REVISED

COURSES SCHEME

FOR

B.E.

MECHANICAL ENGINEERING

2015

B.E. (Mechanical Engineering) 2015–Course Scheme (ALL YEARS) after Modifications as suggested in 109th SUGC held on October18, 2016

1.	UMA003	Mathematics-I
2.	UTA007	Computer Programming - I
3.	UPH004	Applied Physics
4.	UEE001	Electrical Engineering
5.	UHU003	Introduction To Professional Engineering#
6.	UTA008	Engineering Design-I
7.	UMA004	Mathematics-II
8.	UTA009	Computer Programming-II
9.	UCB008	Applied Chemistry
10.	UEC001	Electronic Engineering
11.	UES009	Mechanics *
12.	UTA010	Engineering Design-II (Catapult Project) 6 Self
13.	UMA031	Optimization Techniques
14.	UES010	Solids And Structures
15.	UES011	Thermo-Fluids
16.	UTA002	Manufacturing Processes
17.	UTA011	Engineering Design-III (Buggy Project) 8 Self
18.	UME306	Mechanics of Machines
19.	UMA007	Numerical Analysis
20.	UES012	Engineering Materials
21.	UEN002	Energy & Environment
22.	UHU005	Humanities for Engineers
23.	UME504	Machine Design
24.	UME409	Computer Aided Design & Analysis
25.	UME515	Industrial Engineering
26.	UTA012	Innovation & Entrepreneurship *
27.	UME501	Applied Thermodynamics
28.	UME404	Mechanics of Deformable Bodies
29.	UME505	Manufacturing Technology
30.	UME513	Dynamics & Vibrations
31.	UME696	Project Semester
32.	UME697	Group Project
33.	UME833	Inspection and Quality Control
34.	UME847	Rapid Prototyping
35.	UME711	Advanced Machine Design
36.	UME502	Automobile Engineering
37.	UME712	Heat Transfer
38.	UME713	Fluid Mechanics & Machinery
39.	UME793	Capstone Project (Starts)
40.	UME803	Refrigeration and Air Conditioning
41.	UME807	Gas Dynamics & Turbo machines
42.	UME705	Machining Science
43.	UME802	Mechatronics
44.	UME793	Capstone Project (Completion)
45.	UME832	Finite Element Methods
46.	UME842	Mechanics of Composite Materials
47.	UME805	Robotics Engineering
48.	UME721	Tribology

49.	UME722	System Modelling and Simulation
50.	UPE501	Work study and Ergonomics Engineering
51.	UME732	CAM & Industrial Automation
52.	UME844	Machine Tool Design
53.	UPE703	Metal Forming
54.	UME733	Industrial Metallurgy
55.	UME831	Computational Fluid Dynamics
56.	UME834	Internal Combustion Engines
57.	UME852	Power Plant and Process Utility Systems
58.	UME839	Renewable Energy Systems
59.	UME853	Solar Energy Engineering

UTA008: ENGINEERING DESIGN-I

L	T	P	Cr
2	0	3	3.5

Course Objectives: This module is dedicated to graphics and includes two sections: manual drawing and AutoCAD. This course is aimed at to make the student understand dimensioned projections, learn how to create two-dimensional images of objects using first and third angle orthographic projection as well as isometric, perspective and auxiliary projection, to interpret the meaning and intent of toleranced dimensions and geometric tolerance symbolism and to create and edit drawings using drafting software AutoCAD.

Course Learning Outcomes (CLO):

Upon completion of this module, students will be able to:

1. creatively comprehend geometrical details of common engineering objects
2. draw dimensioned orthographic and isometric projections of simple engineering objects.
3. interpret the meaning and intent of toleranced dimensions and geometric tolerance symbolism;
4. create the engineering drawings for simple engineering objects using AutoCAD
5. manage screen menus and commands using AutoCAD
6. operate data entry modes and define drawings geometrically in terms of Cartesian, polar and relative coordinates in AutoCAD
7. create and edit drawings making selections of objects, discriminating by layering and using entities, object snap modes, editing commands, angles and displacements using AutoCAD

UTA002: MANUFACTURING PROCESSES

Course Objectives: This course introduces the basic concepts of manufacturing via machining, forming, joining, casting and assembly, enabling the students to develop a basic knowledge of the mechanics, operation and limitations of basic machining tools. The course also introduces the concept of metrology and measurement of parts.

Course Learning Outcomes (CLO):

Upon completion of this module, students will be able to:

1. analyze various machining processes and calculate relevant quantities such as velocities, forces, powers etc.;
2. suggest appropriate process parameters and tool materials for a range of different operations and workpiece materials;
3. understand the basic mechanics of the chip formation process and how these are related to surface finish and process parameters;
4. recognize cutting tool wear and identify possible causes and solutions;
5. develop simple CNC code, and use it to produce components while working in groups.
6. perform calculations of the more common bulk and sheet forming, casting and welding processes and given a particular component.
7. select the most appropriate manufacturing process to achieve product quality through the efficient use of materials, energy and process.

UTA010: ENGINEERING DESIGN-II

L	T	P	Cr
1	0	2	5

Course Objectives: To develop design skills according to a Conceive-Design-Implement-Operate (CDIO) compliant methodology. To apply engineering sciences through learning-by-doing project work. To provide a framework to encourage creativity and innovation. To develop team work and communication skills through group-based activity. To foster self-directing learning and critical evaluation.

To provide a basis for the technical aspects of the project, a small number of lectures are incorporated into the module. As the students would have received little in the way of formal engineering instruction at this early stage in the degree course, the level of the lectures is to be introductory with an emphasis on the physical aspects of the subject matter as applied to the Mangonel. The lecture series include subject areas such as Materials, Structures, Dynamics and Digital Electronics delivered by experts in the field.

This module is delivered using a combination of introductory lectures and participation by the students in 15 "activities". The activities are executed to support the syllabus of the course and might take place in specialized laboratories or on the open ground used for firing the Mangonel. Students work in groups throughout the semester to encourage teamwork, cooperation and to avail of the different skills of its members.

Course Learning Outcomes (CLO):

Upon completion of this module, students will be able to:

1. model trajectories of masses with and without aerodynamic drag;
2. develop a software tool to allow trajectories be optimised;
3. analyse the static and dynamic stresses of elements of an engineering mechanism;
4. optimally design structural elements of an engineering mechanism;
5. perform a test to acquire an engineering material property;
6. develop and test software code to process sensor data;
7. design and construct and test an electronic hardware solution to process sensor data;
8. construct a Roman catapult "Mangonel" using tools, materials and assembly instructions;
9. operate and evaluate the "Mangonel" for functional and structural performance;
10. validate theoretical models by comparison with experiments;
11. integrate skills to innovatively redesign an element of the "Mangonel";
12. participate and cooperate in a team.

UME306: MECHANICS OF MACHINES

L	T	P	Cr
3	1	2	4.5

Course Objectives: To introduce different types of mechanisms forming different subsystem of machines. To impart the knowledge of vector and matrix methods for position, velocity and acceleration analysis with software tools. To carryout force analysis of engine mechanism analytically. To impart knowledge of force analysis and balancing of rotors. To introduce fundamentals of single degree of freedom vibrating system.

Course Learning Outcomes (CLO):

Upon completion of this module, students will be able to:

1. select and analyze a set of mechanisms to achieve desired motion transformation.
2. use analytical methods and software tools for analysis of mechanisms.
3. evaluate and carry out balancing of rotors.
4. determine the unbalance and evaluate the balancing strategies in multi cylinder in-line engines.
5. formulate equations of motion, evaluate the responses of different real life vibration problems and suggest methods for vibration isolation.

UME409: COMPUTER AIDED DESIGN AND ANALYSIS (WITH PROJECT)

L	T	P	Cr
3	0	3	8.0

Course Objectives: Introduce components and assemblies used in machines and use of 3D parametric CAD, CAE software for mechanical design. To provide an experiential learning environment using projects done by student groups, while applying CAD, CAE software tools to design mechanisms and structures for mechanical design evaluation, optimization of mass properties, static-stresses, deformations, etc. with experimental validation of simulation models.

Course Learning Outcomes (CLO):

The students will be able to:

1. interpret mechanical drawings for components, assemblies and use parametric 3D CAD software tools in the correct manner for creating their geometric part models, assemblies and automated drawings.
2. create assembly of mechanism from schematic or component drawing and conduct position/ path/ kinematic / dynamic analysis of a mechanism in motion using CAD software tools.
3. evaluate design and create an optimized solution using commercial CAD, CAE software as black box for required analysis of mass properties/ stress, deflection / temperature distribution etc. under realistic loading and constraining conditions.
4. Produce design reports for Geometric modelling, Assembly, drawings, analysis, evaluation of results, reflection and suggestions for design evaluation and improvement

UME504: MACHINE DESIGN

L	T	P	Cr
3	2	0	4.0

Course Objectives: Provide students with the ability to apply design procedure with specific design tools representing empirical, semi-empirical and analytical approaches. Using analytical and computer aided design with real world problems.

The detailed design of mechanical systems considers realistic examples from the mechanical laboratories/workshop. Design a mechanical power transmission system given the power to be transmitted, speed ratio, orientation and center distance of the shafts. Design will include:

1. Selection of materials, standard sizes of parts, for all the components.
2. Pulley with belt
3. Flexible Coupling
4. Stepped shaft and keys
5. Ball bearing
6. Gears
7. Threaded fasteners with cover plates
8. Stress concentration under static and fluctuating loading

Failure analysis, factor of safety, types of loading, selection of appropriate materials, lubrication, design for manufacturing, fits and tolerance will also be covered for the use in all the above case based designs.

Course Learning Outcomes (CLO):

Upon completion of this module, students will be able to:

1. conduct a failure analysis for the design/sizing of mechanical components
2. calculate stresses involved with static/ fatigue loading
3. design and analyze a real engineering system through projects
4. represent machine elements with a free body diagram and solve for unknown reactions
5. select the suitable materials and manufacturing considerations.

UME515: INDUSTRIAL ENGINEERING

L	T	P	Cr
2	1	0	2.5

Course Objectives: This course introduces the concept, tools, and techniques of industrial engineering viz. control charts, acceptance sampling, concepts of line balancing, work measurement, and production management etc., to enable the students to develop knowledge and skills in using and integrating these tools.

Course Learning Outcomes (CLOs):

The students will be able to:

1. analyze lacunae in existing layout of a shop floor in manufacturing and service organizations and develop an improved plant layout.
2. apply quality engineering tools for process control and improvement.
3. develop a production schedule using information/ data from different functional areas.
4. determine the optimum time standards using work study principles and human factors in engineering.

UME501: APPLIED THERMODYNAMICS

L	T	P	Cr
3	1	2	4.5

Course Objectives: This course introduces the principles of the conversion of fossil fuel energy to useful power, concept of Rankine cycle, heat balance sheet and draught system of the boiler. This course also introduces fundamental thermodynamic operating principles, phenomena of I.C. engines and performance parameters of I.C. engines.

Course Learning Outcomes (CLOs):

The students will be able to:

1. apply the first and second laws of thermodynamics for the complete thermal analysis of vapor power cycle.
2. analyze simple Brayton cycle and determine the performance parameters of jet engine.
3. draw heat balance sheet of a boiler.
4. determine the performance parameters of I.C. engines in an engine test rig.
5. derive and analyze Otto, Diesel and Dual cycle air standard thermal efficiencies.

6 *Vasandani, V. P. and Kumar, D. S., Heat Engineering, Metropolitan Book Company, New Delhi (2003).*

UME404: MECHANICS OF DEFORMABLE BODIES

L	T	P	Cr
3	1	0	3.5

Course Objectives: The objective for this course is to develop the basic skills and knowledge required to analyze displacement field, stress, strain and failure in deformable solids using analytical solutions. This course also introduces an overview of important structural engineering design philosophies. This understanding will include concepts such as curved beam, unsymmetrical bending, helical spring, pressure vessel etc.

Course Learning Outcomes (CLOs):

The students will be able to:

1. calculate the state of stress at the critical point of the object.
2. analyze the failure analysis under static loading in ductile and brittle materials using different theories of failures.
3. calculate deflection at any point on a solid structure using Castigliano's theorems.
4. determine the distribution of circumferential and radial stress along the thickness of thick cylinders.
5. model real structures using fundamental component analysis.
6. use contemporary s/w tools of MATLAB and FEA commercial packages for solving and displaying results.

UME505 : MANUFACTURING TECHNOLOGY

L	T	P	Cr
3	0	3	4.5

Course objective: The objective of this course is to introduce to the students different modes of solidification in metal casting and design of gating, riser system required for casting. The students will understand the principles of the metal cutting in single and multi-point cutting, estimating the cutting force and power requirements. The students will also understand the principle of different arc and gas welding process and know the utilization of heat during welding. The students will study bulk metal forming and sheet metal shearing operations and calculate the force, power requirements during different forming processes. Further the students will also study different manufacturing processes for plastics and ceramics.

Course Learning Outcomes (CLOs):

The student will be able to:

1. decide suitable casting technique for a particular application based on the differentiation in process salient features, evaluate the molding sand property for sand casting process.
2. design the gating and riser system for the casting process and calculate the charge constituents in liquid metal
3. determine the welding machine characteristics, calculate heat balance, estimate the size of weld and decide suitable welding technique for different applications.
4. calculate the shear angle, strain, strain rate, velocities during metal cutting and estimate the cutting force, power during single and multipoint cutting operations.
5. calculate the force and power requirements during different bulk metal forming processes estimate the die or punch size for a suitable sheet metal shearing operation.

UME513 : DYNAMICS AND VIBRATIONS

L	T	P	Cr
3	1	2	4.5

Course Objectives: This course deals with the dynamics of various physical systems like flywheels, governors, gyroscopes etc. In continuation to the topics covered in Mechanics of Machines, this course reviews the detailed concepts of single-DOF vibrating systems. Moreover, the aim of this course is to model and analyze two- and multi-DOFs systems with their applications in the real world

Course Learning Outcomes (CLOs):

The students will be able to:

1. apply engineering principle of mechanics to design motion transmission devices and flywheels.
2. determine the appropriate parameters for stability of a vehicle using the concept of gyroscopic action.
3. derive the dynamic model of real-life problems and verify the natural frequencies and mode shapes.
4. analyze two- and multi-DOF physical systems analytically and validate using a commercial package

UME847: RAPID PROTOTYPING

L	T	P	Cr
2	1	2	3.5

Course objectives: This course introduces the basic fundamentals of rapid prototyping, its fabrication methodology, different techniques of part fabrication, materials and various areas of defects and improvements in RP. The course also introduces the concept of reverse engineering.

Course learning outcome (CLO):

On completion of this course the student will be able to:

1. develop physical prototype applying the fundamental concepts of rapid prototyping.
2. develop a solid model applying the concepts of transformations & solid modelling.
3. analyze different rapid prototyping systems based on their principles of operation and materials used.
4. analyze & detect the errors in STL files and implement the repair algorithms associated with the errors.
5. calculate layer thickness, orientation and shrinkage compensation in different layering techniques.

UME833: INSPECTION AND QUALITY CONTROL

L	T	P	Cr
3	1	0	3.5

Course Objectives: This course enables the students to understand the organization and procedures for industrial inspection. It helps in developing an understanding with regards to the basic concepts/ tools of quality engineering. The course helps to study the development, operational procedure, and applications of control charts to signify their role in quality control. The course enables the students to study, design and use acceptance sampling plans. The course introduces the concept of process capability analysis to gage process performance.

Course Learning Outcomes (CLOs):

The students will be able to:

1. identify and analyze the functions and organization of industrial inspection.
2. apply and analyze the seven Ishikawa's tools and conduct quality cost analysis.
3. analyze various control charts for quality control of the different production processes
4. evaluate through process capability studies if a given process is proficient in meeting customer's specifications

UME697: Group Project

L	T	P	Cr
-	-	-	13.0

Course Objectives: To develop design skills according to a Conceive-Design-Implement-Operate (CDIO) compliant methodology. To implement engineering skill and knowledge to complete the identified project work while encouraging creativity and innovation. To develop spirit of team work, communication skills through group-based activity and foster self-directing learning and critical evaluation.

Course Learning Outcomes (CLOs):

The students will be able to:

1. identify a problem based on the need analysis of community /industry/ research.
2. create a flowchart of methodology for solving the identified problem
3. demonstrate team work with work division, team meetings and communications among team members.
4. write technical report for the project work and present the same through power point presentations or posters.

UME711 : ADVANCED MACHINE DESIGN

L	T	P	CR
3	1	0	3.5

Course objectives: The objective for this course is to apply design procedure of the machine elements using analytical approach and mechanical engineering design theory to identify machine elements in the design of commonly used mechanical systems. The course also introduces the concept of computer based techniques in the analysis, design and/or selection of machine components.

Course Learning Outcomes (CLOs):

The students will be able to:

1. select the suitable materials and manufacturing considerations.
2. determine suitable module and specifications of gears from strength and wear considerations.
3. apply different theories for designing friction clutches and brakes.
4. select bearings for a given load carrying capacity.
5. design and analyze real engineering systems through research assignments.

UME502 : AUTOMOBILE ENGINEERING

L	T	P	CR
3	0	2	4.0

Course Objectives: To deliver basic knowledge of different components of automobiles and expose the students with performance parameters of a vehicle. Course provides the learning of design procedure of various components and factors affecting operation of vehicle on road. Objective also involves the enhancement of fault diagnosis and troubleshooting capabilities.

Course Learning Outcomes (CLOs):

The students will be able to:

1. evaluate the power requirement of a vehicle under different operating conditions.
2. calculate the energy losses and define the design parameters in different vehicle components
3. solve the technical issues related to vehicle design and malfunctioning of different components through fault-diagnosis and troubleshooting exercises of real case studies performed at the vehicle service stations.

UME712: HEAT TRANSFER

L	T	P	Cr
3	1	2	4.5

Course objective: To impart knowledge on the principles of heat transfer through conduction, convection and radiation modes. To impart knowledge on heat transfer during phase-change processes, such as boiling and condensation. To impart knowledge on the practical aspects of the theories of heat transfer, such as design of heat exchangers. To enable students carry out laboratory tests verifying the various principles of heat transfer.

Course Learning Outcomes (CLOs):

The students will be able to:

1. apply the principles of conduction, convention and radiation mode of heat transfer to solve heat transfer problems.
2. design a heat exchanger through analysis of the thermal performance of heat exchangers and recognize and evaluate the conflicting requirements of heat transfer optimization and pressure drop minimization.
3. calibrate equipment, acquire, tabulate and analyze useful data in the laboratory, checks for repeatability and reproducibility.
4. assess thermal systems and develop conceptual designs of improved systems

UME713 : FLUID MECHANICS AND MACHINERY

L	T	P	Cr
3	1	2	4.5

Course Objectives: Students will expose to the basic fundamentals of momentum equation, basics theory of fluid dynamics, Euler's equation for energy transfer, impact of jets. To study the working principle of the hydropower plant, hydro turbine component, basic working principle of pump, centrifugal pumps, design parameters of the centrifugal pump, reciprocating pump, indicator diagram.

Course Learning Outcomes (CLOs):

The students will be able to:

1. develop dimensionless groups using Buckingham's Pi method
2. determine the drag and lift forces of various shapes.
3. determine the various flow characteristics of pumps and turbine
4. simulate fluid machinery problems using commercial CFD tools

UME803 : REFRIGERATION & AIR CONDITIONING

L	T	P	Cr
3	1	2	4.5

Course Objectives: This course provides an introduction of different types of refrigeration systems and enables the students to analyze their performance using basic concepts of thermodynamics. This course also introduces the concept of psychometrics, air conditioning processes, air conditioning systems and refrigeration & air conditioning system components.

Course Learning Outcomes (CLOs):

The students will be able to:

1. determine the COP for different types of air refrigeration systems
2. determine the COP for vapour compression systems and heat pump
3. perform thermodynamic analysis of absorption refrigeration systems and steam jet refrigeration system
4. perform the load calculations for the different type of air conditioning systems
5. identify and determine the heating and cooling loads for air conditioning systems involving practical applications like; rooms/halls/restaurant/ theatre/auditorium etc

UME807 : GAS DYNAMICS & TURBO MACHINES

L	T	P	Cr
3	1	0	3.5

Course Objectives: Students will be exposed to compressible flow, study of subsonic and supersonic flows through nozzles of gases and vapour, steam turbine designs and types, governing of steam turbines, gas turbine cycles and their thermal refinements, jet propulsion. Students will study basics of centrifugal, axial flow, screw, lobe and reciprocating compressors, performance and design characteristics of compressors, basic principles of condensers, types, draught, cooling towers.

Course Learning Outcomes (CLOs):

The students will be able to:

1. derive and apply thermodynamic and fluid terminology to turbo machines.
2. draw the velocity triangles in turbo machinery stages operating at design and off-design conditions.
3. determine methods to analyze flow behavior depending upon nature of working fluid and geometric configuration of turbo machine.
4. dsetermine methodologies to evaluate solutions for efficiency, effectiveness and sustainability

UME705: MACHINING SCIENCE

L	T	P	Cr
3	**1**	**2**	**4.5**

Course objective: The objective of this course is to expose the students about the principles of the metal cutting in single and multi-point cutting, estimating the cutting force and power requirements. This course also cultivates the ability to develop and optimize the non- conventional machining methods resulting in creation and distribution of value in engineering applications.

Course Learning Outcomes (CLOs):

The students will be able to:

1. calculate cutting forces and power requirement during single point cutting, multi-point cutting operations
2. develop mathematical models to predict material removal rate surface quality for different process parameters in different non-conventional machining methods
3. design the conditions for the maximum tool life and factors influencing surface quality, dimensional accuracy and material removal rate in machining
4. analyze the thermal and frictional aspects of machining parameters used in manufacturing industries

UME802 : MECHATRONICS

L	T	P	Cr
3	0	2	4.0

Course Objectives: The course imparts interdisciplinary knowledge to study modern products like household appliances, digital cameras, mobiles etc., which falls under the mechatronics domain. The aim of this course to make a bridge between mechanical, electronics, instrumentation, computer and controls field.

Course Learning Outcomes (CLOs):

The students will be able to:

1. calculate the output to input relation of any physical model in the form of a transfer function using block diagram reduction and signal flow graphs.
2. develop the block diagram of any mechatronic system after analyzing the key inputs, outputs, sensors, transducers and controllers of any physical device.
3. develop the state-space representation of the physical model and analyze the performance and stability of the system in MATLAB environment.
4. interface different sensors, actuators, micro-controllers and data acquisition cards of a given mechatronic device to the computer/laptop.
5. analyze the key features of different type of controllers and develop a suitable controller to obtain the desired performance from the system.

UME793: CAPSTONE PROJECT

UME793: Semester VII Part-I (Starts)	**0**	**0**	**2**	**--**
UME793: Semester VIII Part-II (Completion)	**0**	**0**	**2**	**8.0**

Course Objectives: A design project based course to implement integrated approach to the design of mechanical systems using concepts of mechanical design, thermal and manufacturing courses studied in the previous semesters. Design a mechanical system from component level to assembly using CAD and CAE tools individually or in a team and generate a design project report with production drawings using drawing standards, symbols, conventions and rules. Plan the production of a mechanical system given the detailed drawings. Schedule and execute a production plan for the components and assemble the working prototype of the mechanical system. Analyze the prototype manufactured for improvement in design, manufacturing and function.

Course Learning Outcomes (CLOs):

The students will be able to:

1. design a mechanical system implementing an integrated system design approach applying knowledge accrued in various professional courses.
2. work in a design team lead by a team leader and demonstrate team work.
3. design, analyze and optimize the design of a mechanical system considering various requirements like reliability, fatigue loading, optimized design, manufacturing, assembly, installation, maintenance, cost and transportation-to-site aspects, use of design standards, industry standards.
4. create production drawings for mechanical components and systems using manual drafting and CAD tools following relevant standards and conventions.
5. read production drawings for mechanical components and systems and plan a production based on it.
6. use suitable manufacturing and fabrication processes for manufacturing a prototype.
7. assemble a mechanical system after manufacturing its components and analyze its working.

UME832: FINITE ELEMENT METHODS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To expose the students to the basics of Finite Element Methods.

Course Learning Outcomes (CLOs):

The students will be able to:

1. apply the procedure involved to solve a problem using Finite Element Methods.
2. develop the element stiffness matrices using different approach.
3. analyze a 2D and 3D problem using different types of elements.
4. solve problems using the available commercial package.

UME842: MECHANICS OF COMPOSITE MATERIALS

L	T	P	Cr
3	1	0	3.5

Course Objectives: The objective for this course is to develop an understanding of the elastic analysis of composite materials. This course also introduces the concept of unidirectional composites, short fiber composites, orthotropic lamina, laminated plates and beams.

Course Learning Outcomes (CLOs):

The students will be able to:

1. determine the properties of fiber and matrix of composite material in different orientations.
2. predict the elastic properties of both long and short fiber composites.
3. relate stress, strain and stiffness tensors using ideas from matrix algebra.
4. analyze a laminated plate in bending, including finding laminate properties from lamina properties.
5. determine the failure strength of a laminated composite plate.

UME805: ROBOTICS ENGINEERING

L	T	P	Cr
3	1	0	3.5

Course Objectives: This course introduces the basic concepts, standard terminologies, applications, design specifications, and the mechanical design aspects of robotics related to kinematics, trajectory planning, dynamics, control and simulation of serial industrial robotic manipulators.

Course Learning Outcomes (CLOs):

The students will be able to:

1. identify and formulate the desired robotic design specifications for a particular application.
2. develop and simulate the forward kinematics model using D-H conventions..
3. develop the inverse kinematics model of a serial manipulator.
4. develop and analyze the mathematical model for robotics trajectory planning, resolved motion rate control and dynamics for a given serial robotic manipulator.
5. apply the joint- and Cartesian-based schemes to control the manipulators in different applications.

UME721 : TRIBOLOGY

L	T	P	Cr
3	1	0	3.5

Course Objectives: The objective for this course is to develop an understanding of the Tribological behavior of different machine elements. This course also introduces the concept of lubricants, analysis of friction and wear, bearings and other tribological applications.

Course Learning Outcomes (CLOs):

The students will be able to:

1. identify different wears and causes of friction in different contact surfaces.
2. calculate load carrying capacity of hydrostatic bearings.
3. analyze real life problem in Tribology.

UME722: SYSTEM MODELLING AND SIMULATION

L	T	P	Cr
3	1	0	3.5

Course Objectives: The objective for this course is to develop an understanding of the interaction of different components of a system. This understanding will include concepts such as analysis of rigid bodies, structural systems, hydraulic systems, thermal systems, electronic and mechatronic systems, multibody systems and control strategies.

Course Learning Outcomes (CLOs):

The students will be able to:

1. frame bond graphs of systems using power variables, reference power directions, causality.
2. generate the system equations from bond graph models.
3. make signal flow graph from the bond graph model and predict stability using Routh's criterion.
4. create different control systems using bond graph.

UME732: CAM & INDUSTRIAL AUTOMATION

L	T	P	Cr
3	1	0	3.5

Course objective: To impart the students an understanding of standard terminologies, conventions, processes, design, operational characteristics, applications and interfacing of key components of contemporary automation technologies used in computer numeric control (CNC) systems, hydraulic, pneumatic, electro-pneumatic and PLC based automation systems. The course introduces the students to the advanced CNC part programming techniques for milling and turning centers. Also this course introduces the students to various automation system devices and control elements used in modern automatic manufacturing environments.

Course Learning Outcomes (CLOs):

The students will be able to:

1. apply the underlying fundamentals of automation strategies, industrial automation and CNC technology
   .
2. develop a complete machining plan for precision parts using an appropriate CNC machining centers.
3. design and simulate an automation system for manufacturing automation based on pneumatic, hydraulic or electro-hydraulic control using logic circuits and control elements.
4. design and develop a complete automation solution for a recognized need.

UME844: MACHINE TOOL DESIGN

L	T	P	Cr
3	1	0	3.5

Course objectives: The objective of this course is to develop the basic skills and understanding on the working principles, mechanics, technological capabilities, design philosophy of machine tool elements and their subsystems.

Course Learning Outcomes (CLOs):

The students will be able to:

1. analyze the design philosophy and design process adopted for the development of machine tools.
2. analyze the constructions and structural behavior of a machine tool.
3. analyze the drive and control systems used in machine tools
4. design the components and subsystems of a given machine.

UME733: INDUSTRIAL METALLURGY

L	T	P	Cr
3	1	0	3.5

Course Objectives: This course identifies the key variables which affect the mechanical properties of mechanical engineering materials, especially alloys. It explains the role of TTT/ CCT diagrams in explaining changes in microstructure and properties of steels under various processing conditions. It enables the students to understand the kinetics of formation and decomposition of austenite phase and the various heat treatment processes for industrial processing of iron-carbon alloys. The course introduces the role of various surface hardening treatments. It enables the students to identify, analyze, and solve problems related to concepts of industrial metallurgy.

Course Learning Outcomes (CLOs):

The students will be able to:

1. describe the microstructures and phases that will occur in material alloys in general, and steels and eutectic series alloys in particular.
2. predict how microstructure will be affected by alloy composition and thermomechanical treatments.
3. describe the structure and processing of some typical steels; to compare the mechanical properties of these materials to those of composites explaining under what circumstances composites might be

used in the industry.

4. select and analyze suitable surface heat treatment for a given alloy composition.
5. predict the failure loads in components to ensure their safe life.
6. appreciate the considerations involved in mechanical engineering materials selection: to use a systematic approach to the selection of the optimum material for a given mechanical engineering application.

UME831: COMPUTATIONAL FLUID DYNAMICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: This course introduces the basic knowledge of governing equations for fluid flow and different turbulence models. The course also introduces the concept of numerical methods used to solve the partial differential equation. Further, solve the fluid flow problem using CFD tool.

Course Learning Outcomes (CLOs):

The students will be able to:

1. derive and analyse the various types of fluid flow governing equations.
2. analyse the internal fluid flow phenomena of thermal and fluid system.
3. simulateengineering problems using commercial CFD tools

UME834: INTERNAL COMBUSTION ENGINES

L	T	P	Cr
3	1	0	3.5

Course objectives: The students will learn to classify different types of internal combustion engines and their applications .Students will be exposed to fuel air cycles, combustion charts, two stroke engines. The students will study fuel supply systems in SI and CI engines, dual fuel and multi fuel engines, alternative fuels. Detailed study will be done on recent trends in IC engines, emission control strategies.

Course Learning Outcomes (CLOs):

The students will be able to:

1. analyze the engine thermodynamic characteristics using fuel air cycles and combustion charts.
2. evaluate and analyze the parameters in the engine for issues of power generation, emissions and environmental impact, fuel economy.
3. analyze the effects of fuel composition on engine operation and mechanical limitations for ideal performance.
4. analyze the air induction and fuel supply processes for both SI and CI engines.
5. analyze the effect of spark timing, valve timing and lift, cylinder dimensions, compression ratio, combustion chamber design shape.

UME852: POWER PLANT AND PROCESS UTILITY SYSTEMS

L	T	P	Cr
3	1	0	3.5

Course objectives: To impart knowledge on the principle of operation, layouts, components, construction, selection criteria and maintenance and troubleshooting aspects of different types of power plants and industrial utility systems. To impart knowledge on the methods of designing industrial processes and systems using design codes and standards and by developing computer program

Course Learning Outcomes (CLOs):

The students will be able to:

1. design system/process/components by applying the guidelines of codes, standards and catalogs
2. develop process flow diagrams (P&IDs)
3. assess troubleshooting requirements for selected systems, analyze and propose optimum solution
4. develop process flow models acquire/interpret/analyze data from loggers,

UME839 : RENEWABLE ENERGY SYSTEMS

L	T	P	Cr
3	1	0	3.5

Course Objectives: This course introduces various types of renewable energy resources, their characteristics and their advantages over conventional fuels. This course also introduces the technologies for harnessing these energy resources by using simple to advanced energy systems.

Course Learning Outcomes (CLOs):

The students will be able to:

1. calculate the terrestrial solar radiation on an arbitrary tilted surface.
2. use flat plate solar collector mathematical model to calculate the efficiency and performance parameters of the same.
3. determine the plant efficiency of geothermal power plant.
4. select the factors that are required to consider when selecting sites for tapping renewable energy.
5. determine maximum efficiency and maximum obtainable power from a given wind turbine

UME853: SOLAR ENERGY ENGINEERING

L	T	P	Cr
3	1	0	3.5

Course Objectives: The course intends to provide the fundamentals underlying solar energy utilization: Solar Thermal and Solar Photovoltaic. To impart the students, the ability to carry out heat transfer and optical analysis of these solar energy systems. To impart application based knowledge so that students are able to identify key parameters in solar energy utilization.

Course Learning Outcomes (CLOs):

The students will be able to:

1. calculate incident solar irradiance (diffuse and direct components) on flat and inclined surfaces for a given geographical location
2. identify optimum heat transfer fluids for solar energy utilization.
3. select solar selective materials and optimum geometric configurations for harnessing solar energy.
4. draw thermal resistance diagrams relevant to the constituents elements of a given solar thermal system.
5. evaluate the thermal and optical performance of PV and solar thermal systems.