METHODIST COLLEGE

OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

B.E. HONORS

IN

MECHANICAL ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

Scheme of Instructions, Examinations
&
Syllabus

(Curriculum for Honors degree in Mechanical Engineering)
Academic Year 2023-2024.
(Courses to be studied in addition to the regular courses offered for the award of B.E**)**

S. No.	Code No.	Subject	Scheme of Instructions				Scheme of Examination		Credits
			L	T	P/D	Duration in Hrs.	CIE	SEE	
Theory Courses									
1	HME 01	Industrial Robotics	3	0	0	3	40	60	3
2	HME 02	Heat Exchangers: Fundamentals and Design Analysis	3	0	0	3	40	60	3
3	HME 03	Design for Manufacturing, Assembly and Environment	3	0	0	3	40	60	3
4	HME 04	Mechanical Vibrations	3	0	0	3	40	60	3
5	HME 05	Advanced Materials Technology	3	0	0	3	40	60	3
6	HME 06	Robotics Lab	0	0	2	2	40	60	1
7	HME 07	Design Project	-	0	4	4	40	60	2
Total			**15**	**0**	**6**	**21**	**280**	**420**	**18**

Course Coding Nomenclature:

- HME denotes that Honors degree in “Mechanical Engg.”.
- 01, 02, 03, 04, 05, 06 are courses in order they have to be taken, if taken in different semesters. Multiple courses may also be taken in the same semester (if required).
- It is preferable to take HME 07 after completing all previous courses or at least after completing HME 01, HME 02, HME 03, in parallel with HME 04.

Course Code	Course Title	Course Type					
		CORE					
		L	T	P/D	Credits	CIE	SEE
HME 01	INDUSTRIAL ROBOTICS	3	0	0	3	40	60

Course Objectives: The main objective of the course is to

- Familiarize the students with the concepts and techniques in robotic engineering, manipulator kinematics, dynamics and control and incorporate robotic technology in engineering systems.
- Make the students acquainted with the theoretical aspects of Robotics.
- Enable the students to acquire practical experience in the field of Robotics through design projects and case studies.
- Make the students to understand the importance of robots in various fields of engineering.
- Expose the students to various robots and their operational details.

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

1. Understand the basic components of robots.
2. Differentiate types of robots and robot grippers.
3. Model forward and inverse kinematics of robot manipulators.
4. Analyze forces in links and joints of a robot.
5. Programme a robot to perform tasks in industrial applications.

UNIT I

Introduction: Types of Industrial Robots, definitions, classifications based on work envelope- Generations, configurations and control loops, co-ordinate system - need for robot - basic parts and functions – specifications.

UNIT II

Mechanical design of robot system: Robot motion - Kinematics of Robot motion-Direct and Indirect kinematics, Homogeneous transformations-linkages and joints - mechanism - method for location and orientation of objects -drive systems - end effectors-types, selection, classification and design of grippers - gripper force analysis.

UNIT III

Sensors: Functions of Sensors - Position and proximity's sensing - tactile sensing - sensing joint forces - vision system - object recognition and image transformation - safety monitoring sensor systems - image analysis - application of image processing.

UNIT IV

Robot programming & AI techniques: Types of Programming, Teach pendant programming - Basic concepts in A1 techniques - Concept of knowledge representations - Expert system and its components.

UNIT V

Robotic work cells and applications of robots: Robotic cell layouts - Inter locks - Humanoid robots - Micro robots - Application of robots in surgery, Manufacturing industries, space and underwater.

Text Books:

1. Robot Dynamics and Controls / Spony and Vidyasagar / John Wiley
2. Robot Analysis and control / Asada, Slotine / Wiley Inter-Science
3. Robotics – Fu et al / TMH Publications.

Reference Books:

1. Industrial Robotics / Grover M P /Mc Grew Hill
2. Introduction to Industrial Robotics / Ramachandran Nagarajan / Pearson.

Course Code	Course Title	Course Type					
HME 02	HEAT EXCHANGERS: FUNDAMENTALS AND DESIGN ANALYSIS	CORE					
		L	T	P/D	Credits	CIE	SEE
		3	0	0	3	40	60

Course Objectives: The main objective of the course is to

- Understand the basic concept and design methodology of heat exchangers.
- Distinguish different types of heat exchangers.
- Identify the important heat-exchanger design parameters
- Estimate the overall heat transfer coefficient and the effectiveness of a heat exchanger
- To understand the unique aspects and applications of heat exchangers that involve phase changes, such as boiling and condensation

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

1. Evaluate the effectiveness of heat exchanger
2. Discuss the tubular and compact heat exchangers
3. Analyze the plate fin and direct contact heat exchangers
4. Analyze the heat pipes and micro scale heat exchangers
5. Understand the concept of phase change heat transfer.

UNIT-I

Background, applications and classification of Heat Exchangers, common terminologies used in Heat Exchangers, introduction to thermal and hydraulic aspects, pressure drop and heat transfer, sizing and rating, F-LMTD and NTU method.

UNIT-II

Tubular Heat Exchangers: Different designs, brief description of shell and tube heat exchangers, special types, compact heat exchangers, enhancement of heat transfer, extended surface or fin, fundamental of extended surface heat transfer, fin tube heat exchanger.

UNIT-III

Plate Fin Heat Exchangers (PFHE): Types, construction, fabrication, design, application, multi stream PFHE, direct contact heat exchangers, types, applications, simple analysis, regenerators, types of regenerators, construction, applications, theory of regenerator.

UNIT-IV

Heat pipes: Construction, working principle, applications, analysis, special heat pipes, micro scale heat exchangers and heat sinks, heat transfer and fluid flow through narrow conduits, special design considerations.

UNIT-V

Phase change HEX: Phase change heat transfer, introduction to evaporators and condensers, phase change HEX, heat exchanger testing, steady state and dynamic methods.

Text Books:

1. R. K. Shah, Dusan P. Sekulic, "Fundamentals of Heat Exchanger Design", John Wiley & Sons.
2. Kuppan Thulukkanam, "Heat Exchanger Design Handbook", Taylor & Francis.

Reference Books:

1. Sadik Kakac, Hongtan Liu, "Heat Exchangers: Selection, Rating, and Thermal Design", 3/e ,CRC-Press.
2. Randall F. Barron, Gregory F. Nellis, "Cryogenic Heat Transfer", 2/e, CRC Press.

Course Code	Course Title	Course Type					
HME 03	DESIGN FOR MANUFACTURING, ASSEMBLY & ENVIRONMENT	CORE					
		L	T	P/D	Credits	CIE	SEE
		3	0	0	3	40	60

Course Objectives: The main objective of the course is to

- Introduce and aware students about the basic design process which based on different aspects of manufacturing as well assembly.
- Student will have idea about different criteria made on design such as machining and casting.
- To have knowledge on Environment factors.

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

1. Outline the appropriate design for economical production and select the materials.
2. Select between various machining and metal joining processes.
3. Apply a systematic understanding of knowledge in the field of metal casting and forging.
4. Fabricate basic parts and assemblies using powered and non – powered machine shop equipment in conjunction with mechanical documentation.
5. Integrate the knowledge of compliance analysis and interference analysis for assembly and also use visco-elastic and creep in plastics.

UNIT-I

Introduction: Design philosophy – steps in design process – general design rules for manufacturability – basic principles of designing for economical production – creativity in design, application of linear & non-linear optimization techniques. Materials: Selection of materials for design – developments in material technology – criteria for material selection – material selection interrelationship with process selection – process selection charts.

UNIT-II

Machining process: Overview of various machining processes – general design rules for machining - dimensional tolerance and surface roughness – design for machining – redesigning of components for machining ease with suitable examples, general design recommendations for machined parts. Metal joining: Appraisal of various welding processes, factors in design of weldments – general design guidelines – pre and post treatment of welds – effects of thermal stresses in weld joints – design of brazed joints.

UNIT-III

Metal casting: Appraisal of various casting processes, selection of casting process, - general design considerations for casting – casting tolerances – use of solidification simulation in

casting design – product design rules for sand casting. Forging: Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations.

UNIT-IV

Extrusion and sheet metal work: Design guidelines for extruded sections - design principles for punching, blanking, bending, and deep drawing – Keeler Goodman forming line diagram component design for blanking.

UNIT-V

Assembly: Compliance analysis and interference analysis for the design of assembly – design and development of features for automatic assembly – liaison diagrams. Environment: Introduction to environment; motivations for environment, principles of environment- eco-efficiency, product life cycle perspective, environment tools and processes, environment design guidelines.

Text Books:

1. James G. Bralla, —Hand book of product design for manufacturing, McGraw Hill Co.
2. A K Chitale and R C Gupta, "Product Design and Manufacturing", PHI, New Delhi.

Reference Books:

1. George E Deiter, " Engineering Design", McGrawHill International.
2. 2. Boothroyd G, "Product design for Manufacture and Assembly", First Edition, Marcel Dekker Inc, New York.

Course Code	Course Title	Course Type					
HME 04	MECHANICAL VIBRATIONS	CORE					
		L	T	P/D	Credits	CIE	SEE
		3	0	0	3	40	60

Course Objectives: The main objective of the course is to

- Introduce basic aspects of vibrational analysis, considering both single and multi-degree-of-freedom systems.
- Discuss the use of exact and approximate methods in the analysis of complex systems.

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

1. Understand the importance of studying vibrations
2. Understand free and forced vibrations of single degree freedom systems
3. Understand free and forced vibrations of single and multi degree freedom systems
4. Analyze vibration isolation techniques
5. Analyze Vibration of Continuous Systems

UNIT-I

Introduction to Mechanical Vibrations

Definition of vibrations, Importance of studying vibrations Classification of vibrations. Examples of vibrating systems, Simple Harmonic Motion (S.H.M.), Work done by harmonic force, Principle of super position applied to SHM.

UNIT-II

Undamped (1DOF) Free Vibrations

Derivations for spring mass systems, Methods of Analysis, Natural frequencies of simple systems, Springs in series and parallel, Torsional and transverse vibrations, Effect of mass of spring and Problems.

UNIT-III

Damped free vibrations (1DOF)

Types of damping, Analysis with viscous damping - Derivations for over, critical and under damped systems, Logarithmic decrement and Problems.

Forced Vibrations (1DOF)

Introduction, Analysis of forced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbalances, excitation of support (relative and absolute amplitudes), force and motion transmissibility, Energy dissipated due to damping and Problems.

UNIT-IV

Multiple-Degree-of-Freedom (MDOF) Systems

Principle modes of vibrations, Normal mode and natural frequencies of systems (without damping) – Simple spring mass systems, masses on tightly stretched strings, double pendulum, torsional systems, combined rectilinear and angular systems, geared systems and Problems. Undamped dynamic vibration absorber and Problems.

UNIT-V

Vibration Isolation and Control

Passive and active vibration isolation techniques, Tuned mass dampers, Vibration absorbers. Active vibration control

Text Books:

1. Grover, G.K., " Mechanical Vibrations", 7th Ed., Nem Chand & Bros.
2. Rao, S.S., " Mechanical Vibrations", 5th Ed., Addison-Wesley Longman, Incorporated.

Reference Books:

1. Thomason, W.T., "Theory of Vibrations with Applications", 5th Ed., Prentice-Hall.
2. Timoshenko, S.P., "Vibration Problems in Engineering", 2nd Reprint Ed., Wolfenden Press.
3. Kelly, S.G., "Mechanical Vibrations", Scgaum's Outlines, Mc Graw Hill Education

Course Code	Course Title	Course Type					
HME 05	ADVANCED MATERIALS TECHNOLOGY	CORE					
		L	T	P/D	Credits	CIE	SEE
		3	0	0	3	40	60

Course Objectives: The main objective of the course is to

- To impart knowledge on material selection methods and basics of advanced engineering materials.
- To introduce the basics of smart materials, composite materials, ceramics and glasses and modern metallic materials and their applications in engineering.

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

1. Understand the criteria for selecting materials for specific applications
2. Select suitable material for different industrial applications
3. Understand the important properties and applications of composite and ceramic materials.
4. Select suitable material for high and low temperature applications.
5. Understand the behavior and applications of smart materials, glasses and non-metallic materials.

UNIT-I

Classification and Selection of Materials: Classification of materials, properties required in Engineering materials, Selection of Materials; Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications.

UNIT-II

Composite Materials: Fiber reinforced, laminated and dispersed materials with metallic matrix of aluminium, copper and Titanium alloys and with non-metallic matrix of unsaturated polyesters and epoxy resins. Development, important properties and applications of these materials.

UNIT-III

Ceramics and Glasses -

Bio-ceramics: Nearly inert ceramics, bio-reactive glasses and glass ceramics, porous ceramics; Calcium phosphate ceramics: grafts, coatings Physico-chemical surface modification of materials used in medicine.

Low & High Temperature Materials:

Properties required for low temperature applications, Materials available for low temperature applications, Requirements of materials for high temperature applications, Materials available for high temperature applications, Applications of low and high temperature materials.

UNIT-IV

Modern Metallic Materials: Dual Steels, Micro alloyed, High Strength Low Alloy (HSLA) Steel, Transformation induced plasticity (TRIP) Steel, Maraging Steel, Inter metallics, Ni and Ti Aluminides. Non-metallic Materials: Polymeric materials and their molecular structures, Production Techniques for Fibers, Foams, Adhesives and Coatings structure, Properties and Applications of Engineering Polymers.

UNIT-V

Smart Materials: Shape Memory Alloys, Varistors and Intelligent materials for bio-medical applications. Nano materials: Definition, Types of nano materials including carbon nano tubes and nano composites, Physical and mechanical properties, Applications of nano materials.

Text Books:

1. Engineering Material Technology James A. Jacobs & Thomas F. Kilduff Prentice Hall
2. Materials Science and Engineering WD. Callister Jr. Wiley India Pvt. Ltd.

Reference Books:

1. Engineering Design: A Materials and Processing Approach G.E. Dieter McGraw Hill.
2. Materials Selection in Mechanical Design M.F. Ashby Pergamon Press 1992.
3. Introduction to Engineering Materials & Manufacturing Processes NIIT Prentice Hall of India.
4. Engineering Materials Properties and Selection Kenneth G. Budinski Prentice Hall of India.
5. Selection of Engineering Materials Gladius Lewis Prentice-Hall, New Jersey.

Course Code	Course Title	Course Type					
HME 06	ROBOTICS LAB	CORE					
		L	T	P/D	Credits	CIE	SEE
		0	0	2	1	40	60

Course Objectives: The main objective of the course is to

- To advance the field of robotics through cutting-edge research and development.
- To educate and train students and researchers in robotics technology.
- To facilitate innovation and technology transfer for real-world applications and industry solutions.

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

1. Gain a fundamental understanding of robotics principles, including robot kinematics, dynamics, control systems, and sensors.
2. Develop proficiency in programming languages commonly used in robotics, such as Python, C++, or ROS (Robot Operating System).
3. Write code to control and interact with robots.
4. Understand various control strategies used in robotics, including feedback control, motion planning, and path following algorithms.
5. Learn how to integrate sensors (e.g., cameras, LiDAR, IMUs) into robots and process sensor data for navigation, perception, and decision-making.

List of Lab Experiments to be performed:

1. Determination of maximum and minimum position of links.
2. Verification of transformation (Position and orientation) with respect to gripper and world coordinate system.
3. Estimation of accuracy, repeatability and resolution.
4. Robot programming and simulation for pick and place
5. Robot programming and simulation for colour identification
6. Robot programming and simulation for shape identification
7. Robot programming and simulation for assembly process
8. Trajectory control modelling with Inverse Kinematics
9. Robot programming for joint torque calculation.
10. Build a control system for a mobile robot using ARDUINO with sensors for obstacle detection systems
11. Demonstration of Robot with 2 DOF, 3 DOF & 4 DOF Etc
12. Two case studies of applications in industry (welding & spray painting)

Note: Student has to perform a minimum of 10 experiments.

Course Code	Course Title	Course Type					
HME 07	DESIGN PROJECT	CORE					
		L	T	P/D	Credits	CIE	SEE
		0	0	4	2	40	60

Course Objectives:

Design Project is to realize the design in various fields of interest related to the mechanical engineering profession that solves an existing problem, improves an existing technology, process or product and bring in innovative ideas that can be implemented through design. Students have to understand the importance of design and how to do it as this is the main professional goal.

This course is planned to understand the various segments of activities connected with simple design and to encourage students to think differently and formulate design solutions to meet society needs. Further, students are encouraged to take up mini-projects to realize the designs. They also get exposed to availability and usage of various engineering tools to be used to meet the final objective of design. These include CAD, Analysis Tools, Simulation Tools, Optimization Tools and the like.

The main objective of this course is to use the knowledge acquired in Mechanical Engineering and take up a mini project, which allows the students to come up with design / analyse and fabrication of models/ prototypes expressing their ideas in a novel way. The course enables the students to get experience in solving various design problems related to mechanical Engineering and to impart and improve the design capability of the student.

Course outcomes:

1. The student shall have knowledge on using and adapting existing methods and learn new methods, for problem solving in practical development projects.
2. The student shall also know how systematic technical problem solving and research shall be reported.
3. The student must be able to prepare a project plan with milestones, report partial results and write a project report in accordance with established standards.
4. The student shall on general basis be able to apply captured knowledge, competence and skills in a project setting where s/he works with others with different competence.
5. Furthermore, s/he should know how to work in a practical development project, within given circumstances and limitations, and deliver results.

Guidelines:

Two to three students will form a team. As part of the curriculum each team shall do a mini project. Each team will be allotted to a faculty supervisor for mentoring. Mini projects shall have domain / inter-disciplinary/ industry relevance. The students can select a design, modelling and analysis / Experimental investigations or Numerical modelling. All the investigations should be clearly stated and documented with the reasons/explanations. The

report of mini-project shall contain a clear statement of the problem, background of work, literature review; techniques used and detailed discussion on results, conclusions and reference.