



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MECHANICAL ENGINEERING

III YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	PCC-ME	Dynamics of Machinery	3	--	--	3
2	PCC-ME	Design of Machine Members-II	3	--	--	3
3	PCC-ME	Mechanical Measurements & Metrology	3	--	--	3
4	HSIMS	Managerial Economics and Financial Accountancy	3	--	--	3
5	PCC-ME	IC Engines & Gas turbines	3	--	--	3
6	PCC-Lab	Thermal Engineering Lab	--	--	3	1.5
7	PCC-Lab	Theory of Machines Lab	--	--	3	1.5
8	PCC-Lab	Mechanical Measurements & Metrology Lab	--	--	3	1.5
9	PROJ-3101	Socially Relevant Project				0.5
		Total Credits	15	--	9	20

III YEAR II SEMESTER

S. No	Course Code	Course Title	L	T	P	Credits
1	PCC-ME	Operations Research	3	--	--	3
2	PCC-ME	Heat Transfer	3	--	--	3
3	PCC-ME	CAD/CAM	3	--	--	3
4	PEC-ME1	1.Composite Materials 2.Refrigeration & Air Conditioning 3. Unconventional Machining Processes 4. Advanced Mechanics of Solids 5.MOOCs(NPTEL/Swayam)	3	--	--	3
5	PEC-ME2	1. Material Characterization 2. Tribology 3. Automobile Engineering 4.Mechatronics 5.MOOCs(NPTEL/Swayam)	3	--	--	3
6	PCC-Lab	Simulation of Mechanical Systems Lab	--	--	2	1
7	PCC-Lab	Heat Transfer Lab	--	--	3	1.5
8	PCC-Lab	CAD /CAM Lab	--	--	3	1.5
9	PROJ- ME	Summer Internship*	--	--		1
		Total Credits	15	--	9	20

*The students have to undergo a summer internship for minimum of Four weeks duration from Industries/R&D/ Govt. Organizations after B.Tech III year II-Semester and credits will be awarded in B.Tech IV year I-Semester after evaluation.



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III Year - II Semester		L	T	P	C
		3	0	0	3
OPERATIONS RESEARCH					

Course Objectives:

The objective of the course is to understand the availability of resources and constraints in an industry and optimize them through the applications of appropriate resource management tools.

UNIT – I

Development – definition– characteristics and phases – operation research models – applications.

LINEAR PROGRAMMING: problem formulation – graphical solution – simplex method – artificial variables techniques -two–phase method, big-M method – duality principle.

UNIT – II

TRANSPORTATION PROBLEM: Formulation – optimal solution, unbalanced transportation problem – degeneracy, assignment problem – formulation – optimal solution - variants of assignment problem- traveling salesman problem.

SEQUENCING – Introduction – flow –shop sequencing – n jobs through two machines – n jobs through three machines – job shop sequencing – two jobs through ‘ m ’ machines.

UNIT – III

REPLACEMENT: Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.

UNIT – IV

THEORY OF GAMES: Introduction to decision theory – mini. max (max. mini) – criterion and optimal strategy – solution of games with saddle points – rectangular games without saddle points – 2×2 games – dominance principle – $m \times 2$ & $2 \times n$ games -graphical method.

WAITING LINES: Introduction to Kendall's notation–classification of queuing models, single channel – with infinite population and finite population models– multichannel – with infinite population.

UNIT – V

Network Analysis: Project planning, scheduling and controlling – tools for project management – critical path method – programme evaluation and review technique (PERT) – cost analysis and crashing – resource leveling – updating.

TEXT BOOKS:

1. Operations Research-An Introduction/Hamdy A Taha/Pearson publishers
2. Operations Research –Theory & publications / S.D.Sharma-Kedarnath/McMillan publishers India Ltd

REFERENCES:

1. Introduction to O.R/Hiller & Libermann/TMH
2. Operations Research /A.M.Natarajan,P.Balasubramani,A. Tamilarasi/Pearson Education.
3. Operations Research: Methods & Problems / Maurice Saseini, Arhur Yaspan & Lawrence Friedman/Wiley
4. Operations Research / R.Pannerselvam/ PHI Publications.
5. Operations Research / Wagner/ PHI Publications.



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6. Operation Research /J.K.Sharma/MacMilan Publ.
7. Operations Research/ Pai/ Oxford Publications
8. Operations Research/S Kalavathy / Vikas Publishers
9. Operations Research / DS Cheema/University Science Press
- 10.Operations Research / Ravindran, Philips, Solberg / Wiley publishers

Course Outcomes:

After studying the course, the students are able to

1. Formulate the resource management problems and identify appropriate methods to solve them
2. Apply LPP, transportation and assignment models to optimize the industrial resources
3. Solve decision theory problems through the application of game theory
4. Apply the replacement and queuing models to increase the efficiency of the system
5. Model the project management problems through CPM and PERT



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		3	0	0	3
HEAT TRANSFER					

Course Objective: To understand different modes of heat transfer and apply these basics in the design of thermal systems

UNIT – I:

Introduction: Modes and mechanisms of heat transfer – Basic laws of heat transfer –General discussion about applications of heat transfer.

Conduction Heat Transfer: Fourier rate equation – General heat conduction equation in Cartesian, Cylindrical and Spherical coordinates – simplification and forms of the field equation – steady, unsteady and periodic heat transfer – Initial and boundary conditions

One Dimensional Steady State Conduction Heat Transfer: Homogeneous slabs, hollow cylinders and spheres- Composite systems– overall heat transfer coefficient – Electrical analogy – Critical radius of insulation

UNIT – II:

One Dimensional Steady State Conduction Heat Transfer: Variable Thermal conductivity – systems with heat sources or Heat generation-Extended surface (fins) Heat Transfer – Long Fin, Fin with insulated tip and Short Fin, Application to error measurement of Temperature

One Dimensional Transient Conduction Heat Transfer: Systems with negligible internal resistance – Significance of Biot and Fourier Numbers –Infinite bodies- Chart solutions of transient conduction systems- Concept of Semi infinite body.

UNIT – III:

Convective Heat Transfer: Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow – Dimensional analysis as a tool for experimental investigation – Buckingham Π Theorem and method, application for developing semi – empirical non- dimensional correlation for convection heat transfer – Significance of non-dimensional numbers – Concepts of Continuity, Momentum and Energy Equations.

Forced convection: External Flows: Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer -Flat plates and Cylinders.

Internal Flows: Concepts about Hydrodynamic and Thermal Entry Lengths – Division of internal flow based on this –Use of empirical relations for Horizontal Pipe Flow and annulus flow.

UNIT – IV:

Free Convection: Development of Hydrodynamic and thermal boundary layer along a vertical plate - Use of empirical relations for Vertical plates and pipes.

Heat Exchangers: Classification of heat exchangers – overall heat transfer Coefficient and fouling factor – Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods.

UNIT V:

Heat Transfer with Phase Change:

Boiling: – Pool boiling – Regimes – Calculations on Nucleate boiling, Critical Heat flux and Film boiling

Condensation: Film wise and drop wise condensation –Nusselt's Theory of Condensation on a vertical plate - Film condensation on vertical and horizontal cylinders using empirical correlations.

Radiation Heat Transfer : Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchoff, Lambert, Stefan and Boltzmann– heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks.

TEXT BOOKS:

1. Heat Transfer by HOLMAN, Tata McgrawHill



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2. Heat Transfer by P.K.Nag, TMH

REFERENCE BOOKS:

1. Fundamentals of Heat Transfer by Incropera & Dewitt, John wiley
2. Fundamentals of Engineering, Heat& Mass Transfer by R.C.Sachdeva, NewAge.
3. Heat& Mass Transfer by Amit Pal – Pearson Publishers
4. Heat Transfer by Ghosh dastidar, Oxford University press.
5. Heat Transfer by a Practical Approach, YunusCengel, Boles, TMH
6. Engineering Heat and Mass Transfer by Sarit K. Das, DhanpatRai Pub

Note: Heat and Mass transfer Data Book by C P Kothandaraman and Subrahmanyam is used to design and analyze various thermal processes and thermal equipment.

Course Outcomes: At the end of the course, the student should be able to

CO1: Compute rate of heat transfer for 1D, steady state composite systems without heat generation.

CO2: Analyze the system with heat generation, variable thermal conductivity, fins and 1D transient conduction heat transfer problems.

CO3: Develop the empirical equations for forced convection problems by using Buckingham's pi theorem.

CO4: Compute the rate of heat transfer for natural convection systems and design and analysis of heat exchangers.

CO5: Solve the heat transfer systems with phase change and radiation.



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		3	0	0	3
CAD/CAM					

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand the basic fundamentals of computer aided design and manufacturing.
2. To learn 2D & 3D transformations of the basic entities like line, circle, ellipse etc
3. To understand the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc. and to visualize how the components look like before its manufacturing or fabrication
4. To learn the part programming, importance of group technology, computer aided process planning, computer aided quality control
5. To learn the overall configuration and elements of computer integrated manufacturing systems.

UNIT – I

Introduction to CAD/CAM, product cycle, CAD / CAM Hardware, basic structure.

COMPUTER GRAPHICS: Raster scan graphics coordinate system, database structure for graphics modeling, transformation of geometry, 2D and 3D transformations, mathematics of projections, clipping, hidden surface removal.

UNIT – II

GEOMETRIC MODELING: Requirements, geometric models, geometric construction models, curve representation methods, parametric representation of various curves: cubic spline, bezier curves. surface representation methods, Solid modelling.

UNIT – III

PART PROGRAMMING FOR NC MACHINES: NC, NC modes, NC elements, CNC machine tools, structure of CNC machine tools, features of Machining center, turning center, CNC Part Programming: fundamentals, manual part programming methods, Computer Aided Part Programming. Direct Numerical Control, Adaptive Control.

UNIT – IV

GROUP TECHNOLOGY: Part family, coding and classification, production flow analysis, types and advantages. Computer aided processes planning – importance, types. FMS- Introduction, Equipment, Tool management systems, Layouts, FMS Control

UNIT – V

COMPUTER INTEGRATED MANUFACTURING SYSTEMS: Types of manufacturing systems, machine tools and related equipment, material handling systems, material requirement planning, computer control systems, human labor in manufacturing systems, CIMS benefits.

COMPUTER AIDED QUALITY CONTROL: Terminology used in quality control, use of computers in Quality control. Inspection methods- contact and noncontact types, computer aided testing, integration of CAQC with CAD/CAM.



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Text Books:

1. CAD / CAM Principles and Applications/PN Rao / McGraw-Hill
2. Automation, Production systems & Computer integrated Manufacturing/ M.P. Groover/Pearson Education

References:

1. Mastering CAD / CAM / Ibrahim Zeid / McGraw-Hill
2. Principles of Computer Aided Design and Manufacturing / Farid Amirouche / Pearson
3. Computer Numerical Control Concepts and programming / Warren S Seames / Thomson learning, Inc
4. Product manufacturing and cost estimation using CAD/CAE/ Kuang Hua Chang/Elsevier Publishers

Course Outcomes:

At the end of the course the students shall be able to:

1. Describe the mathematical basis in the technique of representation of geometric entities including points, lines, and parametric curves, surfaces and solid, and the technique of transformation of geometric entities using transformation matrix
2. Describe the use of GT and CAPP for the product development
3. Identify the various elements and their activities in the Computer Integrated Manufacturing Systems.



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		3	0	0	3
COMPOSITE MATERIALS					

Course Objective: The prime objective of this course is to introduce, classify, and process composite materials which are novel and widely applied materials. The applications of composite materials that would suit the requirements are also dealt in detail as an integral part.

UNIT - I

Introduction: Definition – Classification of Composite materials based on structure and matrix. Advantages and disadvantages application of composites based on structure – Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT - II

Reinforcements: Preparation, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical behavior of composites; Rule of mixtures, Inverse rule of mixtures. Loading under Isostrain and Isostress conditions.

UNIT - III

Manufacturing of Polymer matrix composites; Preparation of Moulding compounds and prepregs – hand lay-up method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications

UNIT - IV

Manufacturing of Metal Matrix Composites; Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications polymer composites

UNIT - V

Nanocomposites:- Synthesis, properties and characterization, advantages and disadvantages over conventional composites, applications of nano composites.

TEXT BOOKS:

1. Composite Materials – K. K. Chawla
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007

REFERENCE:

1. Composite Materials Science and Applications – Deborah D.L. Chung
2. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi

Course Outcomes:

After learning the course the students should be able to

1. Explain various composite materials with their constituents, advantages, limitations and applications
2. Enumerate different reinforcements with their application.
3. Describe various manufacturing methods of polymer and metal matrix composites materials.
4. Describe various manufacturing methods of metal matrix composites materials and their applications.
5. Explain the synthesis and characterization procedures of nanocomposites.



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		3	0	0	3
REFRIGERATION AND AIR CONDITIONING					

Course Objective: To apply the principles of Thermodynamics to analyse different types of refrigeration and air conditioning systems and to understand the functionality of the major components.

UNIT – I:

Introduction to Refrigeration: - Necessity and applications – Unit of refrigeration and C.O.P. – Mechanical Refrigeration – Types of Ideal cycle of refrigeration.

Air Refrigeration: Bell Coleman cycle and Brayton Cycle, Open and Dense air systems – Actual air refrigeration system – Refrigeration needs of Aircrafts- Air systems – Actual Air refrigeration system – Refrigeration needs of Aircrafts – Application of Air Refrigeration, Justification – Types of systems – Problems.

UNIT – II:

Vapour compression refrigeration – working principle and essential components of the plant – Simple Vapour compression refrigeration cycle – COP – Representation of cycle on T-S and p-h charts – effect of sub cooling and super heating – cycle analysis – Actual cycle Influence of various parameters on system performance – Use of p-h charts – Problems.

UNIT III:

System Components: Compressors – General classification – comparison – Advantages and Disadvantages.

Condensers – classification – Working Principles, Evaporators – classification – Working Principles

Expansion devices – Types – Working Principles,

Refrigerants: Desirable properties – common refrigerants used – Nomenclature – Ozone Depletion – Global Warming – Azeotropes and Zeotropes

UNIT IV:

Vapor Absorption System – Calculation of max COP – description and working of NH₃ – water system – Li – Br system. Principle of operation Three Fluid absorption system, salient features.

Steam Jet Refrigeration System – Working Principle and Basic Components

Principle and operation of (i) Thermoelectric refrigerator (ii) Vortex tube or Hilsch tube.

UNIT – V:

Introduction to Air Conditioning:

Psychometric Properties & Processes – Sensible and latent heat loads – Characterization – Need for Ventilation, Consideration of Infiltration – Load concepts of RSHF, ASHF, ESHF and ADP.

Concept of human comfort and effective temperature – Comfort Air conditioning – Industrial air conditioning and Requirements – Air conditioning Load Calculations.

Air Conditioning systems - Classification of equipment, cooling, heating humidification and dehumidification, filters, grills and registers, deodorants, fans and blowers.

Heat Pump – Heat sources – different heat pump circuits – Applications.

TEXT BOOKS:

1. A Course in Refrigeration and Air conditioning - SC Arora & Domkundwar, Dhanpatrai Rai Publishers
2. Refrigeration and Air Conditioning - CP Arora, Tata McGraw Hill

REFERENCE BOOKS:

1. Refrigeration and Air Conditioning - Manohar Prasad, New Age
2. Principles of Refrigeration - Dossat, Pearson Education



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3. Basic Refrigeration and Air-Conditioning- Ananthanarayanan, TMH

Course Outcomes: At the end of the course, the student should be able to

- Differentiate between different types of refrigeration systems with respect to engineering applications
- Thermodynamically analyse refrigeration and air conditioning systems and evaluate performance parameters
- Apply the principles of Psychrometrics to design the air conditioning loads for the industrial applications
- perform cooling load calculations and select the appropriate process and equipment for the required comfort and industrial air-conditioning.



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		3	0	0	3
UNCONVENTIONAL MACHINING PROCESSES					

Course Objectives:

The objective of the course is to study the fundamentals and operational behaviors of different types of unconventional / nontraditional machining processes

UNIT – I

INTRODUCTION: Need for non-traditional machining methods-classification of modern machining processes – considerations in process selection, applications.

Ultrasonic machining – Elements of the process, mechanics of material removal, MRR process parameters, economic considerations, applications and limitations.

UNIT-II

Abrasive jet machining, Water jet machining and abrasive water jet machining: Basic principles, equipments, process variables, mechanics of material removal, MRR, application and limitations,

UNIT – III

ELECTRO – CHEMICAL MACHINING: Fundamentals of electro chemical machining, electrochemical grinding, electro chemical honing and deburring process, metal removal rate in ECM, Tool design, Surface finish and accuracy, economic aspects of ECM – Simple problems for estimation of metal removal rate, fundamentals of chemical, machining, advantages and applications.

UNIT - IV

THERMAL METAL REMOVAL PROCESSES: General principle and applications of Electric Discharge Machining, Electric Discharge Grinding and wire EDM – Power circuits for EDM, Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, surface finish and machining accuracy, characteristics of spark eroded surface

UNIT – V

Electron Beam Machining, Laser Beam Machining and plasma machining - Basic principle and theory, mechanics of material removal, process parameters, accuracy, surface finish, efficiency and applications .

Comparison of various nontraditional machining processes based on MRR, surface finish and applications.

Text Books:

1. Fundamentals of Machining Processes-Conventional and non – conventional processes/Hassan Abdel –Gawad El-Hafy/CRC Press-2016.

References:

1. Modern Machining Process / Pandey P.C. and Shah H.S./ TMH.
2. New Technology / Bhattacharya A/ the Institution of Engineers, India 1984.
3. Non Traditional Manufacturing Processes / Benedict /



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Course outcomes:

After studying the course, the students are able to

- Understand the characteristics and importance of different types of unconventional machining processes
- Identify the appropriate unconventional machining process for the implementation in a typical industrial scenario based on the applications
- Understand the significance of tools and resources used for machining the components in unconventional machining
- Machine the components through ECM / EDM and other machining processes
- Perform experiments in the advanced unconventional machining processes such as laser beam machining and electron beam machining



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		3	0	0	3
ADVANCED MECHANICS OF SOLIDS					

COURSE OBJECTIVES:

- To understand the concept of theory of elasticity equations for solving various engineering problems
- To study the failure modes of different structural members.
- To analyse the internal stresses in curved beams and beams subjected to un-symmetrical bending.
- To understand the deformations and stresses in non circular cross section members with torsional loading.

UNIT I

Theories of stress and strain, Definition of stress at a point, stress notation, principal stresses, other properties, differential equations of motion of a deformable body, deformation of a deformable body, strain theory, principal strains, strain of a volume element, small displacement theory.

UNIT II

Failure criteria: Modes of failure, Failure criteria, Excessive deflections, Yield initiation, fracture, Progressive fracture, (High Cycle fatigue for number of cycles $N > 10^6$, buckling.

Application of energy methods: Elastic deflections and statically indeterminate members and structures: Principle of stationary potential energy, Castiglione's theorem on deflections, Castiglione's theorem on deflections for linear load deflection relations, deflections of statically determinate structures.

UNIT III

Unsymmetrical bending: Bending stresses in Beams subjected to Nonsymmetrical bending; Deflection of straight beams due to nonsymmetrical bending.

UNIT IV

Curved beam theory: Winkler Bach formula for circumferential stress – Limitations – Correction factors –Radial stress in curved beams – closed ring subjected to concentrated and uniform loads–stresses in chain links.

UNIT V

Torsion : Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section ;Hollow thin wall torsion members ,Multiply connected Cross Section.

TEXTBOOKS:

1. Advanced Mechanics of materials by Boresi & Sidebottom- Wiely International.
2. Theory of elasticity by Timoschenko S.P. and Goodier J.N. McGraw-Hill Publishers 3rd

Edition



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REFERENCES:

1. Strength of materials & Theory of structures (Vol I & II) by B.C Punmia
2. Strength of materials by Sadhu singh.
3. Advanced Mechanics of Solids, L.S Srinath

COURSE OUTCOMES:

- Able to identify the failure modes of different structural members and apply various energy methods for statically determinant and in determinant structures.
- Gets acquainted with solving problems of curved beams and beams with un-symmetrical loading
- Able to apply the Soap-film analogy concept for torsional problems with non-circular cross section



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MATERIAL CHARACTERIZATION					

Course Objectives: To introduce the students to the principles of optical and electron microscopy, X-ray diffraction and various spectroscopic techniques.

UNIT I

Introduction to materials and characterization Techniques, X-ray diffraction: Bragg's law, phase identification, indexing and lattice parameter determination. Analytical line profile fitting using various models, Neutron diffraction, Reflection High Energy Electron Diffraction, and Low Energy Electron Diffraction.

UNIT II

Microscopy techniques: Optical microscopy, energy dispersive X-ray microanalysis (EDS), scanning electron microscopy (SEM), transmission electron microscopy (TEM), atomic force microscopy (AFM) and scanning probe microscopy (SPM), merits of TEM over SEM.

UNIT III

Thermal analysis technique: Differential thermal analysis (DTA), Differential Scanning Calorimetry (DSC), Thermo gravimetric analysis (TGA), determination of different thermal properties by DTA, DSC and TGA

UNIT IV

Magnetic characterization techniques: Introduction to Magnetism, Measurement Methods, Measuring Magnetization by Force, Measuring Magnetization by Induction method, Types of measurements using magnetometers: M-H loop, temperature dependent magnetization, time dependent magnetization, Measurements using AC susceptibility, Magneto-optical Kerr effect, Nuclear Magnetic Resonance, Electron Spin Resonance.

UNIT V

Optical and electronic characterization techniques: UV-VIS spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy, X-ray photoelectron spectroscopy.

TEXT BOOKS:

1. Characterization of Materials (Materials Science and Technology: A Comprehensive Treatment, Vol 2A & 2B, VCH (1992).
2. Semiconductor Material and Device Characterization, 3rd Edition, D. K. Schroder, Wiley-IEEE Press (2006).
3. Materials Characterization Techniques, S Zhang, L. Li and Shok Kumar, CRC Press (2008).

REFERENCES:

1. Physical methods for Materials Characterization, P. E. J. Flewitt and R. K. Wild, IOP Publishing (2003).
2. Characterization of Nanophase materials, Ed. Z. L. Wang, Wiley-VCH (2000).



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COURSE OUTCOMES: Students will have achieved the ability to:

1. choose and appropriate electron microscopy techniques to investigate microstructure of materials at high resolution
2. Determine crystal structure of specimen and estimate its crystallite size
3. Use appropriate spectroscopic technique to measure vibrational / electronic transitions to estimate parameters like energy band gap, elemental concentration, etc.
4. Apply thermal analysis techniques to determine thermal stability of and thermodynamic transitions of the specimen.



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TRIBOLOGY					

COURSE OBJECTIVES:

- To provide broad based understanding of the interdisciplinary subject ‘tribology’ and surface characterization techniques.
- To learn about the contact of solid surfaces and their interactions consequences of wear, wear mechanisms, wear theories and analysis of wear problems
- To understand the genesis of friction, the theories/laws of sliding and rolling friction
- To learn about the principles of lubrication, lubrication regimes, theories of hydrodynamic, elastohydrodynamic and mixed/ boundary lubrication
- To learn about tribotesting and experimental techniques in tribology and tribological modelling and simulation
- To learn about tribology of different machine components and emerging areas such as micro/nano tribology

UNIT – I

Introduction: Nature of surfaces and contact-Surface topography-friction and wear mechanisms, wear maps, effect of lubricants- methods of fluid film formation.

Lubrication: Choice of lubricants, types of oil, Grease and solid lubricants- additives- lubrication systems and their selection.

UNIT – II

Selection of rolling element bearings: Nominal life, static and dynamic capacity-Equivalent load, probabilities of survival- cubic mean load- bearing mounting details, pre loading of bearings, conditioning monitoring using shock pulse method.

UNIT – III

Hydrostatic Bearings: Thrust bearings – pad coefficients- restriction- optimum film thickness-journal bearings – design procedure –Aerostatic bearings; Thrust bearings and Journal bearings – design procedure.

UNIT – IV

Hydrodynamic bearings: Fundamentals of fluid formation – Reynold’s equation; Hydrodynamic journal bearings – Sommerfield number- performance parameters – optimum bearing with maximum load capacity – Friction – Heat generated and Heat dissipated. Hydrodynamic thrust bearings; Raimondi and Boyd solution for hydrodynamic thrust bearings- fixed tilting pads, single and multiple pad bearings- optimum condition with largest minimum film thickness.

UNIT – V

Seals: different type-mechanical seals, lip seals, packed glands, soft piston seals, Mechanical piston rod packing, labyrinth seals and throttling bushes, oil flinger rings and drain grooves – selection of mechanical seals.

Failure of Tribological components: Failure analysis of plain bearings, rolling bearings, gears and seals, wear analysis using soap and Ferrography.

Dry rubbing Bearings: porous metal bearings and oscillatory journal bearings – qualitative approach only.

TEXT BOOKS:



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1. Rowe WW & O' Dionoghue, "Hydrostatic and Hybrid bearing design" Butterworths & Co. Publishers Ltd, 1983.
2. Collacott R.A., "Mechanical Fault diagnosis and condition monitoring", Chapman and Hall, London 1977.
3. Bernard J. Hamrock, "Fundamentals of fluid film lubricant", McGraw-Hill Co., 1994.
4. Introduction to Tribology of bearings – B.C. Majumdar – S Chand Publishing.

REFERENCES:

1. Neale MJ, (Editor) "Tribology hand Book" Neumann Butterworths, 1975.
2. Connor and Boyd JJO (Editors) "Standard hand book of lubrication engineers" ASLE, McGraw Hill Book & Co., 1968
3. Shigley J, E Charles, "Mechanical Engineering Design", McGraw Hill Co., 1989

COURSE OUTCOMES:

- Students will demonstrate basic understanding of friction, lubrication and wear processes.
- Students will become familiar with mathematical tools used to analyze tribological processes.
- To enhance students' awareness of tribological issues in the design of machine components, such as rolling element bearings, journal bearings, thrust bearings, seals and braking systems.
- Students will become familiar with common anti-friction and anti-wear components and the lubricants used therein.
- Students will be able to describe the detailed operation of selected anti-friction or anti-wear components.
- Students will be exposed to design a tribological system for optimal performance. Students will be able to develop technical project reports and technical presentations



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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MECHANICAL ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
AUTOMOBILE ENGINEERING					

Course Objectives:

- (1) Understand the basic lay-out of an automobile.
- (2) Understand the operation of engine cooling, lubrication, ignition, electrical and air conditioning systems.
- (3) Understand the principles of transmission, suspension, steering and braking systems.
- (4) Understand automotive electronics.
- (5) Study latest developments in automobiles.

UNIT – I:

Introduction: Components of four wheeler automobile – chassis and body – power unit – power transmission – rear wheel drive, front wheel drive, 4 wheel drive – types of automobile engines, engine construction – engine lubrication, splash and pressure lubrication systems, oil filters, oil pumps – crank case ventilation – engine service, reborning, decarburization, Nitriding of crank shaft.

Emission from Automobiles – Pollution standards, National and international – Pollution Control – Techniques – Noise Pollution & control.

UNIT – II:

Fuel System: S.I. Engine: Fuel supply systems, Mechanical and electrical fuel pumps – carburetor – types – air filters – petrol injection.

C.I. Engines: Requirements of diesel injection systems, types of injection systems, fuel pump, nozzle, Alternative fuels for Automobiles-injection, Classification, Properties, Hybrid vehicles injection timing, testing of fuel, pumps.

UNIT – III:

Cooling System: Cooling Requirements, Air Cooling, Liquid Cooling and Forced Circulation System – Radiators – Types – Cooling Fan - water pump, thermostat, evaporating cooling – pressure sealed cooling – antifreeze solutions.

Ignition System: Function of an ignition system, battery ignition system, constructional features of storage battery, auto transformer, contact breaker points, condenser and spark plug – Magneto coil ignition system, electronic ignition system using contact breaker, electronic ignition using contact triggers – spark advance and retard mechanism.

UNIT – IV:

Electrical System: Charging circuit, generator, current – voltage regulator – starting system, bendix drive mechanism solenoid switch, lighting systems, Horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator etc.

Transmission System: Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid fly wheel – Gear boxes, types, sliding mesh, construct mesh, synchro mesh gear boxes, epicyclic gear box, over drive torque converter.

Propeller shaft – Hoatch – Kiss drive, Torque tube drive universal joint, differential rear axles – types – wheels and tyres.

UNIT – V:

Steering System: Steering geometry – camber, castor, king pin rake, combined angle toe in, center point steering. Types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism, steering gears – types, steering linkages.

Suspension System: Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system.



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Braking System: Mechanical brake system, Hydraulic brake system, Master cylinder, wheel cylinder tandem master cylinder Requirement of brake fluid, Pneumatic and vacuum brakes.

TEXT BOOKS:

1. Automobile Engineering by Kripal Singh Vol. 1 & Vol. 2
2. Automobile Engineering by K.M Gupta, Umesh publication, Vol. 1 & Vol. 2,

REFERENCE BOOKS:

1. A System approach to Automotive Technology by Jack Erjavec YesDee publishing pvt Ltd.
2. Automobile Engineering by William Crouse
3. Automotive Mechanics by Heitner
4. Alternative fuels of Automobiles by P.Rami Reddy, Frontline publications

Course Outcomes: At the end of the course, the student will be able to:

- (1) Describe the basic lay-out of an automobile and its components and enlist the emission standards of an automobile.
- (2) Describe different engine cooling, lubrication, ignition, electrical and air conditioning systems and suggest suitable systems for a given application.
- (3) Explain the principles of transmission, suspension, steering and braking systems.
- (4) Describe various fuel supply systems in SI and CI engines



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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - II Semester	L	T	P	C
	3	0	0	3
MECHATRONICS				

Course Objective

The main objective of this course is to introduce the integrative nature of Mechatronics. To describe the different components and devices of mechatronics systems.

UNIT-I

Mechatronics systems – elements & levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

UNIT-II

Hydraulic and pneumatic actuating systems - Fluid systems, Hydraulic systems, and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems. Mechanical actuating systems and electrical actuating systems – basic principles and elements.

UNIT-III

Digital electronics and systems, digital logic control, micro processors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

UNIT-IV

System and interfacing and data acquisition – Data Acquisition Systems, Analog to Digital and Digital to Analog conversions; Digital Signal Processing – data flow in DSPs, block diagrams, typical layouts, Interfacing motor drives.

UNIT-V

Dynamic models and analogies, System response. Process Controllers – Digital Controllers, Programmable Logic Controllers, Design of mechatronics systems & future trends.

Text Books:

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran, GK Vijaya Raghavan & MS Balasundaram/WILEY India Edition

References:

1. Mechatronics /Smaili A, Mrad F/ Oxford Higher Education, Oxford University Press
2. Mechatronics Source Book / Newton C Braga/Thomson Publications, Chennai.
3. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
4. Mechatronics System Design / Devdas shetty/Richard/Thomson.
5. Mechatronics/M.D.Singh/J.G.Joshi/PHI.
6. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition / W. Bolton/ Pearson, 2012
7. Mechatronics – Principles and Application / Godfrey C. Onwubolu/Elsevier, Indian print



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DEPARTMENT OF MECHANICAL ENGINEERING

Course outcomes:

After completion of this course, the student shall be able to use the various mechatronics systems devices and components in the design of electro mechanical systems.

Course Outcomes

CO1. Shall be able to use the various mechatronics systems devices and components in the design of electro mechanical systems.

At the end of the course, the student will be able to

CO1: Explain mechatronics design process and outline appropriate sensors and actuators for engineering applications

CO2: Develop a simulation model for simple physical systems

CO3: Write simple microcontroller programs

CO4: Explain linearization of nonlinear systems and elements of data acquisition

CO5: Explain various applications of design of mechatronic systems



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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - II Semester		L	T	P	C
		0	0	2	1
SIMULATION OF MECHANICAL SYSTEMS LAB					

1. Mass-Spring-Damper with controller
2. Double Mass-Spring- Damper
3. Simple Mechanical System
4. Mechanical System with Translational Friction
5. Mechanical System with Translational Hard stop
6. Mechanical Rotational System with stick-slip motion
7. Linkage Mechanism
8. Steering Mechanism

Softwares Used: MATLAB/SCILAB



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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - II Semester		L	T	P	C
		0	0	3	1.5

HEAT TRANSFER LAB

Objectives:

The laboratory course is aimed to provide the practical exposure to the students with regard to the determination of amount of heat exchange in various modes of heat transfer including condensation & boiling for several geometries.

Note: The students have to perform minimum 12 Experiments.

1. COP of VCR System with Capillary and thermal expansion valve.
2. Determination of overall heat transfer co-efficient of a composite slab
3. Determination of heat transfer rate through a lagged pipe.
4. Determination of heat transfer rate through a concentric sphere
5. Determination of thermal conductivity of a metal rod.
6. Determination of efficiency of a pin-fin
7. Determination of heat transfer coefficient in natural and forced convection
8. Determination of effectiveness of parallel and counter flow heat exchangers.
9. Determination of emissivity of a given surface.
10. Determination of Stefan Boltzman constant.
11. Determination of heat transfer rate in drop and film wise condensation.
12. Determination of critical heat flux.
13. Determination of Thermal conductivity of liquids and gases.
14. Investigation of Lambert's cosine law.

Outcomes:

The student should be able to evaluate the amount of heat exchange for plane, cylindrical & spherical geometries and should be able to compare the performance of extended surfaces and heat exchangers



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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - II Semester		L	T	P	C
		0	0	3	1.5
CAD/CAM LAB					

Course Objectives:

1. To impart the fundamental knowledge on using various analytical tools like ANSYS, FLUENT, etc., for Engineering Simulation
 2. To know various fields of engineering where these tools can be effectively used to improve the output of a product.
 3. To impart knowledge on how these tools are used in Industries by solving some real time problems using these tools..
1. **DRAFTING:** Development of part drawings for various components in the form of orthographic and isometric. representation of dimensioning and tolerances scanning and plotting. study of script, DXE and IGES files.
 2. **PART MODELING:** Generation of various 3D models through protrusion, revolve, shell sweep. creation of various features. study of parent child relation. feature based and boolean based modeling surface and assembly modeling. study of various standard translators. design simple components.
 3. a). Study of various post processors used in NC Machines.
 b). Machining of simple components on NC lathe and Mill by transferring NC Code / from a CAM package. Through RS 232.
 c). Practice on CNC Sinutrain Turning
 d). Practice on CNC Sinutrain Milling
 e). CNC programming for turned components using FANUC Controller
 f). CNC programming for milled components using FANUC Controller
 g). Automated CNC Tool path & G-Code generation using Pro/E/MasterCAM

Packages to be provided to cater to drafting and modeling from the following:

CATIA, Pro-E, I-DEAS, Gibbs CAM, Master CAM etc.

Course outcomes:

Upon successful completion of this course student should be able to:

1. The student will be able to appreciate the utility of the modeling tools in creating 2D and 3D drawings.
2. Use of these tools for any engineering and real time applications
3. Acquire knowledge on utilizing these tools for a better project in their curriculum as well as they will be prepared to handle industry problems with confidence when it matters to use these tools in their Employment