Second - Year Course Structure (III Semester)							
S. No.	Course Category	Course Code	Course Title	L	P	T	Credits
1	BS	MTH-200	Probability and Statistics	3	0	1	4
2	PC	MEC-200	Engineering Thermodynamics	3	2	0	4
3	PC	MEC-201	Mechanics of Deformed Solids	3	2	0	4
4	PC	MEC-202	Metallurgy and Materials	3	2	0	4
5	ES	MEC-203	Python Programming	3	2	0	4
6	AEC	ENG-200	Soft Skill-1	1	0	0	1
7	VAC	CVL-204	Environmental Science and Engineering	1	0	0	1
Total Credits							22

Course Code: MEC-200	**Course Name: Engineering Thermodynamics**	**L-T-P: 3- 2-0**	**Credit: 04**

Course Objectives:

1. *To introduce foundational thermodynamic concepts, laws, and the classification of systems and properties.*
2. To enable students to apply the First Law of Thermodynamics to analyze closed and open systems, including processes involving pure substances.
3. To build the conceptual framework for the Second Law, entropy, and exergy to understand energy quality and irreversibility.
4. To provide the analytical skills required to evaluate and improve the performance of steam power plant components and cycles.

Syllabus:

Module I: Fundamentals of Thermodynamics [10 Hours]

Scope and applications of thermodynamics, Macroscopic vs. microscopic approaches, Thermodynamic systems: closed system (fixed mass) and control volume(open system), Properties of systems: intensive and extensive, Thermodynamic state and process, property diagrams, Thermodynamic cycles and their representation, Path and point functions, quasi-equilibrium, Reversible vs. irreversible processes, Thermodynamic equilibrium: thermal, mechanical, chemical, Zeroth Law and temperature measurement

Module II: First Law of Thermodynamics & Pure Substances [10 Hours]

Forms of energy: internal, kinetic, potential, and flow energy, Heat and work interactions: mechanical and electrical, Moving boundary (PdV) work for different processes, First law for closed systems (cyclic and non-cyclic processes), Definition and significance of internal energy, First law for open systems (control volume): steady flow energy equation (SFEE) and applications, Enthalpy: definition and usage in energy equations

Pure Substances:

Definition of a pure substance, Phase change and phase diagrams (P-v, P,-T, T-v, T-s, h-s), Saturated liquid, wet vapor, and superheated vapor states, Use of steam tables to find u, h, s; dryness fraction, Applications: use of steam tables in solving first law problems for closed and open systems (e.g., boilers, turbines, nozzles)

Module III: Second Law, Entropy & Exergy **[10 Hours]**

Limitations of First Law; concept of energy quality, Second law statements: Kelvin–Planck & Clausius, Carnot cycle, Carnot principles, and ideal heat engines, Effciency and Co-effcient of Performance (COP), Clausius inequality and reversible processes

Entropy: definition and evaluation for ideal gases and steam, Principle of increase in entropy; entropy generation

Exergy: available energy, dead state, and flow availability, Exergy balance for closed and open systems, Irreversibility, lost work, and second law efficiency

Module IV: Steam Power Plants **[10 Hours]**

Introduction to Vapour Power Cycle, Ideal Rankine Cycle, Energy Analysis of Ideal Cycle, Actual Rankine Cycle, Superheating and Reheating, Regenerative Feed Heating, Feedwater Heaters and Deaerators, Combined Cycle & Cogeneration Concepts

Course Outcomes:

1. *Explain the fundamental concepts, laws, and thermodynamic properties of systems and processes using macroscopic and microscopic approaches.*
2. *Apply the first law of thermodynamics to closed and open systems to evaluate energy interactions in various engineering devices such as turbines, compressors, and nozzles.*
3. *Analyze the performance of heat engines and refrigeration cycles using the second law of thermodynamics, entropy balance, and exergy analysis.*
4. *Evaluate the efficiency of steam power plants by modeling ideal and actual Rankine cycles and incorporating concepts like reheating, regeneration, and cogeneration.*

Text Books:

1. *Cengel, Y.A., & Boles, M.A. (2019). Thermodynamics: An Engineering Approach (9th ed.). McGraw-Hill Education. ISBN: 978-1-260-25053-7*
2. *Sonntag, R.E., Borgnakke, C., & Van Wylen, G.J. (2002). Fundamentals of Thermodynamics (6th ed.). John Wiley & Sons. ISBN: 978-0-471-38101-2*
3. *Moran, M.J., & Shapiro, H.N. (2020). Fundamentals of Engineering Thermodynamics (9th ed.). Wiley. ISBN: 978-1-119-39480-1*
4. P. K. Nag, Engineering Thermodynamics, Sixth Edition, Tata McGraw Hill Publishing Company, 2017, New Delhi

Reference books:

1. P. *Chattopadhyay*, *Engineering Thermodynamics, Second Edition, OXFORD University Press, 2011, New Delhi.*
2. *E. Radhakrishnan, Fundamentals* of Engineering Thermodynamics, Second Edition, PHI Publication, 2005, New Delhi

Digital Learning Resources:

Course Name	Engineering Thermodynamics
Course Link	https://nptel.ac.in/courses/101/104/101104063
Course Instructor	IIT Kanpur

Engineering Thermodynamics Laboratory

Course Objectives:

1. To provide practical exposure to the working principles of steam power cycles and their subsystems.
2. To understand the thermodynamic processes governing internal combustion engines and evaluate timing mechanisms.
3. To analyze the performance characteristics of air compressors and gas turbines.
4. To investigate vapor compression and absorption refrigeration cycles and their key performance parameters.

Syllabus:

List pf Experiments:

Select any 8 experiments from the list of 10 experiments

1. Model study of Steam Power cycle.
2. Port timing diagram of Two stroke I.C. Engine.
3. Valve timing diagram of Four stroke I.C. Engine.
4. Performance analysis of reciprocating air-compressor.
5. Performance analysis of Centrifugal / Axial Flow compressor.
6. Verification of Joule-Thomson coefficient.
7. Performance analysis of gas turbine.
8. Calibration of Bourdon Tube Pressure gauge and measurement of pressure using manometers.
9. Study of Vapour Compression Cycle
10. Study of Vapour Absorption Cycle

Course Outcomes:

On Completion of this Course, the students should be able to:

1. Demonstrate the layout and working of steam power plants and interpret associated thermodynamic cycles.
2. Interpret valve and port timing diagrams for various I.C. engines and relate them to combustion efficiency.

3. Evaluate the operational performance of reciprocating and centrifugal compressors using experimental data.
4. Analyze the components and performance metrics (COP, cooling load) of vapor compression and absorption refrigeration systems.

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Course Code: MEC-201	**Course Name: Mechanics of Deformed Solids**	L-T-P: 3- 2- 0	Credit: 04

Course Objectives:

1. To introduce the fundamental principles of stress, strain, and material behavior under axial and shear loading.
2. To analyze structural elements under bending, torsion, and complex stress states including thin pressure vessels.
3. To evaluate deflection in beams and assess stability of columns using analytical methods.
4. To design basic mechanical components like shafts, beams, and struts based on strength and deformation criteria.

Syllabus:

Module I: Stress-Strain Fundamentals & Elastic Constants [10 Hours]

Concepts of normal and shear stress, strain, Hooke's Law, modulus of elasticity, strain energy, impact loading, Axially loaded members, temperature stress in composite bars, Shear stress and strain, Poisson's ratio, elastic constants and their relationships, Statically indeterminate members

Module II: Biaxial Stress, Thin Shells & Strain Analysis [10 Hours]

Biaxial state of stress, principal stresses, Mohr's circle, Two-dimensional strain, principal strains, Mohr's circle for strain, strain rosette, Calculation of stresses from strain data

Module III: Shear Force, Bending Moment & Beam Bending [10 Hours]

Shear force and bending moment diagrams for various loadings, Simple bending theory, normal and shear stress distribution in beams, Point of inflection, composite beams, Design considerations for beam sections

Module IV: Deflection, Columns & Torsion [10 Hours]

Slope and deflection using integration and area-moment methods, Euler's theory of columns, critical load, slenderness ratio, Torsion in solid and hollow shafts, torsional energy, shafts under combined bending and twisting

Course Outcomes:

After completing the course, the students will be able to

1. Apply the principles of stress and strain to analyze deformation and stability in axially and torsionally loaded members.

2. Analyze complex stress and strain states using Mohr's circle and design thin-walled pressure vessels.
3. Construct shear force and bending moment diagrams and evaluate bending and shear stresses in structural beams.
4. Evaluate deflections in beams and stability of columns and design mechanical components under torsional loads.

Text Books:

1. S. P. Timoshenko and D. H. Young, Elements of Strength of Materials, Affiliated East West Press, 5th edition, 2003, New Delhi
2. G. H. Ryder, Strength of Materials by Macmillan Publishers India Limited, 3rd edition, 2002, Chennai

Reference Books:

1. S. S. Rattan, Strength of Materials by Tata Mc Graw Hill, 3rd edition, 2017, New Delhi
2. R. Subramaniam, Strength of Materials, Oxford University Press, 3rd edition, 2016, New Delhi

Digital Learning Resources:

Course Name	Mechanics of Solids
Course Link	https://nptel.ac.in/courses/112/102/112102284/
Course Instructor	Prof. Ajeet Kumar

Mechanics of Solids Laboratory

Course Objectives: The students able to

1. Evaluate fundamental mechanical properties of engineering materials through experimental methods.
2. Understand the behavior of materials under tensile, compressive, shear, bending, and impact loads.
3. Determine hardness, rigidity, and fatigue strength using standard material testing techniques.
4. Measure strain, stress, and spring constants to correlate experimental results with theoretical predictions.

Syllabus:

List of the Experiments:

1. Determination of tensile strength of materials by Universal Testing Machine
2. Determination of compressive strength of materials by Universal testing Machine
3. Determination of bending strength of materials by Universal Testing Machine
4. Double shear test in Universal Testing Machine
5. Determination of Impact strength of material (Charpy and Izod)
6. Determination of Hardness strength of materials (Brinnel, Rockwell and Vickers)
7. Determination of Rigidity modulus of material
8. Determination of Fatigue strength of material
9. Load measurement using Load indicator, Load Cells.
10. Strain measurement using Strain Gauge.
11. Stress measurement using strain rosette.

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

1. Perform standard tests to determine mechanical properties such as tensile, compressive, bending, and impact strength.
2. Analyze and interpret test data to evaluate material behavior under different loading conditions.

3. Use instruments such as strain gauges, load cells, and hardness testers for property measurement and validation.
4. Relate stress-strain behavior, fatigue limits, and spring constants to design and analysis applications.

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Course Code: MEC202	**Course Name: Metallurgy and Materials**	**L-T-P: 3- 0- 0**	**Credit: 3**

Course Objectives:

1. **To provide fundamental knowledge of materials science and physical metallurgy, including atomic bonding and crystal structures.**
2. **To understand the influence of microstructure, heat treatment, and phase transformations on material behavior and properties.**
3. **To introduce phase diagrams and their role in predicting alloy behavior and microstructure evolution.**
4. **To familiarize students with engineering applications of advanced materials such as polymers, ceramics, and composites.**

Syllabus:

Module–I: Atomic Structure and Crystal Geometry **[10 Hours]**

Classification of engineering materials, Atomic bonding: ionic, covalent, metallic, Crystal structures: SC, BCC, FCC, HCP,Miller indices, packing factor, crystal defects, Mechanical properties of materials

Module–II: Alloy Systems and Heat Treatment **[10 Hours]**

Alloy formation and types: substitutional and interstitial, Factors affecting solid solubility,Order–disorder transformations, Heat treatment processes: annealing, normalizing, hardening, tempering, Microstructural changes and their effect on properties

Module–III: Phase Diagrams and Ferrous Alloys **[10 Hours]**

Binary phase diagrams: isomorphous, eutectic, peritectic, eutectoid, peritectoid, Lever rule and microstructure prediction

Iron–cementite diagram, Properties and applications of steels, cast irons, and alloy steels

Module–IV: Composite Materials: **[10 Hours]**

Thermosets and thermoplastics, Ceramics: types, structure, properties, and uses,Composites: fiber-reinforced plastics, metal matrix composites, Agglomerated materials: cermets, reinforced concrete

Course Outcomes:

1. Identify and compare different crystal structures and relate them to material properties.

2. Interpret binary phase diagrams and predict phase transformations during solidification and cooling.
3. Analyze the effects of heat treatment on the microstructure and mechanical behavior of metals.
4. Classify polymers, ceramics, and composite materials and suggest suitable materials for engineering applications.

Text Books:

1. W. D. Callister, Materials Science and Engineering, Eighth Edition, Wiley and Sons Inc, 2017, New Delhi.

Reference Books:

1. Avner, Sidney H.,Introduction to Physical Metallurgy, Second Edition, Tata McGraw Hill Publishing Company, 2017, New Delhi.
2. Raghavan, V., Physical Metallurgy: Principles and Practice, Third Edition, PHI Publication, 2015, New Delhi.

Digital Learning Resources:

Course Name	Introduction to Physical Metallurgy &Engineering Materials
Course Link	https://nptel.ac.in/courses/113/102/113102080/
Course Instructor	IIT Delhi

Metallurgy and Materials Laboratory

Course Objectives:

1. To develop an understanding of crystal structures and their visual representation through models.
2. To impart practical knowledge of specimen preparation and metallographic analysis techniques.
3. To demonstrate the influence of heat treatment processes on mechanical and microstructural properties.
4. To familiarize students with standard mechanical tests for hardness, impact strength, and hardenability.

Syllabus:

List of the Experiments:

1. Study of crystal structures using ball and stick models
2. Principles and operations of the metallurgical microscope
3. Specimen preparation for metallographic analysis
4. Microstructural analysis of carbon steels and cast irons
5. Microstructural analysis of non-ferrous metals (brass and copper)
6. Hardness testing of ferrous materials (Brinell, Rockwell, Vickers)
7. Impact testing (Charpy/Izod)
8. Heat treatment of steels (annealing, hardening, tempering)
9. Jominy end quench test for hardenability

Course Outcomes:

Upon successful completion of the course, students will be able to:

1. Visualize and construct atomic arrangements of metallic crystals using models.
2. Prepare metallographic specimens and interpret microstructures using an optical microscope.
3. Apply heat treatment processes and analyze their effect on material properties.
4. Perform standard mechanical tests and interpret results to evaluate material behavior under different conditions.

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Course Code: MEC-203	**Course Name: Python Programming**	**L-T-P: 3-2-0**	**Credit: 3**

Course Objective:

1. To introduce students to the Python programming environment, including its syntax, structure, and basic programming constructs.
2. To familiarize students with Python data types, variables, expressions, and operators for effective problem-solving.
3. To enable students to design modular and maintainable programs using functions and control structures.
4. To develop a foundational understanding of object-oriented programming principles, file handling, and exception management in Python.

Syllabus:

Module-I: Introduction to Python Programming Language [10 Hours]

Introduction to Python Language and installation, interpreters and complier, Numeric Data Types: int, float, Boolean, complex and string and its operations, Standard Data Types: List, tuple, set and Dictionaries, Data Type conversions, commenting in python.

Module-II: Variables and Operators: [10 Hours]

Understanding Python variables, Multiple variable declarations, Python basic statements, Python basic operators: Arithmetic operators, Assignment operators, Comparison operators, Logical operators, Identity operators, Membership operators, Bitwise operators, Precedence of operators, Expressions.

Control Flow and Loops: Conditional (if), alternative (if-else), chained conditional (if- elif -else), Loops: For loop using ranges, string, Use of while loops in python, Loop manipulation using pass, continue and break.

Module-III: Functions: [10 Hours]

Defining Your Own Functions, Calling Functions, passing parameters and arguments, Python Function arguments: Keyword Arguments, Default Arguments, Variable length arguments, Anonymous Functions, Fruitful Functions, Scope of the Variables in a Function - Global and Local Variables. Powerful Lambda functions in python.

Module-IV: Object Oriented Programming: [10 Hours]

Class and Object, Defining variables and functions inside class, Creating objects, Inheritance, Inheritance, Encapsulation, Polymorphism, Abstraction.

I/O and Error Handling in Python: Introduction, Access Modes, Writing Data to a File, Reading Data from a File, Additional File Methods introduction to Errors and Exceptions, Handling IO Exceptions, Run Time Errors, Handling Multiple Exceptions.

Course outcomes:

1. Understand Python syntax, data types, and perform basic operations and data conversions.
2. Apply variables, operators, and control structures to implement logic and loops in Python.
3. Develop modular code using user-defined and anonymous functions with different argument types.
4. Implement object-oriented concepts and perform file operations with proper error handling.

Reference Book:

1. Python Programming: Using Problem Solving Approach by Reema Thareja, Oxford, 2018
2. Core Python Programming, 2nd. Edition, by R. Nageswara Rao, Dreamtech Press (Wiley), 2019
3. Introduction to Computing and Problem Solving Using Python, E. Balagurusamy, 1st. Edition, MGH, 2016.
4. Introduction to Computing Using Python: An Application Development Focus, Ljubomir Perkovic, John Wiley & Sons, 2012

Digital Learning Resources:

Course Name	Programming, Data Structures and Algorithms using Python
Course Link	https://nptel.ac.in/courses/106106145
Course Instructor	PROF. MADHAVAN MUKUND, Department of Computer Science and Engineering,Chennai Mathematical Institute

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Python Programming Lab

Course Objectives:

The course will enable students to:

1. Learn and understand Python programming basics and control statements.
2. Illustrate the applications of string handling and regular expressions in building Python programs using functions.
3. Discover the use of supported data structures like lists, dictionaries and tuple in Python.
4. To apply object-oriented concepts and explore Python's advanced data structures and inheritance.

Syllabus

List of Experiments:

1. Demonstrate about Basics of Python Programming.
2. Demonstrate about fundamental Data types in Python Programming. (i.e., int, float, complex, bool and string types)
3. Demonstrate the working of following functions in Python. (type(), range())
4. Demonstrate the Operators in Python with suitable examples.
5. Write Python programs to demonstrate print().
6. Demonstrate the Conditional statements in Python with suitable examples.
7. Demonstrate the Iterative statements in Python with suitable examples.
8. Demonstrate the control transfer statements in Python with suitable examples (break, continue and pass)
9. Write Python programs to print different Patterns.
10. Write a Python program to demonstrate various ways of accessing the string.
11. Indexing (positive and negative)
12. Slice operation
13. Demonstrate the functions/methods which operate on strings in Python with suitable examples.
14. Demonstrate the functions/methods which operate on lists in Python with suitable examples.

15. Demonstrate the functions/methods which operate on tuple in Python with suitable examples.
16. Demonstrate the functions/methods which operate on set in Python with suitable examples.
17. Demonstrate the functions/methods which operate on dictionary in Python with suitable examples.
18. Demonstrate the kinds of Parameters used while writing functions in Python.
19. Create classes with attributes and methods. Instantiate objects and access their attributes in Python with suitable examples.
20. Demonstrate single and multilevel inheritance with real-world class examples, along with encapsulation and method overriding in Python with suitable examples.

Course Outcomes:

At the end of the course, the students will be able to:

1. Understand and demonstrate fundamental Python syntax, data types, and built-in functions.
2. Apply conditional, looping, and control transfer statements to solve basic computational problems.
3. Use Python functions, strings, lists, tuples, sets, and dictionaries effectively in programs.
4. Implement object-oriented features including classes, inheritance, and encapsulation in Python

Second - Year Course Structure (IV Semester)							
S. No.	Course Category	Course Code	Course Title	L	P	T	Cred-its
1	BS	MEC-206	Fluid Mechanics	3	2	0	4
2	PC	MEC-207	Kinematics and Dynamics of Machines	3	2	0	4
3	PC	MEC-208	Manufacturing Science	3	2	0	4
4	PC	MEC-209	Introduction to Robotics and AI	3	2	0	4
5	HS	MGT-202	Organizational Behavior/Engineering Economics	3	0	0	3
6	SEC	MEC-204	CREO	0	2	0	1
7	SEC	MGT-200	Aptitude and Reasoning-I	0	2	0	1
8	VAC	MGT-201	Constitution of India	1	0	0	1
Total Credits							22

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Course Code:MEC-206	**Course Name: Fluid Mechanics**	**L-T-P: 3-0-2**	**Credit: 4**

Course Objectives:

1. Compute pressure through manometer and design and develop marine systems with the usage of hydrostatic forces and buoyancy.
2. Differentiate velocity, acceleration, rotation and deformation etc. of fluid particles.
3. Establish Euler's theorem and deduce Bernoulli's equation for a ideal fluid and real fluids.
4. Examine and evaluate energy losses in fluid transmission trough pipes and open channel flow.

Syllabus:

Module I: fundamentals of fluid properties and statics [10 hours]

Scope and development of fluid mechanics, physical properties of fluids: density, specific gravity, specific weight, specific volume, surface tension and capillarity, viscosity, compressibility, and bulk modulus, classification of fluids

Fluid statics: pressure and pascal's law, pressure variation in incompressible fluids, absolute, gauge, atmospheric, and vacuum pressures, manometers and pressure measurement techniques

Module II: Hydrostatics and buoyancy [10 hours]

Hydrostatic force on submerged surfaces: horizontal and vertical plane surfaces, buoyancy and flotation, Archimedes' principle, equilibrium and stability of floating and submerged bodies, determination of metacentric height and its significance

Module III: Kinematics and dynamics of fluid flow [10 hours]

Description and classification of fluid flow, Reynold's number and flow regimes, acceleration of fluid particles, continuity equation (integral and differential forms), stream function and potential function, irrotational and rotational flows, circulation, flow net construction and applications, Euler's and Bernoulli's equations, application of Bernoulli's equation: siphon, venturimeter, orifice meter, pitot tube

Module IV: Pipe flow, dimensional analysis & open channel flow [10 hours]

Pipe flow: Head loss due to friction and minor losses, Hydraulic Gradient Line (HGL) and Total Energy Line (TEL), power transmission through pipes, series and parallel pipe systems, flow through nozzles

Dimensional analysis: Dimensional homogeneity, Rayleigh's method and Buckingham's π-theorem, model analysis and dimensionless numbers

Open channel flow: Classification and definitions, Chezy's and Manning's formulae,

Flow through orifices: Types and discharge equations, mouthpieces, weirs and notches; discharge calculations

Course Outcomes:

1. Apply conservation laws to fluid flow problems in engineering applications.
2. Design and compute flow kinematics of the fluid.
3. Apply the concept of dynamics of flow.
4. Analyze the free surface and pipe flows for design hydraulic structures.

Text Books:

1. Y. A. Cengel and J. M. Cimbala, Fluid Mechanics , Tata McGraw-Hill, 3rd edition, 2017, New Delhi
2. CSP Ojha and P.N. Chandramouli, Fluid Mechanics and Machinery, Oxford University Press, 4th edition, 2010, New Delhi
3. S. K. Som and G. Biswas, Introduction to Fluid Mechanics and Fluid Machines, McGraw Hill Education, 6th edition, 2017, New Delhi

Reference Books:

1. R. W. Fox, A. T. McDonald and P. J. Pritchard, Introduction to Fluid Mechanics, John Wiley, 8th edition, 2011, New Delhi
2. Piyush Kundu, Ira Cohen & David Dowling, Fluid Mechanics, Elsevier, 6th edition, 2016, Cambridge

Digital Learning Resources:

Course Name	Fluid Mechanics and Hydraulic Machines
Course Link	https://swayam.gov.in/nd1_noc19_me55/
Course Instructor	Dr. Sankar Kumar Som

Fluid Mechanics Laboratory

Course Objectives: By the end of this course, the students will be able to

1. Understand the principles of fluid statics and dynamics through hands-on experiments.
2. Gain knowledge about buoyancy, metacentric height, and their applications in floating body stability.
3. Learn to calibrate flow measurement devices like venturimeter, orifice meter, and notches.
4. Analyze flow behavior and energy losses in internal and open channel flows.

Syllabus:

(Any 8 to 10 experiments may be selected based on availability)

1. Determination of Meta-centric Height and study of stability of floating bodies
2. Calibration of a Venturimeter
3. Calibration of an Orifice meter
4. Calibration of an Orifice
5. Calibration of a V-notch
6. Flow measurement using Rectangular Notch
7. Determination of Impact Force by Jet on Vanes
8. Classification of Flow using Reynolds Apparatus
9. Verification of Stokes' Law for Spherical Particles in Fluids
10. Determination of Manning's Roughness Coefficient for Open Channels
11. Study of Friction Losses in Pipe Flow

Course Outcomes: Upon successful completion of this course, students will be able to

1. Evaluate the stability of floating and submerged bodies using the concept of metacentric height.
2. Distinguish between laminar and turbulent flow regimes using experimental validation (e.g., Reynolds apparatus).
3. Calibrate and interpret data from flow-measuring devices such as venturimeter, orifice meter, and V-notch.
4. Determine head loss and frictional effects in pipe and open channel flows.

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Course Code: MEC207	**Course Name: Kinematics & Dynamics of Machines**	**L-T-P: 3-0-2**	**Credit: 4**

Course Objective:

1. To introduce the fundamental principles of mechanisms, kinematic linkages, and the degrees of freedom in mechanical systems.
2. To enable students to perform velocity and acceleration analysis of planar mechanisms using graphical and analytical methods.
3. To impart knowledge of various mechanical power transmission systems, including belt, rope, and chain drives.
4. To develop understanding of cam and gear mechanisms, gyroscopic effects, and machine balancing for dynamic performance analysis.

Syllabus:

Module-I: **[08 hours]**

Basics of Mechanisms and Machines: Types of Motion, Links, Kinematic Pair, Types of Joints, Degree of Freedom, Classification of Kinematic Pairs, Kinematic Chain, Linkage, Mechanism and Structure, Inversions of Four-bar and Slider Crank Mechanism, Mobility of Mechanisms, Transmission Angle.

Module-II: **[12 hours]**

Velocity and Acceleration Analysis of Mechanisms: Absolute and Relative Motion, Velocity and Acceleration Diagrams for four bar mechanisms, Velocity by Instantaneous Centre Method, Coriolis Acceleration, Klein Construction.

Cams: Types of Cams and Followers, Cam Terminology, Derivatives of Follower Motion, Cam Profile Layout.

Module-III: **[10 hours]**

Gears and Gear Trains: Classification of Gears, Gear Terminology, Law of Gearing, Velocity of sliding, Gear Teeth Profile, Path of Contact, Arc of Contact, Contact Ratio, Interference of in Involute Gears, Minimum Number of Teeth, Undercutting, Different Types of Gear Trains.

Module-IV: **[10 hours]**

Gyroscope: Angular Velocity, Angular acceleration, Gyroscopic Torque, Gyroscopic Effect on Naval Ships, Aero plane, Two wheel and Four wheel Automobile.

Balancing: Static Balancing and Dynamic balancing of Rotating Masses, Balancing of Several Masses in Different Planes, Balancing of Reciprocating Mass.

COURSE OUTCOMES: Students will be able to

1. Classify mechanisms and compute degrees of freedom for planar systems.
2. Perform velocity and acceleration analysis using graphical and analytical methods.
3. Analyze and design belt, rope, and chain drives for efficient power transmission.
4. Design cam profiles, evaluate gear trains, and analyze gyroscopic and balancing effects.

Text Books:

1. Theory of Machines, Rattan S S, Tata McGraw-Hill, Fourth Edition, 2017
2. Kinematics and Dynamics of Machinery, Norton R L, McGraw-Hill, Special Indian Edition, 2017
3. Theory of Machines, V P Singh, Dhanpat Rai & Co, Fifth Edition, 2017

Reference Book:

1. Theory of Mechanisms and Machines, Amitabha Ghosh & Mallik A. K., EastWest Press, 2008
2. Mechanism and Machine Theory by J. S. Rao and R. V. Dukipatti, New Age International.
3. Theory of Machines and Mechanisms by J.J. Uicker , G. P. Pennock , and J. E. Shigley, 4th Edition, International Version, Oxford University Press, New Delhi.
4. The Theory of Machines: A textbook for Engineering students by Thomas Bevan Pearson, New Delhi.

Digital Learning Resources:

Course Name	Kinematics of Machines
Course Link	https://archive.nptel.ac.in/courses/112/104/112104121/
Course Instructor	Prof. Ashok K Mallik, Department of Mechanical EngineeringIIT Kanpur

www.nist.edu	**NIST UNIVERSITY** **INSTITUTE PARK, PALUR HILLS, BERHAMPUR, ODISHA - 761008**

Course Name	KINEMATICS OF MECHANISMS AND MACHINES
Course Link	https://archive.nptel.ac.in/courses/112/105/112105268/
Course Instructor	PROF. ANIRVAN DASGUPTA, Department of Mechanical Engineering, IIT Kharagpur

Kinematics and Dynamics of Machines Lab

Course Objectives:

The course will enable students to:

1. Determine the radius of gyration for compound pendulums and connecting rods experimentally.
2. Analyze the dynamic behavior of systems using bi-filar, tri-filar, and gyroscopic apparatus.
3. Understand the working principles and motion characteristics of various gear train configurations.
4. Study and evaluate mechanical phenomena such as balancing, cam dynamics, and Coriolis acceleration.

Syllabus

List of Experiments (Any 8 Experiments):

1. Radius of gyration of compound pendulum
2. Radius of gyration of connecting rod
3. TRI –FILAR / BI-FILAR System
4. Experiment on Coriolis component of acceleration
5. Experiment on Epicyclic gear train
6. Experiments on Simple/Compound/Reverted Gear trains
7. Determination of gyroscopic couple using gyroscopic test rig.
8. Experiment on static and dynamic balancing apparatus
9. Study of interference and undercutting for gear drives
10. Experiment on Cam Analysis Apparatus.

Course Outcomes:

At the end of the course, the students will be able to:

1. Calculate the radius of gyration and moment of inertia for various mechanical components to evaluate their dynamic behavior.
2. Analyze gyroscopic motion and apply dynamic balancing techniques to rotating and reciprocating systems.

3. Examine simple, compound, and epicyclic gear trains, and identify conditions for interference, undercutting, and velocity ratio optimization.
4. Construct cam profiles and analyze the displacement, velocity, and acceleration of followers under different operating conditions.

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Course Code:MEC-208	Course Name: Manufacturing Science	L-T-P: 3-2-0	Credit: 4

Course Objectives

The students will be able to:

1. Understand the fundamentals of manufacturing processes and their relevance in industrial applications.
2. Analyze mechanics of metal cutting, tool geometry, tool wear, and cutting fluids in conventional machining.
3. Gain knowledge about the working principles, operations, and mechanisms of various machine tools.
4. Explore the working principles, advantages, and applications of non-traditional machining processes.

Syllabus:

Module 1: Introduction to Manufacturing and Casting Processes [10 hours]

Overview of manufacturing industries and classifications, Importance of manufacturing in the economy, Types of materials used (metals, polymers, ceramics, composites), Fundamentals of casting: Sand casting, patterns, cores, moulding, gating system, Casting defects, inspection techniques, Special casting methods: Die casting, Investment casting, Centrifugal casting

Module 2: Mechanics of Machining and Tool Materials [10 hours]

Geometry of cutting tools (ASA system), Mechanics of chip formation: Merchant's circle, force and velocity relations, Tool wear: Flank and crater, Taylor's tool life equation, Cutting fluids: Purpose and types, Machinability and economy of machining, Overview of conventional machining: Turning, Drilling, Milling, Shaping, Grinding, Introduction to tool materials and their properties

Module 3: Machine Tools and Mechanisms [10 hours]

Construction and operation of: Lathe, milling, shaping, drilling, grinding machines, Indexing mechanism, quick return mechanism, feed motion systems, Tool mounting, work holding devices, Introduction to production machines: Gear hobbing, gear shaping, copying lathe, Surface finish and tolerances in machining, Introduction to CNC machining basics

Module 4: Non-Traditional Machining Processes [10 hours]

Principles, working, and applications of: Ultrasonic Machining (USM), Electrochemical Machining (ECM), Electro discharge Machining (EDM) and Wire EDM, Laser Beam Machining (LBM), Plasma Arc Machining (PAM), Abrasive Jet Machining (AJM)

Course Outcomes

At the end of this course, students will be able to:

1. Describe different metal removal processes and conventional machine tools such as lathe, drilling, milling, and grinding machines.
2. Analyze tool geometry, cutting mechanics, tool wear, and machinability criteria.
3. Illustrate the working of various machine tool mechanisms such as indexing and quick return mechanisms.
4. Compare various non-traditional machining processes with respect to materials, capabilities, and applications.

Manufacturing Science Laboratory:

Course Objectives:

The course aims to:

1. Introduce students to fundamental metal cutting and forming processes.
2. Develop hands-on experience in the use of conventional and non-conventional machine tools.
3. Train students in measurement of surface roughness, tool wear, and cutting forces.
4. Provide exposure to welding, casting, and sheet metal forming processes.

List of Experiments:*(Perform any 8 out of 10)*

1. **Measurement of Cutting Forces** using lathe tool dynamometer during turning operation.
2. **Study of Tool Wear** and calculation of tool life using Taylor's equation.
3. **Drilling and Tapping Practice** on different materials to study machinability.
4. **Surface Roughness Measurement** after various machining operations.
5. **Single Pass Turning Operation** on a lathe to study cutting speed, feed, and depth of cut.
6. **Milling Operations**: Slotting and gear cutting on horizontal/vertical milling machine.
7. **Grinding Operation**: Surface grinding and measurement of surface finish.
8. **Foundry Practice**: Preparation of sand mould and casting of a simple component.
9. **Welding Practice**: Demonstration of arc welding and TIG welding techniques.
10. **Sheet Metal Forming**: Bending and blanking of sheet metal using press tools.

Course Outcomes (COs):

Upon successful completion of the laboratory course, students will be able to:

1. Apply appropriate machining parameters and measure cutting forces, tool wear, and surface finish.
2. Operate conventional machine tools such as lathe, milling, drilling, and grinding machines.
3. Demonstrate basic skills in welding, foundry, and sheet metal operations.
4. Analyze the relationship between process variables and product quality in metal cutting and forming operations.

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Course Code: MEC209	**Course Name: Introduction Robotics & AI**	**L-T-P: 3-2-0**	**Credit: 4**

Course Objectives:

1. To provide foundational knowledge of robotics and classify robots based on geometry and application.
2. To understand the role and selection of sensors, drives, controllers, and grippers in robotic systems.
3. To analyze and compute manipulator kinematics including forward, inverse, and differential kinematics.
4. To introduce the fundamentals of artificial intelligence and its application in robotics.

Syllabus:

Module 1: **[10 hours]**

Introduction: Introduction to Robotics, Classification with respect to geometrical configuration, Industrial robots specifications. Selection based on the Application. Controlled system & chain type: Serial manipulator & Parallel Manipulator. Components of Industrial robotics-precession of movement-resolution, accuracy & Repeatability-Dynamic characteristics- speed of motion, load carrying capacity & speed of response.

Module 2: **[10 hours]**

Sensors, Drives and Grippers: Characteristics of sensing devices, Criterion for selections of sensors, Classification, & applications of sensors. Internal sensors: Position sensors, & Velocity sensors, External sensors: Proximity sensors, Tactile Sensors, & Force or Torque sensors. Drives – Basic types of drives. Advantages and Disadvantages of each type. Selection / suitability of drives for Robotic application. Controllers, Types of Controller and introduction to close loop controller Grippers, Mechanical Gripper-Grasping force, mechanisms for actuation, Magnetic gripper vacuum cup gripper considerations in gripper selection & design.

Module 3: **[12 hours]**

Kinematics of Manipulators: Kinematics-Manipulators Kinematics, Rotation Matrix, Homogeneous Transformation Matrix, D-H transformation matrix, D-H method of assignment of frames. Direct and Inverse Kinematics for industrial robots. Differential Kinematics for planar serial robots Robot Applications: Material transfer and machine loading/unloading, processing operations assembly and inspection.

Module 4: **[8 hours]**

Introduction to Artificial Intelligence: Overview: foundations, scope, problems, and approaches of AI. Intelligent agents: reactive, deliberative, goal driven, utility-driven, and learning agents, Artificial Intelligence programming techniques.

Course Outcomes:

1. Classify and select industrial robots based on configuration and application requirements.
2. Identify suitable sensors, drives, and grippers for specific robotic tasks.
3. Apply kinematic models to determine robot motion and position.
4. Demonstrate basic understanding of AI concepts and agent-based approaches in robotics.

Text Books:

1. Robotics and Control by R.K. Mittal & I.J. Nagrath, Tata McGraw Hill
2. Robotics by S. R. Deb & S. Deb, Tata McGraw Hill
3. Robotics: Fundamental Concepts and Analysis by Ashitava Ghosal, Oxford University Press
4. Artificial Intelligence and Machine Learning by P. Anand, PHI Learning
5. Artificial Intelligence by S. Rajasekaran & G.A. Vijayalakshmi Pai, PHI Learning

Digital Learning Resources:

Course Name	Introduction to robotics
Course Link	https://nptel.ac.in/courses/107106090
Course Instructor	Dr. Krishna Vasudevan, Dr. T Asokan, Dr. Balaraman Ravindran, IIT Madras

Course Name	Fundamentals of Artificial intelligence
Course Link	https://onlinecourses.nptel.ac.in/noc24_ge47/preview
Course Instructor	Prof. Shyamanta M. Hazarika, IIT Guwahati