INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIC-503 **Course Title:** Finite Element Methods

L-T-P: 3-0-2 **Credits:** 4 **Subject Area:** PCC

Course Outlines: Basic concepts of finite element analysis, different approaches of finite element analysis, weak formulation, weighted residual methods, Galerkin's method, solution of one-dimensional problems, scalar field problems, eigen value and time dependent problems, single variable problems in 2D, isoparametric formulation, numerical integration, plane stress and plane strain problems.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIC-505 **Course Title:** Numerical Methods for Engineers

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PCC

Course Outlines: Introduction to accuracy, precision, and errors, solving system of linear equations, solving techniques for non-linear equations, numerical differentiation and integration methods, regression analysis, interpolation and curve fitting techniques, solving ordinary differential equations, introduction to finite difference and finite volume methods.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIC-507 **Course Title:** Continuum Mechanics

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PCC

Course Outlines: Introduction and Mathematics Preliminaries, kinematics of deformation, Force and Stress, Conservation laws, Constitutive Theories and boundary value problems, linear elastic, non-linear elastic, and plastic behavior.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIC-501 **Course Title:** Measurements and Instrumentation

L-T-P: 3-0-2 **Credits:** 4 **Subject Area:** PCC

Course Outlines: Essential concepts in measurement and instrumentation, including the importance of process monitoring, sensor functionality, instrument performance, mechanical measurements, data analysis, signal processing, Fourier and Laplace transforms, Optical and imaging-based measurements, environmental condition assessments like emissivity, radiation, and chemical composition.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-514 **Course Title:** Operations Management

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Basic concepts of operations and production management, types of manufacturing systems and their characteristics, System planning and design, qualitative and quantitative techniquesof demand forecasting, Production Planning and Scheduling, Aggregate production planning, material requirement planning (MRP) and manufacturing resource planning (MRP-II), Plant design,types and considerations in the plant location, plant layout types, design, evaluation.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-518 **Course Title:** Forming of sheet metals

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outline: Introduction to SMF and applications, Deformation of sheet materials: uniaxial, biaxial and shear testing, flow stress, instability, effect of temperature and strain rate. Plastic behaviorof sheet metals: stress deviator, invariants, stress triaxiality, Lode parameter, 3D Mohr's circle. Description of yield theories: Isotropic yield models, pi-plane. Introduction to anisotropic yield theories. Hardening models, plastic stress-strain relationship. Process analyses and formabilityevaluation for all processes. Advanced SMF processes and industrial applicationsFailure prediction during SMF, Introduction to finite element modeling of SMF processes. Sustainability in sheet forming.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-572 **Course Title:** Advanced Manufacturing Processes

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Mechanisms of machining, Advances in machining processes: Diamond turning, Hybrid machining processes, Micro machining, Advanced casting processes, process chain in RP, layering techniques, classification of metal working processes, various methods of analyzing the metal working processes (slip-line field theory; stab methods), Effect of strain rate and temperature in metal forming, Advanced metal forming processes.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-575 **Course Title:** Product Design and Development

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Traditional and modern design processes; Organization objectives; Innovation, creation, and diffusion techniques; Evaluation of new product ideas – functional, technological, ecological, legal, Product Modeling and Reverse Engineering, Concept of concurrent engineering, Rapid Prototyping (RP) Methods.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-582 **Course Title:** Flexible Manufacturing Systems

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Classification of manufacturing systems, fundamentals of automated production cycle, types of FMS, applications of FMS, functions of FMS host computer, host system design, planning, scheduling of FMS, FMS simulation, Databases in FMS, GT in FMS, cell design and layout design, CAPP in FMS, Material handling in FMS, case studies in FMS.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-583 **Course Title:** Materials Management

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Bill of materials, Material requirement plans and planning process, capacity planning, Capacity requirement planning, capacity available and required, Scheduling order, forecasting techniques, seasonality, tracking the forecast, inventory and flow of materials, supply anddemand pattern, functions of inventories, ABC, VED and FSN system of selective inventory, JIT philosophy, JIT environment, Manufacturing planning and control in JIT environment.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-584 **Course Title:** Operations Research

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Classification of optimization problems; Optimization techniques, Complex and revised simplex algorithms; Duality theorems, sensitivity analysis; Assignment, transportation and transshipment models; Game Problems: Mini-max criterion and optimal strategy, Waiting Line Problems: Classification of queuing situations; Kendall's notation, Dynamic Programming, Non- linear Programming: One dimensional minimization methods; Unconstrained optimization techniques.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-585 **Course Title:** Supply Chain Management

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Understanding supply chain, supply chain performance; supply chain drivers and obstacles, planning supply and demand; managing predictable variability, Economic Order Quantity Models, Reorder Point Models, Multi-echelon Inventory Systems, Managing economies of supply chain, managing uncertainty in a supply chain, Network design in a supply chain, Role of Coordination and E-business in a supply chain.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-586 **Course Title:** Metal Forming

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Stress/strain, strain-rate characteristics of materials, yield criteria of metals, c1assification of metal working processes, formability and theory of sheet metal working, friction and lubrication in metal working operation, theories of friction and lubrication; assessment of friction at interface, Process analysis, Mechanics of forming processes, Hydrostatic extrusion, High speed forming.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-587 **Course Title:** Metal Casting

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Features of casting problem, a survey and scope of foundry industry, Solidification of pure metals and al1oys, nucleation and growth in alloys, solidification of actual castings, progressive and directional solidification, Riser design, risering curves, NRL method of riser design, recent developments in riser design by the application of geometrical programming, Pattern and Casting Design, Melting, Molding and Core Making Processes, Internal Stresses, Defects and Surface Finish, Testing, Inspection and Quality Control.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-588 **Course Title:** Non-Traditional Machining Processes

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Types of advanced manufacturing processes; Evolution, need, and classificationof advanced machining processes, Mechanical Type AMPs, Advanced Fine Finishing Process, Chemical Type AMPs, Electro Chemical Type AMPs, Thermal Type AMPs, Derived and HybridAMPs, Process Parameters; Process Capabilities; Applications; Limitations of above processes.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-599 **Course Title:** Surface engineering

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Different surface degradation phenomena, importance of the surface engineering techniques, their benefits and limitations. Materials for Surface Engineering, Coating based Surface Modification Techniques, Diffusion based Surface Modification Techniques, Selective characterisation techniques for quality assurance of engineered surfaces.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-601 **Course Title:** Additive manufacturing

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Classification of additive manufacturing (AM) processes, geometric modeling, curves design, surface designs and various solid modeling techniques for additive manufacturing, transformations for computer graphics, Process planning for additive manufacturing, STL file generation, Accuracy issues in additive manufacturing, properties of metallic and non-metallic additive manufactured surfaces.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-607 **Course Title:** Processing of non-metals

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Classification of engineering materials and processing techniques, various types of non-metals, basic nature of non-metals, properties of various non-metals, challenges in processing ofnon-metals, glass forming, heat treating glass; classification of ceramics, structure and properties, synthesis of ceramic powders, processing of ceramic products, ceramic coatings.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-633 **Course Title:** Quality Management

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Quality of products, services and total quality control and its impact on the organization; product reliability and life cycle, safety, product quality and process capability, Machineand process capability analysis, attributes quantities and their measurements etc; Theory of control charts, acceptance sampling plans for attributes and variables. Just in Time (JIT) – philosophy, ISO-9000 prerequisites, Participative approach and team work, training and motivation.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-553 **Course Title:** Industrial Tribology

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Brief Overview, Tribological considerations, Stribeck curve, Surface topography, Friction Theories, Wear mechanism, Functions of lubricants, Industrial lubricants and additives, Various types of lubricants (ER, MR, Couple stress, Micro-polar, ferro etc.) and lubrication systems, VI Index, Influence of various parameters on lubricating performance of lubricants, Selection of lubricants, Fundamentals of fluid film lubrication, Hydrodynamic/Hydrostatic bearing configurations, Common fluid film bearing failures, Failure analysis, Developments of mathematical model for fluid film bearing systems, Use of FEM to predict the performance of fluid film bearings.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-555 **Course Title:** Experimental Stress Analysis

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Introduction, Photoelasticity, Photoelastic methods, Birefringent Coatings, Scattered Light Photoelasticity, Moire Method of Strain Analysis, Brittle Coatings, Digital Image Processing.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-556 **Course Title:** Dynamics of road vehicles

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Introduction to Vehicle Dynamics, Mechanics of Pneumatic tyres, Performance Characteristics of Road Vehicles, Handling and Stability Characteristics, Vehicle Ride Characteristics, Experimental Testing Methods.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-562 **Course Title:** Noise Control in Mechanical Systems

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Introduction to Sound and Noise; Sources of noise in mechanical systems; Sound signal analysis – decibel levels, octave and one-third octave distributions; Instrumentation for measuring noise; Principles of Noise Control; Noise control materials – barriers, enclosures, absorbers, resonators and metamaterials; Measures of noise control performance; Case studies on Noise control in mechanical systems.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-602 **Course Title:** Bond Graph Modelling of Engineering Systems

L-T-P: 3-1-2/2 **Credits**: 4 **Subject Area:** PEC

Course Outlines: Introduction; Causality; Creation of System Equations; Creation of System Bond graph; Use of non-inertial coordinates; Structural members; Modeling of multi body systems; Approaching Control System; Fault Detection and Isolation (FDI).

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-519 **Course Title**: Modeling and Simulation

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Concepts, techniques and tools for design, modeling and simulation of thermal systems; Mathematical modeling of conservation laws, steady state and dynamic simulation of thermal components and systems, numerical solution, optimization of thermal systems and different techniques of optimization.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-520 **Course Title:** Advanced Thermodynamics

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Exergy analysis of power and refrigeration cycles, Thermodynamic property relations, Residual property functions, Properties of saturation states, Thermodynamic properties of homogeneous mixtures, Fugacity relations for real gas mixtures, Ideal solutions, Phase equilibrium, Thermodynamic analysis of reacting systems, Fuel cells, Exergetic efficiency of reacting systems, Chemical equilibrium, Equilibrium flame temperature.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-521 **Course Title**: Advanced Fluid Mechanics

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Advanced analytical tools for fluid flow analysis. Basic laws of fluid mechanics in integral and differential form, Potential flows, low Reynolds number flow, high Reynolds number flow, Compressible and shocks.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-522 **Course Title**: Advanced Heat Transfer

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Advanced techniques for the analysis of heat transfer processes in thermal systems; Different modes of heat transfer such as conduction, convection, radiation, heat transfer with phase change and numerical methods of heat transfer.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-523 **Course Title**: Gas Turbines & Compressors

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Concepts of gas flow through a cascade of blades, the working on centrifugal and axial compressors, axial turbines, and turbo-jet engines. Design considerations and the operating performance of turbines and compressors.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-524 **Course Title**: Two Phase Flow & Heat Transfer

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Types of phase associations, Flow regimes; Flow pattern maps; Analytical models, Homogeneous flow models, Separated flow models, Drift flux model, Numerical models, Regimes of boiling, Heat transfer rates in pool boiling, Forced convection boiling, Heat transfer correlations, Nusselt theory of condensation, boundary layer treatment of laminar film condensation, Slurry transport, Pneumatic conveying.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-525 **Course Title**: Solar Energy

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Solar energy, its availability, utilization and economic viability. Solar radiation, heat transfer concepts, flat plate/focussing collectors, energy storage, solar heating/cooling, solar process modeling and solar photovoltaics.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-527 **Course Title**: Computational Fluid Dynamics & Heat Transfer

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Numerical simulation of fluid flow and heat transfer processes; Mathematical modeling of conservation laws, mathematical classification, finite difference and finite volume techniques for spatial discretization, numerical methods for solution of algebraic systems, time integration methods, methods for Navier-Stokes equations, and numerical approaches for simulation of turbulent flows.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-528 **Course Title**: Boundary Layer Theory

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Concept of boundary layer, Navier-Stokes equations, Energy equation, Exact solutions of N-S Equation, Two dimensional laminar boundary layer equation, Integral approach, Similarity solutions (Wedge flow, flow past a cylinder), Approximate methods, Numerical methods, Axially symmetrical boundary layer, Stability of laminar flow, Boundary layer control, Turbulent boundary layer, Thermal boundary layer, Forced and natural convection.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-529 **Course Title**: Turbulent Flows

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Analytical, experimental, modeling, and computational tools for analyzing turbulent flow. Statistical description of turbulent flow, turbulent transport phenomena, free shear flow, wall bounded turbulent flows, turbulence modelling, experimental techniques used in turbulent measurements.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-532 **Course Title:** Renewable Energy Systems

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Renewable energy systems towards sustainable development of the society; Solar energy systems, micro and smallhydro energy systems, biomass energy systems, wind energy systems, geothermal energysystems, energy from the oceans, integrated energy systems.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-539 **Course Title**: Micro and Nano Scale Thermal Engineering

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Basic statistical thermodynamics, Continuum assumption, Governing equations, Constitutive relations, Slip theory, Surface tension and interfacial energy, Young- Laplace equation, Wetting and contact angles, Capillary flows, Electrokinetic flows, Two-phase flow heat transfer in micro channels, Radiative properties of nano materials, Microscale thermal sensors and actuators, Nanofluids, Micro fluidic devices, Micro Fabrications.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-540 **Course Title:** Combustion

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Combustion phenomenon and various practical combustion systems by covering the basics of thermodynamics of combustion, kinetics of combustion, flames, burning of condensed phase, ignition, combustion generated pollution and its control.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-543 **Course Title**: Fluid Power Systems

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Types of Fluid Power Control System, Pumps and Valves, Actuators, Hydraulic and Pneumatic Control Systems, Hydraulic and Pneumatic Circuit Design and Analysis, Fluid Logic Control System, Electro-hydraulic Servo Control Systems.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-544 **Course Title**: Design of Heat Exchangers

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Construction, design, performance and testing of different types of heat exchangers; Classification and design of different heat exchangers, optimum design, performance behavior of heat exchangers in different conditions, numerical modeling and experimental testing, few case studies related to different components of thermal power plants, refrigeration and HVAC systems.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-604 **Course Title**: Fire Dynamics

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Premixed flames, diffusion flames and fire plumes, steady burning of liquids and solids, frictionless compressible flow, ignition and spread of flames, pre-flashover and post-flashover compartment fire, production and movement of smoke.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-612 **Course Title:** Hydrodynamic Stability

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Linear stability theory and various flow instabilities including thermal and centrifugal instabilities, stability of parallel flows, and instabilities in multiphase systems, along with formulation of stability problems in different flow scenarios.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-632 **Course Title:** Advanced Gas Dynamics

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Compressible, advanced solution methods in gas dynamics such as the Hodograph method, small perturbations theory, methods of characteristics, similarity rules, Riemann Solvers, Flux-Vector Splitting, and Flux-Difference-Splitting Method.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-501 **Course Title:** Failure Analysis and Prevention Joints

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Fundamental sources of failure, industrial engineering tools for failure analysis, general practice in failure analysis, examination of fractured components, identification of mode of failure, factors affecting mode of fracture and defects, analysis of the causes of failure including metallurgical and chemical analysis, application of fracture mechanics in failure analysis.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-610 **Course Title:** Laser Material Processing

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Properties of laser; Types of laser, gas, liquid and solid state lasers, Laser- Material Interaction, Application of laser in material removal processes like cutting, drilling, grooving; Laser assisted machining (LAM); Laser micromachining, Laser Welding, Laser Heat Treatment, Lasers in Surface Engineering Applications.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-613 **Course Title:** Fusion Joining technologies

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Principles of fusion joining, heat sources, power density, weld pool protection, weld thermal cycle and joint performance, metal properties and weldability, weld and heat affected zone, gas metal and slag metal reactions and solid state transformation in weld and HAZ, Fundamentals of resistance welding.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-614 **Course Title:** Solid State Joining Technologies

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Feasibility and applications, comparison with fusion joining technologies, principlesof solid state joining, metal properties and weldability by solid state joining, weld and heat affected zone, deformation and its effect on microstructure and properties of weld and HAZ, Macro and micro deformation based joining, Diffusion based joining, Heat treatment of weld joints for improving joint performance.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-615 **Course Title:** Material Characterization & Testing

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Engineering materials, properties of materials; crystal structure, strengthening mechanisms in metals; fundamentals of materials characterization; basic sample preparation and interpretation of data. Optical Microscopy, Electron Microscopy, X-ray Diffraction, Thermal and Thermomechanical Methods, Mechanical Testing.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-622 **Course Title:** Metallurgical Aspects in Joining and Additive Manufacturing

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Importance of metallurgical changes in metal joining and additive manufacturing, effect of material characteristics namely composition, mechanical properties, physical properties on joining and additive manufacturing, metallurgical transformation in fusion zone and heat affected zone, autogenous and heterogeneous welding, Solidification and weld zone, Transformation in HAZ, Metallurgical aspects of solid state joining.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-624 **Course Title:** Design and Analysis of Joints

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outline: Weldability of structural steels, carbon equivalent, tensile, impact, fatigue and creep properties of welded joints, theories of failures, Design for Static Loading, Design for Fatigue loading, Industrial Applications of Weld Design, Heat flow in Welding.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-627 **Course Title:** Hybrid Joining Technologies

L-T-P: 2-1-0 **Credits:** 3 **Subject Area:** PEC

Course Outlines: Hybrid adhesive bonding with mechanical joining, Hybrid adhesive bonding with solid state joining techniques, bonding with fusion welding, Hybrid fusion welding techniques, Advances in hybrid joining.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-631 **Course Title:** Dissimilar Metal Joining

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Fundamental causes of issues in dissimilar metal joining, common challenges in dissimilar metal joining, applications of dissimilar metal joining, Asymmetric weld andembrittlement of fusion weld joints of dissimilar metals, cracking, residual stress and distortion issues in fusion weld of dissimilar metals, dissimilar metal joining by laser and electron bean welding, Solidstate joining, Quality assessment of dissimilar metal joint.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-502 **Course Title:** Robotics and Control

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines**:** Introduction; Robot Elements and Control; Modeling of Robots; Manipulator Dynamics; Linear and Non-Linear Control of Manipulators; Force Control of manipulators; Robot Programming.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-503 **Course Title:** Computer Aided Manufacturing

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Automation; Introduction to computer integrated manufacturing (CIM), Components of NC system, Computer Numerical Control (CNC), Machining Center, and Direct Numerical Control (DNC), Robot Anatomy and Related Attributes, Robot Control Systems, Material Handling and Storage, Group Technology (GT), Computer Aided Process Planning (CAPP).

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-508 **Course Title:** Advanced Automatic Control

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Mathematical models of linear systems, Linear algebra, State variable analysis, Stability of control systems, Controllability and observability, System realizations, State feedback and observers, Optimal control and estimation, Pole placement and mode matching.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-509 **Course Title:** Extended Finite Element Methods

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Basic concepts of finite element methods, Basics of extended finite element method (XFEM), partition of unity finite element method, generalised finite element method, introduction to XFEM, strong and weak discontinuities, blending elements, level set function and enrichment, XFEM for static cracks, crack growth, bi-materials and phase change problems, concept of phantom nodes, embedded elements, interface elements, smeared cracks.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-510 **Course Title:** Shock Phenomena

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Shock waves; Shock generation in condensed matter; Elastic-plastic response of solid under shock; Properties of Metals and alloys under elevated temperature; Behaviour of brittle material under shock loading; Phase transition in shock-compressed solids.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-511 **Course Title:** Materials Behaviors under Extreme Conditions

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Basic of plasticity in metals; Bulk plastic behavior; Material behavior under shock loading; Effect of limiting sample dimensions on material behavior; Effect of ultrasonic waves on plasticity; Electro-plasticity in metals.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-513 **Course Title:** Impact Mechanics

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: The course aims at providing the basic concepts and broad overview of impact phenomenon as a focused application of diverse topics such as rigid body dynamics, structural dynamics, contact mechanics, shock and vibration, wave propagation, and material modeling, understanding of the physics and mathematics of impact process. Introduction, Rigid body impact mechanics, Single- and multi-dimensional impact mechanics of deformable bodies, Modeling deformation and failure under impact, Experimental and computational techniques, Blunt, ballistic, and blast impact, Application examples and case studies, Impact mitigation.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-515 **Course Title:** Manufacturing System Analysis

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Modes of manufacturing – job/batch/flow and multi-product, small-batch manufacturing, Centralized versus distributed control; Real-time vs. discrete event control, Deterministic and Stochastic models, continuous and discrete mathematical modeling methods-Discrete event, Monte Carlo method; Basic Concepts of Markov Chains and Processes, Transient analysis of manufacturing systems, Analysis of a flexible machining center; Product flow analysis; Rank order clustering; Process flow charting; MRPI& II, Kanban, OPT, JIT-Pull and JIT-Push, Line of balance.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-517 **Course Title:** Automated Materials Handling Systems

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Overview of MHE, consideration in MHS design, Industrial trucks, automated guided vehicle systems, monorails and other rail guided vehicles, conveyor systems, cranes and hoists, Evaluation and Selection of Material Handling Layout, Analysis of Material Transport Systems, Automated Storage & Retrieval Systems (AS/RS).

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-547 **Course Title:** Product and Process Optimization

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Introduction to Classical Optimization; Problem Formulation; Graphical Optimization; Necessary and Sufficient conditions for optimality for different problem types; Linkage of Necessary conditions with Linear Programming; Methods for Unconstrained and Constrained Optimization; Introduction to Single and Multi-objective Evolutionary Optimization; Advanced topics.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-550 **Course Title:** Advanced Machine Design

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Failure theories, Hertzian contact stresses, theory of limit design; residual stresses, design against fracture, linear elastic fracture mechanics, fracture in design, design against fatigue and creep, design for reliability.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-551 **Course Title:** Dynamics of Mechanical Systems

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Basic concepts, Lagrangian Dynamics, Holonomic and non-holonomic constraints, Hamilton's principle, Multibody Dynamics, Newton-Euler Equations, Stability of Motion, Routh's Criteria, Liapunov's theorem, Control System Dynamics, open and Closed loop systems, Proportional, Integral and Derivative Control.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-558 **Course Title:** Fracture Mechanics

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Introduction to fracture mechanics, linear elastic fracture mechanics (LEFM), crack deformation modes and basic concepts, crack tip stresses and deformation, stress intensity factor (SIF), principle of superposition, LEFM design concept applications, concept of energy release rate, fracture toughness, fatigue crack growth, fatigue life calculations, mixed-mode fatigue crack growth, elasto-plastic fracture mechanics (EPFM), crack opening displacement (COD), *J*-integral, crack growth resistance (R-curve).

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-559 **Course Title:** Computer Aided Design

L-T- P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Basic concepts of design, Geometric Modelling, representation of curves, surfaces and solids, Advanced geometric algorithms (Knot insertion, Knot refinement, Knot removal, degree elevation, Degree reduction) features based modeling, Software packages for 3D modelling and design.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-560 **Course Title:** Mechanics of Composite Materials

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Introduction to composites, fabrication techniques, macro-mechanical analysis of lamina, micromechanics, classical laminate theory, analysis of laminates, failure analysis of lamina and laminate, design of laminates.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-561 **Course Title:** Advanced Mechanical Vibrations

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Review of free and forced, undamped and damped vibrations, Vibration isolation, Vibration absorbers, MDOF systems, Stability, Nonlinear Vibration, Vibration of continuous systems, Random Vibration, Diagnostic techniques.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-567 **Course Title:** Computer Graphics

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Role of Computer Graphics in CAD/CAM, Geometric Transformations and Projections, Curves, Surfaces, Geometric Modeling, Data Structure in Computer Graphics, Software packages, Computer programming and algorithm development.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-568 **Course Title:** Advanced Robotics

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Introduction; Robots with Flexible Elements; Parallel Mechanisms and Robots; Mobile Robots: Wheeled mobile robots; Legged robots. Cooperative Manipulators, Advanced Robots; Control of Manipulators; Image Processing and Analysis with Vision Systems; Fuzzy Logic Control.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-608 **Course Title:** Fatigue in Structures & Materials

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Introduction to Fatigue and its failure modes, Types of fatigue, S-N curve, Damage mechanisms in fatigue, Fish-eye formation, Material Modelling under cyclic loadings: Hardening and Softening, Introduction to crack-closure, types of crack closure, S-N-p diagram, Fatigue crack growth, Long and short cracks, Environmental fatigue failures, numerical modeling approaches, Introduction to ASTM codes for fatigue tests.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/ CENTRE/SCHOOL: Department of Mechanical and Industrial Engineering

Subject Code: MIL-570 **Course Title:** Energy and Variational Principles in Engineering Mechanics

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Kinematics and kinetics of deformation; Constitutive laws; Boundary value problems in solid mechanics; Introduction to variational calculus; Idea of a functional; Fundamental lemma of variational calculus; Functions of single and multiple variables; Principle of virtual work; Castigliano's theorems; Analysis of bars, beams, plates and general 3D deformable bodies under static loading conditions; Strong and weak forms of the governing equations; Finite element method; Energy methods in dynamics: Hamiltonian and Lagrangian dynamics; Principle of least action; Deformable body dynamics: vibration of stings, axial bars, beams, plates, and general 3D deformable bodies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Mechanical and Industrial Engineering

Subject Code: MIL-531 **Course Title:** Hydro-dynamic Machines

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Basic principles of hydro-dynamic machines, Performance characteristics of Impulse and Reaction turbines, Design of Pelton wheel and bucket, Francis and Kaplan turbines, Runner design, Cavitation, Speed regulation mechanism, Performance and design of centrifugal, mixed and axial flow Pumps, NPSH and Cavitation, Fluid Power Transmission, Fluid couplings and Torque converters.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Mechanical and Industrial Engineering

Subject Code: MIL-541 **Course Title:** Bio-Fluid Mechanics

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Anatomy and physiology from fluid flow perspective; Conservation equations, models for non-Newtonian fluids; Blood rheology and mechanics of circulation; Arterial wave propagation; Flow through the pulmonary, ocular, and renal system; Flow and lubrication in the musculoskeletal system; Oxygen diffusion from blood to tissues. Computational methods for bio-fluids.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Mechanical and Industrial Engineering

Subject Code: MIL-545 **Course Title**: Fuel Cells

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Basics of fuel cell operation, hydrogen fuel cells, types and applications, fuel cell thermodynamics: electrode kinetics, Butler-Volmer equation, fuel cell electrochemistry, transport mechanisms of charge mass and heat, materials, properties, processes, membrane, electrodes, bipolar plates, stack design, PEM fuel cell, applications. fuel cells and hydrogen economy.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Mechanical and Industrial Engineering

Subject Code: MIL-533 **Course Title:** Refrigeration & Air-Conditioning System Design

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Basics of load calculations in buildings; vapor compression refrigeration: multiple evaporator and compound compression systems; Vapor absorption system- analysis; solid carbon dioxide production. Equipment design: compressors, evaporators, condensers, and expansion devices; AHUs, air diffusers; thermal comfort, indoor environmental health; applications: cold storage, data center, warehouses and mobile air conditioners.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Mechanical and Industrial Engineering

Subject Code: MIL-536 **Course Title**: Convective Heat and Mass Transfer

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Various aspects of the convective heat transfer, Internal and external flow, Laminar boundary layer, Natural/free convection, forced convection, Turbulence fundamentals & turbulence boundary layer flow, Turbulence model, Boiling & condensation, Convective mass transfer & molecular diffusion, and Simultaneous heat & mass transfer.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Mechanical and Industrial Engineering

Subject Code: MIL-537 **Course Title**: I. C. Engines

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Gas exchange processes, Thermodynamic analysis of IC Engine cycles, Combustion in SI Engines: flame structure, cyclic variations in combustion, abnormal combustion, Combustion in CI Engines: diesel combustion systems, fuel spray behavior, ignition delay, Supercharging, Turbocharging, Pollutant formation and control: Nitrogen oxides, Carbon monoxide, unburned hydrocarbons, and particulate matter, Lubrication.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Mechanical and Industrial Engineering

Subject Code: MIL-538 **Course Title**: I. C. Engine Combustion Processes Modelling

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Modeling of processes in IC Engines, optimization of thermodynamic engine cycles. model fluid flows in the engine, e.g., swirl, tumble, etc, modeling of combustion processes in spark and compression ignition engines, knock, autoignition, spray modeling, droplet dynamics, modeling of pollutants (CO, NOx, and soot) formation.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Mechanical and Industrial Engineering

Subject Code: MIL-542 **Course Title:** Energy Management

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Energy scenario, forms of energy, energy management and its importance, recent trends in energy conservation; Energy Auditing and Instrumentation, energy balance; Energy Economics, Payback period, time value of money, IRR NPV, life cycle cost; Monitoring and Targeting, data and information, analysis techniques; Energy Efficiency in Thermal Utilities; Energy Efficiency in Electrical Utilities.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Mechanical and Industrial Engineering

Subject Code: MIL-629 **Course Title:** Reverse Engineering and Rapid Tooling

L-T-P: 2-0-2/2 **Credits:** 3 **Subject area:** PEC

Course Outlines: Introduction to reverse engineering, Methodologies and techniques for reverse engineering, Reverse engineering hardware and software, Reverse engineering in automotive, aerospace, and medical device industries, Introduction to rapid tooling and prototyping, Relationship between reverse engineering and rapid prototyping (RP), Data Translations (CAD to RP), Manipulation and editing of STL data (Triangulated meshes).

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Mechanical and Industrial Engineering

Subject Code: MIL-512 **Course Title:** Introduction to Biomechanics

L-T-P: 3-1-2/2 **Credits:**4 **Subject Area:** PEC

Course Outlines: Introduction to biomechanical analysis, Fundamentals of solid mechanics, Measurement of kinematics and kinetics of motion, Experimental techniques to characterize motion of biological tissues, Biomechanics of human joints, Biomechanics of hard and soft tissues, Mechanical characterization and constitutive modeling of soft tissues, Cellular biomechanics, Biomechanical analysis using computational or experimental techniques.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Mechanical and Industrial Engineering

Subject Code: MIL-516 **Course Title:** Artificial Intelligence

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Artificial Intelligence: Definition, History, scope; State spaces and Production systems: Uniformed and Informed search algorithms, Depth first search, breadth first search, Heuristic search techniques, local search; Knowledge representation; Reasoning and inference strategies: Constraint satisfaction problem, Logic based AI, Probability based AI: Bayesian Network.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Mechanical and Industrial Engineering

Subject Code: MIL-552 **Course Title:** Advanced Mechanics of Solids

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Introduction to kinematics, stress and balance principles, Some aspect of objectivity, objective rates, invariance of elastic material response, Hyper-elasticity materials (Isotropic, Incompressible, Compressible and Transversely isotropic), Material and Spatial elasticity tensors, Strain energy functions, Thermodynamics of materials, potentials, internal variables, Large elasto-plastic deformation, rate kinematics, rate independent plasticity, incremental kinematics, Large deformation viscoelasticity

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Mechanical and Industrial Engineering

Subject Code: MIL-554 **Course Title:** Computer Aided Mechanism Design

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Review of kinematic analysis of mechanisms, degrees of freedom, Grashof's and Gruebler's criteria, transmission and deviation angles, Type, number and dimensional synthesis, Chebyshev accuracy points and polynomials, path motion and function generation, analytical and graphical synthesis, Freudenstein's equation, Inflection points and inflection circle, Euler-Savary equation, Bobillier and Hartmann's construction. Dynamic force analysis, Kinetic-static analysis by superposition and matrix approaches and its applications, introduction to spatial mechanisms, Software packages for the mechanism design.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Mechanical and Industrial Engineering

Subject Code: MIL-563 **Course Title:** Mechatronics

L-T-P: 3-1-2/2 **Credits**: 4 **Subject Area:** PEC

Course Outlines: Sensors and Transducers Performance Terminology; Displacement, Velocity, Acceleration, Force, Flow Sensors; Pneumatic, Hydraulic, Electrical and Mechanical Actuators; Signal Conditioning, OP-AMP as Signal Conditioner; Microprocessors and Microcontrollers; Bond Graph Models of Mechatronic Systems, Modeling and Dynamic Response of Systems; Transfer Function and Frequency Response; Design of Mechatronics Systems; Case Studies of Mechatronic Systems.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Mechanical and Industrial Engineering

Subject Code:MIL-565 **Course Title:** Smart Materials, Structures, and Devices

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Intelligent materials, Intelligence inherent in materials, Materials intelligently harmonizing with humanity, Intelligent biological materials, Actuator materials, Sensing technologies, Microsensors, Intelligent systems, Hybrid smart materials, Passive sensory smart structures, Reactive actuator-based smart structures; Active sensing and reactive smart structures, Electro rheological fluids and actuators, Piezoelectric materials, Shape memory alloys, Shape memory plastics, Light propagation in an optical fiber, Fiberoptic strain sensors, Piezoelectric Vibrations Absorber Systems, Modeling of Shells, Modeling of plates and beams.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Mechanical and Industrial Engineering

Subject Code: MIL-566 **Course Title:** Computer Aided Analysis of Mechanical Systems

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines: Computers in Design and Manufacturing, Basics of Computer Aided Design and analysis, Multibody Mechanical Systems, Computational methods, Vectors and matrices, Basic concept and numerical methods in Kinematics, Planar Kinematics. Algorithm and code development for analysis of planar kinematics, Euler parameters, Special kinematics, Basic concept in dynamics, Planar dynamics, Algorithm and code development for analysis of planar dynamics, Spatial dynamics, Numerical methods for ODE, Numerical methods in dynamics, Static Equilibrium analysis.