SIR PADAMPAT SINGHANIA UNIVERSITY
Department of Mechanical Engineering

Programme: B.Tech **Session:** 2011-14

SEMESTER VIII

Code	**ME407**	**L**	**T**	**P**	**C**
Subject	**Power Generation and Economics**	**3**	**0**	**0**	**3**

Objective: This course discusses the theories and applications of power generation technologies. Various types of plants like hydro-electric, steam power, gas power, nuclear power and non-conventional power are discussed along with the economy associated with them.

Courseoutline:

Introduction:
Energy sources and their availability, Principle types of power plants, their special features and applications, present status and future trends.

Hydro Electric Power Plants:
Essentials, classifications, Hydroelectric Survey, rainfall run off, Hydrograph, flow duration curve, mass curve, storage capacity, site selection, plant layout, various components, Types of turbines, Governor & speed regulation, pumped storage, Small scale Hydro-Electric plants (mini and micro) .

Steam Power Plant :
General developing trends, essentials, plant layout, Coal-its storage, preparation, handling, feeding and burning, Ash handling, dust collection, high pressure boilers and steam turbines, their main components like super heaters, economizers, pre-heaters etc. fuel,efficiency/Heat,balance.

Gas Turbine Power Plants:
Field of use, components, plant layout, comparison with steam power plants, combined steam and gas power plants.

Nuclear Power Plant:
Nuclear fuels, nuclear energy, main components of nuclear power plant, nuclear reactors types and applications, radiation shielding, radioactive and waste disposal safety aspect.

Non Conventional Power Generation:
Geothermal power plants, Electricity from biomass, Direct energy conversion systems, Thermo-Electric conversion system, Fuel Cells, Magneto Hydro Dynamic system.

Power Plant Economics:
Cost of electrical energy, selection of type of generation and generation equipment, performance and operating characteristics of power plants, economic

Scheduling Principle, Load curves, effect of load on power plant design, methods to meet variable load, Load Forecasting, Electric tariffs. Theory of Peak Load Pricing, Theory and Issues of Real Time Pricing Comparison of Public Supply and Private Generating units.

Cogeneration:
Definition and scope, Cogeneration technologies, Allocation of costs, sale of electricity & impact on cogeneration.

Text / Reference Books:

1. Power plant Engineering by Domkundwar
2. Power Plant Engineering, P.K. Nag, Tata McGraw Hill
3. A text Book on Power Plant Engineering by Rajput, Laxmi publishers

Code	**ME408**	**L**	**T**	**P**	**C**
Subject	**Production and Operation Management**	**3**	**0**	**0**	**3**

Objective: This course discusses the various aspects of production management and operation management as prevalent in mechanical industries. Latest relevant management methods will also be discussed.

Courseoutline:

Product development:
Principal of good product design, Component and tolerance design, Efficiency, quality and cost construction, Product life cycle, Standardisation, simplification, diversification 3

Supply chain management 3

Quality Management:
Quality analysis and control, Total Quality Management, TQM and continuous improvement, customer focus, Quality awards and concepts, PDCA cycles, Bench marking, Quality function deployment, Taguchi Method, Design of Experiments, Zero defects, and six sigma, Quality circle. 6

Sales Forecasting and Inventory Control :
Forecasting, Casual and time series models, moving average, exponential smoothening,trend and seasonality. Classification of Inventories – Direct and Indirect, Inventory Control, Need and Advantages, Zero Inventory Economic Lot Size; ABC Analysis and Applications. 8

Net work Techniques:
Historical Development of PERT/CPM Techniques, Basic Definitions in PERT/CPM, Fulkerson I – J Rule, Time Estimates and Critical Path in Network Analysis, Application Areas of PERT/CPM Technique. 6

Aggregate Production Planning:
Master scheduling, bills of materials and MRP, Purpose and scope, Basic strategies, Disaggregating methods, Order control and flow control, Routing, Scheduling and priority dispatching, Operations scheduling. Assembly line balancing. 8

JIT, Kanban pull system, Bottleneck scheduling and theory of constraints 3

Management information system:
Value of information, Information storage and retrieval system-data base and data structure, Interactive system, and Knowledge base systems 2

Text/Reference Books:

1. Production and Operation Management by Adam, Ebert.
2. Production and Operation Management by K.C. Arora.
3. Production Management by Buffa
4. Production Planning & Inventory Control by Narsimhan
5. Operation Research by Hira & Gupta
6. Operation Research by H.A.Taha

Code	**ME4XX**	**L**	**T**	**P**	**C**
Subject	**Elective III**	**3**	**0**	**0**	**3**

Students will choose one course from the following courses covering various specializations of mechanical engineering and other relevant fields.

Code	**ME420**	**L**	**T**	**P**	**C**
Subject	**Non Traditional Machining Methods**	**3**	**0**	**0**	**3**

Objective: This course discusses those machining methods which have special applications in mechanical industries.

Courseoutline:

Introduction:
Classification of non-traditional Machining Processes, considerations in process selection.

Mechanical Processes:
Ultrasonic machining. Elements of USM, Mechanics of cutting, effect of parameters on material removal rate and surface finish, economic considerations, applications and limitations, recent developments; Abrasive Jet Machining, variables affecting material removal rate, applications advantages and limitations;

Electro-Chemical and Chemical Processes:
Electro-Chemical Machining: Elements of the process, Electrolytes and their properties.
Chemistry of the process, metal removal rate; advantages, applications and limitations of the process.

Chemical Machining:
Elements of the process, Resists and Etchants, Advantages and applications.

Thermal Processes:
Electric Discharge machining: Mechanism of metal removal, EDM Equipment , Dielectric fluids, selection of electrode material, accuracy and surface finishapplications.

Plasma Arc Machining:
Mechanism of Metal Removal, PAM parameters. Economics and applications of Plasma jets.

Electron Beam Machining:
Generation and control electron beam, Theory of Electron Beam Machining Process capabilities and limitations.

Laser Beam Machining:
Principles of working. Thermal aspects, material removal, Advantages and Limitations.

Text/Reference books:

1. Pande P. C. and Shan H. S., "Modern Machining Processes", Tata McGraw-Hill Publishing Co. Ltd.
2. Benedict G. F., "Nontraditional Manufacturing Processes", Marcel Dekker Inc.
3. Jain V. K., "Advanced Machining Processes", Allied Publishers.

Code	**ME421**	**L**	**T**	**P**	**C**
Subject	**Tribology and Lubrication Technology**	**3**	**0**	**0**	**3**

Objective: This course discusses the theory of tribology, theory of lubrication and theory of bearing design.

Courseoutline:

Tribological Considerations:
Nature of surfaces and their contact, physico-mechanical properties of surface layer; geometrical properties of surfaces, method of studying surface; Contact ofsmooth surfaces, contact of rough surfaces; Role of friction, laws of static friction, causes of friction; Adhesion, adhesion theory, laws of rolling friction, friction of metals and nonmetals, friction measurement; Wear definitions, types of wear, mechanism of wear, factors affecting wear behaviour, measurement of wear, a brief introduction of wear test equipments, wear in plastics. **12**

Industrial Lubricants and their Additives:
Functions of lubricants; Types of lubricants and their industrial uses; Solid lubricants and
their functions, liquid mineral lubricants, synthetic liquid lubricants, greases, properties of liquid and grease lubricants; Viscosity, Newtonian and non-Newtonian lubricants, temperature and pressure dependence measurement, other properties of lubricants; Lubricant additives, general properties and selection for machines and processes; Oil reclamation and preventive maintenance for lubricants. **10**

Fluid-Film Lubrication:
Fluid mechanics concepts, equations of continuity and motion; Generalized Reynolds equation with incompressible and compressible lubricants; Hydrodynamic lubrication; Tower's experiment, finite bearings, partial journal bearings, solution or finite bearings using Galerkin method, finite difference and FEM; Hydrostatic lubrication: Basic concepts, applications, compensated thrust and journal bearings and their solution using FEM, controlling flow with restrictors, design of restrictors for compensated bearings.

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Bearing Design and Selection of Bearings:
Comparative performance of various modes of lubrication, and bearing selection; Design of slideway bearing and hydrostatic thrust bearing, fixed type hydrodynamic and hydrostatic journal bearings, materials for sliding bearings; Bearing types, selection of rolling elements bearing, bearing life, bearing load, bearing selection. **06**

Text/Reference Books:

1. Balling, J., "Introduction to Tribology", Wykeham **1976**
2. Rowe, W.B., "Hydrostatic and Hybrid Bearing Design", 2nd Ed., Butterworth – Heinemann. **1983**
3. Khonsari, M.M., and Booser, E.R., "Applied Tribology: Bearing Design and Lubrication", 2nd Ed., John Wiley & Sons **2001**
4. Gross, W., Matsch, L., Castelli, V., Eshel, A., Vohr, J., and Wildman, M., "Fluid Film Lubrication", John Wiley & Sons **1980**
5. Hamrock, B. J., Jacobson , B.O., and Steven, R. S., "Fundamentals of Fluid Film Lubrication", 2nd Ed., Marcel Dekker **2004**
6. Mang, T., and Dresel, W., "Lubricants and Lubrication", 2nd Ed., John Wiley & Sons **2007**

Code	**ME422**	**L**	**T**	**P**	**C**
Subject	**Basics of Wind Engineering**	**3**	**0**	**0**	**3**

Objective: This course discusses various aspects of wind engineering and its application in designing different structures.

Courseoutline:

Introduction; state of the art in wind engineering.
Bluff body aerodynamics: boundary layer separation; wake and vortex formations;
pressure, lift, drag and moment effect.
Structural dynamics: single degree of freedom linear system; multi–degree of freedom linear system; example of along–wind response.
Aeroelastic phenomena; vortex shedding and lock–in phenomena; models of vortex– induced response; across wind galloping; wake galloping; flutter; torsional divergence. Wind tunnel simulation of aerodynamic and aero–elastic behaviour of bluff bodies. Application to design of tall buildings, slender towers and stacks.
Effects of wind on low-rise buildings under general and extreme conditions. Codes of practices on analysis and design of wind sensitive structures.

Text/Ref

1. Wind Effects on Structures – E. Simiu & R. Scanlan.

Code	**ME423**	**L**	**T**	**P**	**C**
Subject	**Energy Measurement and Efficiency**	**3**	**0**	**0**	**3**

Objective: This course discusses energy measurement principles and methods of assessing efficiency of energy systems.

Courseoutline:

Introduction:
Energy scenario, various forms of energy, energy management and its importance, recent
trends in energy conservation. **3**

Energy Auditing and Instrumentation:
Definition, methodology, analysis of past trends (plant data), closing the energy balance,
laws of thermodynamics, measuring instruments, portable and on line instruments. 8

Energy Economics:
Simple payback period; Time value of money; IRR NPV, life cycle costing, cost of saved energy, cost of energy generated. **6**

Monitoring and Targeting:
Defining monitoring and targeting elements of monitoring and targeting, data and
information-analysis techniques-energy consumption, production, cumulative sum of differences. **4**

Energy Efficiency in Thermal Utilities:
Boilers, steam system, furnaces insulation and refractories, FBC boilers, cogeneration,waste heat recovery.
10

Energy Efficiency in Electrical Utilities:
Electrical systems, electric motors, compressed air system, HVAC and refrigeration
systems, fans and blowers, pumps and pumping systems, cooling towers, lighting system, diesel generating system.
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Text/ReferenceBooks:

1. Witte, L.C., Schmidt, P.S., and Brown, D.R., “Industrial Energy Management and Utilization”, Hemisphere **1982**
2. Gyftopoulos, E. P., “Industrial Energy Conservation Manuals”, MIT Press **1988**
3. Dryden, I.G.C., “The Efficient Use of Energy”, 2nd Ed., Butterwort h- Heinemann **1982**
4. Capehart, B.L., Turner, W.C., and Kennedy, W.J., “Energy Management Handbook”, John Wiley & Sons **1982**
5. “Technology Menu for Efficient Energy Use: Motor Drive Systems”, Prepared by National Productivity Council and Center for Environmental Studies, Princeton University **1993**

Code	**ME424**	**L**	**T**	**P**	**C**
Subject	**Mechanical System Design**	**3**	**0**	**0**	**3**

Objective: This course deals with the design procedure of a mechanical system in totality.

Courseoutline:

Engineering Process and systems Approach:
Application of Systems concepts in Engineering, Identification of Engineering functions, Systems approach, Engineering Activity Matrix, Defining the proposed effort, Role of Engineer, Engineering Problem Solving, Concurrent Engineering. A case study. 6

Problem Formulation:
Nature of Engineering Problems, Needs Statement, Hierarchical Nature of Systems, Hierarchical nature of problem environment, Problem scope and constraints. Case study. 3

System Theories
System analysis view points, black box approach, state theory approach, component integration approach, Decision Process Approach, Case study. 3

System Modelling
Need for modelling, Modelling types and purposes, Linear graph modelling concepts, Mathematical Modelling Concepts. Case Study. 4

Linear Graph Analysis:
Graph Modelling and Analysis Process, Path problem, Network flow problem. Case Study. 4

Optimisation Concepts
Optimisation process, Motivation and freedom of Choice, goals and objectives-Criteria, methods of optimisation-analytical, combinatorial, subjective. Case Study. 3

System Evaluation
Feasibility Assessment, planning horizon, time value of money, financial analysis. A casestudy 3

Calculus Methods for Optimization:
Model with one or more decision variables, model equality and/ or inequality constraint, Case study. 4

Decision Analysis
Elements of a decision problem, Decision model probability, Expected monetary value,Utility value, Baye?s theorem. Case Study. 4

System Simulation
Simulation Concepts, simulation models, Iconic, Analog, Analytical, Waiting line simulation, Simulation Process Problem definition, input model construction, solution process, limitations of simulation approach: A case study. 4

Axiomatic Approach of Suh:
Problem definition and FRs, Hierarchy of FRs and DPs: decomposition of Design process, Design for manufacture

Text/Reference Books:

1. Design and Planning of Engineering Systems-D.D. Reredith, K.K Wong, R.W. Woodhead, and, R.R.Worthman, Prentice Hall Inc., Englewood Clifts, New Jersey.
2. Design Engineering- J. R. Dixon, Tata Mc Graw Hill Publishing Co., New Delhi.
3. An Introduction to Engineering Design Method- V. Gupta and? PN. Murthy, Tata McGraw Hill.
4. Principles of Design: Nam P Suh, McGraw Hill 1992
5. Optimization Techniques- S. S. Rao.
6. System analysis and Project Management- Devid I. Cleland, Willium R. King, McGraw

Code	**ME425**	**L**	**T**	**P**	**C**
Subject	**Principles of Robotic Engineering**	**3**	**0**	**0**	**3**

Objective: This course deals with principles and application of robotics in mechanical industries.

Courseoutline:

Introduction:
Definition of a Robot, Economic aspects in robot applications w.r.t. quality and productivity. Robot classifications and applications. Robot Kinematics: Homogeneous co-ordinates and co-ordinate transformations, Forward and inverse kinematics

Robot In Work Place:
Work cell organization in robotics environment, Work Cell Design and Control.

Robot Dynamics:
Introduction to Robot Dynamics

Sensors And Vision:
Tactile, Proximity and Range sensors in robots; Velocity sensors, Robot Vision.

Introduction to image processing.

Methods of Robot Programming:
Introduction to on-line and off-line Robot programming methods

Applications of Robots:
Welding, parts handling / transfer, assembly operations, parts sorting, parts inspection, future applications.

Text/Reference Books:

1. Industrial Robotics by Groover TMH
2. Robotics by Fu, K.S. TMH
3. Introduction to Robotics by S.K.Saha TMH
4. Robotics and Control by Mittal and Nagraath TMH

Code	**ME4XX**	**L**	**T**	**P**	**C**
Subject	**Elective IV**	**3**	**0**	**0**	**3**

Students will choose one course from the following courses covering various specializations of mechanical engineering and other relevant fields.

Code	**ME426**	**L**	**T**	**P**	**C**
Subject	**Finite Element Methods for Engineers**	**3**	**0**	**0**	**3**

Objective: This course deals with finite element method as a tool for solving various engineering problems computationally.

Courseoutline:

Introduction:
Finite element methods, history and range of applications.

Finite Elements:
Definition and properties, assembly rules and general assembly procedure, features of assembled matrix, boundary conditions.

Continuum problems:
Classification of differential equations, variational formulation approach, Ritz method, generalized definition of an element, element equations from variations. Galerkins weighted residual approach, energy balance methods.

Element shapes and interpolation functions:
Basic element shapes, generalized co-ordinates, polynomials, natural co-ordinates in one- , two- and three-dimensions, Lagrange and Hermite polynomials, two-D and three-D elements for Co and C1 problems, Co-ordinate transformation, iso-parametric elements and numerical integration.

Application of Finite Element Methods To Elasticity Problems And Heat Transfer Problems.

Text/Reference Books:
1. Finite Element Methods by Alavala PHI

Code	**ME427**	**L**	**T**	**P**	**C**
Subject	**Machine Tools Design**	**3**	**0**	**0**	**3**

Objective: This course concentrates on the various aspects of design of various machine tools.

Courseoutline:

Introduction to Machine Tools and Mechanisms:
General principles of machine tool design, working and auxiliary motions, machine tool drives, hydraulic and mechanical transmission and its elements, general requirements of machine tool design, layout of machine tools. Regulation of Speed and Feed Rates: Purpose, stepped regulation of speed-design of speed box, machine tool drives using multiple speed motors, developing the gearing diagram, step-less regulation of speed and feed rates.

Machine Tool Structure:
Functions and requirements, design criteria, materials used and their properties, static and dynamic stiffness, cross-sectional shapes used for machine tool structures and basic design procedure for the design of beds, columns and other structural elements, model techniques used design,introduction to Finite Element Method (FEM).

Guideways and Power Screws:
Function and types, design considerations & procedure for slideways, design of power screws.

Spindles and Spindle Supports:
Functions and requirements, materials, effect of machine tool compliance on machining
accuracy, design of spindles, bearings design/selection. Control Systems: Functions, requirements and classification, control systems for speeds, feeds & auxiliary motions, manual control systems, automatic control systems, adaptive control systems, criteria and economic selection of machine tools, future trends in development of machine tools.

Text/Reference Books:
1. Donaldson of al Tool Engineering, Tata Mc-Graw Hill, 1980.
2. Pollack, H.W. Tool Design, Reston Publishing Company, Inc. 1966
3. Kempster, M.H.A. Principles of Jig and Tool Design, English University Press Ltd.
4. Machine Tool Design and Numerical Control by Mehta N.K. TMH

Code	**ME428**	**L**	**T**	**P**	**C**
Subject	**Product Design and Development**	**3**	**0**	**0**	**3**

Objective: This course concentrates on the techniques associated with product design and development.

Courseoutline:

General:

Product design objectives, concept, terminology, principles, requirements of a good product design, product types and design considerations for engineering, product life cycle, product specification and range, safety, liability and warranty aspects, patents and copy rights.

Designing For Specific Requirements:

Design features and requirements with regard to manufacturing and assembly, safety, ergonomics, energy conservation, storage, transportation and maintenance, quality and reliability as a factor in product design, quality v/s cost, packaging design, role of national and international standards. Visual Design: Objectives, form, function, material and process, relationship, product graphics, role of color

Product Detailing:

Need and objectives, considerations affecting detailing decisions, illustration of detailing.

Product Development:

Concept and objectives, information sources, role of innovation in product development and competitiveness, part approval process, advance product quality planning, design failure mode and effect analysis, use of computers in product design & development, introduction to reverse engineering and rapid prototype development. The CAD-CAM link.

Code	**ME429**	**L**	**T**	**P**	**C**
Subject	**Advanced Manufacturing Processes**	**3**	**0**	**0**	**3**

Objective: This course discusses the various non-conventional manufacturing processes practiced in industries nowadays.

Courseoutline:

Introduction: Need and classification of unconventional manufacturing processes, brief overview **3**

Non-conventional Machining Processes: Process Principle, Analysis and Applications of Electric Discharge Machining, Laser Beam Machining, Electron Beam Machining, Ion Beam Machining, Plasma Beam Machining, Ultra-Sonic Machining, Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ice Jet Machining, Electrochemical Machining, Chemical Machining, Bio Chemical Machining. ?Hybrid Machining Processes: Electrochemical Discharge Machining, Electro-Chemical Abrasive Grinding, Electro Discharge Abrasive Grinding. **15**

Non-conventional Finishing Processes: Need, classification, process principle and applications of Abrasive Flow Finishing, Magnetic Abrasive Flow Finishing, Magnetic Abrasive Finishing, Electrogel Magnetic Abrasive Finishing, Magneto-Rheological Finishing **3**

Non-conventional Welding Processes: Laser Beam Welding, Electron Beam Welding, Ultra-Sonic Welding, Plasma Arc Welding, Explosive Welding, Under Water Welding, Welding in Space, Micro Welding Processes **6**

Generative Manufacturing Processes: Concept of generative manufacturing, need and Classification, Process principle and Applications of Selective Laser Sintering, Fused Deposition Manufacturing, SterioLithography, Ballistic Particle Manufacturing, Three Dimensional Printing, Laminated Object Manufacturing. **6**

Non-conventional Forming Processes: Explosive forming, Electro hydraulic forming, Electro magnetic forming, Laser Bending, Powder rolling, Spray rolling, Hydro forming, Hydrostatic and Powder extrusion, powder, rotary and isothermal forming **9**

Text/Reference Books:

1. V.K.Jain, Advance Machining Processes, Allied Publisher Bombay
2. Ghosh and Malik, Manufacturing Science,EWP Private Ltd.
3. P.C.Pandey, Modern Machining Processes, TMH Publication, New Delhi
4. Benedict G.F., Non Traditional Manufacturing Processes, Marcel Dekker
5. J.A.McGough, Advanced Machining Methods.
6. D.Kochan, Solid Freeform Manufacturing.

Code	**ME430**	**L**	**T**	**P**	**C**
Subject	**Computational Fluid Dynamics**	**3**	**0**	**0**	**3**

Objective: This course discusses the various computational methods of solving fluid flow related problems.

Courseoutline:

Introduction Theoretical, Computational and Experimental Techniques and their comparison. Scope of CFD. Different CFD Approaches. Modeling, Discretization and Basic Solution Module. Convergence, Stability and Consistency.

Modeling in CFD Navier-Stokes Equation for Laminar Flow in Cartesian Coordinate System. Potential, Boundary-Layer and Fully Viscous Modeling. Streamfunction- Vorticity Formulation. Boundary Conditions in Different Formulations and Case Studies like Potential and Viscous Modeling of Flow in a Cavity, Boundary-Layer Modeling of Flow over a Flat Plate and Viscous Modeling of Flow in Entrance-Region for Flow between Parallel Plates.

Finite-Difference Discretization of CFD Model Discretization of First and Second Derivatives by Forward, Backward and Central Differencing. Truncation and Order of Error, and Accuracy. Case Studies like Potential and Viscous Modeling of Flow in a Cavity, Boundary-Layer Modeling of Flow over a Flat Plate and Viscous Modeling of Steady Flow in Entrance-Region for Flow between Parallel Plates in Streamfunction-Vorticity Formulation along with Role of Upwinding. Unsteady Flow Modeling and Stability.

Special Topics in CFD Solution of Simultaneous Linear Algebraic Equations by TDMA and ADI Techniques. Viscous Flow Modeling in Primitive-Variable Formulation: SIMPLE Algorithm.

Code	**PH421**	**L**	**T**	**P**	**C**
Subject	**Non-linear Dynamics and Chaos**	**3**	**0**	**0**	**3**

Objective: Aim of this course is to introduce the engineering students the non-linear response of various dynamical systems. The course takes a non-abstract and application oriented approach to the tools used for the study of dynamical systems. These tools include bifurcation theory, phase space analysis of systems of differential and difference equations, asymptotic analysis of attracting states including fixed points, limit cycles, almost periodic motion and strange or chaotic attractors, fractals, fractal dimension, attractor reconstruction etc.

Courseoutline:

Overview - Chaos, Fractals and dynamics, importance of being non-linear, a dynamical view of the world.

One dimensional flows – Flows on the line: A geometric way of thinking, fixed points and stability, population growth, linear stability analysis, existence and uniqueness, impossibility of oscillations, potentials. Bifurcations: saddle-node bifurcation, transcritical bifurcation, Hopf bifurcation: laser threshold, pitchfork bifurcation, over damped bead on rotating hoop. Flows on the circle: uniform and non-uniform oscillators, over damped pendulum, fireflies, superconducting Josephson junctions.

Two dimensional flows – Linear systems: definitions and examples, classification of linear systems. Phase plane: phase portraits, existence, uniqueness and consequences, fixed points and linearization, conservative systems, reversible systems, pendulum. Limit cycles: introduction and examples, Poincare-Bendixon theorem, Lienard systems, relaxation and weakly non-linear oscillators.

Chaos – Lorenz equations-a model of convecting fluids: A chaotic waterwheel, simple properties of Lorenz equations, chaos on a strange attractor, Lorenz map, exploring parameter space, Controlling chaos and application of chaos in sending message. One dimensional maps: fixed points and cobwebs, logistic maps (numerics and analysis), periodic windows, Lypunov exponent, universality and experiments.
Basic introduction of fractals and strange attractors.

Text/ReferenceBooks:

1. Nonlinear Dynamics and Chaos by Steven H. Strogatz, Addison Wesley 1994.
2. Chaos in Dynamical Systems, by Edward Ott, 2nd Edition (Cambridge University Press, 1993).
3. Chaos and Nonlinear Dynamics by Robert C. Hillborn, (Oxford University Press, 2000).
4. Nonlinear Dynamics by M. Lakshmanan and S. Rajasekar (Springer Verlag, 2003)
5. Order within Chaos by Pierre Berge, Yves Pomeau, Christian Vidal (John Wiley & Sons, New York, 1984).

Code	**ME431**	**L**	**T**	**P**	**C**
Subject	**Advanced Machine Design**	**3**	**0**	**0**	**3**

Objective: This course discusses the methods for designing various critical machine elements.

Courseoutline:

Design of levers. 4

Design of chains and wire ropes 6

Worm Gears:
Types of Worm gearing, analysis of forces, power rating efficiency, worm gear standards and proportions. 6

Bevel Gears:
Straight bevel gears, design for bending, wear and dynamic loading, spiral bevel gears, hypoid gears. 6

Engine parts:
Design of Connecting rod, cross-head, crank shaft and piston, valve gear mechanism. 15

Text/Reference Books:
1. Shigley and Mische. Mechanical Engineering Design, Mc Graw Hill, 1992.
2. Phelan, Machine Design
3. Black and adamas, Machine Design, McGraw Hill.
4. Maleev and Hartman. Machine Design.

Code	**ME409**	**L**	**T**	**P**	**C**
Subject	**Major Project**	**0**	**0**	**5**	**5**

Objective: This course will make the students carry out a full-fledged research project based on a topic relevant to mechanical industry under faculty guidance.