LORDS INSTITUTE OF ENGINEERING AND TECHNOLOGY
(An Autonomous Institution)
DEPARTMENT OF MECHANICAL ENGINEERING
SCHEME OF INSTRUCTIONS & EXAMINATIONS [LR-23]
(w.e.f. Academic Year 2025-26)
B.E. V-Semester

S. No.	Course Code	Category	Course Title	Scheme of Instruction				Scheme of Examination			Credits
				L	T	P/D	Contact Hours/Week	Maximum Marks		Duration in Hours	
								CIE	SEE		
Theory Course											
1	U23ME501	PCC	Mechanics of Fluids and Hydraulic Machinery	3	-	-	3	40	60	3	3
2	U23ME502	PCC	Dynamics of Machines	3	-	-	3	40	60	3	3
3	U23ME503	PCC	Design of Machine Elements	3	-	-	3	40	60	3	3
4	-	PEC	Professional Elective Course-I	3	-	-	3	40	60	3	3
5	-	OEC	Open Elective Course -I	3	-	-	3	40	60	3	3
Practical/ Laboratory Course											
6	U23ME5L1	PCC	Mechanics of Fluids and Hydraulic Machinery Lab	-	-	3	3	25	50	3	1.5
7	U23ME5L2	PCC	Dynamics of Machines Lab	-	-	3	3	25	50	3	1.5
8	U23EN5L1	HSMC	Research Writing	-	-	2	2	50	-	-	1
Internship											
9	U23ME5P1	PROJ	Internship-1 (During Vacations after IV Semester)	-	-	-	-	50	-	-	1
Total				**15**	**-**	**8**	**23**	**350**	**400**	**21**	**20**

L: Lecture (Hrs/Wk/Sem) **T**: Tutorial (Hrs/Wk/Sem) **P**: Practical **D**: Drawing (Hrs/Wk/Sem)

Professional Elective Course-I		
1.	U23ME504	Non-destructive Testing
2.	U23ME505	Composite Materials
3.	U23ME506	Production and Operations Management
4.	U23ME507	Renewable Energy Resources
5.	U23ME508	Mechatronics Systems

CIE: Continuous Internal Evaluation
ESC: Engineering Science Course
OEC: Open Elective Course
ME: Mechanical Engineering
CS: Computer Science
SEE: Semester End Examination
PCC: Professional Core Courses
PEC: Professional Elective Courses
PROJ: Project

Note:
1. Each contact hour is a Clock Hour.
2. The duration of the practical class is three hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

Course Code	Course Title						Core/Elective
U23ME501	**Mechanics of Fluids and Hydraulic Machinery**						**Core**
Pre requisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Mathematics & Engineering Mechanics	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives

The objective of the course is to:

1. Know various fluid properties, concepts and methods of fluid measurement.
2. Understand the basic concepts and principle of fluid flow.
3. Study different equations of fluid motion and fluid dynamics.
4. Analyze different flow characteristics of laminar flows.
5. Understand the working principle of hydraulic turbines and pumps and their performance**.**

Course Outcomes

After completing the course, the student will be able to:

1. Identify the various fluid properties and pressure measurement techniques for determining the behavior of the fluids at static and in motion.
2. Explain the type of fluid flow patterns and describe continuity equation, and apply fundamental laws of fluid mechanics and the Bernoulli's principle for analyzing practical.
3. Apply appropriate equations and principles to analyze problems and losses in pipe flows.
4. Interpret and apply performance laws to turbomachines of different types.
5. Demonstrate the working principles of various hydraulic turbines and estimate their performances.
6. Estimate performance parameters of a given Centrifugal and Reciprocating pump.

UNIT–I

Basic Concepts and Properties of Fluid : Definition, distinction between solid and fluid, , Properties of fluids, density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface tension, units and dimensions. **Fluid statics:** Concept of fluid static pressure, absolute and gauge pressures, pressure measurements by manometers and pressure gauges.

UNIT-II

Fluid Kinematics: Stream line, path line and streak lines and stream tube, classification of flows-steady & unsteady, uniform & non-uniform, laminar & turbulent, rotational &irrotational flows-equation of continuity for one dimensional flow and three-dimensional flows.

Fluid Dynamics: Equations of motion, Euler's equation along a streamline, Bernoulli's equation, applications. Venturi meter, Orifice meter, Pitot tube.

UNIT-III

Flow through pipes: Reynold's experiment- Darcy Weisbach equation- Minor losses in pipes- pipes in series and pipes in parallel- total energy line-hydraulic gradient line.
Basics of turbo machinery: Hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency,flow over radial vanes.

UNIT-IV

Hydraulic Turbines: Definitions and Classification of turbines, Heads and efficiencies, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-workingproportions, work done, efficiencies, hydraulic design –draft tube theory- functions and efficiency.

Performance of hydraulic turbines: Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer.

UNIT-V

Hydraulic Pumps: Definition and classifications, Centrifugal pump: classifications, working principles, velocity triangles, specific speed, efficiency and performance curves.**Reciprocating pump:** classification, working principles, indicator diagram, performance curves, cavitation in pumps.

Suggested Readings:

1. Fluid Mechanics and Hydraulics Machine, Bansal, R.K.,, Laxmi publications(P) Ltd.Delhi (5^{th} edition),1995.
2. Hydraulic and Fluid Mechanics, Modi & Seth –standard book house, 2002.
3. Fluid Mechanics and Fluid Power Engineering, Kumar D.S., S.K. Kataria &Sons.
4. Introduction to fluid mechanics and fluid machines, Som, S.K.,and Biswas,G., Tata Mc Graw-Hill, ^{2nd} edition,2004.
5. Fluid Mechanics, White, F.M., Tata Mc Graw-Hill, 5^{th} Edition, New Delhi, 2003.

Course Code	Course Title						Core / Elective
U23ME502	Dynamics of Machines						Core
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Mechanics of Solids	3	-	-	-	40	60	3

Course Objectives:

The objective of the course is to:

1. Introduce some of the components mainly used in IC Engines and make analysis of various forces involved. Understand the gyroscopic couple and its effect on vehicles in motion.
2. Know the working principles and characteristics of typical governors, as also the function of flywheels.
3. Compute frictional torque in clutches and understand the working of brakes and dynamometers.
4. Know the concept of unbalancing rotating and reciprocating masses in single and multi-cylinder in line and radial engines and understand the phenomena of free vibration, including the effect of damping for single, DOF systems.
5. Determine natural frequencies of undammed, damped and forced vibrating systems of one, two and freedom systems.

Course Outcomes:

After completing the course, the student will be able to:

1. Analyse static and dynamic forces in slider crank and other mechanisms; determine the magnitude of gyroscopic couple and its effect on vehicles in motion
2. Evaluate the performance of various types of governors and design flywheels considering speed and energy fluctuation.
3. Determine frictional torque in clutches and understand the working of brakes and dynamometers.
4. Analyse problems of balancing in rotating and reciprocating machinery.
5. Evaluate the natural frequencies of single and two degree of freedom systems in free and forced vibration mode, also considering the effect of damping

Unit-I

Static and Dynamic Force Analysis: Static force analysis of planar mechanisms – Analytical Method Dynamic Force Analysis – D'Alembert's principle, Dynamic Analysis of 4-link mechanism, Slider Crank Mechanism.

Precession: Gyroscopes, effect of precession, motion on the stability of moving vehicles such as motor car, motor cycle, aeroplanes and ships.

Unit-II

Governors: Working principle of governor, Classification & types of governors, analysis of Watt, Porter, Proell and Hartnell governors. Characteristics of governors: Controlling Force, Stability, Isochronism, Sensitivity, Power and Effort of governors.

Turning Moment Diagram and Flywheels: Engine Force Analysis – Piston Effort, Crank Effort, etc, Turning moment diagram –fluctuation of energy – flywheels and their design – crank effort and torque diagrams.

Unit-III

Friction: pivots and collars – uniform pressure, uniform wear – friction circle and friction axis: lubricated surfaces – boundary friction – film lubrication. Clutches – Types – Single plate, multi-plate and cone clutches

Brakes and Dynamometers: Simple block brakes, internal expanding brake, band brake of vehicle, Dynamometers – absorption and transmission types.

Unit-IV

Balancing Rotating Masses: Static balancing, dynamic balancing, balancing of several masses rotating in several planes,

Balancing of Reciprocating Masses: primary balancing shaking forces in single cylinder engine, partial balancing and its effects, secondary balancing, Balancing of locomotives, hammer blow, variation of traction effort and swaying couple

Unit-V

Vibrations: Vibrations of Single degree freedom system (axial, transverse and torsional), Whirling speed of shafts.

Damped Vibrations: Types of damping, Vibrations with viscous damping, damping factor and logarithmic decrement.

Torsional Vibrations: Two rotor, three rotor system, Natural frequencies of two degree freedomsystems, Modes of vibration approximate methods for determining natural frequencies: Dunkerley's method, Rayleigh's method.

Suggested Readings:

1. Theory of Machines, S.S. Rattan, Tata McGraw-Hill, 3rdEdition, 2009.
2. Theory of machines and Mechanisms, J. E. Shigley, McGraw Hill Publications, 2005.
3. Theory of Machines and Mechanisms- Rao & Dukkipati (Wiley)
4. The Theory of Machines, Thomas Bevan, CBS Publishers & Distributors, 2004.
5. heory and Practice of Mechanical Vibrations, J.S. Rao and Gupta, Prentice Hall, 1984

Course Code	Course Title						Core / Elective
U23ME503	Design of Machine Elements						Core
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Mechanics of Solids	3	-	-	-	40	60	3

Course Objectives:

The objective of the course is to:

1. Understand the various steps involved in the Design Process.
2. Explain the principles involved in design of machine elements, subjected to different kinds of forces, from the considerations of strength, rigidity, functional and manufacturing requirements.
3. Understand and interpret different failure modes and application of appropriate criteria for design of machine elements.
4. Learn to use national and international standards, standard practices, standard data, catalogs, and standard components used in design of machine elements.
5. Develop the capability to design elements like shafts, couplings, welded joints, screwed joints, and power screws.

Course Outcomes:

After completing the course, the student will be able to:

1. Apply the fundamentals of design of machine elements, and behavior of members subjected to various types of complex loads, and criteria of failure to satisfy the applications.
2. Identify the principles involved in evaluating the shape and dimensions of a component, when subjected to various types of fatigue loading, and methods to reduce the stress concentration.
3. Design the shafts used in various industrial applications.
4. Map out and design the different Couplings used in different industrial applications.
5. Design the machine components joined by Riveted, Welded and bolted joints, and to analyze the different ways in which riveted and welded joints can fail.

UNIT-I

Introduction: Design Process, definition of design, phases of design, and review of engineering materials and their properties and manufacturing processes; use of codes and standards, selection of preferred sizes. Review of axial, bending, shear and torsion loading on machine components, combined loading, two- and three dimensional stresses, principal stresses, stress tensors.

Design for static strength: Factor of safety and service factor. Failure mode: definition and types. , Failure of brittle and ductile materials; even and uneven materials; Theories of failure- maximum normal stress theory, maximum shear stress theory, distortion energy theory, strain energy theory

UNIT-II

Fatigue loading: Introduction to fatigue failure, Mechanism of fatigue failure, types of fatigue loading,S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit. Modifying factors: size effect, surface effect,

Stress concentration effects, Notch sensitivity, Soderberg and Goodman relationships, stresses due to combined loading, cumulative fatigue damage, and Miner's equation.

UNIT-III

Design of shafts: Torsion of shafts, solid and hollow shaft design with steady loading based on strength and rigidity, ASME and BIS codes for power transmission shafting, design of shafts subjected to combined bending, torsion and axial loading. Design of shafts subjected to fluctuating loads

Design of keys and couplings :Keys: Types of keys and their applications, design considerations in parallel and tapered sunk keys, Design of square and rectangular sunk keys. Couplings: Rigid and flexible coupling-types and applications, design of Flange coupling, and Bush and Pin type coupling.

UNIT-IV

Design of Permanent Joints: Types of permanent joints-Riveted and Welded Joints.

Riveted joints: Types of rivets, rivet materials, Caulking and fullering, analysis of riveted joints, joint efficiency, failures of riveted joints, boiler joints, riveted brackets.

Welded joints: Types, strength of butt and fillet welds, eccentrically loaded welded joints

UNIT-V

Design of Temporary Joints: Types of temporary joints- cotter joints, knuckle joint and fasteners. Design of Cotter and Knuckle Joint.

Threaded Fasteners: Stresses in threaded fasteners, effect of initial tension, design of threaded fasteners under static, dynamic and impact loads, design of eccentrically loaded bolted joints

Suggested Readings :

1. Design of Machine Elements, V. B. Bhandari, Tata McGraw-Hill Publ, 3rd Edn. 2010.
2. Mechanical Engineering Design, J.E. Shigley & Charles R. Mischke Tata McGraw-Hill.,6th ed.2010.
3. Machine Design, P. Kannaiah, Sci-Tech Publ., 2009.
4. Machine Design, P.C. Sharma & D.K. Aggarwal, S.K. Kataria & Sons, 10th edn, 2003
5. Design Data Book, 2nd edition", V. B. Bhandari, Tata McGraw-Hill Publ, 2019

Course Code	Course Title						Core / Elective
U23ME504	Non-Destructive Testing						Elective
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

The objective of the course is to:

1. Need, basic concepts and technologies of Non-Destructive Testing (NDT).
2. Security precautions from Radiography, protection from radiation and measurement of radiation received by personnel.
3. Technology of acoustic emission (AE), the associated instrumentation and applications.
4. Technologies like neutron radiography; laser induced ultrasonics, surface analysis and Thermography.
5. Merits and demerits of the different NDT Technologies.
6. Latest research and developments in NDT.

Course Outcomes:

After completing the course, the student will be able to:

1. Apply knowledge of different NDT techniques.
2. Analyse liquid penetrates inspection and magnetic particle inspection.
3. Interpret radiographs, utilize the various principles of radiography for different components of different shapes
4. Elaborate the knowledge of acoustic emission for NDT and the instrumentation used for NDT
5. Summarize knowledge of latest research, developments and trends in NDT

Unit-I

Liquid Penetrate inspection: Principle of penetrate inspection, characteristics of a penetrate, water washable system, post emulsification system, solvent removable system, surface preparation and cleaning, penetrate application, development, advantages, limitations, and applications.

Magnetic Particle Inspection: Principle, magnetization methods, continuous and residual methods, sensitivities, demagnetization, Advantages, Limitations, and Applications.

Unit-II

Eddy Current Testing: Principle, lift-off factor, and edge effect, skin effect, inspection frequency, coil arrangements, inspection probes, types of circuits, reference pieces, phase analysis, display methods and applications

Unit-III

Ultrasonic Testing: Generation of ultra sound, Characteristics of an ultrasonic beam, sound Waves at interfaces, sound attenuation, display systems, probe construction, type of display, inspection techniques, identification of defects, immersion testing, sensitivity and calibration. Reference standards, surface conditions, applications

UNIT-IV

Radiography: Principle and uses of radiography, limitation principle, radiation sources, production of X-rays, X-ray spectra, attenuation of radiation, shadow formation enlargement and distortion, radiographic film and paper, inspection of simple and complex shapes, radiation hazard, protection against radiation.

Unit-V

Acoustic Emission: physical principles, sources of emission, instrumentation and applications.

Other NDT Techniques: Neuron radiography, laser induced ultrasonics, surface analysis, and thermography.

Suggested Reading:

1. Barry Hull & Vernon John, *Non-Destructive Testing* , 1988.
2. Non-Destructive examination and quality control, ASM International, Vol.17, 9th edition 1989
3. J. Prasad and C.G.K. Nair, Non-Destructive Test and evaluation of materials, Tata McGraw-Hill Education, 2nd edition 2011
4. B. Raj, T. Jayakumar and M. Thavasimuth, Practical Non-Destructive Testing, Alpha Science International Limited, 3rd edition 2002
5. T. Rangachari, J. Prasad and B.N.S. Murthy, Treatise on Non-Destructive Testing and Evaluation, Navbharath enterprises, Vol.3, 1983.

Course Code	Course Title						Core / Elective
U23ME505	Composite Materials						Elective
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Metallurgy and Material Science	3	-	-	-	40	60	3

Course Objectives:

The objective of the course is to:

1. Discuss the basic structure of composites
2. Define Elastic constants and Hygro-thermal stresses
3. Identify stress-strain relations in composites
4. Describe the behavior and Design with composites
5. Demonstrate the basic equations of plate bending

Course Outcomes:

After completing the course, the student will be able to:

1. Demonstrate knowledge of composites and their structure
2. Predict the Elastic constants and Hygrothermal stresses
3. Analyse the stress - strain relationship in composites
4. Summarise and apply the Design procedure and the failure criteria.
5. Formulate Plate bending equations for various Boundary conditions of composite plates.

Unit-I

Introduction: Fibres, Matrix materials, interfaces, polymer matrix composites, metal matrixcomposites, 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

Macromechanics 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 laminate 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 shell: 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.

Suggested Readings :

1. Mechanics of Composite Materials, Jones, R.M., Mc-Graw Hill Co., 1967.
2. The Analysis of Laminated Composite Structures, Calcote, L.R., Van Nostrand, 1969.
3. Experimental Mechanics of Fibre Reinforced Composite Materials‘,Whitney. I.M., Daniel, R.B. Pipes, Prentice Hall, 1984.
4. Stress Analysis of Fibre-Reinforced Composite Materials‘,Hyer. M.W., McGraw Hill Co., 1998.
5. Principles of Composite Material Mechanics, Ronald Gibson, TMH, 1994.

Course Code	Course Title						Core / Elective
U21ME506	Production and Operation Management						Elective
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

The objective of the course is to:

1. To understand the concept of Production & Operations Management.
2. To understand role of work study and work measurement in Industry.
3. To learn use of fore casting and various methods of it.
4. To understand importance Aggregate planning, Materials Requirement Planning for Industry.
5. To understand Project Management approaches in completion of Project.

Course Outcomes:

After completing the course, the student will be able to:

1. Analyse various types of Production Systems, develop suitable layout for a given plant.
2. Develop various methods for work study and apply suitable Recording techniques. Develop standard procedures and time for the operations.
3. Explain necessity of Forecasting and various methods of it. Develop suitable quantitative forecasting technique for the given past data. Compare accuracy of models in connection with forecast errors.
4. Interpret Aggregate planning & Mater scheduling, Materials Requirement Planning Processes and develop quantitative models for Material requirement and resources based on time span.
5. Elaborate the usages of PERT/CPM techniques for a given project and develop suitable quantitative model for the project in successful competition by identifying the time constraints for start and end of process activities.

Unit-I

Production & Operations Management: Introduction, Types of production Systems. Job shop, Batch, Flow shop. Plant location and layout: Factors affecting plant location, Break even analysis, plant layout objectives, Types of layouts, merits and demerits.

Unit-II:

Work Study: Introduction to method study, Steps in method study, Recording techniques- Flow process chart, String diagram, Therbligs, Principles of motion economy. Work measurement: Stop watch time study, Standard time calculation. Work sampling- procedure, applications, advantages and disadvantages, Wages and incentives, types of incentive plans.

Unit-III

Forecasting: Introduction, Forecasting objectives and uses, demand patterns, Qualitative models Market survey, Delphi Tech, Quantitative models, Moving average, Weighted moving average, Simple exponential smoothing, trend adjusted exponential smoothing, Least square method, Simple regression, multiple regression. Forecast errors: Mean absolute Deviation (MAD), Mean Square Error (MSE), Mean

Forecast Error (MFE), Mean absolute percentage error(MAPE).

Unit-IV

Aggregate Planning and Master Scheduling: Introduction, objectives of aggregate planning, Cost in aggregate planning, Strategies in aggregate planning, Master production scheduling. Materials Requirement Planning MRP 1: Importance of MRP, MRP system inputs and outputs, MRP calculations Manufacturing Resource Planning MRP2 & Enterprise Resource Planning(ERP): Features of ERP packages like SAP, People soft etc.,

Unit-V

Project Management: Project management: Network fundamentals. Fulkerson‘s rule. Earliest and latest times. Determination of ES and EF in the forward path. LS and LF in backward path. Determination of critical path. Free float, independent float, Total float, Program evaluation and review technique, crashing of network.

Suggested Reading:

1. Joseph Monk, Operations Management, TMH Publishers, New Delhi,2004.
2. Buffa Elwood S, Modern Production/Operations Management, John Wiley Publishers, Singapore, 2002.
3. Everett E Adam, Jrand Ronald J. Ebert, Production and Operations Management Concepts, Models and Behaviour,5thEd.1998, (EEE), Prentice Hall of India (P) Ltd., New Delhi.
4. PanneerSelvamR,— Operations Research‖, Second Edition, PHI Learning Pvt. Ltd. New Delhi, 2006.
5. S.D.Sharma,—Operations Research‖, Kedarnnath, Ramnath

Course Code	Course Title						Core / Elective
U23ME507	Renewable Energy Resources						Elective
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Basic Electrical Engineering	3	-	-	-	40	60	3

Course Objectives:

The objective of the course is to:

1. Understand the concept of various forms of Renewable energy resources and Non-Renewable energy resources.
2. Outline division aspects and utilization of renewable energy sources for both domestics and industrial applications.
3. Identify Wind energy as alternate form of energy and to know how it can be tapped
4. Make the students understand the advantages and disadvantages of different renewable energy resources
5. Know the concepts of thermo and bio-chemical process along with novel technologies to conversion of biomass to Bio fuel.

Course Outcomes:

After completing the course, the student will be able to:

1. Summarize the renewable and non-renewable sources of energy
2. Acquire the knowledge of various components, principle of operation and present scenario of different conventional and non-conventional sources.
3. Explain the use of solar energy and the various components used in the energy production with respect to applications
4. Design wind turbine blades and know about applications of wind energy for water pumping and electricity generation
5. Relate the concept of Biomass energy resources and their classification, types of biogas Plants-applications and summarize the knowledge of Ocean energy, tidal energy, and geothermal energy.

Unit-I

Introduction: Classification of Energy Resources, Conventional Energy Resources, Non-Conventional Energy Resources, Alternative Energy Resources, World energy status, Current energy scenario in India, Environmental aspects of energy utilization, Energy and sustainable development. Energy policies in India

Unit-II

Solar energy: solar energy basic concepts, Solar cells, Solar collectors, Solar Thermal Applications-Heating, Cooling, Distillation, Desalination, Drying, Cooking, Solar pumping, Solar photo voltaic systems. Solar PV Applications, Government schemes and policies.

Unit-III

Wind energy: Principles of wind energy conversion systems - Nature of wind - Power in the Wind-Basic components of WECS -Classification of WECS -Site selection considerations - Advantages and disadvantages of WECS -Wind energy collectors -Wind electric generating and control systems - Applications of Wind energy -Environmental aspects.

UNIT-IV

Energy from the Oceans: Ocean Thermal Electric Conversion (OTEC) methods - Principles of tidal power generation -Advantages and limitations of tidal power generation -Ocean waves - Wave energy conversion devices -Advantages and disadvantages of wave energy - Geo-thermal Energy - Types of Geo-thermal Energy Systems - Applications of Geo-thermal Energy.

Unit-V

Energy from Biomass: Biomass conversion technologies / processes - Photosynthesis - Photosynthetic efficiency - Biogas generation - Selection of site for Biogas plant - Classification of Biogas plants - Details of commonly used Biogas plants in India - Advantages and disadvantages of Biogas generation - Thermal gasification of biomass -Biomass gasifiers. Bio fuels- Bioethanol, Biobutanol, Biodiesel production

Suggested Readings:

1. Non-Conventional Sources of Energy, Rai G.D, Khandala Publishers, New Delhi, 1999.
2. Power Plant Technology, M.M.El-Wakil, McGraw Hill, 1984.
3. Solar Energy, Sukhatme S.P., Tata McGraw Hill, 1984
4. Renewable Energy Engineering and Technology, Kishore V V N, Teri Press, New Delhi,2012.
5. Wind Energy Conversion Systems, Freris. L.L., Prentice Hall, UK, 1990.

Course Code	Course Title						Core / Elective
U23ME508	Mechatronics Systems						Elective
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
-	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives:

The objective of the course is to:

1. Learn the architecture of mechatronic systems
2. Introduce concept of sensors & actuators to measure & control various physical quantities like volume, pressure, temperature
3. Learn to design simple control systems
4. Learn PLC programming to build simple control systems

Course Outcomes:

After completing the course, the student will be able to:

1. Illustrate the architecture of mechatronic systems.
2. Design some simple measurement systems using different sensors.
3. Demonstrated ability to design basic control systems using different actuators.
4. Execute PLC programs for industrial Applications.
5. Demonstrate an understanding of analogue and digital interfacing.

Unit 1:

Introduction: Definition of Mechatronics, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach.

Unit II:

Review of fundamentals of electronics. Data conversion devices, sensors, microsensors, transducers, signal processing devices, relays, contactors and timers. Microprocessors controllers and PLCs.

Unit III:

Drives: stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer systems.

Unit IV:

Hydraulic systems: flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps. Design of hydraulic circuits. Pneumatics: production, distribution and conditioning of compressed air, system components and graphic representations, design of systems.

Unit V:

Description of PID controllers. CNC machines and part programming. Industrial Robotics.

Suggested Readings:

1. G.W. Kurtz, J.K. Schueller, P.W. Claar . II, Machine design for mobile and industrial applications, SAE,1994.
2. T.O. Boucher, Computer Automation in Manufacturing - an Introduction, Chappman and Hall, 1996.
3. Devdas Shetty, Richard Klok “Mechatronic system design”, 2nd edition, Cengage Learning,
4. Boltan, W., “Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering”, Longman, Singapore, 1999

Course Code	Course Title						Core/Elective
U23ME5L1	**Mechanics of Fluids and Hydraulic Machinery Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Material Testing Lab	-	-	-	3	25	50	1.5

Course Objectives

The objective of the course is to:

1. Understand the working of pumps of different kinds and their behaviour.
2. Understand the concept of different kinds of turbines and their behaviour.
3. Gain theory knowledge of working of various flow measuring devices and their utility in industry.

Course Outcomes

After completing this course, the student will be able to:

1. Apply the principles of different flow measuring instruments and their adoptability to the industry.
2. Calibrate flow measuring devices such as venturimeter and orifice meter.
3. Determine and analyse the friction factor for a given pipe line.
4. Determine and compare the coefficient of impact of jet on vanes at different flow rates.
5. Investigate through experimentation different types of pump models and estimate their performance under different working conditions.
6. Estimate the performance of hydraulic turbines at constant speed and constant head.

List of Experiments:

1. Verification of Bernoulli's Theorems.
2. To determine coefficient of discharge of venturi meter
3. To determine coefficient of discharge of orifice meter
4. Determination of friction factor for a given pipe line.
5. Impact of Jets on Vanes
6. Performance and characteristic curves of Reciprocating pump
7. Performance and characteristic curves of Single Stage Centrifugal Pump.
8. Performance Test on Multi Stage Centrifugal Pump.
9. Performance and characteristic curves of Pelton Wheel
10. Performance and characteristic curves of Francis Turbine
11. Performance and characteristic curves of Kaplan Turbine

Note: At least 10 experiments must be conducted in the semester.

Course Code	Course Title						Core / Elective
U23ME5L2	Dynamics of Machines Lab						Core
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Material Testing	-	-	-	3	25	50	1.5

Course Objectives:

The objective of the course is to:

1. Understand the effects and importance of kinematic and dynamic analysis of mechanisms.
2. Study the gyroscope, governors and cams.
3. Understand static and dynamic balance.
4. Understand effects and analysis of Single degree freedom vibration systems.

Course Outcomes:

After completing the course, the student will be able to:

1. Estimate the Gyroscopic couple and its effect on a Precessing rotating member.
2. Evaluate performance characteristics of centrifugal governors.
3. Determine the magnitude, location and orientation of a balancing mass required to balance the unbalance rotating system and verify the static and dynamic balancing.
4. Analyze the cam profile for motion characteristics.
5. Determine the time period and natural frequencies of simple and compound pendulum.

List of Experiments:

1. To determine time period and natural frequency of a simple pendulum.
2. To determine time period and natural frequency of a compound pendulum.
3. Undamped torsional vibrations of single and double rotor system.
4. Free vibration of simply supported / cantilever beam.
5. Damped and undamped torsional vibrations of single rotor system.
6. Find the motion of the follower for the given profile of the cam.
7. To Study the gyroscopic effects and estimation of gyroscopic couple on a rotating disc.
8. To Study the controlling force curves on Watt governor.
9. To determine the effect of varying mass on the centre of sleeve in porter governor.

10. To determine time period, amplitude and frequency of undamped free longitudinal vibration of single degree spring mass systems.
11. The balance masses statically and dynamically for single rotating mass systems.
12. To determine the critical speed of a given shaft for different n-conditions.
13. Dunkerley Method to Find Fundamental Frequencies.

Note: At least 10 experiments must be conducted in the semester.

Course Code	Course Title						Core/Elective
U23EN5L2	**Research Writing**						**-**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
English for Technical Communication	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

The objective of the course is to:

1. Improve students' writing skills and level of readability
2. Understand the nuances of a research paper.
3. Develop the content and format of a research paper.
4. Produce original research papers without plagiarism

Course Outcomes

After completion of this course, the student will be able to:

1. Demonstrate the ethics and nuances of plagiarism.
2. Construct the topic of research and formulate hypothesis.
3. Analyze the research process elaborately.
4. Organize and rephrase the data in a sequential order as per format.
5. Interpret the data by the use of methodology and discussion

ACTIVITY - I

Introduction to Research: What is research, Purpose of research, Types of research, Ethics and Plagiarism, Format of a research paper

ACTIVITY - II

Research Process-I: Selection of topic, Formulation of Hypothesis

ACTIVITY - III

Research Process-II: Collection of data, Analysis of Data, Interpretation of Data, Presentation of Data

ACTIVITY - IV

Structure of a Research Paper-I: Title, Abstract, Introduction, Literature Review

ACTIVITY - V

Structure of a Research Paper II: Methodology, Discussion, Finding/Results, Conclusion, Documenting Sources (IEEE style)

Suggested Readings:

1. Research Methodology Methods and Techniques, C. R Kothari, Gaurav, Garg,4/e, New AgeInternational Publishers.
2. How to Write and Publish a Scientific Paper**",** Day R, Cambridge University Press, 2006
3. Quick Guide to Writing Great Research Papers, Lauri Rozakis, Schaum's, Tata McGraw Hills Pvt. Ltd, New Delhi.
4. Cite Right: A quick guide to citation styles; MLA, APA, Chicago, the sciences, professions, and more, Lipson, Charles (2011), (2^{nd} ed.) Chicago [u.a]: University of Chicago Press.

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Course Code	Course Title						Core / Elective
U23ME5P1	**Internship-1**						**Core**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	-	50	-	1

Course Objectives:

The objective of the course is to:

1. Produce an accurate record of work performed during the Internship/Co-op
2. Apply engineering knowledge to a problem in industry
3. Produce a technical report
4. Discuss work in a team environment, if relevant to the project
5. Conduct herself/himself responsibly, safely, and ethically in a professional environment

Course Outcomes:

After completing the course, the student will be able to:

1. Design/develop a small and simple product in hardware or software.
2. Complete the task or realize a pre specified target, with limited scope, rather than taking up a complex task and leave it.
3. Learn to find alternate viable solutions for a given problem.
4. Evaluate these alternatives with reference to pre specified criteria.
5. Implement the selected solution and document the same.

Internship is introduced as part of the curricula of encouraging students to work on problems of interest to industries. A batch upto five students will be attached to a person from the Government or Private Organizations/Computer Industry/Software Companies/R&D Organization for a period of 4 weeks. This will be during the summer vacation following the completion of the II-year Course. One faculty coordinator will also be attached to the group of 3 students to monitor the progress and to interact with the industry co- ordinate (person from industry). The course schedule will depend on the specific internship/training experience. The typical time per topic will vary depending on the internship

1. Overview of company/project, its vision and missions.
2. Safety training and disaster management.
3. Discussions with project teams
4. Background research, review of documents, scientific papers and its implementation.
5. Planning, designing, and reviewing the planned work

6. Executing the plans
7. Documenting progress, experiments, and other technical documentation
8. Further team discussions to discuss results
9. Final report writing and presentation

After the completion of the project, each student will be required to:

1. Submit a brief technical report on the project executed and
2. Present the work through a seminar talk (to be organized by the Department)

Note: Students have to undergo summer internship of 4 weeks at the end of semester IV and credits will be awarded after evaluation in V semester.

LORDS INSTITUTE OF ENGINEERING AND TECHNOLOGY
(An Autonomous Institution)
DEPARTMENT OF MECHANICAL ENGINEERING
SCHEME OF INSTRUCTIONS & EXAMINATIONS [LR-23]
(w.e.f. Academic Year 2025-26)
B.E. VI-Semester

S. No.	Course Code	Category	Course Title	Scheme of Instruction				Scheme of Examination			Credits
				L	T	P/D	Contact Hours/Wee	Maximum Marks CIE	Maximum Marks SEE	Duration in Hours	
Theory Course											
1	U23ME601	PCC	Metal Cutting and Machine Tools	3	-	-	3	40	60	3	3
2	U23ME602	PCC	Machine Design	3	-	-	3	40	60	3	3
3	U23ME603	PCC	Heat Transfer	3	-	-	3	40	60	3	3
4	U23ME604	PCC	CAD/ CAM	3	-	-	3	40	60	3	3
5	-	PEC	Professional Elective Course- II	3	-	-	3	40	60	3	3
6	-	OEC	Open Elective Course-II	3	-	-	3	40	60	3	3
Practical/ Laboratory Course											
6	U23ME6L1	PCC	Metal Cutting and Machine Tools Lab	-	-	3	3	25	50	3	1.5
7	U23ME6L2	PCC	Heat Transfer Lab	-	-	3	3	25	50	3	1.5
Project											
8	U23ME6P1	PROJ	Mini Project	-	-	4	4	50	50	-	2
Total				**18**	**-**	**10**	**28**	**340**	**510**	**24**	**23**

L: Lecture (Hrs/Wk/Sem) **T**: Tutorial (Hrs/Wk/Sem) **P**: Practical **D**: Drawing (Hrs/Wk/Sem)

Professional Elective Course-II		
1.	U23ME605	Automobile Engineering
2.	U23ME606	Quality and Reliability Engineering
3.	U23ME607	Flexible Manufacturing System
4.	U23ME608	Robotics
5.	U23ME609	Industry 4.0 and IIoT

CIE: Continuous Internal Evaluation **SEE**: Semester End Examination
PCC: Professional Core Courses **OEC**: Open Elective Courses
EN: English **ME**: Mechanical Engineering
HSMC: Humanities & Social Sciences Including Management Courses
PROJ: Project

Note:
1. Each contact hour is a Clock Hour.
2. The duration of the practical class is three hours, however it can be extended wherever necessary, to enable the student to complete the experiment.
3. At the end of VI semester students should undergo summer Industrial Internship of four-week

Course Code	Course Title						Core / Elective
U23ME601	Metal Cutting and Machine Tools						Core
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Metallurgy and Material Science	2	-	-	-	40	60	2

Course Objectives:

The objective of the course is to:

1. Learn the geometry and mechanics of metal cutting for turning, drilling milling and tool materials.
2. Understand the heat distribution, tool wear and tool life.
3. Know the various machining processes such as lathe, drilling, milling, boring, broaching, grinding etc.
4. Know various types of work and tool holding devices for conventional machining.
5. Understand the basics of Unconventional Machining processes.

Course Outcomes:

After completing the course, the student will be able to:

1. Develop the relations for shear angle, shear strain, forces and temperatures associated with orthogonal cutting.
2. Select the cutting fluids, tool materials and coatings to control the tool wear and temperature.
3. Evaluate the tool life and economics of machining for maximum production and minimum cost.
4. Select the appropriate machine tool and tool & work holding devices for machining of components.
5. Illustrate the various finishing techniques and unconventional machining processes.

Unit-I

Basic chip formation process. Tool geometry: Nomenclature of single point cutting tool by ASA,ORS and NRS. Geometry of drills, Milling cutters and broaches. Recommended Tool angles. Chip formation: Types of chips, BUE, Chip breakers. Machining: Orthogonal and oblique cutting, Mechanics of Orthogonal Cutting: Merchant‟s analysis, Friction. Shear angle: Shear angle Solutions of Merchant and Lee & Shafer. Cutting tool materials: High carbon steel, HSS, Carbides, Ceramics, Coated carbides, Cermets, HPC, cBN & Diamond.

Unit-II

Measurement of Cutting Forces: Lathe tool dynamometers, Drilling, Milling and Grinding Dynamometers. Thermal aspects of metal cutting: Sources of heat and heat distribution, various methods of measurement of temperature, Cutting fluids and applications. Tool wear, Tool life & Machinability : Types of wear, mechanism of tool wear, Tool life & Machinability . Effects of process parameters on Tool life, Taylor's tool life equation. Economics of machining: Tool life for maximum production, minimum cost.

Unit-III

Constructional features and specifications of machine tools: Various operations on Lathe, Types of

Lathes and special attachments on a Centre Lathe. Drilling, Milling operations. Indexing methods.Shaper, planer and slotter and their differences. Quick return mechanisms, Automatic feed devices. Jig Boring machines- Differences between horizontal and vertical jig boring machines. Principles of Broaching.

UNIT-IV

Abrasive Processes: Grinding machines. Types of grinding, Abrasives and bonds used for grinding wheels. Specification and selection of wheels. Lapping, Honing, Polishing, Buffing, Super finishing and burnishing. Screws and gear manufacturing: Screw making by tapping, Chasers, Thread rolling, Thread milling, Thread grinding. Gear shaping, Gear hobbing, Gear shaving and grinding.

Unit-V

Jigs and Fixtures: Design principles for location and clamping. Tool holding and work holding devices. Quick clamping devices. Types of Jigs and fixtures. Unconventional machining: Principles of working and applications of USM, AJM, WJM, EDM, ECM,LBM , EBM and PAM.

Suggested Readings:

1. Metal Cutting Theory and Practice, A. Bhattacharyya, New Central Book Agency (P) Ltd., 2006.
2. Fundamentals of Metal Machining and Machine Tools / Geoffrey Boothroyd / McGraw Hill.
3. Manufacturing Technology – Metal Culling & Machine Tools", P.N. Rao,Vol. 2, Tata McGraw Hill Education Pvt. Ltd, 2010.
4. Machine Tool Practices/ Kibbe, Johne. Neely, T. White, Rolando O. Meyer/ Pearson
5. Manufacturing Science, Amitabha Ghosh and Ashok Kumar Mallik, Affiliated East-West Press Pvt. Ltd., 2nd Edition, 2010.

Course Code	Course Title						Core / Elective
U23ME602	Machine Design						Core
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Design of Machine Elements-I	3	-	-	-	40	60	3

Course Objectives:

The objective of the course is to:

1. Understand various elements involved in a mechanical system.
2. Analyze various forces acting on the elements of a mechanical system and design them using appropriate techniques, codes, and standards
3. Select transmission elements like gears, belts, pulleys, bearings from the manufacturers' catalogue
4. Design a mechanical system integrating machine elements
5. Produce assembly and working drawings of various mechanical systems involving machine elements like belts, pulleys, gears, springs, bearings

Course Outcomes:

After completing the course, the student will be able to:

1. Demonstrate the design, development and use of Different types of Springs and apply design principles for the design of mechanical systems involving belts, pulleys, and wire rope.
2. Apply design concepts of hydrodynamic bearings for different applications and select anti friction bearings for different applications using the manufacturers, catalogue
3. Apply the knowledge of design, selection of material, shape and standard parameters of fins for piston, to withstand the buckling, tension and compressive loads for piston and connecting rod.
4. Analyze and differentiate the of curved beams and straight beams in terms of load distribution across the section of different shaped elements
5. Demonstrate the basic knowledge in the designing, choosing the best materials for Spur gear, helical gear, worm gears for different operating temperature, speed and number of operating hours.

UNIT-I

Springs: Types of springs, spring materials, stresses in helical coil springs of circular and non- circular cross sections. Tension and compression springs, concentric springs; springs under fluctuating loads.
Leaf Springs: Stresses in leaf springs, equalized stresses, and nipping of leaf springs. Introduction to torsion and Belleville springs.

UNIT-II

Belts: Materials of construction of flat and V belts, power rating of belts, concept of slip and creep, initial tension, effect of centrifugal tension, maximum power condition. Selection of flat and V belts-

length & cross section from manufacturers' catalogues. Construction and application of timing belts.
Wire ropes: Construction of wire ropes, stresses in wire ropes, and selection of wire ropes.

UNIT-III

Bearings: Classification of Bearings. Viscosity of Lubricants Theory of Hydrostatic and Hydrodynamic lubrication
Sliding contact bearings: Types of Journal bearings – Lubrication – Bearing Modulus – Full and partial bearings – Clearance ratio – Heat dissipation of bearings, bearing materials – journal bearing design.
Rolling contact bearings: Ball and roller bearings – Static load – dynamic load – equivalent radial load – design and selection of ball & roller bearings

UNIT-IV

Engine Parts: Connecting Rod: Thrust in connecting rod – stress due to whipping action onconnecting rod ends –Pistons, Forces acting on piston – Construction, Design and proportions of piston.

UNIT-V

Gear drives: Classification of gears, materials for gears, standard systems of gear tooth, lubrication of gears, and gear tooth failure modes.
Spur Gears: Definitions, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear.
Helical Gears: Definitions, transverse and normal module, formative number of teeth, design based on strength, dynamic load and wear
Bevel Gears: Definitions, formative number of teeth, design based on strength, dynamic load and wear

Suggested Readings :

1. Design of Machine Elements, V. B. Bhandari, Tata McGraw-Hill Publ, 3rd Edn. 2010.
2. Mechanical Engineering Design, J.E. Shigley & Charles R. Mischke, Tata McGraw-Hill.,6th ed.2010.
3. Machine Design, P. Kannaiah, Sci-Tech Publ., 2009.
4. Machine Design, P.C. Sharma & D.K. Aggarwal, S.K. Kataria & Sons, 10th edn, 2003
5. Design Data Book, V. B. Bhandari, 2nd edition, ", Tata McGraw-Hill Publ, 2019

Course-Code	Course Title						Core/ Elective
U23ME603	**Heat Transfer**						Core
Prerequisites	Contact Hour per Week				CIE	SEE	Credit
	L	T	D	P			
Thermodynamics	3	-	-	-	40	60	3

Course Objectives :

The objective of the course is to:

1. Develop the fundamental principles and laws of heat transfer and to explore the implications of these principles for system behavior.
2. Formulate the models necessary to study, analyse and design heat transfer systems through the application of these principles.
3. Develop the problem-solving skills essential to good engineering practice of heat transfer in real-world applications.

Course Outcomes :

After completing the course, the student will be able to:

1. Illustrate the basic modes of heat transfer with its associated laws in simple geometries.
2. Solve the problems of steady state and transient heat conduction with simple and multi-layer geometries. Analyze heat transfer coefficients for free and forced convection, considering boundary layers.
3. Develop relationships for radiation exchange between (Opaque, Diffuse, Gray) Surfaces in an enclosure.
4. Familiarize with time dependent heat transfer and compute convective heat transfer coefficients in forced, natural convection.
5. Analyse heat exchanger performance by using the methods of Log Mean Temperature Difference (LMTD).

UNIT-I

Heat transfer fundamentals; Basic heat transfer mechanisms (conduction, convection and radiation), Conduction: General conduction equation on cartesian coordinates, Cylinders and spheres. One dimensional steady state conduction through plane walls, hollow cylinders and spheres with and without heat generation. Thermal resistance network, Boundary Conditions, Effect of variable thermal conductivity for one-dimensional steady-state conduction in a planewall.

UNIT-II

Fins: Heat transfer analysis of a body with negligible internal temperature gradients, fins efficiency and effectiveness. Lumped system analysis within the body with negligible internal temperature

gradients. Transient heat transfer analysis of an infinite slab with specified temperature and connective boundary conditions.

UNIT-III

Convection: Physical mechanism of convection, Buckingham pi-theorem and use of dimensional analysis in free and forced convection, Physical significance of different dimensionless numbers. Concept of velocity boundary layer, thermal boundary layer. Reynolds analogy, Chilton-Colburn analogy for turbulent flow over flat surfaces. Calculation of heat transfer for flow over plates, cylinders and in pipes in free and forced convection using empirical formulae.

UNIT-IV

Radiation: Absorptivity, Reflectivity, and Transmissivity, Concept of a blackbody, Emissivity, the Planck Distribution law, Wien's Displacement Law, Stefan-Boltzmann, Kirchhoff's Law. The View factor, View factor relations, View Factors between Infinitely Long Surfaces: The Crossed- Strings Method, Radiation exchange between Opaque, Diffuse, Gray Surfaces in an enclosure.

UNIT-V

Heat Exchangers: Heat exchanger types, overall heat transfer coefficient. Heat exchanger analysis: Use of the Log Mean Temperature Difference (Parallel-Flow, Counter-Flow), the Effectiveness–NTU Method. Heat Exchanger Design and Performance Calculations (LMTD, ε-NTU methods), Selection of heat exchangers. Boiling: Pool boiling regimes, nucleate pool boiling, and critical heat flux for nucleate pool boiling, minimum heat flux. Conduction Process.

Suggested Readings :

1. Heat Transfer, Holman, J.P., McGraw Hill Publication, New Delhi, 2010 2.
2. Heat and Mass Transfer, Rajput, R.K., S. Chand & Company Ltd, New Delhi, 2004.
3. Heat and Mass Transfer, Yadav, R., Sanjay. and Rajay.,Central Publishing House, Allahabad, 2004
4. Fundamentals of Engineering Heat and Mass Transfer , Sachdeva,R.C., New Age International (P) Ltd Publishers, New Delhi,
5. A course in Heat and Mass Transfer, Arora, S.C. and Domkandwar., DhanpatRai& Sons, New Delhi, 2004.

Course Code	Course Title						Core / Elective
U23ME604	CAD/CAM						Elective
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Metal Cutting and Machine Tools	3	-	-	-	40	60	3

Course Objectives:

The objective of the course is to:

1. Introduce the concepts of CAD and advanced modeling techniques
2. Help the student in understanding advanced manufacturing concepts like Group technology, flexible manufacturing systems, Computer aided Process Planning, and Computer aided quality control, Artificial Intelligence etc.
3. Help the students in understanding the functioning of computer numerical control machine tools and also in writing programs for operating this machines.
4. Understand the various assemblies and part design with CAD Software's.
5. Create awareness among students about the advanced Software's.

Course Outcomes:

After completing the course, the student will be able to:

1. Apply the fundamental applications of computer in design, manufacturing and geometric transformation techniques in CAD.
2. Develop mathematical Model for curves, surfaces, solid models and understand the fundamental concepts of Finite Element Analysis.
3. Develop CNC Part program for manufacturing components.
4. Differentiate the concepts of Machining Centre's, adaptive control and as well as fundamentals knowledge of robotics.
5. Analyze the working of various components of an modern manufacturing systems

Unit-I

CAD Fundamentals, Product life cycle in conventional and computer-based manufacturing system, Hardware integration and networking. CAD Software: Definitions of system software and application software. Graphic Standards and Exchange Formats. CAD database and structure.

Unit-II

Geometric modeling: 3-D wire frame modeling: wire frame entities and their definitions, Interpolation and approximation of curves, synthetic curves and curve fitting. Definitions of cubic, Bezier, and B- spline curves.

Unit-III

Surface modeling: Definitions of basic surfaces, surface of revolution, blends, intersection, and Cubic, Bezier, B-spline surfaces. Solid Modeling: Solid entities, Boolean operations, B-rep and C-rep approaches. Feature based modeling: Concepts and applications, Assembly modeling.

UNIT-IV

Parametric Representation of Synthetic Surfaces: Hermite Bicubic surface, Bezier surface, BSplinesurface, COONs surface, Blending surface Sculptured surface, Surface manipulation Displaying, Segmentation, Trimming, Intersection, Transformations (both 2D and 3D).

Unit-V

Group Technology: Organization, G.T. layout, part classification and coding, CAPP: Variant and Generative approaches and their relative features. Computer Aided Quality Control: Computer in quality control, Contact and non-contact inspection, optical and non-optical computer aided testing, Experts systems. Artificial intelligence, CAD/CAM integration.

Suggested Readings:

1. CAD/CAM, theory and practice, Ibrahim Zeid, McGraw Hill Inc, N.Y.1991.
2. CAD/CAM, Grover, MP and Zimmers E.W., Prenctice Hall of India 1989.
3. Computer Aided Manufacturing, Rao P.N., Tiwari N.K., Kundra T.K., Tata McGraw Hill, New Delhi, 1993.
4. CAD/CAM/CIM, Radhakrishnan. P, Subramanyan. S, Raju. V, New Age international (P) Ltd., 2nd Edn., 2004.

Course Code	Course Title						Core / Elective
U23ME605	Automobile Engineering						Elective
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Thermodynamics	3	-	-	-	40	60	3

Course Objectives:

The objective of the course is to:

1. Understand the Working of Fuel, Ignition, and cooling Systems.
2. Understand the Working of Lubrication and Electrical Systems
3. Understand the Working of Suspension, Steering and Braking Systems.
4. Understand the Working of Power Transmission.
5. Understand the Necessity of Pollution Control and Maintenance

Course Outcomes:

After completing the course, the student will be able to:

1. Generalize the different types of automobiles, list the engine components, describe the functioning of IC engines and classify the fuel supply system for S.I and C.I engines
2. Differentiate the types of lubrication system; identify different lubrication and cooling systems used in vehicles. Classify ignition system and describe the functioning of battery and automobile air conditioning system.
3. List the salient features of different steering mechanisms, describe the importance of wheel alignment and wheel balancing, describe the importance of different suspension systems and shock absorbers used in an automobile
4. Identify different components in power transmission system design a system, components, or process to meet desired needs with in realistic constrains such as economic, environmental, health and safety, describe about braking system
5. Adapt techniques, skills and modern engineering tools necessary to control the pollution, record the automobile parts maintenance, design and build components and system to reduce pollution of automobile vehicles.

Unit-I

Types of automobiles: Normal, Hybrid and Hydrogen fuel vehicles. Engine location and its components, chassis layout, crank shaft proportion, firing order, piston and piston rings, cylinder liners, valves and operation mechanism, inlet and exhaust manifolds, carburetion and fuel injection system, mechanical fuel injection system & electronic fuel injection system.

Unit-II

Lubricating systems: Wet sump, dry sump and petrol systems, and Cooling systems: Water pumps, radiators, thermostat control anti freezing compounds. Types of Ignition systems, modern ignition systems, types of batteries and charging systems, starting motors, lighting and electrical accessories, automobile air-conditioning.

Unit-III

Steering systems: Linkage arrangements and its components modified Ackerman linkage, wheel alignment, caster and camber. Rack and pinion assembly – recent trends Wheel and tyres: Tyre construction, specification. Tyre wear and causes, wheel balancing, types of suspension system, independent suspension coil and leaf springs, torsion bar, shock absorbers.

Unit-IV

Power Train: Clutches, gear and gearbox manual, semi-automatic and automatic gearboxes. Torque converter, propeller shaft, universal coupling differential, four-wheel drive system.Brake systems: Description and operation of hydraulic brake, leading and trailing shoe layout, disc brakes, master cylinder, hand brake linkage, recent trends.

Unit-V

Maintenance: Pollution control, trouble shooting and servicing procedure overhauling, engine tune up, tools and equipment for repair and overhaul, testing equipment, pollution control technologies used for petrol and diesel engines, types and study of catalytic converters, Euro norms 2 & 3 and Bharat Norms – recent trends.

Suggested Reading:

1. Crouse & Anglin, 'Automotive Mechanics' Tata McGraw Hill, Publishing Co., Ltd., New Delhi, Tenth edition - 2004..
2. Kirpal Singh, ―Automobile Engineering‖, Vol I & II Standard Publishers, Delhi.
3. Joseph Heitner, ‗Automotive Mechanics', Affiliated East West Pvt., Ltd.,
4. C.P. Nakra, ―Basic Automobile Engineering‖, Dhanpat Rai Publishing Co.(P) Ltd., New Delhi, 2003

Course Code	Course Title						Core / Elective
U21ME606	Quality and Reliability Engineering						Elective
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

The objective of the course is to:

1. Study about TQM Principles
2. Study about TQM Tools & Techniques
3. Study about Quality Systems
4. Study about QFD and Iso Standards
5. Study about Maintenance Concepts
6. Study about Reliability Concepts

Course Outcomes:

After completing the course, the student will be able to:

1. Discuss the concepts of quality systems and quality engineering in design and processes.
2. Utilize knowledge about the statistical process control charts and sampling techniques.
3. Analyze the loss function and quality function deployment.
4. Explain the QFD and ISO 9000 standards
5. Judge the models of reliability engineering.
6. Apply knowledge about the concepts of complex system and reliability engineering techniques.

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.

Unit-II

Statistical process control, R, p, c charts, other types of control charts, process capability, process capability analysis, process capability index. (SQC tables can be used in the examination) Acceptance sampling by variables and attributes, design of sampling plans, single, double, sequential and continuous sampling plans, design of various sampling plans.

Unit-III

Loss function, tolerance design N type, L type, S type; determination of tolerance for these types. Online quality control variable characteristics, attribute characteristics, parameter design. 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, reliability prediction based on Weibull distribution, Reliability improvement.

UNIT-V

Complex system, reliability, reliability of series, parallel & standby systems & complex systems & reliability prediction and system effectiveness. Maintainability, availability, economics of reliability engineering, replacement of items, maintenance costing and budgeting, reliability testing.

Suggested Reading:

1. Quality Engineering in Production Systems / G Taguchi /McGraw Hill.
2. Reliability Engineering/ E.Bala Guruswamy/Tata McGraw Hill.
3. Statistical Quality Control: A Modern Introduction/ Montgomery/Wiley.
4. Jurans Quality planning & Analysis/ Frank.M.Gryna Jr. / McGraw Hill.
5. Taguchi Techniques for Quality Engineering/ Philipposs/ McGraw Hill.
6. L S Srinath, Reliability Engineering, East West, 2005

Course Code	Course Title						Core / Elective
U21ME607	Flexible Manufacturing Systems						Elective
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

The objective of the course is to:

1. Understand the Fundamentals of FMS, evolution, definition, need, objectives, components, merits, demerits, and applications of Flexible Manufacturing Systems (FMS), including flexibility in push and pull-type systems.
2. Learn about various FMS layout types—such as single line, dual line, loop, ladder, and robot-centered layouts—and understand their salient features and suitability for different manufacturing environments.
3. Study key processing stations in FMS including machining centers, turning centers, coordinate measuring machines (CMM), and washing/deburring stations, along with their roles and functionalities.
4. Gain knowledge of essential MHS components like conveyors, robots, Automated Guided Vehicles (AGVs), and Automated Storage and Retrieval Systems (ASRS) used in FMS.
5. Learn about tool management (including magazines, presetting, and monitoring), fault detection, and key functions like FMS configuration planning, routing, production planning, scheduling, and loading.

Course Outcomes:

After completing the course, the student will be able to:

1. Classify and distinguish FMS and other manufacturing systems including job-shop and mass production systems.
2. Explain processing stations and material handling systems used in FMS environments
3. Design and analyze FMS using simulation and analytical techniques.
4. Describe tool management in FMS.
5. Analyze the production management problems in planning, loading, scheduling, routing and breakdown in a typical FMS.

Unit-1

Understanding of FMS: Evolution of Manufacturing Systems, FMS: Definition, objective and Need, FMS: components, Merits, Demerits and Applications, Flexibility in Pull and Push type.

Unit-2

Classification of FMS Layout: FMS: Layouts and their Salient features, Single line, dual line, loop, ladder, robot centre type etc.

Unit-3

Salient features of processing stations: Processing stations- Machining Centers, Turning centre, Coordinate measuring machine (CMM), Washing/ Deburring station.

Unit-4

MHS; An introduction: Material Handling System Conveyor, Robots, Automated Guided Vehicle (AGV), Automated Storage Retrieval System (ASRS).

Unit-5

Management Technology: Tool Management, tool magazine, Tool preset, identification, Tool monitoring and fault detection, FMS: Configuration planning and routing, FMS: Production Planning and Control, FMS: Scheduling and loading.

1. William W Luggen, “Flexible Manufacturing Cells and System” Prentice Hall of Inc New Jersey, 1991
2. Reza A Maleki “Flexible Manufacturing system” Prentice Hall of Inc New Jersey, 1991
3. John E Lenz “Flexible Manufacturing” marcel Dekker Inc New York, 1989.
4. Groover,M.P “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India Pvt.Ltd. New Delhi 2009

Course Code	Course Title						Core / Elective
U23ME608	Robotics						Elective
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives:

The objective of the course is to:

1. Explain the fundamentals of robotic systems, including classifications, anatomy, sensors, and selection criteria based on applications.
2. Apply kinematic and dynamic modeling techniques for industrial robotic manipulators using mathematical and simulation tools.
3. Analyze and design motion trajectories and control systems for robotic applications.
4. Explore advanced topics in robotics, including vision systems and path planning techniques using modern technologies.
5. Evaluate and integrate robotics solutions in industrial manufacturing, material handling, and inspection processes.

Course Outcomes:

After completing the course, the student will be able to:

1. Explain the anatomy, classification, and selection of robots, sensors, and grippers for specific automation applications.
2. Formulate and solve direct and inverse kinematics problems for different robot configurations using transformation matrices.
3. Analyze robot dynamics using Lagrangian and Newton-Euler methods and demonstrate differential kinematics using simulation tools.
4. Develop and implement motion control strategies and trajectory planning using control architectures and robot programming techniques.
5. Assess and recommend appropriate robotic systems for real-world industrial applications such as welding, assembly, inspection, and material handling.

UNIT-I

Introduction: Multibody systems, Automation, Classification of robots, Anatomy, Sensors (velocity, proximity, touch, torque etc), Grippers, selection of Robot based on the Application. Demonstration of different types of Robots & tools using Robot Simulator Software like ROBODK.

UNIT-II

Kinematics: Manipulators Kinematics, Rotation Matrix, Homogenous Transformation Matrix, Direct and Inverse Kinematics for industrial robots for Position and orientation. Demonstrate FK and IK using simulation tools.

Differential Kinematics, statics and Dynamics: Jacobian, Lagrangian Formulation, Newton- Euler Formulation for RR & RP Manipulators. Demonstrate differential kinematics using simulation tools.

UNIT-III

Trajectory planning: Motion Control- Interaction control, Rigid Body mechanics. Demonstrate trajectory planning using simulation tools.

Control: architecture- position, path velocity and force control systems, computed torque control, Adaptive control, and Servo system for robot control.

UNIT-IV

Advanced Topics in Robotics: Motion Planning (Methods of Path planners), Robot Vision (Feature Detection & Matching, Motion Tracking, Machine Learning methods).

Robot programming: Programming of Robots and Vision System- overview of various programming Languages.

UNIT-V

Applications: Application of Robots in production systems- Application of robot in welding, machine tools, material handling, and assembly operations parts sorting and parts inspection.

Suggested Reading:

1. Craig, J.J., Introduction to Robotics Mechanics and Control, Addison Wesley, 1999.
2. Saha, Subir Kumar, Introduction to robotics, Tata McGraw-Hill Education, 2014.
3. Spong, Mark W., Seth Hutchinson, and Mathukumalli Vidyasagar, Robot modeling and control, New York: Wiley, 2006.
4. Kevin M. Lynch, Frank C. Park, Modern Robotics: Mechanics, Planning, and Control, Cambridge University Press, 2017.

Course-Code	Course Title						Core/ Elective
U23ME6L1	Metal Cutting and Machine Tools Lab						Core
Prerequisites	Contact Hour per Week				CIE	SEE	Credit
	L	T	D	P			
Manufacturing Processes Lab	-	-	-	3	25	50	1.5

Course Objectives :

The objective of the course is to:

1. Have knowledge of various precision measuring instruments.
2. Familiarise machining and metal cutting operations.

Course Outcomes :

After completing the course, the student will be able to:

1. Demonstrate the need of machine alignment test for qualitative production.
2. Practice calibration principles for maintaining the required precision of instruments / tools.
3. Select and practice the methods of temperature measurement.
4. Select cutting tool materials and tool geometries along with appropriate cutting conditions for different work materials and grind the cutting tools to the required geometry.
5. Recognize and summarize the features and applications of various machine tools like Lathe, Milling, Drilling, Grinding, Shaping, Slotting etc.
6. Practice calibration principles for maintaining the required precision of instruments / tools

List of Experiments:

1. Typical exercises on lathe machine (Turning, Step Turning).
2. Typical exercises on lathe machine (Taper Turning and Knurling).
3. Thread cutting exercise on lathe machine as single start .
4. Machining of holes using Drilling and boring machines.
5. Typical exercises on shaper machine.
6. Typical exercises on cylindrical grinding machine.
7. Typical Exercise on milling machine.
8. Typical Exercise on slotting machine.
9. Typical Exercise on Planning machine.
10. Production of threads with taps and threading dies and milling cutters.
11. Grinding of Tool angles using Cylindrical / Surface Grinding.
12. Study of geometrical tests on lathe machine.

Note: At least 10 experiments must be conducted in the semester.

Course-Code	Course Title						Core/ Elective
U23ME6L2	Heat Transfer Lab						Core
Prerequisites	Contact Hour per Week				CIE	SEE	Credit
	L	T	D	P			
Thermal Engineering Lab	-	-	-	3	25	50	1.5

Course Objectives :

The objective of the course is to:

1. Understand applications of Heat Transfer Concepts through experimentation.
2. Provide knowledge in Concentric Sphere, Metal Rod.
3. Understand the working principal of Conduction and Convection.
4. Understand the Heat Flow Exchangers and the Demonstrations.

Course Outcomes :

After completing the course, the student will be able to:

1. Perform steady state conduction experiments to estimate thermal conductivity of different materials.
2. Perform transient heat conduction experiment.
3. Estimate heat transfer coefficients in forced convection, free convection , condensation and correlate with theoretical values
4. Obtain variation of temperature along the length of the pin fin under forced and free convection.
5. Perform radiation experiments: Determine surface emissivity of a test plate and Stefan-Boltzmann's constant and compare with theoretical value.

List of Experiments:

1. Composite Slab Apparatus – Overall heat transfer co-efficient.
2. Heat transfer through lagged pipe.
3. Heat Transfer through a Concentric Sphere
4. Thermal Conductivity of given metal rod.
5. Heat transfer in pin-fin
6. Experiment on Transient Heat Conduction
7. Heat transfer in forced convection apparatus.
8. Heat transfer in natural convection
9. Parallel and counter flow heat exchanger.
10. Emissivity apparatus.

11. Stefan Boltzman Apparatus.
12. Critical Heat flux apparatus.
13. Study of heat pipe and its demonstration.
14. Film and Drop wise condensation apparatus

Note: At least 10 experiments must be conducted in the semester.

Course Code	Course Title					Core / Elective
U23ME6P1	**Mini Project**					**Elective**
Prerequisite	Contact Hours Per Week			CIE	SEE	Credits
Internship	L	T	P			
	-	-	4	50	50	2

Course Objectives:

The objective of the course is to:

1. Enhance practical and professional skills.
2. Familiarize tools and techniques of systematic literature survey and documentation
3. Expose the students to industry practices and team work.
4. Encourage students to work with innovative and entrepreneurial ideas and its implementation.
5. Make students evaluate different solutions based on economic and technical feasibility

Course Outcomes:

After completing the course, the student will be able to:

1. Formulate a specific problem and give valuable and economical solution
2. Develop model/models either theoretical/practical/numerical form
3. Solve, interpret/correlate the results and discussions
4. Conclude the results obtained
5. Write the documentation in standard format

Guidelines:

1. As part of the curriculum in the VI- semester of the programme each student shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment.
2. Four students will be allotted to one faculty supervisor for mentoring.
3. Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something more original.
4. Mini projects shall have inter-disciplinary/ industry relevance, which can be implemented practically.
5. The students can select a mathematical modelling based/Experimental investigations or Numerical modelling
6. All the investigations should be clearly stated and documented with the reasons/explanations/Justifications.
7. The mini-project shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions and reference
8. Project Review Committee: Supervisor and a minimum of two faculty members.