGraw Hill, 2007
4. Arthur P. Bores, Richard J, SCH midt "Advanced Mechanics of Materials", John Wiley, 2002
5. Allen F Bower "Applied Mechanics of Solids", CRC Press, 2012

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

THEORY OF ELASTICITY AND PLASTICITY (ELECTIVE)		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • enable the student to understand the basic concepts of stress • enable the student to understand the basic concepts of strain • interpret the stress strain relations and differential equations of equilibrium • understand the yeild criteria • describe the various flow processes for material deformation	On completion of the course student will be able to : • **understand** the mathematical formulation for stress • **understand** the mathematical formulation for strain • **apply** the stress-strain relations for elastic behaviour to various materials • **assess** various yeild criteria and their application • **analyse** various plastic flow processes

Unit-I
Basic concepts of stress: Definition, State of stress at a point, stress tensor, invariants of stress tensor, principal stresses, stress ellipsoid, derivation for maximum shear stress and planes of maximum shear stress, octahedral shear stress, deviatoric and hydrostatic components of stress, invariance of deviatoric stress tensor, plane stress.

Unit-II
Basic concepts of strain: Deformation tensor, strain tensor and rotation tensor; invariants of strain tensor, principle strains, derivation for maximum shear strain and planes of maximum shear strain, octahedral shear strain, deviatoric and hydrostatic components of strain tensor, invariance of deviatoric strain tensor, plane strain.

Unit-III
Generalized Hooke's law: Stress-strain relationships for an isotropic body for three dimensional stress space for plane stress and plane strain conditions, differential equations of equilibrium, compatibility equations, material (D) matrix for Orthotropic Materials.

Unit-IV
True stress and true strain, von-Mise's and Tresca yield criteria, Haigh-Westergard stress space representation of von-Mise's and Tresca yield criteria, effective stress and effective strain, St. Venants theory of plastic flow, Prandtle –Reuss and Levy-Mise's constitutive equations of plastic flow, strain hardening theories, work of plastic deformation.

Unit-V
Analysis methods: Slab method, slip line field method, uniform deformation energy method, upper and lower bound solutions. Application of slab method to forging, wire drawing, extrusion and rolling processes.

Learning Resources:

1. Timoshenko and Goodier,– '*Theory of Elasticity*', McGrawHill Publications 3rd Edition 2001.
2. LS Srinath "Advanced Mechanics of Solids", McGraw Hill Publications, 3rd Edition, 2009
3. George E Dieter, Mechanical Metallurgy, McGraw Hill Publications 3rd Ed., 1988
4. J. Chakrabarty, Theory of Plasticity, McGraw Hill Publications, 2nd Edition 1998
5. Alexander Mendelson "Plasticity: Theory and Application", Krieger Publishing Company, 2nd Ed, 1983

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

MECHANICS OF COMPOSITE MATERIALS (ELECTIVE)		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: **ME ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • Discuss the basic structure of composites • Define Elastic constants and Hygro-thermal stresses • identify stress-strain relations in composites • Describe the behaviour and Design with composites • Demonstrate the basic equations of plate bending	On completion of the course the student will be able to: • **demonstrate** knowledge of composites and their structure • **predict** the Elastic constants and Hygrothermal stresses • **analyse** the stress - strain relationship in composites • **summarise and apply** the Design procedure and the failure criteria. • **formulate** Plate bending equations for various Boundary conditions of composite plates.

Unit-I
Introduction: Fibres, Matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composite, carbon fibre composites.

Unit-II
Micromechanics of Composites:
Mechanical Properties: Prediction of Elastic constant, micromechanical approach, Halpin-Tsai equations, Transverse stresses.
Thermal properties: Hygrothermal stresses, mechanics of load transfer from matrix to fibre.

Unit-III
Macro-mechanics of Composites:
Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation, inter-laminar stresses and edge effects. Simplified composite beam solutions. Bending of laminated beams.

Unit-IV
Strength, fracture, fatigue and design:
Tensile and compressive strength of unidirectional fibre composites, fracture modes in composites: Single and multiple fracture, de-bonding, fibre pullout and de-lamination failure, fatigue of liminate composites, Effect of variability of fibre strength.
Strength of an orthotropic lamina: Max stress theory, max strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria. Designing with composite materials.

Unit-V
Analysis of plates and stress:
Plate equilibrium equations, Bending of composite plates, Levy and Navier solution for plates of composite material. Analysis of composite cylindrical shells under axially symmetric loads.

Learning Resources:

1. Jones, R.M., '*Mechanics of Composite Materials*', Mc-Graw Hill Co., 1967.
2. Calcote, L.R., '*The Analysis of Laminated Composite Structures*', Van Nostrand, 1969.
3. Whitney. I.M., Daniel, R.B. Pipes, '*Experimental Mechanics of Fibre Reinforced Composite Materials*', Prentice Hall, 1984.
4. Hyer. M.W., '*Stress Analysis of Fibre-Reinforced Composite Materials*', McGraw Hill Co., 1998.
5. Carl. T.Herakovich, '*Mechanics of Fibrous Composites*', John Wiley Sons Inc., 1998.

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

ROBOTIC ENGINEERING (ELECTIVE)		
Instruction: 3 Hours/ week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • Laws of robotics terms related with robotics, manipulator configurations, types of actuators, applications of robots. • Kinematics of robotics and its homogenous transformation matrix. • Inverse kinematics and jacobian with singularities and about bug algorithms, trajectory. • Dynamics of a robotics and programming methods. • Types of sensors including vision.	On completion of the course the student will be able to: • **understand** basic concepts of industrial robotics and application of robotics with different manipulator configurations. • **model** the motion of robotic systems in terms of kinematics using Denavit-Hartenberg algorithm. • **derive** inverse kinematics and jacobian using forward kinematics, trajectory path planning and also sensor based motion planning. • **evaluate** dynamics using Largrange_Euler and Newton-Euler methods, controls and robotic programming. • **identify** the sensors used for displacement, velocity, acceleration, force and Machine vision

UNIT-I

Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission, End effectors and Different types of grippers, vacuum and other methods of gripping. Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.

UNIT-II

Rotation matrices, Euler angle and RPY representation, Homogeneous transformation matrices, Denavit-Hartenberg notation, representation of absolute position and orientation in terms of joint parameters, direct kinematics.

UNIT-III

Inverse Kinematics, inverse orientation, inverse locations, Singularities, Jacobian, Trajectory Planning: joint interpolation, task space interpolation, executing user specified tasks, sensor based motion planning: The Bug Algorithm, The Tangent Bug Algorithm, The Incremental Voronoi Graph.

UNIT-IV

Static force analysis of RP type and RR type planar robots, Dynamic analysis using Lagrangean and Newton-Euler formulations of RR and RP type planar robots, , Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, force feedback, hybrid control.

UNIT-V

Sensors and controllers: Internal and external sensors, position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder. Robot vision: image processing fundamentals for robotic applications, image acquisition and preprocessing. Segmentation and region characterization object recognition by image matching and based on features

Learning Resources:

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw-Hill, 2003.
2. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and sons, 2008.
3. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, Robotics, control, sensing, Vision and Intelligence, McGraw Hill International, 1987
4. Steve LaValle, "Planning Algorithms", Cambridge Univ. Press, New York, 2006.
5. Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and Sebastian Thurn, "Principles of Robot Motion: Theory, Algorithms, and Implementations", Prentice Hall of India, 2005.

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

GEAR DESIGN AND ENGINEERING (ELECTIVE)		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objective of this course is to: • understand the principles of gear tooth action, gear manufacturing process, gear tooth failure modes, stresses developed in them and selection of a right kind of gear for the given application. • understand the design considerations and methodology involved in design of various types of gears • understand the different gear trains (simple, compound and epicyclic) • understand the different parameters involved in gear design optimization	On completion of the course the student will be able to: • **calculate** strength of gear tooth under dynamic considerations • **interpret** the type of gear teeth failure from the failed specimen. • **design** a gear shaft with different types of gears (spur, helical, worm and bevel). • **design** a gear box for an automobile and gear trains from the propeller shaft of airplane for auxiliary systems. • **design** compact gear trains using optimization techniques.

UNIT – I

Introduction, Principles of gear tooth action, Generation of Cycloid and Involute gears, Involutometry, gear manufacturing process and Inspection, gear tooth failure modes, stresses, selection of right kind of gears.

SPUR GEARS: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of spur gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load. Design of gear shaft and bearings.

UNIT – II

HELICAL GEARS: Tooth loads, Principles of Geometry, Design considerations and methodology, complete design of helical gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load. Design of gear shaft and bearings.

GEAR FAILURES: Analysis of gear tooth failures, Nomenclature of gear tooth wear and failure, tooth - breakage, pitting, scoring, wear, overloading, gear-casing problems, lubrication failures.

UNIT – III

WORM GEARS: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of worm gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load. Heat dissipation consideration. Design of gear shaft and bearings.

UNIT – IV

BEVEL GEARS: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of bevel gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load. Design of gear shaft and bearings.

UNIT – V

GEAR TRAINS: Simple, compound and epicyclic gear trains, Ray diagrams, Design of a gear box of an automobile, Design of gear trains from the propeller shafts of airplanes for auxiliary systems.

OPTIMAL GEAR DESIGN: Optimization of gear design parameters. Weight Minimization, Constraints in gear train design-space, interference, strength, dynamic considerations, rigidity etc. Compact design of gear trains, multi objective optimization of gear trains. Application of Traditional and non-traditional optimization techniques.

Note: PSG Design Data book is allowed.

Learning Resources:

1. W Dudley, "Handbook of Practical Gear Design", CRC Press LLC, 2002.
2. Gitin M Maitra, "Handbook of Gear Design", Tata McGraw-Hill, 2nd Edition, 2003.
3. H. E Merritt, "Gear Engineering", Wheeler Publication, 3rd Indian Edition, 1992.
4. Joseph E Shigley, Charles R Mischke, "Mechanical Engineering Design", Tata McGraw Hill, 6th Edition, 2003.
5. Robert C Juvinall, Kurt M Marshek, "Fundamentals of Machine Component Design", John Wiley & Sons, 3rd Edition, 2000.

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14/9

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

DESIGN OF PRESSURE VESSELS AND PIPING (ELECTIVE)		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objective of this course is to:. • understand the stresses in pressure vessels. • Perform stress analysis for cylinder components • design supports for various cylinder configurations. • interpret the buckling phenomenon in cylinders • identify the components of piping layout	On completion of the course, the student will be able to: • identify and estimate the stresses in a Pressure vessel • analyze the stresses in cylinder components • estimate the supporting column and allied component stresses. • calculate the buckling load and stresses • familiarize with piping layout and stresses

UNIT I

Introduction: stresses in pressure vessels, determination of radial stress hoop stress and longitudinal stress, shrink fit stresses in built up cylinders, autofrettage of thick cylinders, thermal stresses and their significance, methods for determining stresses – Terminology and Ligament Efficiency – Applications.

UNIT II

STRESSES IN PRESSURE VESSELS Introduction – Stresses in a circular ring, cylinder – Membrane stress Analysis of Vessel Shell components – Cylindrical shells, spherical Heads, conical heads – Thermal Stresses – Discontinuity stresses in pressure vessels.

UNIT III

DESIGN OF VESSELS Design of Tall cylindrical self supporting process columns –Supports for short, vertical and horizontal vessels – stress concentration – at a variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of Reinforcement – pressure vessel Design. Introduction to ASME pressure vessel codes

UNIT IV

BUCKLING OF VESSELS Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

UNIT V

Piping Introduction – Flow diagram – piping layout and piping stress Analysis.

Learning Resources:

1. John F. Harvey, Theory and Design of Pressure Vessels, CBS Publishers and Distributors, 1987.
2. Henry H. Bedner, "Pressure Vessels, Design Hand Book, CBS publishers and Distributors, 1987.
3. Stanley, M. Wales, "Chemical process equipment, selection and Design. Buterworths series in Chemical Engineering, 1988.
4. William. J., Bees, "Approximate Methods in the Design and Analysis of Pressure Vessels and Piping", Pre ASME Pressure Vessels and Piping Conference, 1997.
5. Sam Kannapan, "Introduction to Pipe Stress Analysis". John Wiley and Sons, 1985.

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14/9

ELECTIVES – MANUFACTURING GROUP

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

FLEXIBLE MANUFACTURING SYSTEMS (ELECTIVE)		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • set up schemes for machine and accessory layouts for effective manufacture under CIM • have a thorough knowledge in part family identification using group technology • analyze mathematically the manufacturing situations so as to prevent bottlenecks in manufacture under CIM • be in a position to choose the most appropriate material handling scheme of relevance in CIM operations • plan for hardware and software for the various computational resources and electronic devices used in FMS	On completion of the course the student will be able to: • **interpret** meaning, importance and utility of various layouts • **Specify** equipment for FMS operations after detailed study through group technology, process planning and technology planning • **Plan** for FMS operations and its schemes using JIT. etc. • **distinguish** material handling requirements for traditional manufacture and those needed in FMS environment • **Specify** the hardware and software requirements and **integrate** different subsystems

UNIT-I

Evolution of Manufacturing Systems: FMS definition and description, General FMS considerations, Manufacturing cells, Cellular versus Flexible Manufacturing. Systems Planning: Objective, introduction planning, preparation guidelines, the project team, supplier selection, system description and sizing, facility preparation planning, FMS layouts. Human resources: staff considerations, team work, communication and involvement, the supervisors role, personnel selection, job classifications, employee training.

UNIT-II

Manufacturing's Driving Force: Definition, description and characteristics. Just in-time manufacturing, definition and description, benefits and relationship to FMS, implementation cornerstones, quality and quantity application principles. Single manufacture Cell – design scheduling of jobs on single manufacturing cells. Group Technology: Concepts, classification and coding, benefits and relationship to FMS, design of group technology using rank order clustering technique.

UNIT-III

FMS Design – Using Bottleneck, Extended bottleneck models, Processing and Quality Assurance: Turning centres, Machining centre, construction and operations performed, axes, programming, and format information, work-holding and work-changing equipment, automated features and capabilities, cleaning and deburring – station types and operation description, importance to automated manufacturing, coordinate measuring machines, types, construction and general function, operation cycle description, importance to flexible cells and systems.

UNIT-IV

Automated movement and storage systems–AGVs, Robots, automated storage and retrieval systems, storage space design, queuing carousels and automatic work changers, coolant and chip Disposal and recovery systems, auxiliary support equipment, cutting tools and tool Management – introduction, getting control of cutting tools, Tool Management, tool strategies, data transfer, tool monitoring and fault detection, guidelines, work holding considerations, General fixturing, Modular fixturing. FMS and the relationship with workstations – Manual, automated and transfer lines design aspects.

UNIT-V

FMS: computer Hardware, Software, Communications networks and Nanotechnology – general functions, and manufacturing usages, hardware configuration, programmable logic controllers, cell controllers, communications networks. FMS implementation.

Learning Resources:

1. William Luggen, "Flexible Manufacturing Systems", Prentice-Hall, Newjersy, 1991
2. Parrish, D.J., "*Flexible Manufacturing*" , - Butter Worths – Heinemann, Oxford, 1993.
3. Groover, M.P., "*Automation, Production Systems and CI*", - Prentice Hall India, 1989.
4. Kusiak, A., "*Intelligent Manufacturing Systems*" , - Prentice Hall, 1990.
5. Ranky, P.G., "Design and Operation of FMS", - IFS Publishers, UK, 1988

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

ADVANCED NON-DESTRUCTIVE EVALUATION TECHNIQUES (ELECTIVE)		
Instruction: 3 Hours/ week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • study the importance of various non-destructive testing method. • study different methods to find the surface and subsurface defects in the components • study different methods of finding surface, internal defects and properties of the components. • study computer aided inspection processes to find defects in components used in medical field • study inspection method using light source.	On completion of the course the student will be able to: • **understand** the importance and practical applications of various non-destructive methods in industry • **evaluate** the surface and sub surface defects of the components produced in industry. • **apply** the methods for inspecting surface, internal defects and to find mechanical properties of the components. • **select** appropriate computer aided method of inspection of the components depending upon applications • **apply** appropriate methods based on light as source of inspection.

Unit-I

Types of defects and characteristics, Quantification aspects relevant for NDE including fracture aspects and stress intensity factors - NDT overview – quality assurance–visual inspection–comparative features of conventional Non destructive Testing and Evaluation Methods including Optical, Radiography, Ultrasonic Testing, Dye penetrate testing, Eddy current testing etc.

Unit-II

Leak testing – liquid penetrant testing – penetrant used – equipment – penetration, emulsification, solvent removal. Eddy current testing – material conductivity – coil impedance–coils and instruments–testing in non-ferromagnetic conducting materials and Ferro magnetic materials – skin effect – frequency used – inspection probes – phase analysis.

Unit-III

Radiography–sources of radiation–shadow formation, enlargement and distortion – recording media – exposures, markers.

Infrared and thermal testing – imaging systems – detectors – analysis methods.

Ultrasonic testing – generation of ultrasound – methodologies – transducers and equipment used – flaw detection - sensitivity and calibration.

Magnetic particle testing–magnetization methods–continuous and residual methods – sensitivity – demagnetization.

Unit-IV

Computer aided image processing methods for radiography and ultrasonic's, tomography in these areas.

Optical techniques of nondestructive evaluation: Principles of Photo elasticity, holographic Interferometry and Laser speckle techniques; use of fibre optics, non-invasive techniques in medical field and NDT.

Unit-V

Machine Vision-system components, Sensors, specifications for resolution & range.

Grid and Moire NDT, acoustic, shearography, Principles of Microwave, acoustic emission techniques.

Learning Resources:

1. Barry Hull, '*Non-Destructive Testing*' –Vernon John, ELBS/ Macmillan, 1988.
2. Baldev Raj, T.JayaKumar, M.Thavansimuthee, '*Practical Non-Destructive Testing*', - Narosa Publishing House, New Delhi, 1997.
3. Journals: British Journal of NDT, Materials Evaluation, ISNDT Journal.
4. ASM Handbook: Non-Destructive Evaluation and Quality Control, ASM International, Vol. 17, 1989
5. Ravi Prakash, Non-Destructive Testing Techniques, New Age Science, 2009

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

ADDITIVE MANUFACTURING (ELECTIVE)		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • understand the importance of RPT • Apply various liquid and solid based RPT Systems • Apply various powder based RPT systems and rapid tooling • Recognize various STL formats and slicing methods and tessellation • Application of RPT in Engineering, Jewelry and Bio medical etc.	On completion of the course the student will be able to: • **understand** the developments of RPT and its terminology, Advantages and limitations of RPT • **understand** mechanism involved in stereo lithography apparatus system, and terminated object manufacturing, fused deposition modeling and their applications. • **understand** mechanism in selective laser interims and its application. Understand the importance of Rapid tooling • **recognize** various types of file format and slicing methods in RP and various software available to convert 3D models. • **apply** RPT in various fields like Engineering, Jewelry, medical and Bio – Medical Engineering

Unit-I

Introduction: Prototyping fundamentals, Historical development, fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, Commonly used terms, classification of RP process, Rapid prototyping process chain: Fundamental Automated processes, process chain.

Unit-II

Liquid based rapid prototyping systems: Stereo lithography apparatus (SLA): Models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid ground curing (SGC): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

Solid based rapid prototyping systems: Laminated object manufacturing (LOM): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Fused deposition modeling (FDM): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

Unit-III

Powder Based Rapid Prototyping Systems: Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Three dimensional printing (3DP): Models and specification, process, working principle, applications, advantages and disadvantages, case studies.

Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs Rt, Need for RT. Rapid Tooling Classification: Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, investment casting, spin casting, die csting, sand casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP

Unit-IV

Rapid Prototyping Data Formats: STL Format, STL File Problems, Consequence of Building Valid and invalid tessellated models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats.

Rapid Prototyping Software's: Features of various RP software's like Magics, Mimics, Solid View, view expert, 3 D view, velocity 2, Rhino, STL view 3 data expert and 3 D doctor

Unit-V

RP Applications: Application – Material Relationship, application in design, application in engineering, Analysis and planning, aerospace industry, automatic industry, Jewelry industry, coin industry, GIS application, Arts and Architecture.

RP Medical and Bioengineering Application: Planning and simulation of complex surgery, customized implant and prosthesis, design and production of medical devices, forensic science and anthropology, visualization of biomolecules.

Learning Resources:

1. Chua C.K., Leong K.F. and LIM C.S Rapid prototyping: Principles an Applications, World Scientific publications, 3rd Ed., 2010
2. D.T. Pham and S.S. Dimov, "Rapid Manufacturing", Springer, 2001
3. Terry Wohlers, " Wholers Report 2000", Wohlers Associates, 2000
4. Paul F. Jacobs, " Rapid Prototyping and Manufacturing"–, ASME Press, 1996
5. Ian Gibson, Davin Rosen, Brent Stucker "Additive Manufacturing Technologies, Springer, 2nd Ed, 2014

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

AN INTRODUCTION TO NANO SCIENCE AND TECHNOLOGY (ELECTIVE)		
Instruction: 3 Hours/ week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • **understand** basic fundamentals of nanotechnology • **identify** and classify nano materials • **explain** synthesis and processing of nano powders • **explain** nano, micro fabrication techniques	On completion of the course the student will be able to: • **understand** basic fundamentals of nanotechnology and differentiate it from nano science • **classify** nano materials and identify their applications • **explain** various synthesis and processing steps for nano materials • **describe** and use nano, micro fabrication techniques

Unit-I
Introduction: Evolution of science and technology, Introduction to Nanotechnology, Nanotechnology – Definition – Difference between Nanoscience and Nanotechnology, Feynman predictions on Nanotechnology, Moores law, Role of Bottom up and top down approaches in nanotechnology, challenges in Nanotechnology.

Unit-II
Nano materials: History of materials, Nanomaterials – Definition, Classification of Nanostructured materials, cause of interest in nanomaterials, some present and future applications of nanomaterials.

Unit-III
Synthesis and processing of nano powders: Processes for producing ultrafine powders – mechanical milling, wet chemical synthesis, gas condensation process, chemical vapour condensation, laser ablation.

Design and Synthesis of self assembled nano structured materials.

Unit-IV
Special nanomaterials, characterization and tools: Carbon nanotubes, nano composites, carbon fullerenes: An overview of preparation, properties applications. Electron Microscopy Techniques: Scanning Electron Microscopy, Transmission Electron Microscopy, Scanning Probe Microscopy – X ray methods.

Unit-V
Nanoelectronics: Introduction to micro, nano fabrication: Optical lithography, Electron beam lithography, Atomic lithography, Molecular beam epitaxy, MEMS:- Introduction, Principles, Types of MEMS:- Mechanical, Thermal, Magnetic MEMS; Fabrication of MEMS.

Learning Resources:

1. Dieter Vollath, Nanomaterials: An Introduction to Synthesis, Properties and Applications, Second Edition, Wiley, 2013
2. Guozhong Cao, Ying Wang, Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, World Scientific, 2011
3. Nitaigour P. Mahalik, Micromanufacturing and Nanotechnology, Springer Science & Business Media, 2006.
4. Mark A. Ratner, Daniel Ratner, Nanotechnology: A Gentle Introduction to the Next Big Idea, Prentice Hall Professional, 2003
5. A.S Edelstein, R.C Cammaratra, Nanomaterials: Synthesis, Properties and Applications, Second Edition, CRC Press, 1998.

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

PRODUCT DESIGN AND PROCESS PLANNING (ELECTIVE)		
Instruction: 3 Hours/ week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • know about the features of good product design. • familiarize the cost concepts, reliability systems. • apply the design rules for manufacturing process and improving tolerances. • familiarize the Ergonomic considerations, Just-in time, Kanban systems and RPT • familiarize the concepts of computers in manufacturing.	On completion of the course, the students will be able to: • **analyse** the effective product design features • **understand** effective product and process design elements such as function and producibility, cost, schedule, reliability, customer preferences etc. • **analyse** process capability studies, methods of improving tolerances and product design rules for various manufacturing processes. • **evaluate** ergonomic considerations, Just-in time, Kanban systems and RPT • **apply** of computers in the manufacturing.

Unit-I

Product design and process design functions, selection of a right product, essential factors of product design, Morphology of design, sources of new ideas for products, evaluations of new product ideas. Product innovation procedure-Flow chart. Qualifications of product design engineer. Criteria for success/failure of a product. Value of appearance, colours and laws of appearance.

Unit-II

Product Reliability, Mortality curve, Reliability system, Manufacturing reliability and quality control. Patents: Definitions, classes of patents, applying for patents. Trade marks and copy rights. Cost & Quality sensitivity of products, Elements of cost of a product, costing methods, cost reduction and cost control activities. Economic analysis, break even analysis Charts. Value engineering in product design, creativity aspects and techniques. Procedures of value analysis - cost reduction, material and process selection.

Unit-III

Various manufacturing processes, degree of accuracy and finish obtainable, process capability studies. Methods of Improving tolerances. Basic Product design rules for Casting, Forging, Machining, Sheet metal and Welding. Physical properties of engineering materials and their importance on products. Selection of plastics, rubber and ceramics for product design.

Unit-IV

Industrial ergonomics: Man-machine considerations, ease of maintenance. Ergonomic considerations in product design-Anthropometry, Design of controls, Man-machine information exchange. Process sheet detail and their importance, Advanced techniques for higher productivity. Just-in-time and Kanban System. Modern approaches to product design; quality function development, Rapid prototyping.

Unit-V

Role of computer in product design and management of manufacturing, creation of manufacturing data base, Computer Integrated Manufacturing, communication network, production flow analysis, Group Technology, Computer Aided design and process planning. Integrating product design, manufacture and production control.

Learning Resources:

1. Niebel B.W., and Draper A.B, '*Product design and process Engineering*', Mc.Graw Hill-Kogakusha Ltd., Tokyo, 1974.
2. Chitale A.K., & Gupta R.C., '*Product Design and manufacturing*', Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. Mahajan M., '*Industrial Engineering and Production Management*', Dhanpath Rai &Co., 2000.
4. Harry, B. Waton, *New Product Planning,* Prentice Hall Inc., 1992

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

QUALITY & RELIABILITY ENGINEERING (ELECTIVE)		
Instruction: 3 Hours/ week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • understand the process capability and control charts • Analysis the importance of tolerance design • Relate QFD and house of quality and its use in product design • Apply various techniques to improve reliability systems • Selective maintainability and availability of equipment	On completion of the course, the students will be able to: • **understand** importance of quality applications of various control charts and acceptance sampling in quality engineering • **estimate** the loss function, and consequence of tolerance design for a product and checking of online quality control • **prepare** a house of quality for a product and QFD matrix, importance of ISO and quality circles. • **analyze** Various methods to estimate system reliability and how to improve it. Usage of weibull distribution in quality control and reliability • **identify** the best way of maintenance of an equipment, How to increase the availability and economics of reliability engineering.

Unit-I
Quality value and engineering – Quality systems – quality engineering in product design and production process – system design – parameter design – tolerance design quality costs – quality improvement.
Statistical Process Control-$\bar{x}$, R, P, C charts, process capability. Acceptance Sampling by variables and attributes, Design of Sampling Plans, Single, Double, Sequential plans.

Unit-II
Loss Function, Tolerance Design – N Type, L Type, S Type; determination of tolerance for these types, nonlinear tolerances. Online Quality Control – Variable Characteristics, Attribute Characteristics, Parameter Design.

Unit-III
Quality function deployment – House of Quality, QFD Matrix, Total Quality Management Concepts. Quality Information Systems; Quality Circles, Introduction to ISO 9000 Standards.

Unit-IV
Reliability – Evaluation of design by tests - Hazard Models; Linear, Releigh, Weibull. Failure Data Analysis System, Reliability, Reliability of series, Parallel Standey Systems; reliability prediction and system effectiveness, reliability prediction based on weibull distribution, Reliability improvement.

Unit-V
Maintainability, Availability, Economics of Reliability Engineering; Replacement of items, Maintenance Costing and Budgeting, Reliability Testing – Burn in testing by binomial, exponential models, Accelerated life testing.

Learning Resources:

1. G Taguchi, '*Quality Engineering in Production Systems*', - McGraw Hill, 1989.
2. W.A. Taylor, '*Optimization & Variation Reduction in Quality*', Tata McGraw Hill, 1991, 1st Edition.
3. Philipposs, '*Taguchi Techniques for Quality Engineering*', McGraw Hill, 1996, 2nd Edition.
4. E.Bala Guruswamy, '*Reliability Engineering*', Tata McGraw Hill, 1994.
5. LS Srinath, '*Reliability Engineering*', Affiliated East West Pvt. Ltd., 1991, 3rd Edition.

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

VALUE ENGINEERING (ELECTIVE)		
Instruction: 3 Hours/ week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • Know the basic concepts of value engineering • Learn different types of manufacturing processes with respect to time, cost etc. • Use critical path of function for quick analysis • Improve the quality of the product by choosing proper design and manufacturing method. • Select alternate and best possible method. • Enhance the value of the existing product.	On completion of the course, the students will be able to: • **understand** the manufacturing methods to be implemented. • **identify** the materials needed to meet the required mechanical properties. • **assess** and conclude best possible method for problem solving . • **demonstrate** improvement in productivity using value analysis techniques. • **develop** a product which is functionally sound.

Unit-I
Basic concepts of Value Engineering – Function, Value, Value analysis, Value of job plan, Study of Engineering materials specially latest materials with respect to their mechanical properties, Cost and availability. Study of wide range of manufacturing processes based on the factors – productivity time, cost, surface finish, tolerance etc. Mechanical properties of products based on manufacturing processes.

Unit-II
Information phase, Functional phase, Creation – phase, Evaluation phase, Recommendation phase. DARSIRI method.
Fast diagramming: Critical path of function, how, why and when logic, supporing and all time functions, Ground rule for FAST diagram.

Unit-III
Productivity, improvement by Value Engineering and Value analysis – Selection of Engineering Products of different applications and studying each one of them about design, types of stresses induced, manufacturing method.

Unit-IV
Results acceleration – Basic steps, valuation of Value Engineering, Problem setting, Problem solving case studies alternative methods and best possible method.

Unit-V
Work study and Value Engineering Methods: Case studies in work study and Value Engineering methods – product Design implementation using Value Engineering.
Developing any one product (important in functional aspect) which actually adds Value to Existing product in use.

Learning Resources:

1. L.D. Miles, '*Techniques of Value Analysis and Engineering*', McGraw Hill, 1961
2. A.E. Mudge, '*Value Engineering A Systematic Approach*', McGraw Hill, 1971.
3. Greve J.W. and Wilson, '*Value Engineering in Manufacturing*', Prentice Hall, Englewood Cliffs, 1967.
4. SS Iyer, '*Value Engineering*', New Age International Pvt. Ltd.

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

MECHATRONICS (ELECTIVE)		
Instruction: 3 Hours/ week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • Understand key elements of Mechatronics system, representation into block diagram • Understand concept of transfer function, reduction and analysis • Understand principles of sensors, its characteristics, interfacing with DAQ microcontroller • Understand the concept of PLC system and its ladder programming, and significance of PLC systems in industrial application • Understand the system modeling and analysis in time domain and frequency domain	On completion of the course, the students will be able to: • Identification of key elements of mechatronics system and its representation in terms of block diagram • Understanding the concept of signal processing and use of interfacing systems such as ADC, DAC, digital I/O • Interfacing of Sensors, Actuators using appropriate DAQ micro-controller • Time and Frequency domain analysis of system model (for control application) • Development of PLC ladder programming and implementation of real life system

Unit – I

Introduction to Sensors & Actuators: Introduction to Mechatronics, Measurement characteristics: - Static and Dynamic Sensors: Position Sensors: - Potentiometer, LVDT, Encoders; Proximity sensors:- Optical, Inductive, Capacitive; Motion Sensors:- Variable Reluctance; Temperature Sensor: RTD, Thermocouples; Force / Pressure Sensors:- Strain gauges; Flow sensors: - Electromagnetic Actuators: Stepper motor, Servo motor, Solenoids

Unit – II

Block Diagram Representation: Open and Closed loop control system, identification of key elements of mechatronics systems and represent into block diagram (Electro-Mechanical Systems), Concept of transfer function, Block diagram reduction principles, Applications of mechatronics systems:- Household, Automotive, Shop floor (industrial).

Unit – III

Data Acquisition & Microcontroller System: Interfacing of Sensors / Actuators to DAQ system, Bit width, Sampling theorem, Aliasing, Sample and hold circuit, Sampling frequency, ADC (Successive Approximation), DAC (R-2R), Current and Voltage Amplifier.

Unit – IV

PLC Programming: Introduction, Architecture, Ladder Logic programming for different types of logic gates, Latching, Timers, Counter, Practical Examples of Ladder Programming, Introduction to SCADA system

Unit –V

Modelling and Analysis of Mechatronics System: System modeling (Mechanical, Thermal and Fluid), Stability Analysis via identification of poles and zeros, Time Domain Analysis of System and estimation of Transient characteristics: % Overshoot, damping factor, damping frequency, Rise time, Frequency Domain Analysis of System and Estimation of frequency domain parameters such as Natural Frequency, Damping Frequency and Damping Factor

Learning Resources:

1. K.P. Ramchandran, G.K. Vijyaraghavan, M.S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Willey Publication, 2008
2. Bolton, Mechatronics - A Multidisciplinary approach, 4th Edition, Prentice Hall, 2009
3. Alciatore &Histand, Introduction to Mechatronics and Measurement system, 4th Edition, Mc-Graw Hill publication, 2011.
4. Bishop (Editor), Mechatronics – An Introduction, CRC Press, 2006.
5. Mahalik, Mechatronics – Principles, concepts and applications, Tata Mc-Graw Hill publication, New Delhi.

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ELECTIVES – ANALYSIS GROUP

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

FINITE ELEMENT TECHNIQUES		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • equip the students with the Finite Element Analysis fundamentals. • enable the students to convert the design problems into FE formulations • introduce basic aspects of finite element techniques, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems. • familiarise the students with higher order elements and eigen value problems in FET • introduce the students to the concepts of 3D finite element analysis and FET software packages.	On completion of the course the student will be able to: • **identify** mathematical model for solution of common engineering problems. • **formulate** simple problems into finite elements. • **solve** structural, thermal, fluid flow problems. • **use** professional-level finite element software to solve engineering problems in Solid mechanics, fluid mechanics and heat transfer. • **derive** element matrix equation by different methods by applying basic laws in mechanics and integration by parts. • **model** 2D and 3D problems using FEA and work on software to model simple problems

UNIT-I

Introduction to Finite Element Method of solving field problems. Stress and Equilibrium. Boundary conditions. Strain-Displacement relations. Stress-strain relations. One Dimensional Bar Element: Finite element modeling. Local, natural and global coordinates and shape functions. Potential Energy approach : Assembly of Global stiffness matrix and load vector. Finite element equations, treatment of boundary conditions. Quadratic shape functions.

UNIT-II

Analysis of trusses and frames: Analysis of plane truss. Analysis of frames with two translations and a rotational degree of freedom at each node. Analysis of Beams: Element stiffness matrix for two noded, two degrees of freedom per node for beam element.

UNIT-III

Finite element modeling of two dimensional stress analysis problems with constant strain triangles and treatment of boundary conditions. Two dimensional four noded isoparametric elements and numerical integration. Finite element modeling of Axisymmentric solids subjected of axisymmetric loading with triangular elements. Convergence requirements and geometric isotropy.

UNIT-IV

Steady state heat transfer analysis: One dimensional analysis of a fin and two dimensional conduction analysis of thin plate. Time dependent field problems: Application to one dimensional heat flow in a rod.

Dynamic analysis: Formulation of finite element modeling of Eigen value problem for a stepped bar and beam. Evaluation of Eigen values and Eigen vectors.

UNIT-V

Analysis of a uniform shaft subjected to torsion using Finite Element Analysis. Finite element formulation of three dimensional problems in stress analysis. Finite Element formulation of an incompressible fluid. Potential flow problems Bending of elastic plates. Introduction to non-linear problems and Finite Element analysis software.

Learning Resources:

1. Tirupathi R Chandraputla and Ashok. D. Belegundu, *Introduction of Finite Element in Engineering,* Prentice Hall of India, 1997.
2. Rao S.S., *The Finite Element Methods in Engineering,* Pergamon Press, 1989.
3. Segerland. L.J., *Applied Finite Element Analysis,* Wiley Publication, 1984.
4. Reddy J.N., *An Introduction to Finite Element Methods,* Mc Graw Hill Company, 1984.
5. Bathe KJ, Finite element Procedures, Prentice Hall of India, 2002

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

ENGINEERING RESEARCH METHODOLOGY (ELECTIVE)		
Instruction: 3 Hours/ week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • To explore the significance of different research methods. • To locate sources of information for research and its reviews • To setup good research design as per standards and codes. • To adopt different methods of data collection and its analysis. • To write a research proposal and research report.	On completion of the course, the Students will be able to • **plan** the process and requirements for conducting successful research • **identify** the library resources in gathering information related to research project of the individual • **devise** the process of data collection, analysis and report preparation • **use** the statistical techniques for data analysis • **appraise**, **review** and publish technical articles

UNIT-I

Research Methodology: Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods verses Methodology, Research and Scientific Method, Important of Research Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general.

Defining the Research Problem: Definition of Research Problem, Problem Formulation, Necessity of Defining the Problem, Technique involved in Defining a Problem.

UNIT-II

Literature Survey: Importance of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet.

Literature Review: Need of Review, Guidelines for Review, Record of Research Review.

UNIT-III

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design, Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set-up, Use of Standards and Codes.

UNIT-IV

Data Collection: Exploring the data, Description and Analysis of Data, Sample Design and Sampling, Role of Statistics for Data Analysis, Functions of Statistics, Estimates of Population, Parameters, Parametric V/s Non Parametric methods, Descriptive Statistics, Points of Central tendency, Measures of Variability, Measures of relationship, Inferential Statistics-Estimation, Hypothesis Testing, Use of Statistical software.

Data Analysis: Deterministic and random data, Uncertainty analysis, Tests for significance: Chi-square, student's't' test, Regression modeling, Direct and Interaction effects, ANOVA, F-test, Time Series analysis, Autocorrelation and Autoregressive modeling.

UNIT-V

Research Report Writing: Format of the Research report, Style of writing report, References/Bibliography/Webliography, Technical paper writing/Journal report writing.

Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal..

Learning Resources:

1. C.R Kothari, *"Research Methodology, Methods & Technique"*; New Age International Publishers, 2004
2. R. Ganesan, *"Research Methodology for Engineers"*, MJP Publishers, 2011
3. Y.P. Agarwal, *"Statistical Methods: Concepts, Application and Computation"*, Sterling Publs., Pvt., Ltd., New Delhi, 2004
4. Vijay Upagade and Aravind Shende, *"Research Methodology"*, S. Chand & Company Ltd., New Delhi, 2009
5. P. Ramdass and A. Wilson Aruni, *"Research and Writing across the Disciplines"*, MJP Publishers, Chennai, 2009

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(Dr. Jeevan Jaidi) 1) OU Nominee	(Prof. Sriram Venkatesh) 2) Subject Expert-1	(Dr. B. Venkatesham) 3) Subject Expert-2	(Dr. N.K. Singh) 4) Industry Expert

(Dr. G.V. Ramana Murty)
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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

OPTIMIZATION TECHNIQUES (ELECTIVE)		
Instruction: 3 Hours/ week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • Understand linear programming & transportation & sensitivity analysis • Compute non L.P and unconstrained optimization. • Compute the non L.P.P and constrained optimization. • Apply principle of optimality in dynamic programming and integer programming • Apply CPM & PERT for project scheduling and control.	On completion of the course, the Students will be able to: • **explain** simplex, dual simplex and revised simplex & sensitivity analysis and transportation and their applications for shop floor problems. • **apply** of non LPP like unconstrained method univariate method, steepest descent conjugate gradient, quasi Newton method. • **apply** Lagrange multiplier, Kuhn-Tucker conditions, Beal's method penalty, Function for constrained optimization problems. • **describe** the importance of dynamic principles and its applications like Cargo loading, product scheduling and forecasting. Integer programming like branch and bound and Gromery's cutting plane method. • **apply** the project management techniques like CPM & PERT

Unit-I
Linear Programming:

Statement of Optimization Problem, Linear Programming: Simplex method, revised simplex method, sensitivity analysis and transportation problems.

Unit-II
Non Linear Programming unconstrained optimization:

Nonlinear programming approach, convergence and scaling of design variables;
Unconstrained optimization direct search methods: Random Search, Univariate, Pattern search, Powell Method, Hook – Jeeves algorithm ;.
Non linear unconstrained optimisation indirect Search methods: Steepest Descent, Conjugate Gradient, Newton, Quasi Newton.

Unit-III
Non Linear Programming constrained optimization

Nonlinear programming constrained optimization direct methods: Lagrange multipliers, Kuhn-Tucker conditions, Beal's method, indirect method: Penalty function and applications

Unit-IV
Dynamic Programming:

Introduction to dynamic programming; Concept of sub optimization and the principle of optimality; Linear and continuous dynamic programming with applications; Introduction to integer programming; Cutting plane method; Branch and bound method; Introduction to genetic algorithms, particle swarm optimization.

Unit-V
Project scheduling: PERT-CPM, Probability and cost consideration in project scheduling; Crashing analysis, Resource allocation, Resource levelling.

Learning Resources:

1. Rao, S.S., 'Engineering Optimization Theory and Practice', New Age Int. Pub., 3rd Ed., 1996
2. Deb, K., "Optimization for Engineering Design", Prentice Hall of India, 1995.
3. Haug, E.J. and Arora, J.S., 'Applied optimal design' Wiley Inter Science Publication, NY, 1979
4. Douglas J. Willde, 'Globally optimal design' Jhon Wiley & Sons, New York, 1978
5. S.D. Sharma, 'Operations Research', Khanna Publications, 2001
6. David Goldberg, Genetic Algorithms, pearson publications, 2006

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

COMPUTATIONAL FLUID DYNAMICS		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • develop an understanding for the major theories, approaches and methodologies used in CFD. • build up the skills in the actual implementation of CFD methods (e.g. boundary conditions, turbulence modelling etc.) • gain experience in the application of CFD analysis to real engineering designs	On completion of the course the student will be able to: • **solve** differential equations for flow phenomena and heat transfer • **familiarize** with the turbulence models and types of partial differential equations. • **describe** the major theories, approaches and methodologies used in CFD • **use** and **develop** flow simulation code for the flows in engineering and science using FDM. • critically **analyze** different solvers and grid generation techniques • **use** and **develop** flow simulation code for the flows in engineering and science using FVM

Unit– I

Review of the basic fluid dynamics: Continuity, Momentum and Energy equations Navier Stokes equations. Heat transfer conduction equation for steady and un–steady flows, steady convection– diffusion equation.

Unit– II

Introduction to turbulence, Reynolds averaged N–S equations, Mixing length model, K–epsilon turbulence model, Favre averaged N–S equations. Classification of partial differential equations – Elliptic, parabolic and hyperbolic equations. Initial and boundary value problems.

Unit– III

Concepts of Finite difference methods– forward, backward and central difference. examples: 1-D steady state heat conduction without and with constant source term 1-D unsteady state diffusion problems: implicit, fully explicit and Crank-Nicholson scheme; Errors, consistency, stability analysis – Von Neumann analysis, convergence criteria; Viscous incompressible flow, stream function– Vorticity method.

Unit– IV

Solution techniques for systems of linear algebraic equations: Elimination method: Forward elimination and backward substitution, Tridiagonal matrix algorithm (TDMA): Thomas algorithm, Iteration methods: Jacobi's method and Gauss Siedel method and ADI methods.

Introduction to grid generation, Structured and Unstructured grids, Types of grid – O,H,C.

Unit– V

Introduction to finite volume method. Finite volume formulations for diffusion equation, convection diffusion equation. Solution algorithm for pressure velocity coupling in steady flows staggered grid, SIMPLE Algorithm.

Suggested Reading:

1. Pradip Niyogi, Chakrabartty SK, Laha M K,'Introduction to Computational Fluid Dynamics', Pearson Education, 2005.
2. Muralidhar K, Sundararajan T,'Computational Fluid Flow and Heat Transfer',Narosa publication House, New Delhi, 2003
3. Chung T J,'Computational Fluid Dynamics, Cambridge University Press, New York, 2002
4. John D Anderson, 'Computational Fluid Dynamics', Mc Graw Hill Inc., New York, 2003
5. Patankar S V,'Numerical Heat Transfer and Fluid Flow', Hemisphere Publishing Company, New York 1980
6. H.K. Versteeg, W. Malalasekara, An Introduction to computational Fluid Dynamics, Pearson Education, 2nd Ed.2007.

Web resources:

1. http://nptel.ac.in/courses/103106073 & 112104030 & 112105045 & 112107080
2. http://freevideolectures.com/Course/3486/Introduction-to-CFD

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

ADVANCED FINITE ELEMENT ANALYSIS (ELECTIVE)		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course is to: • understand basic theory of plates and shells • interpret the concept of non-linearity • familiarize with the numerical methods in dynamic analysis • understand fluid flow and heat transfer analysis • familiarize with adaptive meshing and error estimates	On completion of the course, the Students will be able to: • identify the FE formulations for plates and shells • formulate the non-linear problems. • calculate dynamic characteristics using numerical methods • formulate the fluid flow and heat transfer analysis. • estimate the errors and convergence rates

Unit-I
BENDING OF PLATES AND SHELLS : Review of Elasticity Equations – Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements - Conforming and Non Conforming Elements – C0 and C1 Continuity Elements –Degenerated shell elements- Application and Examples.

Unit-II
NON-LINEAR PROBLEMS : Introduction – Iterative Techniques – Material non-linearity – Elasto Plasticity – Plasticity – Visco Plasticity – Geometric Non linearity – large displacement Formulation –Solution procedure- Application in Metal Forming Process and Contact Problems.

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

Unit-IV
FLUID MECHANICS AND HEAT TRANSFER : Governing Equations of Fluid Mechanics – Solid structure interaction - Inviscid and Incompressible Flow – Potential Formulations – Slow Non-Newtonian Flow – Metal and Polymer Forming – Navier Stokes Equation – Steady and Transient Solution.

Unit-V
ERROR ESTIMATES AND ADAPTIVE REFINEMENT : Error norms and Convergence rates – h-refinement with adaptivity – Adaptive refinement.

Learning Resources:
1. Zienkiewicz, O.C. and Taylor, R.L., "The Finite Element Method", Fourth Edition, Volumes 1 & 2, McGraw Hill International Edition, Physics Services, 1991.
2. Cook R.D., "Concepts and Applications of Finite Element Analysis",John Wiley and Sons Inc., Newyork, 1989.
3. Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall, 1990
4. S.S.Rao, "Mechanical Vibrations" Addison-Wesley publishing co. 1998
5. V. Rammurti "computer aided mechanical design and analysis" Tata Mc-Grawhill 1992

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

MECHANICAL BEHAVIOUR OF ENGINEERING MATERIALS		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: ME 50x0
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • to assess the elastic behavior of materials • to identify various crystal defects in materials • to develop viscoelastic and viscoplastic models of the materials • to analyze causes for creep and fracture of materials • to illustrate the fatigue loading and failure of materials	On completion of the course the student will be able to: • to Correlate microscopic and macroscopic material behaviors • to explain causes and mechanism of plastic deformation of materials • to estimate the responses of viscoelastic and viscoplastic response of the materials • to assess creep and fracture behavior of materials • to estimate the fatigue behavior of materials and design for safety against fatigue.

Unit I

Overview: Different responses of material to loading, material properties, macroscopic experiments and its relevance, physical mechanisms controlling the behavior. Elasticity: Atomic structure and bonding, Atomic interaction, physical origin of elastic modulus, Generalized Hooke's law, Anisotropic linear elasticity of crystals, orientation dependence of elastic modulus.

Unit II

Plasticity: Theoretical shear strength of crystals, Point, line and volume defects, edge and screw dislocations, Burgers circuit and Burgers vector, force between dislocations, movement and interactions of dislocations, slip planes, twinning, strengthening mechanisms, work hardening, grain boundary strengthening and solid solution strengthening, true stress-strain curve, necking phenomenon, yield criteria, rheological models, plastic stress- strain relationships.

Unit III

Viscoelasticity and viscoplasticity: Responses of viscoelastic materials under different loading, creep and relaxation, Maxwell and Kelvin models, Three parameter solid and four parameter fluid, generalized Maxwell's and generalized Kelvin's models

Unit IV

Creep and Fracture: primary, secondary and tertiary creep, creep mechanisms, dislocation creep, diffusion creep and grain boundary creep. Mechanisms, creep laws, Analysis and Applications in Design, Brittle, ductile and fatigue fracture, fracture surfaces, Griffith's theory, modes of fracture, energy release rate, stress intensity factor, crack tip plasticity, J-integral and Crack Tip Opening Displacement

Unit V

Fatigue: Cyclic loads, constant amplitude and variable amplitude loads, cycle counting techniques, infinite life, safe-life, fail-safe, damage-tolerant design philosophies, Low cycle and high cycle fatigue, Stress-Life approach, Strain-Life approach, and Fracture mechanics approach, Cumulative damage theories. Mechanical Characterization of Materials: Mechanical testing for material Characterization, Measurement techniques in experimental solid mechanics, Non destructive testing.

Learning Resources:

1. Norman E. Dowling, Mechanical behavior of materials : Engineering Methods for Deformation, Fracture and Fatigue, Prentice Hall
2. Marc Meyers and Krishnan K. Chawla, Mechanical behavior of materials, Cambridge University Press
3. William F. Hosford, Mechanical behavior of materials, Cambridge University Press
4. Thomas H. Courtney, Mechanical behavior of materials, Overseas Press
5. Joachim Roesler, Harald Harders, and Martin Baeker, Mechanical Behavior of Engineering Materials, Springer.

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

EXPERIMENTAL TECHNIQUES AND DATA ANALYSIS (ELECTIVE)		
Instruction: 3 Hours/ week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • Understanding measurement of force, temperature, flow measurement • Applying the above techniques in experimental setup. • Recognise micro-structure & surface measurement techniques • Design various experiments and validate using testing method. • Introduce Taguchi method and conclude quality loss function	On completion of the course, the Students will be able to: • **estimating** force using strain gauges, transducers and strain by photoelasticity, holography, interferometer. • **estimating** temperature by electrical resistance, pyrometers thermo couples, biometalic etc and flow measurement by laser dopler, hot wire anemometer, ultrasonic, shadow graphs. • **recognise** various microstructure of metals and alloys under different working conditions. Measurement of surface finish. • **describe** various hypothesis using t-, F & chi-square test, selection of process parameters and factorial design for experiments, ANOVA to estimate contribution of each parameter. • **Applying** orthogonally array for experimental design and optimization of response function, estimating loss function and its applications.

Unit-I

Measurement of cutting forces: Strain gauge and piezoelectric transducers and their characteristics. Dynamometer construction, Bridge circuits. Instrumentation and calibration. Displacement and Strain measurements by photoelasticity, Holography, interferometer, Moir techniques, strain gauge rosettes.

Unit-II

Temperature Measurement: Circuits and instrumentation for different transducers viz., bimetallic, expanding fluid, electrical resistance, thermister, thermocouples, pyrometers.
Flow Measurement: Transducers for flow measurements of Non-compressible fluids, Obstruction and drag methods. Vortex shredding flow meters. Ultrasonic, Laser Dopler and Hotwire anemometer. Flow visualization techniques, Shadow graphs, Schilieren photography. Interferometer.

Unit-III

Metallurgical Studies: Optical and electron microscopy, X-ray diffraction, Bragg's Law and its application for studying crystal structure and residual stresses. Electron spectroscopy, electron microprobe.
Surface Measurement: Micro hardness, roughness, accuracy of dimensions and forms. 3-D Co-ordinate measuring machines.

Unit-IV

Experiment design & data analysis: Statistical methods, Randomised block design, Latin and orthogonal squares, factorial design. Replication and randomization.
Data Analysis: Deterministic and random data, uncertainty analysis, test of significance: Chi-square, student's 't' test. Regression modeling, direct and interaction effects. ANOVA, F-test. Time Series analysis, Autocorrelation and autoregressive modeling.

Unit-V

Taguchi Methods: Experimental design and planning with Orthogonal arrays and linear graphs. Additive cause-effect model, Optimization of response level. Identification of Design and noise factors. Performance evaluation and Optimization by signal to noise ratios. Concepts of loss function and its application.

Learning Resources:

1. Jack Philip Holman, Experimental Methods for Engineers, 7th edition, McGraw-Hill, 2001
2. V. C. Venkatesh, H. Chandrasekaran, Experimental Techniques in Metal Cutting, Eastern economy edition, Prentice-Hall of India, 1987
3. George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung, Time Series Analysis: Forecasting and Control, 5th Edition, John Wiley & Sons, 2015
4. Richard C. Dove, Paul H. Adams, Experimental stress analysis and motion measurement: theory, instruments and circuits, techniques, C. E. Merrill Books, 1964
5. Bagchi Tapan P, Taguchi Methods Explained: Practical Steps to Robust Design, Prentice-Hall (India), 1993.

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)

FRACTURE MECHANICS (ELECTIVE)		
Instruction: 3 Hours / week	Semester End Exam Marks: 70	Subject Reference Code: **ME 50x0**
Credits: 3	Sessional Marks: 30	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • study different types of fractures • study the stress field of elastic crack and its solution. • study about the crack growth and crack arrest • study about the elastic-plastic fracture mechanics • study about the application of fracture mechanics	On completion of the course the student will be able to: • **understand** the crack and its effect on the service. • **solve** the elastic crack problems • **analyse** factors effecting crack growth and its arrest • **solve** crack problems using FEM • **derive** relationship between fracture design and selection of materials.

Unit-I
Introduction: Crack in a Structure – Griffth Criterion – Cleavage fracture – Ductile fracture – Fatigue Cracking. Service failure analysis.

Unit-II
Elastic Crack: Elastic Crack tip stress field – Solution to crack problems. Effect of finite size stress intensity factor – Special cases – Irwin plastic zone correction. Actual shape of plastic zone – Plane stress – Plane strain.

Unit-III
Energy Principle: Energy release rate – Criterion for crack growth – Crack resistance curve – Principles of crack arrest – Crack arrest in practice.

Fatigue Crack Growth: Fatigue crack growth test, stress intensity factor, factors affecting stress intensity factor – Variable amplitude service loading, retardation model.

Unit-IV
Elastic Plastic Fracture Mechanics: Elastic plastic fracture concept – Crack tip opening displacement – J-integral technique; Determination of J-using FEM.

Unit-V
Application of Fracture Mechanics: Fracture design – Selection of materials – fatigue crack growth rate curve – Stress intensity factor range – Use of crack growth law.

Learning Resources:

1. David Broek – Elementary Engineering Fracture Mechanics: Sifth off an Noordhoff Internal Publishers – 1978.
2. John M. Barson and Stanely T. Rolfe: Fracture and Fatigue Control in Structures – Prentice Hall, Inc. USA 1987.
3. Jean Cemative and Jean Louis Chboche Mechanics of Solid Materials, Cambridge University Press, Cambridge, 1987.
4. Prashant Kumar, "Elements of Fracture Mechanics", Wheeler Publications, 1999

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LABORATORY COURSES

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

CAD / CAM LABORATORY		
Instruction: 2 Hours/ week	Semester End Exam Marks: 50	Subject Reference Code: **ME 5111**
Credits: 1	Sessional Marks: 25	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • Students will be able to create part models make an assembly of engineering products and produce components using software package and CNC machines • Analyse mechanical engineering designs using CAE software	On completion of the course, the Students will be able to: • **construct** part model using modeling software • **prepare** 3D models using different modeling approaches • **apply** assembly constrains for developing mechanical engineering components • **show** the machining operations using NC programming through simulation • **operate** CNC machines for different machining operations • **create** or **convert** 3D model into finite element model • **analyse** static structural problems

List of Experiments:

CAD
1. 2 D sketching
2. Part modelling
3. Assembly
4. Simulation – Static Analysis

CAM
1. Understanding of CNC Machines and CNC Programming and Creation of 2-D controur pockets, slots
2. Drills and Facing, 2-D high speed blend
3. Surface Roughing for Bottle die
4. Surface finishing for phone die
5. Manufacturing simulation of
   - Crane hook
   - Connecting rod
   - Turbine blade

Learning Resources:
1. Siemens NX Software manual
2. ANSYS Software manual
3. Sinumeric CNC controller instructions
4. G & M codes

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

MODELING & SIMULATION LABORATORY		
Instruction: 2 Hours/ week	Semester End Exam Marks: 50	Subject Reference Code: **ME 5211**
Credits: 1	Sessional Marks: 25	Duration of Semester End Exam: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: • learn to use modeling software for mechanical applications • learn to use simulation software for mechanical applications	On completion of the course, the Students will be able to: • **solve** logical and mathematical equations using MATLAB • **solve** exercises using simulation softwares (ADAMS & ANSYS)

List of Experiments

I. MAT LAB

1. Basic syntax and command-line exercises
2. Basic array exercises
3. Relational and logical operations
4. Control of flow: if-blocks
5. Loop constructs: for and while
6. Basic 2D and 3 D plots
7. Solving ordinary differential equations
8. Curve fitting and interpolation
9. Data Analysis and statistics
10. Soving non-linear algebraic equations
11. Introduction to ptimiztion methods like GA, Fuzzy, Neural & PSO
12. Introduction to SIMULINK
13. Modeling of problems related to design of robot using MATLAB

II. SIMULATION SOFTWARE

14. Static analysis using ANSYS
15. Dynamic analysis using ANSYS
16. PLC simulator
17. Simulation of mechanisms using ADAMS software

Learning resources:
1) MAT LAB programming for Engineers, S.J. Chapman, Thomson Brooks / Cole 2002
2) ADAMS training manual

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SEMINARS & DISSERTATION

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

SEMINAR-I		
Instruction: 2 Hours/ week	Semester End Exam Marks: ---	Subject Reference Code: **ME 5112**
Credits: 1	Sessional Marks: 25	Duration of Semester End Exam: ----

Course Objectives	**Course Outcomes**
The objectives of this course are to: • prepare the student for a systematic and independent study of state of the art topics in a broad area of his / her specialization	On completion of the course, the students will be able to: • **write** a suitable abstract • **write** a seminar report • **present and deliver** a seminar

Seminar *topics* may be chosen by the students with advice from the faculty members. Students are to be exposed to following aspects of seminar presentations.

- Selection of Topics from published Journals / Conference Proceedings in the areas of Design, Manufacturing and Analysis.
- Report to be prepared showing literature survey, organisation of material, preparation of PPT and displaying technical writing skills.
- Must display the presentation skills

Each student is required to

1. Submit a one page synopsis of the seminar talk.
2. Give a 20 minutes presentation through OHP, PC, Slide projector followed by a 10 minutes discussions
3. Submit a report on the seminar topic with literature survey

Seminars are to be scheduled from the 3rd week to the last week of the semester and any change in schedule should be discouraged.

The sessional marks will be awarded to the students by at least 2 faculty members on the basis of an oral and a written presentation as well as their involvement in the discussions.

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

SEMINAR-II		
Instruction: 2 Hours /week	Semester End Exam Marks: ---	Subject Reference Code: **ME 5212**
Credits: 1	Sessional Marks: 25	Duration of Semester End Exam: ----

Course Objectives	Course Outcomes
The objectives of this course are to: • prepare the student for a systematic and independent study of state of the art topics in a broad area of his / her specialization	On completion of the course, the students will be able to: • **write** a suitable abstract • **write** a seminar report • **presentation** of the seminar

Seminar *topics* may be chosen by the students with advice from the faculty members. Students are to be exposed to following aspects of seminar presentations.

- Selection of Topics from published Journals / Conference Proceedings in the areas of Design, Manufacturing and Analysis.
- Report to be prepared showing literature survey, organisation of material, preparation of PPT and displaying technical writing skills.
- Must display the presentation skills

Each student is required to

1. Submit a one page synopsis of the seminar talk.
2. Give a 30 minutes presentation through OHP, PC, Slide projector followed by a 10 minutes discussions
3. Submit a report on the seminar topic with literature survey

Seminars are to be scheduled from the 3rd week to the last week of the semester and any change in schedule should be discouraged.

The sessional marks will be awarded to the students by at least 2 faculty members on the basis of an oral and a written presentation as well as their involvement in the discussions.

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) III-SEMESTER

Dissertation Seminar		
Instruction: 4 hours /week	Semester End Exam Marks: ---	Subject Reference Code: **ME 6112**
Credits: 2	Sessional Marks: 50	Duration of Semester End Exam: ----

Course Objective	Course Outcomes
The objective of this course is to: Enable the student to do the literature survey to identify and select a suitable dissertation work in the area of his specialization and to start with the preparatory work like abstract preparation, design, modeling, analysis and experimentation and to present the findings in the Dissertation seminar.	On completion of the course, the students will be able to: • Complete the literature survey • Progress in the Dissertation work • Prepare a Presentation of the work done • Give a Dissertation seminar to the committee

Each student is required to

1. Submit a one page synopsis of the dissertation seminar talk.
2. Give a 30 minutes presentation through OHP, PC, Slide projector followed by a 10 minutes discussion
3. Submit a report on the seminar topic with literature survey

Seminars are to be scheduled from the third week to the sixth week of the semester and any change in schedule should be discouraged.

The sessional marks will be awarded to the students by at least 2 faculty members on the basis of an oral and a written presentation as well as their involvement in the discussions.

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DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)III-SEMESTER

Dissertation Phase I		
Instruction: 16 Hours /week	Semester End Exam Marks: ---	Subject Reference Code: **ME6115**
Credits: 8	Sessional Marks: 100	Duration of Semester End Exam: ----

Course Objective	Course Outcomes
The objective of this course is to: • Start with a suitable Dissertation work in consultation with the supervisor in the areas of his/her specialization either in the Institute or Industry.	On completion of the course, the students will be able to: • apply and Solve the problems in the relevant field of specialization from the knowledge gained from theoretical and practical courses pursued during the course. • Develop flair for R&D work.

- A research project topic may be selected either from published lists or from the creative ideas of the students themselves in consultation with their project supervisor.
- To improve the student research and development activities.

The sessional marks will be awarded to the students by at least 2 faculty members and the supervisor on the basis of an oral presentation and submission of a progress report.

SYLLABUS IS APPROVED BY MEMBERS OF BOS

SIGNATURES:

(Dr. Jeevan Jaidi)
1) OU Nominee

(Prof. Sriram Venkatesh)
2) Subject Expert-1

B. Venkatesham
(Dr. B. Venkatesham)
3) Subject Expert-2

(Dr. N.K. Singh)
4) Industry Expert

(Dr. G.V. Ramana Murty)
5)Chairman, BOS
14/9

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M)IV-SEMESTER

Dissertation Phase II		
Instruction: 30 Hours /week	Semester End Exam Marks: ---	Subject Reference Code: **ME 6215**
Credits: 15	Sessional Marks: -	Duration of Semester End Exam: ----

Course Objectives	Course Outcomes
The objectives of this course are to: • Complete the Dissertation work in line with the chosen field in the areas of his/her specialization.	On completion of the course, the students will be able to: • Prepare a thesis with all the findings in the chosen area. • Present a seminar with all the results during the Viva-voce examination.

The final assessment involves presentation of the dissertation work by the student and the award of the grade by an expert of relevant specialization.

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