MASTER OF TECHNOLOGY

IN

MECHANICAL ENGINEERING

PROGRAMME SCHEME AND SYLLABUS

(w.e.f. 2015-16)

DEPARTMENT OF MECHANICAL ENGINEERING

GURU JAMBHESWAR UNIVERSITY OF SCIENCE AND TECHNOLOGY, HISAR
<table>
<thead>
<tr>
<th>PROGRAMME EDUCATIONAL OBJECTIVES</th>
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</thead>
<tbody>
<tr>
<td><strong>PEO1</strong> : To impart knowledge to students in the latest technological topics on Mechanical Engineering and to provide them with opportunities in taking up advanced topics in the field of research.</td>
</tr>
<tr>
<td><strong>PEO2</strong> : To create a congenial environment that promotes learning, growth and imparts ability to work with inter-disciplinary research.</td>
</tr>
<tr>
<td><strong>PEO3</strong> : To broaden and deepen their capabilities in analytical and experimental research methods, analysis of data, and drawing relevant conclusions for scholarly writing and presentation of their research work.</td>
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<tr>
<td><strong>PEO4</strong> : To provide guidance to students for their choices in research and professional career outlook and to encourage students to take up research.</td>
</tr>
<tr>
<td><strong>PEO5</strong> : To equip students with integrity and ethical values so that they become responsible technocrats.</td>
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<tr>
<td>PROGRAMME OUTCOMES</td>
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<tr>
<td><strong>PO1</strong> : Acquiring fundamental knowledge and understanding in the field of Mechanical Engineering.</td>
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<td><strong>PO2</strong> : Formulating relevant research problems; conducting experimental and/or analytical work and analyzing results using modern mathematical and scientific methods.</td>
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<td><strong>PO3</strong> : Reviewing and documenting the knowledge developed by scholarly predecessors and critically assess the relevant technological issues.</td>
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<tr>
<td><strong>PO4</strong> : Designing and validating technological solutions to defined problems and write clearly and effectively for the practical utilization of their work.</td>
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<tr>
<td><strong>PO5</strong> : Ability to use the techniques, skills, and modern engineering tools necessary for mechanical engineering practice.</td>
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<td><strong>PO6</strong> : Ability to function effectively on multidisciplinary teams</td>
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</table>
# DEPARTMENT OF MECHANICAL ENGINEERING

GURU JAMBHESHWAR UNIVERSITY OF SCIENCE AND TECHNOLOGY, HISAR

M.Tech. (Mechanical Engineering)

(w.e.f. 2015-2016)

## FIRST SEMESTER

<table>
<thead>
<tr>
<th>Course No.</th>
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<td>Tool Engineering</td>
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## FOURTH SEMESTER

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Total Credits: 70.0
### LIST OF PROGRAMME ELECTIVES - I

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<td>ME-734</td>
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<td>Mechatronics</td>
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### LIST OF PROGRAMME ELECTIVES - II

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<td>Optimal design of thermal systems</td>
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<td>ME-733</td>
<td>Computational fluid dynamics</td>
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<td>ME-737</td>
<td>Heat exchanger analysis and design</td>
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### LIST OF OPEN ELECTIVES

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<td>ECE-700</td>
<td>Advancements in Communication System</td>
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<td>CSE-700</td>
<td>Introduction to Soft Computing Techniques</td>
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ME-751 ADVANCED MECHANICS OF SOLIDS

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</table>

Course Objectives

- To understand the concepts of stress and strain, strength and stiffness, deformation and displacement and energy theorems.
- To predict the behaviour of the solid bodies subjected to various types of loading.
- To design machine elements using theories of deformable bodies.

Unit I

3-D dimensional stress and strain: Analysis of Stresses and Strains in rectangular and polar coordinates: Cauchy’s formula, Principal stresses and principal strains, 3D Mohr’s Circle, Octahedral Stresses, Hydrostatic and deviatoric stress, Differential equations of equilibrium, Plane stress and plane strain, compatibility conditions.

Energy Theorems: Strain energy due to axial load, bending, shear and torsion, Maxwell’s reciprocal theorem, Castigliano’s theorem, analysis of helical springs by energy method.

Unit II

Unsymmetrical bending: Shear centers for sections with one axis of symmetry, shear center for any unsymmetrical Section, stress and deflection of beams subjected to unsymmetrical bending.

Axi-Symmetric Problems: Rotating Discs – Flat discs, Discs of uniform thickness, Discs of Uniform Strength, Rotating Cylinders.

Unit III

Buckling of columns: Beam columns single concentrated load, number of concentrated loads, contious lateral Load, end couple, couples at both ends triangular loads.

Bending of plates: Basic definition, stress curvature and moment relations, differential equation of plate deflection. boundry conditions, simply supported rectangular plates, axis symmetric loaded Circular plates.

Unit IV

Beam on Elastic Foundations: General theory, infinite, semi infinite, finite beams classification of beams. Beam supported by equally spaced elastic elements.

Stress concentration: Stress concentration in tension or compression members. Stresses in a plate with a circular hole, elliptical hole, small semi circular grooves.

Course Outcomes

Students would be able to

- understand the concepts of stress and strain, strength and stiffness, deformation and displacement and energy theorems
- predict the behaviour of the solid bodies subjected to various types of loading.
- design machine elements using theories of deformable bodies.

Books recommended


Note

In the semester examination, nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus (all four units). It will contain seven short answer type questions, each of two marks. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt other four questions by selecting one from each of the four units.
ME-753 ADVANCED ENGINEERING MATERIALS

<table>
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<td>30</td>
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</table>

**Course Objectives**

- To understand significance of material science and its role in manufacturing.
- To analyze the importance of various engineering materials (metals, polymers, ceramics, composites, Semi-conductor).
- To recite ceramics and composites, their manufacturing techniques, properties and applications.
- To propose appropriate plastics and polymers for different applications.

**Unit I**


**Unit II**


**Unit III**

Polymers, Composites and Ceramics: Polymer Materials (Introduction), Polymer Structure, Thermoplastics, Thermosets, Elastomers, Types and Applications of Ceramics, Properties of Ceramics Materials, Glass, Cements, Refractories and Advanced Ceramics, Structure of Composites, Metal Matrix Composites, Ceramic Matrix Composites, Polymer Matrix Composites, Fiberglass, Carbon Fiber Reinforced Polymer Composites, Properties of Composites

**Unit IV**

Miscellaneous Materials: Smart Materials, Shape Memory Phenomenon and Alloys, Hydrogen Storage Alloys, Functionally gradient material, Adhesives, Metals for Nuclear energy, Sound Insulating Materials

**Project**

Students are required to carry out a project related to the course contents. The topic of the project will be selected in consultation with course coordinator. The project report will be submitted at the end of semester. The evaluation will be done internally by the course coordinator.

**Course Outcomes**

Students would be able to

- understand significance of material science and its role in manufacturing.
- analyze the importance of various engineering materials (metals, polymers, ceramics, composites, Semi-conductor).
- recite ceramics and composites, their manufacturing techniques, properties and applications.
- propose appropriate plastics and polymers for different applications.

**Books recommended**


**Note**

In the semester examination, nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus (all four units). It will contain seven short answer type questions, each of two marks. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt other four questions by selecting one from each of the four units.
ME- 755: AUTOMATION IN MANUFACTURING

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</table>

Course Objectives

To inculcate the ability to design of hydraulic, pneumatic and electro-pneumatic logic circuits for automating processes in manufacturing, demonstrate problem-solving skills in automation and safely use the machines in the industries. Also, to explore the use of different sensors, control valves, controllers and actuators for electro-pneumatic & hydraulic circuits.

Unit I


Unit II


Unit III

Materials for RP: Plastics, Ceramics, Resins, Metals, Selection criterions for materials for different processes, the advantages and limitations of different types of materials.

Unit IV

Automatic transfer machines: Classifications, Analysis of automated transfer lines, without and with buffer storage, Group technology and flexible manufacturing system.
Assembly automation: Types of assembly systems, Assembly line balancing, Performance and economics of assembly system.

Project Work

Students are required to carry out a project related to the course contents. The topic of the project will be selected in consultation with course coordinator. The project report will be submitted at the end of semester. The evaluation will be done internally by the course coordinator.

Course Outcomes

Students will be able to

- understand the concepts of automation theory and its applications in various fields of manufacturing.
- understand principles, methods, and hardware/software tools used in modern computerized design and manufacturing of discrete parts.
- understand the main principals and components involved in optimizing production system design and operations.

Books recommended

<table>
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<th>Note</th>
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<tbody>
<tr>
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ME-757 CNC TECHNOLOGY AND PROGRAMMING

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Course Objectives

- To understand fundamentals of the CNC technology.
- To understand the programming methods in CNC machines.

Unit I

Computer numerical control machining: Axis standards, Coordinate systems, CNC machine motions.
CNC hardware basics: Structure, Drives, Actuation systems, Sensors and Feedback devices.

Unit II

Programming fundamentals: Coding standards, Preparatory functions, Miscellaneous functions.
Programming features: Tool length and radius compensation, Tool nose radius compensation, Canned cycles, Branching logics, Thread cutting, Cut planning etc. Fundamentals and programming of CNC turning center and CNC machining center, Problems.

Unit III

CAD/CAM aided CNC part programming: Use of WinNC, ELCAM and ELPULS for product design and manufacturing.

Unit IV

CNC Tooling: Cutting tool material and characteristics, Turning tool geometry, Tooling system for turning, milling and wire cut EDM, Tool presetting, Automatic tool changers, Work holding.

Course Outcomes

Students will be able to:

- understand the basics of CNC machines.
- write CNC programs proficiently.

Books recommended


Note

In the semester examination, nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus (all four units). It will contain seven short answer type questions, each of two marks. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt other four questions by selecting one from each of the four units.
## Course Objectives

- To understand the basic concepts of heat transfer and conduction.
- To understand the extended surfaces and the principles of convection.
- To understand the concept of phase change heat transfer, principles of radiation and mass transfer.

## Unit I

Brief introduction to different modes of heat transfer: Conduction: General heat Conduction equations-initial and boundary conditions, variable thermal conductivity, Internal distributed heat sources, Extended surfaces


## Unit II

Finite difference methods for conduction: ID & 2D steady state and simple transient heat conduction problems-implicit and explicit methods.


## Unit III

Internal and External flows: Fully developed flow: integral analysis for laminar heat transfer coefficient-types of flow-constant wall temperature and constant heat flux boundary conditions-hydrodynamic &thermal entry lengths; use of empirical correlations, flow over a flat plate: integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to variation geometries for laminar and turbulent flows.


## Unit IV

Radiation heat transfer: Radiant heat exchange in grey, non-grey bodies, with transmitting. Reflecting and absorbing media, specular surfaces, gas radiation-radiation from flames.

Mass Transfer: Concepts of mass transfer-diffusion & convective mass transfer analogies significance of non-dimensional numbers.

## Project Work

*Students are required to carry out a project related to the course contents. The topic of the project will be selected in consultation with course coordinator. The project report will be submitted at the end of semester. The evaluation will be done internally by the course coordinator.*

## Course Outcomes

- Students will be able to understand and can analyze heat conduction problems under steady and transient states.
- Students will be to understand the physical phenomena associated with free and forced convection, boiling and condensation and will be able to solve problems based on them.
- Each student understands the physical mechanisms involved in radiation heat and mass transfer.

## Books recommended


Note
In the semester examination, nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus (all four units). It will contain seven short answer type questions, each of two marks. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt other four questions by selecting one from each of the four units.
ME-761 ADVANCED MECHANICS OF SOLIDS LAB

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Course Objectives

- To predict the behavior of the solid bodies subjected to various types of loading.

List of experiments

1. To perform uniaxial tension and compression tests for ductile and brittle materials, compare stress-strain curves for ductile and brittle materials, verify failure criterions for ductile and brittle materials and find out reasons of erratic failure, if any.
2. To perform torsion tests for ductile and brittle materials, verify failure criterions for ductile and brittle materials and find out reasons of erratic failure, if any.
3. To find out hardness value (Vickers/Rockwell/Brinell) of the given specimen and interpret the obtained experimental results and use them as a tool for material selection in engineering applications.
4. To understand principle of fatigue testing machine in a reverse loading manner and to find the endurance limit of the given specimen on Fatigue Testing Machine. To construct an S-N curve (stress level - number of cycles to failure) of the test samples provided and interpret the obtained experimental results and use them as a tool for material selection in engineering applications.
5. To prepare a given specimen (mild steel) for micro structural examination. To observe different micro-structures like ferrite, perlite, cementite, austenite, bainite and martensite and study their properties.

Course Outcomes

Students will be able to

- predict the behaviour of the solid bodies subjected to various types of loading.
- design machine elements using theories of deformable bodies.
- select material in engineering applications based upon experimental data.

Note

The internal evaluation will be done by course coordinator. At the end of the semester, viva-voce will be conducted both by internal and external examiners to be appointed by the University.
### Course Objectives

- To understand and operate CNC machines.
- To create manual part programming on CNC machines.

### List of Experiments

1. To perform basic setup, startup, and safely features in CNC turning, machining and wire-cut EDM machine tools.
2. To select optimum cutters, cutting and spindle speeds, and other parameters of CNC turning, machining and wire-cut EDM machine tools according to tool and work material.
3. To set up cutting tools and part holding devices in CNC turning, machining and wire-cut EDM machine tools for optimal movement of tool and piece.
4. To create manual part programs for least machining time and simulate the tool-path on CNC turning, machining and wire-cut EDM machine tools.
5. To operate CNC turning center, machining center and wire-cut EDM. Load a program and execute actual machining.

### Course Outcomes

Students will be able to
- manually write, edit, debug, and use CNC programs to produce products.

### Note

The internal evaluation will be done by course coordinator. At the end of the semester, viva-voce will be conducted both by internal and external examiners to be appointed by the University.
PROGRAMME ELECTIVE - I
ME-732 ROBOTICS

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Course Objectives

• To introduce the students to the basic terminologies, applications, design specifications, and mechanical design aspects both kinematics and dynamics of industrial robotics/ manipulator along with various types and working of sensors and actuators used in robotic applications.

Unit I

Introduction: Definition of a robot, Economic aspects in robot applications with respect to quality and productivity, Robot classifications and applications.


Unit II

Robot Kinematics: Homogeneous co-ordinates and co-ordinate transformations, Forward and inverse kinematics.

Robot Dynamics: Introduction to Lagrangian and Newton-Euler formulations.

Unit III

Linear and Non Linear Control of Manipulators: control law partitioning, trajectory following control, multi input multi output control systems, Cartesian based control scheme.

Force Control of manipulators: hybrid position/force control

Unit IV

Robot in Work Place: Robot Trajectory planning considering velocity and acceleration. Work cell organization in robotics environment, Work cell design and control, Robot vision, Introduction to image processing.

Robot Programming: Robot Programming for Manufacturing and Other Applications, Robot Integration with CAD and CAM.

Project Work

Students are required to carry out a project related to the course contents. The topic of the project will be selected in consultation with course coordinator. The project report will be submitted at the end of semester. The evaluation will be done internally by the course coordinator.

Course Outcomes

Students would be able to

• Work individually and/or with an interdisciplinary team for the purpose of manipulator design for a specific need using mechanical kinematic structure along with the understanding of requirements from robotic work cell controller and its programming, for enabling robotic manipulator to work in an integrated automated industrial environment.

• Understand, create and demonstrate the technical reports for robotic automation.

Books recommended


Note

In the semester examination, nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus (all four units). It will contain seven short answer type questions, each of two marks. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt other four questions by selecting one from each of the four units.

Department of Mechanical Engineering, GJUS&T, Hisar, M.Tech. (Mechanical Engineering), w.e.f. 2015-16
ME-734 INSTRUMENTATION AND MEASURING SYSTEMS

L T P Internal Marks External Marks Credit
4 0 0 30 70 4.0

Course Objectives

- The course is intended to give students a thorough understanding of a measuring system, different transduction principles, error analysis response etc. and various other issues related to instrumentation system.

Unit I

Generalized Configuration of Measuring System: Functional elements of a basic measuring system; different types of measurands, description of functional elements. Input-output configuration of a measuring system interfering and modifying inputs; methods for correction for interfering and modifying inputs.

Characteristics of Instruments: Objective of studying the characteristics of the instruments. Static characteristics accuracy precision, error, sensitivity, hysteresis, threshold, drift, span, static stiffness etc. Dynamic characteristics - time domain and frequency domain characteristics terms input-output impedance's and meaning of impedance mismatching. Concept of mechanical loading.

Unit II

Response of Instruments: Description of mathematical model for the generalized configuration of a measurement system. Order of the systems, response of zero, first and second order systems of step, ramp and sinusoidal inputs. Transfer function method to study the response of the system.

Errors: Classification of various types of errors and statistical analysis of experimental data.

Unit III

Principles of Transduction and Transducers: Description of various types of transduction principles. Tranducers based on variable resistance, variable inductance, variable capacitance and piezo-electric effects. Displacement transducers - wire wound potentiometers, LVDT, strain gauges, strain gage designation system. Signal conditioners - filters, low, high, band pass and charge amplifiers.

DAS and Signal Analysis: Data acquisition system via computers. The components of Data acquisition system, DAS Hardware, selection criteria for choosing a DAS. Techniques for signal analysis.

Unit IV

Flow Measurement: Flow visualization, shadowgraph; schlieren and interferometric techniques; Pitot static tubes; hot wire anemometers; Laser Doppler velocimeter; flow measurements using coriolis effect.

Temperature and Heat Flux Measurement: Thermoelectric sensors; electric resistance sensors; thermistors; radiations pyrometers; Temperature measuring problems in flowing fluids, dynamic compensation.

Project Work

Students are required to carry out a project related to the course contents. The topic of the project will be selected in consultation with course coordinator. The project report will be submitted at the end of semester. The evaluation will be done internally by the course coordinator.

Course Outcomes

Students will be able to

- describe the operation of transducers for strain, acceleration, pressure, temperature, and fluid flow measurement.
- select and assemble the components of basic analog and digital data acquisition systems.
- apply theoretical analysis of time-varying signals to selection of signal conditioning components.
- conduct uncertainty analysis and perform basic statistical treatment of experimental data.

Books recommended

Hall, 2006.


**Note**

In the semester examination, nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus (all four units). It will contain seven short answer type questions, each of two marks. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt other four questions by selecting one from each of the four units.
ME-736 FLEXIBLE MANUFACTURING SYSTEMS

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Course Objectives

- Learn the concepts and technologies associated with Flexible Manufacturing System.

Unit I

Manufacturing Automation: Types of Automation systems, Logic Controllers and its applications, Programming of controllers.

Unit II

Flexible Manufacturing System: FMS components, Different types of flexibility in manufacturing, FMS compared to other manufacturing approaches, Optimization of FMS, FMS applications, FMS planning and implementation.

Unit III

Numerical Control: Fundamentals of NC technology, Computer Numerical Control, Distributed Numerical Control, Applications of NC.

Unit IV

Cellular Manufacturing: Part classification and coding, production flow analysis, Machine Cell design, Group Technology.

Project Work

Students are required to carry out a project related to the course contents. The topic of the project will be selected in consultation with course coordinator. The project report will be submitted at the end of semester. The evaluation will be done internally by the course coordinator.

Course Outcomes

Students will be able to
- design the basic Flexible Manufacturing Systems.

Books recommended


Note

In the semester examination, nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus (all four units). It will contain seven short answer type questions, each of two marks. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt other four questions by selecting one from each of the four units.
ME-738 MECHATRONICS

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Course Objectives
- The course deals with basic principles of Mechatronics involving sensors, actuators, control systems, and microprocessor systems. The aim of this course is to make a bridge between Mechanical, Electronics, Instrumentation, Computer and Controls field.

Unit I
Introduction: Definition of mechatronics, measurement system, control systems, microprocessor based controllers, mechatronics approach.

Unit II
Actuators: Actuation systems, pneumatic and hydraulic systems, process control valves, rotary actuators, mechanical actuation systems, electrical actuation systems.
Signal Conditioning: Signal conditioning, filtering digital signal, multiplexers, data acquisition, digital signal processing, pulse modulation, data presentation systems.

Unit III
Microprocessors and Microcontrollers: Microcomputer structure, microcontrollers, applications, programmable logic controllers.
Modeling and System Response: Mathematical models, bond graph models, mechanical, electrical, hydraulic and thermal systems, dynamic response of systems, transfer function and frequency response, closed loop controllers.

Unit IV
Design and Mechatronics: Input/output systems, computer based modular design, system validation, remote monitoring and control, designing, possible design solutions, detailed case studies of mechatronic systems used in photocopier, automobile, robots.
DAS and Signal Analysis: Data acquisition system via computers. The components of Data acquisition system, DAS Hardware, selection criteria for choosing a DAS. Techniques for signal analysis.

Project Work
Students are required to carry out a project related to the course contents. The topic of the project will be selected in consultation with course coordinator. The project report will be submitted at the end of semester. The evaluation will be done internally by the course coordinator.

Course Outcomes
- Students would be able to
  - understand the basic elements of any Mechatronic device.
  - develop the mathematical model of any physical model from any engineering domain.
  - understand the key inputs and outputs of any physical device, different sensors and transducers to measure the outputs, interfacing of the sensors and actuators to the computers.
  - study and design different controllers to obtain the desired performance from the system.

Books recommended

**Note**

In the semester examination, nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus (all four units). It will contain seven short answer type questions, each of two marks. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt other four questions by selecting one from each of the four units.
ME-752 ADVANCED MACHINE DESIGN

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**Course Objectives**

- To understand the concept of design and its considerations for manufacturing, assembly, aesthetics, ergonomics, fatigue and creep.

**Unit I**

Design Philosophy: Design process, design models, design phases, product design strategies, product design planning and specification, need analysis, concept generation, concept selection, concept testing.

Statistical design considerations: Frequency distribution, Histogram and frequency polygon, Normal distribution, Units of measurement of central tendency and dispersion, standard variable - population combinations, Design and natural tolerances

**Unit II**

Design for Manufacture and Assembly: General considerations in design for casting, forging, machining, powder metallurgy and welding. Design considerations for assembly.

**Unit III**

Design for aesthetics and ergonomics: Aesthetics considerations in design - Basic types of product forms, designing for appearance - shape, features, materials and finishes, Ergonomic considerations in design display and controls, workspace design, hand tool design, human engineering considerations - Relation between man, machine and environmental factors.


**Unit IV**

Design for fatigue and creep: Static failure theories, Fatigue mechanisms, Design for fatigue strength and life, creep: Types of stress variation, design for fluctuating stresses, design for limited cycles, multiple stress cycles, Fatigue failure theories, cumulative fatigue damage, thermal fatigue and shock, harmful and beneficial residual stresses, yielding and transformation.

**Project work**

Students are required to carry out a project related to the course contents. The topic of the project will be selected in consultation with course coordinator. The project report will be submitted at the end of semester. The evaluation will be done internally by the course coordinator.

**Course Outcomes**

Students would be able to

- design products for manufacturing, assembly, aesthetics, ergonomics, fatigue and creep.

**Books recommended**

Note

In the semester examination, nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus (all four units). It will contain seven short answer type questions, each of two marks. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt other four questions by selecting one from each of the four units.
# ME-754 COMPUTER AIDED DESIGN AND MANUFACTURING

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## Course Objectives
- To understand the basic parametric fundamentals that are used to create and manipulate geometric models.

## Unit I
Introduction: Definition and scope of CAD/CAM, Introduction to design process and role of computers in the design process.
Transformations: 2D and 3D transformations.

## Unit II
Curves and Surfaces: Analytical, Synthetic curves with advantages, Disadvantages, Comparison with parametric curves, Geometric modeling curves and surfaces, Representation, Wire frame models, Parametric representations, Parametric curves and surfaces.
Solid modeling: Solid models, Fundamentals of solid modeling, Different solid representation schemes, Half-spaces, Boundary representation (B-rep), Constructive solid geometry (CSG).

## Unit III
CAD/CAM Data Exchange Formats: Types of file formats & their exchange, Graphics standards.
Simulation: Need of simulation, concept of a system, Model and its purpose, Types of simulation approaches-Event Scheduling Approach (ESA), Activity Scanning Approach (ASA), Process Interaction Approach (PI A), Steps in a simulation study, advantages disadvantages and pitfalls of simulation, Simulation Languages.

## Unit IV
Computer Aided Manufacturing: CNC machine tools, principle of operation of CNC, Steps in manufacturing, construction features including structure and drives, Direct numerical control (DNC) and its application, advantages and limitations of CNC systems.
Computer Assisted Part Programming: CNC part programming, axes of CNC machines, manual part programming using G code, use of subroutines, computer aided part programming using APT or any other language, Automatic NC program generation from CAD models, Machining of surfaces, Mould, Casting and Die design and manufacture using CAD/CAM software.

## Course Outcomes
Students will be able to
- create the different wireframe and surface primitives using parametric modeling.
- create the different solid primitives using the different representation schemes.
- manipulate the created wireframe, surface and solid models.

## Books recommended

## Note
In the semester examination, nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus (all four units). It will contain seven short answer type questions, each of two marks. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt other four questions by selecting one from each of the four units.
<table>
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<th>Course Objectives</th>
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<tr>
<td><strong>To develop the knowledge and skills needed to apply Finite Element Methods to problems in Mechanical Engineering</strong></td>
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<th>Unit I</th>
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<tr>
<td>Introduction: Basic concepts, Historical background, general applicability of the method, general description of FEM, one dimensional problems with linear &amp; cubic interpolation model, derivation of finite element equations using direct approach, comparison with other methods commercial finite element program packages. Discretization of domain: introduction, basic element shapes, discretization process, node numbering scheme, automatic mesh generation</td>
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<th>Unit II</th>
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<tr>
<td>Interpolation Models: Introduction, polynomial form of interpolation functions, simplex, complex and multiplex elements, interpolation polynomial in terms of nodal degree of freedom, selection of order of interpolation polynomial, convergence requirements, linear interpolation polynomial in terms of global coordinates, interpolation polynomial for vector quantities, linear interpolation polynomial in terms of local coordinates, integration of functions of natural coordinates, patch test</td>
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<tr>
<th>Unit III</th>
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<tr>
<td>Higher order and Isoparametric elements: Introduction, higher order one dimensional elements, higher order elements in terms of natural coordinates, Isoparametric elements Derivation of element matrices and vectors by using direct and weighted residual approach, assembly of element matrices and vector and derivation of system equations, Numerical solution of finite element equations by using Gaussian elimination method.</td>
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<th>Unit IV</th>
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<th>Course Outcomes</th>
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<tbody>
<tr>
<td>The students will be able to select the different types of element, generate mesh, construct element stiffness matrices, assemble element stiffness matrices, impose boundary conditions, solve the equations and interpret the results for different problems. apply Finite Element Methods to 1D, 2D, 3D practical engineering problems.</td>
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<th>Books recommended</th>
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**Note**

In the semester examination, nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus (all four units). It will contain seven short answer type questions, each of two marks. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt other four questions by selecting one from each of the four units.
Course Objectives

- To understand the mechanics of various advanced machining processes including the material removal, tool design, effect of process parameters on the output responses.
- To impart depth knowledge on principle involved, accuracy involved, tooling requirement and knowledge about the process capability.
- To develop knowledge and skills design of various jigs and fixtures to increase the production rate.

Unit I
Design of Cutting Tools: Basic Requirements, Mechanics and Geometry of Chip Formation, General Considerations for Metal Cutting, Design of Single Point Cutting Tools, Design of Milling Cutters, Design of Drills and Drilling, Design of Reamers, Design of Taps

Unit II
Gages and Gage Design: Limits Fits and Tolerances, Geometrical Tolerances-Specification and Measurement, Types of Gages, Gage Design, Gage Tolerances, Material for Gages
Work Holding Devices: Basic Requirements of Work Holding Devices, Location: Principles, Methods and Devices, Clamping: Principles, Methods and Devices

Unit III
Design of Drill Jigs: Definition and Types of Drill Jigs, Chip Formation in Drilling, General Considerations in the Design of Drill Jigs, Drill Bushings, Drill Jigs, and Modern Manufacturing
Design of Fixtures: Fixtures and Economics, Types of Fixtures, Milling Fixtures, Boring Fixtures, Broaching Fixtures, Lathe Fixtures, Grinding Fixtures

Unit IV

Project
Students are required to carry out a project related to the course contents. The topic of the project will be selected in consultation with course coordinator. The project report will be submitted at the end of semester. The evaluation will be done internally by the course coordinator.

Course Outcomes
Students would be able to
- understand the mechanics of various advanced machining processes including the material removal, tool design, effect of process parameters on the output responses.
- impart depth knowledge on principle involved, accuracy involved, tooling requirement and knowledge about the process capability.
- develop knowledge and skills design of various jigs and fixtures to increase the production rate.

Books Recommended


Note
In the semester examination, nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus (all four units). It will contain seven short answer type questions, each of two marks. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt other four questions by selecting one from each of the four units.
ME-760 COMPUTER AIDED DESIGN AND MANUFACTURING LAB

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**Course Objectives**

- To use professional CAD software(s) for modeling, analysis and computer assisted manufacturing.
- To learn advance machining features on CNC machines.

**List of Experiments**

1. Practicing the part modeling, assembly and simulation operations on available CAD package(s).
2. Generating automatic Cutter Location (CL) data from CAD models and post processing for machining on CNC machines.
3. Producing complex cylindrical shaped pieces on CNC machining center with the help of 4th axis.
4. 3-D virtual machining on offline CNC machining center.
5. Creating radial and axial surface profiles by using C-axis and driven tools on CNC turning center.
6. Manufacturing parts on CNC machining center with WinNC.
7. Machining complex parts on CNC wire-cut EDM with ELCAM and ELPULS.
8. Fabrication of 3-D physical part using additive manufacturing technology from 3-D CAD model.

**Course Outcomes**

*Students will be able to*

- use parametric CAD software(s) for geometric modeling, analysis and computer assisted manufacturing of mechanical components.
- manually write, edit, debug, and use CNC programs to produce complex profiles on CNC machines.

**Note**

*The internal evaluation will be done by course coordinator. At the end of the semester, viva-voce will be conducted both by internal and external examiners to be appointed by the University.*
ME-762 FINITE ELEMENT METHODS LAB

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**Course Objectives**

• *To provide practical knowledge in finite element methods and to solve practical engineering problems by developing computer program and by using FEM software*

**List of Experiments**

1. Introduction to basic concepts of programming for FEM problems. To develop the computer program for the addition, multiplication and inverse of matrices.
2. Finite element formulation and analysis of one dimensional problem (direct approach) by developing computer programme.
3. Finite element formulation and analysis of one dimensional problem (Galerkin approach) by developing computer programme.
4. The modeling and analysis two dimensional problems using finite element software (ANSYS).
5. The modeling and analysis three dimensional problems using finite element software (ANSYS).

**Course Outcomes**

*Students will be able to*

• develop the computer program for the analysis and solution of practical engineering problems.
• analyze and solve the practical engineering problems by using the FEM software (ANSYS).

**Note**

*The internal evaluation will be done by course coordinator. At the end of the semester, viva-voce will be conducted both by internal and external examiners to be appointed by the University.*
PROGRAMME ELECTIVE - II
ME-731 OPTIMAL DESIGN OF THERMAL SYSTEMS

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Course Objectives

- To know and understand the different thermal systems and to get familiar with their design, thermal modeling, objectives, simulation, and economic analysis.
- To understand the optimization, its role, and methods in the analysis and design of various types of thermal systems and equipment's.

Unit I

Engineering design: Introduction, engineering design, design as part of engineering undertaking, workable and optimum systems, Basic considerations in design: formulation of the design problem, conceptual design, steps in the design process, computer aided design.

Economic analysis: Calculation of interest, worth of money as a function of time, series of payments, depreciation.

Unit II

Modeling of thermal systems: Types of models, modeling of heat exchangers, evaporators and condensers, mathematical modeling.

Equation fitting: Method of least squares and the art of equation fitting, physical modeling and dimensional analysis.

Unit III

Numerical modeling and simulation: Numerical modeling, system simulation, methods for numerical simulation.

Acceptable design of thermal systems: Initial design, design strategies, design of systems from different application areas, additional considerations for large practical systems.

Unit IV

Optimization: Optimization in design, levels of optimization, basic concepts, practical aspects in optimal design, mathematical representation and statement of the optimization problem, practical aspects in optimal design.

Optimization methods: Lagrange multipliers, search methods, and geometric programming.

Project work

Students are required to carry out a project related to the course contents. The topic of the project will be selected in consultation with course coordinator. The project report will be submitted at the end of semester. The evaluation will be done internally by the course coordinator.

Course Outcomes

Students will be able to

- understand about the thermal interactions and its role in many like processes and to develop the means to tackle the various thermal problems.
- design and selection of the materials/equipments for a particular application based upon its thermal response and to analyze and optimize the thermal problems.

Books recommended

Note

In the semester examination, nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus (all four units). It will contain seven short answer type questions, each of two marks. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt other four questions by selecting one from each of the four units.
ME-733 COMPUTATIONAL FLUID DYNAMICS

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Course Objectives

- To impart the knowledge of governing equations for fluid flow.
- To learn about the Numerical methods used to solve the partial differential equation.
- To solve the fluid flow problem using CFD analysis.

Unit I


Unit II

Nature of Equations: Classification of PDE, General behavior of parabolic, Elliptic and hyperbolic equations, Boundary and initial conditions.


Unit III

Basics of fluid dynamics, CFD Techniques: Introduction, Lax Wendroff Techniques, Mac Cormack’s Technique, Relaxation technique, ADI Technique

Pressure correction Technique and its application to Incompressible Viscous flow, SIMPLE Algorithm

Unit IV

Numerical Solution to Heat Conduction Problems:

Steady-state and Unsteady-state Problems: (i) One-dimensional Heat Conduction Transfer through a Pin-fin (ii) Two-dimensional Conduction through a plate, One dimensional Transient Heat Conduction.

Numerical solution to internal and external flow problems eg. Incompressible Couette Flow using (a) Crank Nicholson solution (b) Pressure correction Technique etc.

Commercial and freely available tools for CFD analysis, Steps to solve a problem using any software, grid independence test

Project work

Students are required to carry out a project related to the course contents. The topic of the project will be selected in consultation with course coordinator. The project report will be submitted at the end of semester. The evaluation will be done internally by the course coordinator.

Course Outcomes

Students will be able to

- acquire adequate knowledge of various types of fluid flow governing equations.
- analyze the internal fluid flow phenomena of any Engineering system.
- acquire enough knowledge to design of the Engineering systems using computational fluid dynamics.

Books Recommended

THIRD SEMESTER


Note

In the semester examination, nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus (all four units). It will contain seven short answer type questions, each of two marks. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt other four questions by selecting one from each of the four units.
ME-735 ADVANCED THERMODYNAMICS

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**Course Objectives**

- To impart knowledge on the fundamentals of theory of energy, its quality and significance for the applications of thermal systems. To impart knowledge on the analysis of simple compressible and multicomponent systems.
- To impart knowledge on the different thermodynamic property relations, applications, power, refrigeration cycles and use of thermodynamics in daily life.

**Unit I**

Basic concepts, work, heat, and first law of thermodynamics: Macroscopic and microscopic views, state, property, interaction by contact, work, the first law, heat, energy, and characteristics of an object.

The second law of thermodynamics: Reversible process, Caratheodory’s formulation, entropy, entropy change in an irreversible process, corollaries of second law, and applications.

**Unit II**

Analysis of simple compressible systems and other simple systems: Basic governing equations, thermodynamic relations, equation of state, cubic equations, generalized compressibility chart, and applications.

Analysis of open systems, exergy and irreversibility: Conservation of mass and energy, steady and transient states, maximum work potential of open and closed systems, exergy analysis of simple processes, and heat engines producing maximum power.

**Unit III**

Multicomponent systems: Fundamental property relationships, partial molar properties, equation of state for mixtures, chemical potential, and fugacity.

Phase equilibrium in multicomponent and reactive mixtures: Conditions for equilibrium, analysis phase equilibrium, stability, mass balance, first law analysis, second law analysis, work potential of a chemical reaction, chemical exergy.

**Unit IV**

Power and refrigeration cycles: Periodic heat engines, vapor power cycles, and gas power cycles, modified vapor compression cycles, actual vapor compression cycles, gas refrigeration and absorption refrigeration cycles.

Non equilibrium thermodynamics and thermodynamics in daily life: Basic postulates, thermoelectric phenomenon, thermal diffusion, the first and second law in daily life.

**Project work**

Students are required to carry out a project related to the course contents. The topic of the project will be selected in consultation with course coordinator. The project report will be submitted at the end of semester. The evaluation will be done internally by the course coordinator.

**Course Outcomes**

Students will be able to

- understand theoretical principles of energy and exergy analysis, behavior of real and ideal gases, thermodynamic property relations and reactive systems.
- analyze thermodynamic processes in daily routine life and in various industries.

**Books recommended**

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Course Objectives

- To study and understand the role of different types of heat exchangers, their design, functioning and related concepts.

Unit I

Classification of heat exchangers, temperature distribution for parallel flow, counter flow, cross flow heat exchangers, evaporators and condensers, concept of LMTD and overall heat transfer coefficient.

Fouling of heat exchangers, NTU method for gauging exchanger performance, LMTD for parallel, counter and cross flow heat exchangers, effectiveness for parallel and counter flow exchangers.

Unit II


Compact heat exchangers, thermal and mechanical design of: Shell & tube heat exchangers, Double pipe, Extended surface, Condensers & evaporators.

Unit III


Heat transfer augmentation in heat exchangers using active and passive techniques.

Unit IV

Selection of Heat Exchangers and their Components on the basis of operating conditions, General Selection guidelines for major exchanger types (shell and tube type, Plate heat exchanger, Extended surface exchanger etc.), Modeling of heat exchanger based on first law of thermodynamics


Applications of heat exchangers in various industries (automobile, electronic, process, chemical etc.)

Project work

Students are required to carry out a project related to the course contents. The topic of the project will be selected in consultation with course coordinator. The project report will be submitted at the end of semester. The evaluation will be done internally by the course coordinator.

Course Outcomes

Students will be able to

- acquire adequate knowledge about working and design concepts of heat exchanger.
- analyze the heat transfer & pressure drop analysis.
- acquire adequate knowledge about heat transfer augmentation Techniques used in heat exchangers

Books recommended


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OPEN ELECTIVES
CSE-700 INTRODUCTION TO SOFT COMPUTING TECHNIQUES

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Course Objectives
- To introduce the soft computing techniques to students of different Engineering Departments.
- To develop the ability to apply the soft computing techniques like genetic algorithms, fuzzy logic and neural networks in diverse Engineering domains.

Unit I
Working of a simple Genetic Algorithm and the related definitions: Block diagram of working of a Genetic Algorithm, Representation/Encoding Schemes, initializing a GA population, evaluation function, genetic operators, study of parameters of genetic algorithms and its performance, sampling and selection mechanisms, Optimizing numerical functions using GA.

Unit II

Unit III

Unit IV
Fuzzy sets: Basic terminology and definitions, Operations on Fuzzy sets, MF formulations and parameterisation, Derivatives of parameterised MFs, Fuzzy numbers, Extension principal and fuzzy relations, Linguistic variables, Fuzzy If-Then Rules, Fuzzy reasoning and compositional rule of inference.

Software and Tools to be learnt: MATLAB tool boxes on global optimization, neural networks and fuzzy logic, R Programming, GALIB 247 and KEEL.

Course Outcomes
Students would be able to
- apply Genetic Algorithms, Neural Networks, Fuzzy Logic or a combination of these as computational tools to solve a variety of problems related to optimization in different domains.
- acquire knowledge of the tools like MATLAB and R to implement soft computing techniques

Books recommended

Note
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# Course Details

**ECE-700 ADVANCEMENTS IN COMMUNICATION SYSTEMS**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Unit I</strong></td>
<td>The essentials of a Communication system, Amplitude modulation, Phase modulation (PM) &amp; frequency modulation (FM), Demodulation, ASK, FSK, BPSK, QPSK, Introduction to GSM, CDMA, Architecture of GSM, CDMA, Frequency Reuse concept, ISDN (Integrated Services Digital Networks)</td>
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<tr>
<td><strong>Unit II</strong></td>
<td>Introduction to optical communication system: Electromagnetic spectrum used for optical communication, block diagram of optical communication system, Advantages of optical fiber communication, Optical fibers structures and their types, fiber characteristics, Basic principles of light propagation, Total internal reflection, Acceptance angle, Numerical aperture, Optical sources, Optical Detectors, Principles of optical detection, Optical Networks, why optical Networks? , SONET/SDH, WDM optical networks.</td>
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<tr>
<td><strong>Unit III</strong></td>
<td>Communication signal multiplexing, Time division multiplexing, Frequency division multiplexing, Introduction to Multiple Access, FDMA, TDMA, Spread Spectrum multiple Access, space division multiple access</td>
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<tr>
<td><strong>Unit IV</strong></td>
<td>Block Diagram and operation of RADAR, SONAR, Simple form of Radar Equation, Pulse Repetition frequency, VSAT (data broadband satellite), MSAT (Mobile Satellite Communication technique), Sarsat (Search &amp; Rescue satellite) &amp; LEOs (Lower earth orbit satellite), Satellite communication with respect to Fiber Optic Communication, LANDSAT, Defense satellite Beam Acquisition, Tracking &amp; Positioning.</td>
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### Books Recommended
- Kennedy, “Electronic Communication systems”, TMH.
- John M Senior, “Optical Fiber Communications”, PHI.
- Merrill I. Skolnik, “Introduction to Radar Systems”, MGH.

### Note
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Course Objectives

- The objective of this course is to impart the basis knowledge of different printing processes along with their role, importance and applications.

Unit I

Historical development in Printing Technology. Recent trends in the field of printing and allied technologies.
Pre-Press, Press and Post press operations

Unit II

Letterpress Printing Process; Characteristics, role, importance and applications.
Offset Printing Process; Characteristics, role, importance and applications.

Unit III

Flexography Printing Process; Characteristics, role, importance and applications.
Gravure Printing Process; Characteristics, role, importance and applications.

Unit IV

Screen Printing Process; Characteristics, role, importance and applications.
Digital Printing Process; Characteristics, role, importance and applications

Course Outcomes

- The learning outcome of this course is expected that after completion of this course the students will be having the detail knowledge of various printing processes and the recent development in this industry and they will implement their knowledge for print production operations.

Books recommended

- C.S. Mishra, “Letterpress Printing”.
- Havoed M Fenton, Frank J. Romao, “On demand printing”.
- Adams Fox, “Printing Technology”.

Note

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Department of Mechanical Engineering, GJUS&T, Hisar, M.Tech. (Mechanical Engineering), w.e.f. 2015-16
**Course Objectives**

- To learn about the basics, design and operation of biomedical instruments, and their role in medical science and health sector.
- To encourage the students of various branches for their possible contribution in biomedical engineering.

**Unit I**

Biomedical Instrumentation: Man-Instrument System, Origin of Biosignals, Classification of Biomedical Instruments, Performance Parameters of Instruments, Physiological Systems.


**Unit II**

Biomedical Equipment and Measurements: Cardiovascular Measurements - Blood Pressure Measurement, Blood Flowmeters, Electrocardiograph (ECG), Vectorcardiography (VCG), Phonocardiograph (PCG).

Neuromuscular and Nervous Measurements: Electroencephalograph (EEG), Electromyography (EMG).

Sensory and Behavioral Measurements: Audiometer, Skin Resistance Measurement, Biofeedback Instrumentation.


**Unit III**


**Unit IV**

Therapeutic Equipment: Cardiac Pacemakers, Need and Types of Pacemakers, Defibrillation, Need and Types of Defibrillators, Need and Types of Diathermy, Hemodialysis, Dialyzer and Its Need, Ventilators and Their Types, Endoscopes.

Patient Safety and Ethical Issues: Physiological Effects of Electricity, Shock Hazards, Safety Standards, Accident Prevention Methods, Biomedical Safety Standards and Ethical Issues.

**Course Outcomes**

Students will be able to

- get acquainted with the construction and operation of biomedical equipment and their significance in health care sector.
- start research and development in biomedical instrumentation and engineering.

**Books recommended**

- Khanpur R.S., “Handbook of Biomedical Instrumentation”, TMH.
- Cormwell L., “Biomedical Instrumentation & Measurements”, PHI.

**Note**

In the semester examination, nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus (all four units). It will contain seven short answer type questions, each of two marks. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt other four questions by selecting one from each of the four units.
ME-700 COMPUTER AIDED DESIGN & MANUFACTURING

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**Course Objectives**

- To understand the basic parametric fundamentals that are used to create and manipulate geometric models.
- To study about the concepts of surface modeling and solid modeling.
- To implement CNC programs for milling and Turning machining operations.
- To create a computer aided manufacturing (CAM) model and generate the machining codes automatically using the CAM system

**Unit I**

Introduction: Introduction to CAD/CAM, Historical developments, Industrial look at CAD/CAM, Introduction to CIM; Basics of geometric and solid modeling, explicit, implicit, intrinsic and parametric equations, coordinate systems.

Transformations: Introduction, transformation of points and line, 2-D rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling, shearing, rotation, reflection and translation, combined transformations, orthographic and perspective projections, reconstruction of 3-D objects.

**Unit II**

Curves: Algebraic and geometric forms, tangents and normal, blending functions reparametrization, straight lines, conics, cubic splines, Bezier curves and B-spline curves.

Surfaces: Algebraic and geometric forms, tangents and normal, blending functions, reparametrization, sixteen point form, four curve form, plane surface, ruled surface, surface of revolution, tabulated cylinder, bi-cubic surface, Bezier surface, B-spline surface.

Solids: Solid models and representation scheme, boundary representation, constructive solid geometry, sweep representation, cell decomposition, spatial occupancy enumeration.

**Unit III**

Automation and Numerical Control: Introduction, fixed, programmable and flexible automation, types of NC systems, MCU and other components, NC manual part programming, coordinate systems, G & M codes, Part program for simple parts, computer assisted part programming.

**Unit IV**

Group Technology: Part families, part classification and coding, production flow analysis, Machine cell design, Advantages of GT

Flexible Manufacturing Systems & Computer aided process planning: Introduction, FMS components, types of FMS, FMS layouts, planning for FMS, advantages and applications Conventional process planning, types of CAPP, Steps in variant process planning, planning for CAPP.

**Course Outcomes**

Students would be able to

- study about the concepts of surface modeling, physically based modeling and surface visualization.
- implement CNC programs for milling and turning machining operations

**Books recommended**

- Groover and Zimmer, “CAD/ CAM”, Prantice Hall.

**Note**

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Department of Mechanical Engineering, GJUS&T, Hisar, M.Tech. (Mechanical Engineering), w.e.f. 2015-16
ME-765 TRIBOLOGY

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Course Objectives

- The course has been designed to give an understanding of tribological phenomena, industrial lubricants and additives.

Unit I


Friction: Laws of static friction, causes of friction, Adhesion, Adhesion theory, laws of rolling friction


Unit II


Unit III


Unit IV

Bearing Materials: Selection of bearing materials, Metal bearings, Nonmetal bearing materials

Future Directions in Tribology: Biotribology-basic concepts; Nanotribology-basic concepts; Environmental implications of Tribology.

Course Outcomes

The students will be able to

- to understand the interdisciplinary subject ‘Tribology’ and its technological significance
- to understand the genesis of friction and wear
- to learn about the principles of lubrication, lubrication regimes, hydrodynamic lubrication and hydrostatic lubrication
- to learn about emerging areas such as bio Tribology and micro/nano Tribology

Books recommended

Note

In the semester examination, nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus (all four units). It will contain seven short answer type questions, each of two marks. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt other four questions by selecting one from each of the four units.
ME-767 TRIBOLOGY LAB

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Course Objectives

- To learn about tribotesting and experimental techniques in Tribology and analysis of real time results.

List of Experiments

1. To perform experiment on the journal bearing test rig for the measurement of Pressure and Temperature distribution in the fluid film of hydrodynamic journal bearings at different loads and speeds. To analyze the real time results obtained through data acquisition system for predicting the performance characteristics of bearing.

2. To perform experiment on the journal bearing test rig for investigating the fluid film thickness of hydrodynamic journal bearings at different loads and speeds. To analyze the real time results obtained through data acquisition system for predicting the performance characteristics of bearing.

3. To measure the frictional torque in hydrodynamic journal bearings at different loads and speeds on journal bearing test rig. To analyze the real time results obtained through data acquisition system for predicting the performance of bearing.

4. To determine wear preventive (WP) and extreme pressure(EP) behavior of lubricants on four ball tester and to measure viscosity of lubricants with the help of viscometer. To analyze the real time results obtained through data acquisition system for predicting behavior of lubricants.

5. To determine the friction and wear characteristics in sliding contacts under various normal loads and speeds on wear and friction monitor. To analyze the real time results obtained through data acquisition system for predicting tribological characteristics.

6. The modeling and analysis hydrodynamic/hydrostatic bearings using software (ARMD).

Course Outcomes

Students will be able to

- predict the performance characteristics of hydrodynamic journal bearings experimentally.
- determine the behaviour of lubricants under different operating conditions.
- predict the friction and wear characteristics under different loads.
- analyze and predict the performance characteristics of hydrodynamic/hydrostatic journal bearings using software (ARMD).

Note

The internal evaluation will be done by course coordinator. At the end of the semester, viva-voce will be conducted both by internal and external examiners to be appointed by the University.
### ME-769 SEMINAR

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#### Course Objectives
- To prepare students for the method of literature survey, realization of journal papers outcomes, expose them to the world of research and compilation/review of a research area of current era and prepare them for presentation of literature summary.
- Presentation on advanced topics in the field of Mechanical Engineering.

#### Course Work
The topic of the seminar will be related to the current research & development in the field of Mechanical Engineering. Each student is required to submit a report on the topic of seminar as per the guidelines decided by the department from time to time.

#### Course Outcomes
Students will be able to
- expose themselves to the world of research
- review of a research area of current era

#### Note
The internal evaluation will be done by course coordinator. During the semester, each student is required to give a presentation before the class and course coordinator.
ME-771 THESIS (STARTS)

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### Course Objectives
- To identify research issue/problem on advance engineering topics related to Mechanical Engineering.
- To gain knowledge on the research problems identified through extensive literature survey.
- To understand the tools required to carry out research work.

### Course Work
The Thesis work should be of research nature only. During the third semester, following must be carried out by the student:
- Literature Survey
- Problem Formulation

Thesis work will be started during the third semester and must be continued in fourth semester. Around 35% of the Thesis work should be completed in this semester. The remaining 65% work will be carried out in the fourth semester.

### Course Outcomes
Students will be able to:
- gain knowledge on the research problems identified through extensive literature survey.
- understand professional & ethical research issues.
- present effectively the research topic through synopsis presentation.

### Note
The internal evaluation will be through synopsis presentation and viva-voice before the faculty members of the department. Each student is required to submit a detailed synopsis report about the work done on topic of Thesis.
FOURTH SEMESTER

ME-772 THESIS

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Course Objectives

- Ability to bring ideas into practice through simulation of analysis of research topic.
- Ability to identify specific industrial problems in the form of research objectives.
- Ability to propose a novel idea/modified technique/new interpretation after analyzing the existing research work.

Course Work

Around 35% of the Thesis work is required to be completed in third semester. The remaining 65% work will be carried out in this semester. Each student is required to submit a detailed Thesis report about the work done (III Sem + IV Sem) on the topic of Thesis.

One paper in national/international conference/journal of repute is required before submission of thesis. Research work should be carried out at GJUS&T Hisar. However, candidate may visit research labs/institutions with the due permission of Chairperson on recommendation of supervisor concerned.

Course Outcomes

Students will be able to

- contribute in the Research and Development
- upgrade knowledge of scientific community and society in general through their research.

Note

Thesis evaluation and viva-voice will be carried out by the internal and external examiners appointed by the University.