Courses of Study

B.Tech Robotics and Automation

Batch 2024 Onwards

4th Semester

Department of Mechanical Engineering

Islamic University of Science and Technology Kashmir

Table of Contents

Detailed Course Contents for 4th Semester

Total Credits = 22+X *Total Hours Per Week = 26+1(S)+X*

Course Code	Course Title	L	T	P	S	Credits
MEC254C	Kinematics and Dynamics of Machines	3	0	0	0	3
MEC257C	Industrial Electronics	3	0	0	0	3
MEC258C	Fundamentals of Fluid Mechanics	3	0	0	0	3
MEC259C	Rigid Body Mechanics	3	0	0	0	3
MEC264C	Sensors and Transducers	2	0	2	0	3
CSE257C	Foundations of Artificial Intelligence	2	0	0	0	2
MEC265C	Introduction to MATLAB/SIMULINK	0	0	4	0	2
MEC266C	Mechanisms Lab	0	0	2	0	1
MEC267C	Practicals on Thermo-Fluids	0	0	2	0	1
MEC269C	Internship/Practical Training I[1]	0	0	0	1	1
	Open Elective	-	-	-	-	X

Note(s):

[1] Contact hours are used for evaluation only. The internship or training has to be completed during winter vacations after the third semester. The minimum duration of such internship or training has to be four weeks.

MEC254C Kinematics and Dynamics of Machines 3-0-0-0

Course Objectives: This course equips students with the fundamentals of machine kinematics and rigid-body dynamics, focusing on displacement, velocity, and acceleration analysis in linked mechanisms. Learners will examine gear train kinematics and apply design principles to develop governor systems with precise motion control. The curriculum blends theory and application to prepare students for real-world mechanical system design challenges.

Course Outcomes: At the end of this course, a student will be able to:

1. Select and analyse the kinematic parameters for designing a suitable linkage mechanism.
2. Determine the degrees of freedom of simple mechanisms.
3. Perform the kinematic analysis of simple mechanisms and draw their velocity and acceleration diagrams.
4. Select and design gears for a given input and output motion relationship.
5. Explain the working principle of governors and gyroscopes in motion control.

Module I
Mechanisms: Definition and types of joints; Lower and higher pairs; Classification of mechanisms based on function and constraints; Degree of freedom and Grübler's formula; Grashof's rule and rotatability limits; Mechanical advantage; Transmission angle; Limit positions, slider crank and 4-bar mechanisms and their inversions; Quick return mechanism, Straight line generators, rocker mechanisms, universal joints, steering mechanisms, etc.

Module II
Kinematic Analysis of Simple mechanisms: Displacement, velocity, and acceleration analysis; Velocity analysis using instantaneous centres; Position, velocity and acceleration analysis using loop closure equations; Coincident points; Coriolis component of acceleration.

Module III
Gears and Gear Trains: Gears, classification, law of gearing, involute and cycloidal profiles, path and arc of contact, contact ratio, interference and undercutting, interchangeable gears, helical, bevel and spiral gears, gear trains, classification, simple, compound, reverted, and epicyclic gear trains, analysis of epicyclic gear trains, sun and planet gears, automobile differential.

Module IV
Governors and Gyroscope: Governors, Watt governor, Porter governor, Proell governor, Hartnell governor, controlling force, sensitivity, stability, hunting, isochronism, effort and power of a governor, gyroscope, gyroscopic torque, gyroscopic effects on an aeroplane and ships, gyroscopic stabilisation, stability analysis of a two-wheel vehicle, four-wheel drive on a curved path.

Module V
Flywheel and Cams: Introduction to flywheel, dynamic theory of flywheels, Classification of cams and followers, Terminology for cams, types of follower motions, pressure angle, considerations influencing choice of cam, construction of cam profiles, layout.

Text Books:

1. J. J. Uicker, G.R. Pennock, J.E. Shigley, Theory of Machines and Mechanisms, Oxford University Press, 4th Edition, 2014.
2. T. Bevan, Theory of Machines, Pearson Education India, 3rd Edition, 2009.

Reference Books:

1. H. H. Mabie, C.F. Reinholtz, Mechanism and Dynamics of Machinery, Wiley, 4th Edition, 1987.
2. S. S. Rattan, Theory of Machines, McGraw Hill Education, 4th Edition, 2017.
3. A. Ambekar, Mechanism and Machine Theory, Prentice Hall India, 1st Edition, 2007.

Online Resources:

1. Kinematics of Mechanisms & Machines by Prof. Anirvan Das Gupta (IIT Kharagpur), NPTEL Course (https:// archive.nptel.ac.in/courses/112105268).

MEC257C Industrial Electronics 3-0-0-0

Course Objectives: This course covers fundamental concepts including number systems, binary arithmetic, Boolean algebra, combinational and sequential circuit design, programmable logic devices, operational amplifiers, and logic families in industrial electronics. Through practical examples and applications, students will master skills to analyse digital data, design circuits, and assess their efficacy, fostering problem-solving and critical thinking.

Course Outcomes: At the end of the course, a student will be able to:

1. Apply a range of number systems, Boolean algebra principles, and error detection codes to manipulate digital data effectively.
2. Design and analyse combinational circuits, including adders, subtractors, multiplexers, and encoders, to perform logical and arithmetic operations.
3. Implement clocked sequential circuits by utilising sequential logic elements like latches, flip-flops, and counters.
4. Examine operational amplifiers and their applications, including differential amplifiers, Schmitt triggers, and active filters, for signal processing tasks.
5. Differentiate and assess the roles of various logic families, programmable logic controllers, and industrial displays within contemporary electronics systems.

Module I

Introduction to Digital Electronics: Number Systems and Codes: Binary, octal, and hexa- decimal number systems, binary arithmetic, binary code, excess-3 code, Gray code, error detection and correction codes. Introduction to alpha numeric codes. Boolean algebra: Postulates/ Boolean algebra relations (commutative, Associative, Distributive etc.) and theorems, logic functions, minimization of Boolean functions using algebraic, Karnaugh map (2, 3, 4 variable) and Quine – McClausky methods, realisation using logic gates.

Module II

Combinational Circuits: Introduction to basic logic gates, truth tables and simple combinational circuits, realisation of basic combinational functions like Half, Full Adder, Half, Full Subtractor, 4-bit RCA, Encoder/Decoder, Multiplexer, Subtraction using 1's complement, Addition subtraction using 2's complement. Introduction to code converters.

Module III

Sequential Logic Circuits: Cross coupled inverters, stable and metastable states (butterfly diagram) latches and clocked and unclocked latches, Flip-Flops: SR, JK, T, D, Master/Slave FF, triggering of FF, Analysis of clocked sequential circuits, state minimization, state assignment, circuit implementation, Registers: shift registers, inter-conversion of shift registers, Counters. Introduction to programmable logic devices (PLDs) and field-programmable gate arrays (FPGAs).

Module IV

Counters and Amplifiers: Ripple counter, decade counter, Mod N counter, presettable counter, programmable counter, implementation for 3, 4 bits, Application of counters. Finite state machine

(FSM) basic concepts. Counter design using FSM. Introduction to Operational Amplifier as differential amplifiers, Op-Amp as ZCD, Inverting/non-inverting amplifier, Op-Amp as Schmitt trigger (and its application as smoke detection circuit), Active filters using Op-Amps, Digital to Analog Converter using Op-Amp.

Module V

Logic Families and Industrial Electronics: RTL, DCTL, I^2L, DTL, HTL, ECL, NMOS and CMOS logic gates, circuit diagram and analysis, characteristics and specifications, TTL families and their ICs. Introduction to Programmable Logic Controllers (PLC), HMIs, PLC Fundamentals - (Block diagram of PLC's) PLC components (Power supply, CPU, I/Os List, Communication bus Various ranges available in PLC's). Introduction to 7-segment and dot-matrix displays Need for decoders in 7-segment display. BCD decoder/7-segment driver circuit/IC.

Text Books:

1. Morris Mano, "Digital logic and Computer Design ", Prentice-Hall of India. Reference
2. Op-amps and linear integrated circuit technology, by Ramakant A. Gayakwad, Pearson.

Reference Books:

1. Ronald J. Tocci, "Digital Systems, Principles and Applications", Prentice-Hall of India.
2. Dr. B.R Gupta, V. Singhal, " Digital Electronics ", Katson Books

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Online Resources:

1. Digital Electronic Circuits, Prof. Goutam Saha (IIT Kharagpur), NPTEL Course (https://nptel.ac.in/courses/108105132).

MEC258C Fundamentals of Fluid Mechanics 3-0-0-0

Course Objectives: To introduce the fundamental principles of fluid mechanics and their applications in robotics and automation, enabling students to analyze fluid behavior, forces, and flow characteristics relevant to fluid-powered and aerodynamically influenced robotic systems.

Course Outcomes: At the end of this course, a student will be able to:

1. Determine and explain pressure exerted by fluids at rest.
2. Apply mass, momentum, and energy conservation equations to various fluid flows.
3. Determine pressure and velocity for simple flow fields

Module I

Fluid statics: Pressure distribution in a fluid. Manometry. Force on plane and curved submerged surfaces. Buoyancy. Fluid flow fields: Eulerian vs. Lagrangian descriptions. Velocity fields. Flow lines. Acceleration fields. Vorticity and Circulation

Module II

Control-volume analysis: Reynolds transport theorem. Mass balance. Momentum balance. Energy balance. Bernoulli's equation. Local analysis: Kinematics. The stream function. Derivation of continuity and Navier-Stokes equations. Simple viscous-flow solutions.

Module III

Pipe flow: Entry region. Fully developed flow. Laminar and turbulent flow. Colebrook formula. Minor losses. External flows: Laminar and turbulent boundary layers. Flow transition. Separation. Drag. Lift, Airfoil Theory fundamentals

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Text Books:

1. F. M. White, Fundamentals of Fluid Mechanics, McGraw Hill Education.

Reference Books:

1. Y. Cengel and J. Cimbala, Fluid Mechanics: Theory and Applications, McGraw-Hill Education.
2. B. R. Munson, Fundamental of Fluid Mechanics, John Wiley & Sons.
3. W. Fox, A.T. McDonald and P. J. Pritchard, Introduction to Fluid Mechanics, Wiley.

Online Resources:

1. Fluid Mechanics by Prof John Biddle (California State Polytechnic University, Pomona) (https://www.cpp.edu/meonline/fluid-mechanics.shtml?gclid=CjwKCAjwzo2mBhAUEiwAf7wjkjD8bCq158MT7UmAWp2LvrCbRbI8xPcp1RvCJwAVPoCyV3yprrO3BBoCtMUQAvD_BwE).

MEC259C — Rigid Body Mechanics — 3-0-0-0

Course Objectives: The objective of this course is to enable students to understand, analyze, and apply the principles of kinematics and kinetics for particles and rigid bodies in two-dimensional and three-dimensional motion. Students will solve problems using different coordinate systems, evaluate Newton's second law and work-energy principles, and examine the dynamics of rotating bodies, preparing them for advanced topics in mechanical engineering.

Course Outcomes: At the end of the course, a student will be able to:

1. Analyze kinematic equations to solve problems involving rectilinear and curvilinear motion.
2. Apply Newton's second law to derive equations of motion for various particle scenarios.
3. Illustrate and evaluate the motion of rigid bodies in a plane, focusing on relative motion.
4. Formulate and solve equations of motion for rigid bodies using work-energy and impulse-momentum methods.
5. Analyze the dynamics of rigid bodies in three dimensions, applying concepts of angular momentum and kinetic energy.

Module I
Kinematics of Particles: Rectilinear Motion; Plane Curvilinear Motion; Rectangular Coordinates; Normal and Tangential Coordinates; Polar Coordinates; Relative Motion.

Module II
Kinetics of Particles: Newton's Second Law; Equation of Motion and Solution of Problems; Rectilinear Motion; Curvilinear Motion; Work and Kinetic Energy; Potential Energy; Linear Impulse and Linear Momentum; Angular Impulse and Angular Momentum

Module III
Plane Kinematics of Rigid Bodies: Rotation; Absolute Motion; Relative Velocity; Instantaneous Center of Zero Velocity; Relative Acceleration; Motion Relative to Rotating Axes.

Module IV
Plane Kinetics of Rigid Bodies: General Equations of Motion; Translation; Fixed-Axis Rotation; General Plane Motion; Work-Energy Relations; Acceleration from Work-Energy; Virtual Work; Impulse-Momentum Equations.

Module V
Introduction to Three-Dimensional Dynamics of Rigid Bodies: Translation; Fixed-Axis Rotation; Parallel-Plane Motion; Rotation about a Fixed Point; General Motion; Angular Momentum; Kinetic Energy; Momentum and Energy Equations of Motion; Parallel-Plane Motion; Gyroscopic Motion: Steady Precession.

Text Books:

1. Meriam, James L., L. Glenn Kraige, and Jeff N. Bolton. Engineering mechanics: dynamics. John Wiley & Sons, 2020, ISBN-13: 978-8126565375.
2. Ferdinand P. Beer, E. Russell Johnston Jr., Phillip J. Cornwell, Brian P. Self, David F. Mazurek and Sanjeev Sanghi, Vector Mechanics For Engineers: Statics And Dynamics, 12th Edition, McGraw-Hill, 2019, ISBN-13: 978-9353166625.

Reference Books:

1. Russell C. Hibbeler, Engineering Mechanics: Statics & Dynamics, Pearson Education, 14th Edition, 2017, ISBN-13: 978-9332584747.

Online Resources:

1. Engineering Mechanics Statics and Dynamics by Prof. Anubhab Roy (IIT Madras), NPTEL Course (https://archive.nptel.ac.in/courses/112/106/112106180/#)

MEC264C — Sensors and Transducers — 2-0-2-0

Course Objectives: This course aims to provide students with a foundational understanding of sensors and transducers used in robotics and automation, focusing on their working principles, signal conditioning, data acquisition, and integration techniques, along with exposure to motion sensing and emerging sensor technologies for intelligent robotic systems.

Course Outcomes: At the end of this course, a student will be able to:

1. Explain the principles and characteristics of sensors and transducers used in robotics.
2. Implement signal conditioning and data acquisition techniques for sensor systems.
3. Select and integrate sensors for position, proximity, force, and torque measurements.
4. Analyze motion sensing and evaluate emerging sensor technologies for robotics.

Module I: Fundamentals of Sensors and Transducers
Importance of sensing in robotics and automation; classification of sensors; key performance characteristics (sensitivity, range, resolution, accuracy, etc.); physical principles of sensing; types of transduction: electrical, optical, mechanical, thermal, and chemical; overview of smart and intelligent sensors.

Module II: Sensor Signal Processing and Conditioning
Introduction to signal processing in sensor systems; signal conditioning techniques: amplification, filtering (low-pass, high-pass, band-pass), isolation, linearization; noise reduction: shielding and grounding; analog-to-digital and digital-to-analog conversion; data acquisition systems (DAQ); sensor interfacing and communication standards.

Module III: Position, Proximity, Force, and Torque Sensing
Position and displacement sensors: potentiometers, LVDTs, optical encoders; proximity sensors: inductive, capacitive, ultrasonic, and infrared; force sensors: strain gauges, piezoelectric transducers; pressure sensors: piezoresistive and capacitive; torque sensors and measurement in robotic joints; applications in robot grippers, industrial automation, and feedback control.

Module IV: Motion Sensing and Emerging Sensor Technologies
Motion sensors: accelerometers, gyroscopes, and Inertial Measurement Units (IMUs); applications in mobile and aerial robotics; introduction to sensor fusion; emerging trends: biosensors, gas/chemical sensors for healthcare and environment monitoring, flexible and wearable sensors, smart sensing systems and their role in next-generation robotic platforms.

List of Practicals:

1. Measure and Linearize Temperature using a Thermistor
2. Interface and Decode an Optical Rotary Encoder to measure angular position and speed for robotic joints or motor shafts.
3. Force Measurement using a Load Cell with HX711 Interface
4. Strain Gauge-Based Force Sensing with Signal Conditioning
5. Motion Tracking using MEMS accelerometer
6. Proximity Detection using Inductive, Capacitive, IR Sensors, Ultrasonic Sensors

7. Analog Signal Conditioning: Amplification and Filtering using MATLAB/Hardware
8. Real-Time Data Acquisition and Filtering using MATLAB with Microcontroller
9. Measure and Visualize Displacement using LVDT/Potentiometer
10. Design a Robotic Gripper with FSR-Based Force Feedback

Text Books:

1. D. Patranabis, *Sensors and Transducers*, PHI Learning Pvt. Ltd., 2nd Edition, 2013.
2. B.C. Nakra and K.K. Chaudhry, *Instrumentation, Measurement and Analysis*, McGraw Hill Education, 3rd Edition, 2009.

Reference Books:

1. Sabrie Soloman, *Sensors Handbook*, McGraw-Hill, 2nd Edition, 2010.
2. Jacob Fraden, *Handbook of Modern Sensors: Physics, Designs, and Applications*, Springer, 5th Edition, 2016.
3. Clarence W. de Silva, *Sensors and Actuators: Control System Instrumentation*, CRC Press, 2nd Edition, 2007.
4. John Turner and Martyn Hill, *Instrumentation for Engineers and Scientists*, Oxford University Press, 4th Edition, 1999.

Online Resources:

1. https://online.stanford.edu/courses/me220-introduction-sensors

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CSE257C Foundations of Artificial Intelligence 2-0-0-0

Course Objectives: This course aims to introduce the foundational concepts of Artificial Intelligence with a focus on robotics applications. It covers intelligent agents, search strategies, expert systems, and knowledge representation. Students will also explore AI techniques used in robotic perception, planning, and control, along with associated ethical considerations.

Course Outcomes: At the end of this course, a student will be able to:

1. Explain the fundamental concepts of Artificial Intelligence and its role in robotics and automation.
2. Apply appropriate search algorithms and problem-solving techniques to model intelligent agent behavior.
3. Analyze the use of expert systems and AI methods in robotic perception, planning, and decision-making.

Module I
Fundamentals of AI: Definition, scope, and significance of AI; Historical development; Narrow vs. General AI; AI in robotics and automation; Introduction to intelligent agents – agents, environments, agent architectures, and problem-solving agents, Ethical and Societal challenges in AI.

Module II
Intelligent Agents and Search Techniques: Intelligent Agents: Agent and Environment, Structure of Agent, Problem Solving Agent, Search Algorithms: Informed and Uninformed Search, BFS, DFS, A*, AO*, and Heuristics.

Module III
Expert Systems and Knowledge Representation: Introduction to Expert system, Basic Characteristics and types of problems handled by Expert System, Architecture, Techniques of Knowledge representation in Expert Systems, Types of Expert Systems.

Module IV
Applications of AI in Robotics: Overview of AI integration in robotic systems; Robotic perception and sensor fusion; Localization and mapping techniques (SLAM); Planning in dynamic and uncertain environments; Introduction to robotic dynamics and movement coordination.

Prerequisites: Nil

Textbook:

1. Russell, Stuart J., and Peter Norvig. Artificial intelligence: a modern approach. Pearson, 2016.

Reference Books:

1. Govers, Francis X. Artificial intelligence for robotics: Build intelligent robots that perform human tasks using AI techniques. Packt Publishing Ltd, 2018.
2. Wooldridge, M.. A brief history of artificial intelligence: what it is, where we are, and where we are going. Flatiron Book, 2021.

Online Resources:

1. An Introduction to Artificial Intelligence - IIT Delhi: nptel.ac.in/courses/106102220
2. Fundamentals of Artificial Intelligence - IIT Guwahati: https://onlinecourses.nptel.ac.in/noc25_ge55/preview

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MEC265C Introduction to MATLAB/SIMULINK 0-0-4-0

Course Objectives: This course provides hands-on MATLAB and Simulink training for technical computing, control systems, and robotic simulations. Students will learn modeling, data visualization, and automation workflows to design and optimize robotic systems through practical projects.

Course Outcomes: At the end of the course, a student will be able to:

1. Recognize the basic tools and commands in MATLAB and Simulink.
2. Build simple system models using Simulink blocks and connections.
3. Compare the behavior of open-loop and closed-loop systems through simulation.
4. Create basic mechanical, electrical, and hydraulic models using Simscape.
5. Present simulation results and explain the working of a simple mechatronic system.

List of Practicals:

1. Introduction to MATLAB interface, command window operations, and basic syntax.
2. Creating and manipulating variables, vectors, matrices, and arrays in MATLAB.
3. Writing scripts, user-defined functions, and using control flow statements (if, for, while).
4. Plotting and visualizing data using 2D and 3D plots (plot, mesh, surf, etc.).
5. Introduction to Simulink: interface overview, block libraries, and simple model construction.
6. Subsystems, scopes, display blocks, and data logging in Simulink.
7. Modeling and simulating control systems: gain blocks, summing junctions, open-loop vs closed-loop responses.
8. Interfacing MATLAB code with Simulink using the MATLAB Function Block.
9. Introduction to Simscape and physical modeling of multi-domain systems.
10. Basics of Simscape Multibody (SimMechanics): modeling simple mechanical linkages.
11. Basics of Simscape Fluids (SimHydraulics): simulating hydraulic circuits and actuators.
12. Basics of Simscape Electrical (SimElectronics): modeling electrical components and circuits.
13. Mini Project: Simulate a basic mechatronic or robotic system integrating multiple domains.
14. Project presentations and viva voce on simulation design and outcomes.

Mini Projects (Indicative only)
Simulate a DC motor with speed control, PID control of a simple robot arm, Line-following robot using basic logic in Simulink, Obstacle detection using logic blocks and simulated sensor inputs, Etc.

Text Books:

1. Rudra Pratap, *Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers*, Oxford University Press, 3rd Edition, 2010.
2. Stephen J. Chapman, *MATLAB Programming for Engineers*, Cengage Learning, 5th Edition, 2015.

Reference Books:

1. William J. Palm III, *Introduction to MATLAB for Engineers*, McGraw Hill Education, 3rd Edition, 2011.

2. Peter Corke, *Robotics, Vision and Control: Fundamental Algorithms in MATLAB*, Springer, 2nd Edition, 2017.
3. Brian Hahn and Daniel T. Valentine, *Essential MATLAB for Engineers and Scientists*, Academic Press, 7th Edition, 2022.

MEC266C Mechanisms Lab 0-0-2-0

Course Objectives: This course aims to introduce students to the fundamentals of mechanical systems, focusing on the analysis of mechanisms, motion diagrams, and key machine components such as brakes, clutches, governors, gears, and gyroscopes. Emphasis is placed on graphical methods and hands-on experiments to develop practical understanding and analysis skills.

Course Outcomes: At the end of the course, a student will be able to:

1. Apply graphical methods to identify and analyze various linkages and their inversions.
2. Analyze velocity and acceleration in mechanisms using graphical and simulation tools.
3. Demonstrate the working and characteristics of brakes, clutches, governors, and gear trains.
4. Evaluate unbalanced forces and perform balancing of rotating and reciprocating systems.
5. Simulate cams, followers, and linkages using appropriate open-source software tools.

List of Practicals

1. Study of Various Links and Mechanisms: Draw inversions of four-bar chain, slider-crank, and double slider mechanisms.
2. Velocity and Acceleration Diagrams by Graphical Method: Use graphical approach to analyze slider-crank and four-bar linkages.
3. Study and Operation of Brakes and Clutches: Examine internal and external shoe brakes, band brakes, single/multi-plate clutches.
4. Experiments on Governors: Watt, Proell, Porter, and Hartnell governors: determine sensitivity, stability, and controlling force.
5. Study of Gears and Gear Trains: Simple, compound, reverted, and epicyclic gear trains.
6. Experiment on Gyroscopic Effect and Precession: Analyze the effect of angular velocity on gyroscopic couple and direction of precession.
7. Balancing of Rotating Masses: Static and dynamic balancing of rotating masses in a disc or shaft.
8. Balancing of Reciprocating Masses: Analyze primary and secondary forces in reciprocating systems.
9. Cam and Follower Analysis: Study displacement, velocity, and acceleration diagrams for different follower motions.
10. Kinematic Analysis of Mechanisms using Simulation Software: Create and simulate planar linkages.

    Use of following software is recommended: Linkage Mechanism Designer and Simulator (by David Rector), GeoGebra, OpenModelica, Python with matplotlib, Scilab/Xcos, Gears Simulator (by Algodoo), MechAnalyzer, MeKinSim for Scilab, Etc.

Text Books:

1. J. E. Shigley, Theory of Machines and Mechanisms, McGraw Hill Education (India).

Online Resources: NA

MEC267C Practicals on Thermo-Fluids 0-0-2-0

Course Objectives: To provide practical understanding of fundamental thermodynamics and fluid mechanics through hands-on experiments focused on temperature and pressure measurement, energy analysis, and flow behavior, with applications in robotics and automation systems.

Course Outcomes: At the end of this course, a student will be able to:

1. To apply standard methods to measure and calibrate temperature, pressure, and flow.
2. To analyze thermodynamic processes like heat capacity and entropy generation through experiments.
3. To evaluate experimental data to assess and improve thermal-fluid performance in robotic and automation systems.

List of Practicals

1. To study and compare different temperature measurement methods and sensor behaviors, and to calibrate sensors for thermal applications in engineering systems.
    a. Calibration of thermocouple using ice and boiling water method
    b. Response time comparison of thermocouple, RTD, and thermistor under step temperature change
    c. Non-contact temperature measurement using infrared thermometer
    d. Practical insights: sensor selection and placement in robotic or automation systems (motors, batteries, enclosures)
2. To evaluate the Heat Capacity Comparison of Different Materials as thermal response of different solid materials when heated equally.
3. Observe entropy generation due to irreversible mixing of Hot and Cold Water at different temperatures.
4. Energy balance on a reciprocating air compressor (input, output, and losses)
5. Study and performance analysis of a vapour compression refrigeration system (COP calculation)
6. Calibration of a pressure gauge and manometer
7. Verification of Bernoulli's theorem using a Bernoulli apparatus
8. Measurement of flow rate using a venturimeter or orifice meter
9. Study of laminar and turbulent flow using Reynolds apparatus
10. Determination of friction factor for flow through pipes

Text Books:

1. F .M. White, Fundamentals of Fluid Mechanics, McGraw Hill Education.

Reference Books:

1. B. R. Munson, Fundamental of Fluid Mechanics, John Wiley & Sons.
2. J. Lal, Hydraulic Machines, S Chand Publishers

Online Resources:

1. Fluid Mechanics by Prof John Biddle (California State Polytechnic University, Pomona) https://www.cpp.edu/meonline/fluid-mechanics.shtml?gclid=CjwKCAjwzo2mBhAUEiwAf7wjkjD8bCq158MT7UmAWp2LvrCbRbI8xPcp1RvCJwAVPoCyV3yprrO3BBoCtMUQAvD_BwE).

MEC269C Internship/Practical Training I 0-0-0-1

Course Objectives: The objective of internship/practical training is to make sure that the students receive hands-on, real-world experience in an industrial setting. It would also provide them exposure to industry-specific challenges, and develop essential skills in problem-solving, teamwork, and project management.

Course Outcomes: At the end of the internship/practical training, a student will be able to explain some of the industrial processes, briefly define a specific industrial environment and develop a deeper understanding of mechanical engineering principles and practices. A student will also develop a heightened awareness of the professional demands and expectations within the industry, preparing them for successful careers in the field.

Few guidelines for the internship/practical training:
The department expects students to do such internships or practical training at some established industrial setups. In particular, the students in the second year shall preferably visit an industry/factory/shop floor or in certain cases only may do some training related to CAD, or other simulation software, etc. All such training shall have to be approved by the Head of the Department beforehand. The internships should be focussed with few objectives rather than just a visit to the industry.

Duration:
Only training or internship of a minimum duration of four weeks shall be considered valid for evaluation and award of credits.

Evaluation Mode and Rubrics:
The internship or practical training shall be evaluated in the fourth semester. Students will be awarded credits based on their internship/practical training report, attendance, presentation before the departmental committee, and submission of the original certificate.
