GOVT. POLYTECHNIC BALANGIR

Department of Mechanical Engineering

LESSON PLAN: 2025-26

Name of the Faculty: Rasmi Ranjan Jena (Lecture Stage-1)

Subject: MANUFACTURING PROCESSES (MEPC201)
Program: Diploma in Mechanical Engineering
Semester: 3rd
Total Contact Hours: 45
Total Marks: 100
Assessment: Progressive –30, End Term – 70
Credits: 3

COURSE OBJECTIVES:

After completion of the course, the students will be able to

1. Illustrate the importance of cutting fluids & lubricants in machining.
2. Study various types of basic production processes. To select, operate and control the appropriate processes for specific applications.
3. Define the concept of gear making and list various gear materials.
4. Describe the importance of press tools and various die operations.
5. Explain grinding and finishing processes.

Unit I – Cutting Fluids, Lubricants & Lathe Operations (10 Hours)

Class No.	Topic	Subtopics	Teaching Aids/Activities	Course Objective
1	Introduction to Cutting Fluids	Definition and role of cutting fluids in machining; impact on heat dissipation, tool life, and finish	Real fluid samples, lecture with board diagrams	CO1
2	Types & Application of Cutting Fluids	Classification – Water-based, emulsions, synthetics; application in turning, drilling, shaping, sawing, broaching	Comparison chart, industry examples, videos	CO1
3	Selection & Delivery of Cutting Fluids	Selection based on operation and material; Methods – flood, mist, spray; criteria for choosing suitable fluid	Flowchart demo, application system videos	CO1
4	Lubricants – Types & Properties	Classification – solid, liquid, gaseous; Key properties – viscosity, thermal stability, lubricity	Sample-based explanation, interactive discussion	CO1
5	Applications of Lubricants	Use in different machining operations; effect on friction, wear, surface quality	Case study charts, lubrication system models	CO1
6	Introduction to Lathe Machine	Lathe machine overview; Types – light, medium, heavy duty, CNC; Functions of basic parts	Physical models/diagrams, lathe part animation	CO2
7	Lathe Operations – I	Explanation of operations: Turning, Parting off, Facing; Tools used in each operation	Video demo, cutting tools chart	CO2
8	Lathe Operations – II	Additional operations: Knurling, Boring, Drilling, Step Turning, Taper Turning	Lab demo or operation images, tools table	CO2
9	Tool Nomenclature	Single Point Cutting Tool – Nomenclature: nose radius, rake angles, flank, etc.	3D tool diagrams, model labelling activity	CO2
10	Lathe Machine Specifications	Understanding lathe specifications; capacity, bed length, spindle speed, etc.; difference between lathe types	Spec sheet comparison, machine walkaround (if lab available)	CO2

Unit II – Broaching Machines & Drilling (9 Hours)

Class No.	Topic	Subtopics	Teaching Aids/Activities	Course Objective
11	Introduction to Broaching	What is broaching? Advantages, typical applications, and comparison with other machining operations	Lecture with component examples, PPT slides	CO2
12	Types of Broaching Machines – I	Horizontal broaching: Single ram and Duplex ram – construction, working, applications	Machine diagrams, operation animations	CO2
13	Types of Broaching Machines – II	Vertical broaching: Pull-up, Pull-down, Push-down – differences, working principles, industrial use	Animated videos, industrial images	CO2
14	Broach Tool Elements and Tooth Details	Elements: body, shank, neck; Tooth regions – roughing, semi-finishing, finishing; Tooth nomenclature (pitch, rake angle, etc.)	Charts, tool drawings, terminology practice	CO2
15	Broaching Tool Materials & Applications	Materials: HSS, Carbides; Use in keyway, spline, gear machining; Limitations of broaching	Case studies, material table	CO2
16	Introduction to Drilling Machines	Definition, Types: Bench, Radial; Basic parts and working principles	Real machine/video explanation, labeled diagram	CO2
17	Drilling Machine Operations	Drilling, Reaming, Counterboring, Tapping; Setup and safety	Workshop video, process flow charts	CO2
18	Types of Drills and Reamers	Twist drills, flat drills; Reamers: straight, fluted; Uses and material considerations	Physical samples/images, comparative chart	CO2
19	Specifications and Applications	Drilling machine specs: capacity, spindle speed, stroke, size; industrial applications	Demo sheets, manufacturer catalogue/specs	CO2

Unit III – Welding & Milling (9 Hours)

Class No.	Topic	Subtopics	Teaching Aids/Activities	Course Objective
20	Introduction to Welding	Classification: Gas welding, Arc welding, Resistance welding, Solid-state welding; Applications in industries	Chart on welding types, video introduction	CO3
21	Gas Welding Techniques	Oxy-acetylene welding: equipment, flame types (neutral, oxidizing, carburizing), applications	Real/nozzle torch demo or videos, flame comparison chart	CO3
22	Arc Welding Methods	Shielded Metal Arc Welding (SMAW), Submerged Arc Welding (SAW), principles and applications	Welding rod samples, equipment video, arc welding animation	CO3
23	TIG, MIG & Resistance Welding	TIG & MIG: Equipment, process flow; Resistance welding: Spot, Seam, Projection welding	Welding video, industry application cases	CO3
24	Welding Defects & Allied Processes	Welding defects (porosity, cracks, undercuts), their causes and remedies; Brazing and Soldering: principles, differences, and uses	Defect chart, process comparison table	CO3
25	Introduction to Milling Machines	Types: Plain, Universal, Vertical; Constructional details and specifications	Machine image explanation, real/lab photo demo	CO3
26	Milling Operations – I	Simple indexing, Compound indexing, Differential indexing – principles, applications	Gear index plate demo (or animated diagram), problems	CO3
27	Milling Operations – II	Face milling, end milling, slab milling; Differences, tools used, work holding devices	Video demonstration, sample components	CO3
28	Milling Cutters & Tool Signature	Milling cutter types; Tooth nomenclature; Cutter materials; Tool signature explanation	Tool sketches, table/chart, classroom quiz	CO3

Unit IV – Gear Making & Press Working (9 Hours)

Class No.	Topic	Subtopics	Teaching Aids/Activities	Course Objective

29	Introduction to Gear Manufacturing	Overview of gear types and manufacturing methods: Casting, Moulding, Stamping, Coining, Extrusion, Rolling, Machining	Gear samples, flowchart of methods	CO4
30	Gear Generating Methods – I	Gear Shaping: Pinion cutter & Rack cutter – working principle, tooth generation process	Animated video or diagram of shaping setup	CO4
31	Gear Generating Methods – II	Gear Hobbing: Operation, Hob description, Setup, Advantages	Model or animation, hob cutter photo/specs	CO4
32	Gear Finishing & Heat Treatment	Finishing processes: shaving, lapping, grinding; Heat treatments: hardening, carburizing, nitriding for durability	Flowchart, real parts, thermal process visuals	CO4
33	Gear Materials & Specifications	Materials: carbon steel, alloy steel, cast iron; Specifications: module, pitch circle diameter, number of teeth	Gear material chart, design specs demo	CO4
34	Introduction to Press Working	Overview of Presses: Mechanical, Hydraulic; Specifications; Applications in industries	Press type images, video demo	CO4
35	Press Working Operations – I	Cutting, Bending, Drawing – principles, die movement, blank preparation	Animated process videos, operation chart	CO4
36	Press Working Operations – II	Punching, Blanking, Notching, Lancing – applications, step-by-step explanations	Lab video or simulation, part samples	CO4
37	Die Set Components & Clearances	Components: punch, die shoe, guide pin, bolster plate, stripper, stock guide; Punch and die clearance principles	Component diagrams, clearance formula explanation	CO4

Unit V – Grinding and Finishing Processes (8 Hours)

Class No.	Topic	Subtopics	Teaching Aids/Activities	Course Objective
38	Introduction to Grinding	Principles of metal removal by grinding; grinding vs. conventional machining	Animated grinding process video, comparison chart	CO5
39	Abrasives & Bond Types	Types of abrasives: Natural & Artificial; Bond types: Vitrified, Silicate, Shellac, Rubber, Bakelite	Samples or images of grinding wheels, classification table	CO5
40	Grinding Wheel Selection Factors	Wheel size and shape, kind of abrasive, grain size, grade, bond type, structure, spacing	Decision table, visual tools	CO5
41	Grinding Wheel Marking System	Standard marking system: Sequence of letters & numbers; Grade classification, interpretation of code	Sample wheels, marking examples	CO5
42	Types of Grinding Machines	Cylindrical, Surface, Tool & Cutter grinding machines – construction, working principles	Machine diagrams or lab demo video	CO5
43	Centerless Grinding	Principle, setup, advantages and limitations	3D animated video, component images	CO5
44	Finishing by Grinding	Honing, Lapping, Superfinishing – working principles, applications	Video demonstrations, sample parts with finishes	CO5
45	Surface Finishing Processes	Electroplating: principles, metals used; Hot dipping (galvanizing, tin coating); Parkerizing, Anodizing, Metal spraying, Organic coatings	Coating samples, video + visual comparison	CO5

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Department of Mechanical Engineering

LESSON PLAN: 2025-26
Name of the Faculty: Paresh Kumar Mishra (Lecture Stage-1)
Subject: STRENGTH OF MATERIALS (MEPC203) Program: Diploma in Mechanical Engineering Semester: 3rd Total Contact Hours: 45 Total Marks: 100 Assessment: Progressive –30, End Term – 70 Credits: 3

COURSE OBJECTIVES:

After completion of the course, the students will be able to

1. Apply the concept of Simple Stresses and Strains.
2. Describe the concept of Strain Energy.
3. Define the concept of Shear Force and Bending Moment Diagrams.
4. Apply the concept of Theory of Simple Bending and Deflection of Beams.
5. Outline the concept of Torsion in Shafts and Springs.
6. Illustrate the concept of Thin Cylindrical Shells.

Unit I: Simple Stresses and Strains + Strain Energy (10 Classes)				
Class	**Topic**	**Subtopics**	**Teaching Aids / Activities**	**Course Objective**
1	Introduction to Stress and Strain	Types of loads (tensile, compressive, torsional), concept of stress and strain, axial loading, notation and units	Real-life structural failure images, physical demonstration with elastic bands, introductory video	CO1
2	Mechanical Properties of Materials	Elasticity, ductility, malleability, toughness, hardness, plasticity, brittleness – definitions with examples	Physical samples of different materials (mild steel, rubber, cast iron), concept map creation activity	CO1
3	Stress-Strain Diagram	Drawing and explaining stress-strain curves for mild steel and brittle material, key points like proportional limit, yield point, UTS	Animation of stress-strain test using UTM, manual plotting exercise	CO1
4	Factor of Safety	Purpose of FoS in design, different FoS values for materials, practical design examples	Bridge design video, case discussion on failure due to inadequate FoS	CO1
5	Elastic Constants	Young's modulus, Modulus of Rigidity, Bulk modulus, Poisson's ratio, their interrelations and formulas	Use of visual formula charts, physical demonstration using sponge models	CO1
6	Composite Sections	Deformation in bars of composite materials or different cross-sections under axial load, compatibility condition	Solved numerical on compound bars, worksheet activity	CO1
7	Thermal Stresses	Thermal expansion, fixed and free condition, formulas for expansion and stress development	Bimetallic strip heating demo, solved examples	CO1
8	Strain Energy Basics	Definitions: resilience, proof resilience, modulus of resilience, strain energy in axial loading	Spring toy demo, energy graph explanation, real-time energy storage examples	CO2
9	Strain Energy Derivations	Derivations for strain energy under gradual, sudden and impact loading; comparison of energy absorbed	Chalkboard derivation, real-time application in crash safety devices	CO2

10	Numerical Practice	Mixed numericals on simple stress, strain, elastic constants, strain energy	Problem-solving class, peer teaching, formative quiz	CO1, CO2
Unit II: Shear Force & Bending Moment Diagrams (9 Classes)				
Class	**Topic**	**Subtopics**	**Teaching Aids / Activities**	**Course Objective**
11	Types of Beams	Definitions and diagrams of cantilever, simply supported, overhanging, fixed beams	Wooden beam models, matching activity with real applications (bridge, cantilever balcony)	CO3
12	Types of Loads	Point load, uniformly distributed load (UDL), uniformly varying load (UVL), practical effects	Use of weights on beams, classroom demonstration of deflection	CO3
13	SFD & BMD Basics	Definitions of shear force and bending moment, sign conventions, importance in design	Diagram explanation using beam simulator software, group discussion	CO3
14	Cantilever with Point Load	Shear force and bending moment calculation, diagrams, nature of curves	Whiteboard sketching of diagrams, loading test on a cantilever scale model	CO3
15	Cantilever with UDL	UDL load derivation and diagrams, quadratic bending moment curve	Video animation of deformation, calculation worksheet	CO3
16	Simply Supported with Point Load	Reactions, shear and moment values, diagram plotting	Beam model on two supports with hanging weight, graphical explanation	CO3
17	Simply Supported with UDL	Linear shear and parabolic moment curves, reactions, diagrams	Use of simulation applets to plot curves, activity-based quiz	CO3
18	Overhanging Beam	Load on extension beyond support, negative bending moment zone	Structural application of balconies and overhangs, real image discussion	CO3
19	Combined Loads	Analysis of beam under multiple load types; logic for breaking down complex loads	Solved assignment, teamwork plotting SFD & BMD	CO3
Unit III: Theory of Simple Bending and Deflection (9 Classes)				
Class	**Topic**	**Subtopics**	**Teaching Aids / Activities**	**Course Objective**
20	Basic Concepts of Bending	Beam section, neutral axis, fiber stress variation, pure bending	Sketches on whiteboard, paper beam model for compression and tension	CO4
21	Assumptions in Bending Theory	Homogeneous material, constant cross-section, plane section remains plane	Real-life contradiction examples, discussion on validity	CO4
22	Bending Equation Derivation	Derivation of $M/I = \sigma/y = E/R$ and units	Guided derivation with class participation, formula recap cards	CO4
23	Section Modulus	Definition, importance in design, values for rectangular, circular, I-sections	Structural models with cut sections, comparison activity	CO4
24	Introduction to Deflection	Types and causes of deflection in beams, industry examples	Video on sagging beams, animation of live loading	CO4
25	Standard Beam Deflections	Formulas for cantilever and simply supported beam under point load and UDL	Flashcards of formulas, numerical sheet practice	CO4
26	Deflection Methods	Introduction to double integration and Macaulay's method, basic idea	Whiteboard summary and visual flowchart	CO4
27	Numerical Problems	Solving standard problems on bending stress and beam deflection	Practice test, peer solution checking	CO4

28	Real-life Applications	Applications in bridge design, cantilevers, and machine beds	Site image review, roleplay as design engineer	CO4

Unit IV: Torsion in Shafts and Springs (9 Classes)

Class	Topic	Subtopics	Teaching Aids / Activities	Course Objective
29	Introduction to Torsion	Concept of torque, torsional effects in solid shafts	Video of twisting shaft, real-life shaft examples	CO5
30	Polar Moment of Inertia	Derivation for circular sections, significance in torsional rigidity	Chart of J values for sections, concept board	CO5
31	Torsion Equation	Derivation of $T/J = \tau/R = G\theta/L$, assumptions, units	Step-by-step derivation, mechanical torsion bar demo	CO5
32	Shaft Design Parameters	Torque capacity, power transmission, angle of twist	Sample motor shaft, shaft comparison activity	CO5
33	Solid vs Hollow Shafts	Strength and weight comparison, efficiency analysis	Aluminum pipe demo, problem solving	CO5
34	Introduction to Springs	Types (helical, leaf), material, applications in machines	Real spring models, suspension animation	CO5
35	Helical Spring Behavior	Load, deflection, spring constant, stiffness	Helical spring compression test with weights	CO5
36	Derivation of Spring Formula	$\delta = \frac{G d^4}{8D^3 n}$, meaning of terms and units	Derivation on board, spring design charts	CO5
37	Design Problems	Spring dimension and load capacity problems	Problem solving in groups, quiz challenge	CO5

Unit V: Thin Cylindrical Shells (8 Classes)

Class	Topic	Subtopics	Teaching Aids / Activities	Course Objective
38	Introduction to Shells	Thin vs thick shells, application areas like tanks, boilers	Industrial shell images, wall thickness demo	CO6
39	Hoop and Longitudinal Stresses	Internal pressure, formula derivation, stress behavior in cylinders	Balloon inflation demo, chalkboard derivation	CO6
40	Failure in Shells	Modes of failure, bursting, leakage, stress concentration	Failure case studies, video of tank bursts	CO6
41	Seamless Cylinders	Use of seamless vessels, derivation of stress formulas	Graphical notes and derivation	CO6
42	Shells with Seams	Riveted and welded joints, joint efficiency and stress distribution	Riveted shell model, animation of seam stress	CO6
43	Safe Pressure Design	Safe internal pressure, allowable stress method, use of codes	Table of allowable stress, design code reference	CO6
44	Thickness Design	Formula to calculate shell thickness, relation with pressure	Design problem-solving, chart for material stress	CO6
45	Revision & Quiz	Objective quiz, recap of formulas, summary board	Interactive MCQ quiz, flashcard revision	CO6

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Department of Mechanical Engineering

LESSON PLAN: 2025-26
Name of the Faculty: Rasmi Ranjan Jena (Lecture Stage-1)
Subject: MATERIAL SCIENCE & ENGINEERING (MEPC205) Program: Diploma in Mechanical Engineering Semester: 3rd Total Contact Hours: 45 Total Marks: 100 Assessment: Progressive –30, End Term – 70 Credits: 3

COURSE OBJECTIVES:

After completion of the course, the students will be able to

1. Explain about crystal structures and atomic bonds.
2. Describe about classification of ferrous metals and their properties.
3. Explain about non-ferrous metals, cutting tool materials and composites along with their properties.
4. Describe about the various metallic failures and knowledge in testing of materials.
5. Explain the principle of corrosion, their types, its prevention methods along with the various surface engineering processes.

Unit 1: Crystal Structures and Bonds (10 classes)				
Class No.	**Topic**	**Subtopic**	**Teaching Aids / Activities**	**Course Objective**
1	Introduction to Crystal Structures	Definition of crystal structure and space lattice. Introduction to the concept of unit cells – Simple Cubic, Body-Centered Cubic (BCC), Face-Centered Cubic (FCC), and Hexagonal Close Packed (HCP). Explanation of lattice points in 3D.	3D crystal models, PPT with diagrams, animations of unit cell structures	CO1
2	Crystal Systems and Unit Cells	Description of seven crystal systems: Cubic, Tetragonal, Orthorhombic, Hexagonal, Trigonal, Monoclinic, and Triclinic. Examples of metals having these structures. Identification of symmetry elements.	Chart showing 7 systems, live demonstration with wooden models	CO1
3	Metallic Crystal Structures	Discussion of metallic structures: BCC (e.g., α-Iron), FCC (e.g., Aluminum, Copper), and HCP (e.g., Zinc, Magnesium). Comparison based on atomic arrangement, coordination number, and atomic packing.	Comparative chart of BCC, FCC, HCP; real metal specimens	CO1
4	Atomic Radius and Coordination Number	Derivation of atomic radius formulas for SC, BCC, and FCC. Concept and calculation of coordination number in each type of unit cell. Importance of coordination number in determining material properties.	Step-by-step derivation sheets, solved examples, classroom Q&A	CO1
5	Atomic Packing Factor (APF)	Derivation and calculation of APF for SC, BCC, FCC, and HCP structures. Interpretation of efficiency of packing and comparison. Significance in understanding density and mechanical behavior of metals.	Problem-solving on board, tabular comparison handout, APF demo models	CO1
6	Imperfections in Crystals (Overview)	Introduction to types of crystal imperfections – point defects (vacancies, interstitials), line defects (dislocations), and surface defects (grain boundaries). Their effect on mechanical properties.	Videos/animations of dislocations, PPT slides, metallographic images	CO1

7	Classification of Bonds in Solids	Types of atomic bonds: Primary (Ionic, Covalent, Metallic) and Secondary (Van der Waals, Hydrogen bonds). Characteristics of each bond and examples in engineering materials.	Animated videos showing electron sharing/transfer, comparison chart of bonding types	CO1
8	Ionic and Covalent Bonds	Explanation of ionic bond (e.g., NaCl structure), covalent bond (e.g., diamond structure), and their implications on properties such as hardness, melting point, and conductivity.	Ball-and-stick models, electron transfer animation, chart comparing ionic vs covalent	CO1
9	Metallic Bonds and Examples	Explanation of metallic bonding theory – sea of electrons. Why metals are good conductors and malleable. Examples like Cu, Fe, Al. Relationship between bonding and mechanical properties.	Real-life metal samples, animation showing metallic bonding	CO1
10	Secondary Bonds and Summary	Overview of secondary bonds – dipole-dipole, London dispersion, hydrogen bonding. Their roles in polymers and ceramics. Summary of bonding types and impact on materials behavior.	Conceptual diagrams, sample polymer materials, group discussion and recap quiz	CO1

Unit-II: Phase diagrams, Ferrous metals and its Alloys (9 Classes)				
Class No.	**Topic**	**Subtopic**	**Teaching Aids / Activities**	**Course Objective**
11	Phase Diagrams: Basics and Isomorphous System	Introduction to phase diagrams; importance in material design. Isomorphous systems – phase rule, single-phase solid solution.	PPT with cooling curves, charts of phase diagrams, class interaction with simple binary examples	CO2
12	Eutectic and Eutectoid Systems	Definitions, eutectic and eutectoid reactions, typical examples like Pb-Sn (eutectic) and steel (eutectoid), microstructure overview.	Diagrams, animation of transformations, group problem-solving exercises	CO2
13	Iron-Carbon Diagram & Classification of Steels	Iron-carbon binary diagram – critical points, eutectoid composition, phase transformation. Types: low, medium, high carbon steels.	Iron-carbon phase diagram handout, steel specimens (or images), phase transformation video	CO2
14	Iron Production Process & Pig Iron	Flow sheet for iron & steel production from ore. Pig iron – composition, classification and effect of impurities.	Industry flow chart, samples of iron ores, video on blast furnace operation	CO2
15	Cast Iron and Wrought Iron	Cast iron – types (grey, white, malleable, ductile), composition, properties and applications. Wrought iron – properties and uses.	Real parts made from cast/wrought iron, comparison table worksheet	CO2
16	Comparison of Iron Types	Comparative study of cast iron, wrought iron, mild steel, and high carbon steel in terms of structure, properties, and applications.	Comparison chart, interactive quiz, display of common products	CO2
17	Standard Commercial Grades of Steel	BIS and AISI steel designation systems, how steels are classified and marked commercially.	Chart of AISI/BIS grades, reading exercise from BIS handbook (or simulated material)	CO2
18	Alloy Steels – Purpose and Effects of Alloying	Purpose of alloying, effects of elements like Cr, Ni, Mo, Si, Mn, V, W etc. on mechanical and thermal properties.	Periodic table cards of alloying elements, data table, property comparison activity	CO2
19	Types and Applications of Important Alloy Steels	Types: Stainless steel (martensitic, ferritic, austenitic), HSS, heat resisting steel, spring steel, silicon steel, magnet steel – uses.	Steel specimen set or images, industry application videos, case discussion on material selection	CO2

Unit-III: Non-ferrous metals and its Alloys (9 Classes)				
Class No.	**Topic**	**Subtopic**	**Teaching Aids / Activities**	**Course Objective**
20	Introduction to Non-Ferrous Metals	Definition, importance of non-ferrous metals in engineering; general comparison with ferrous metals.	PPT presentation with real-world applications (e.g. aircraft, electronics), scrap metal samples or images	CO3
21	Properties & Uses of Aluminum	Physical & mechanical properties of aluminum: lightweight, corrosion resistance, thermal conductivity; engineering applications.	Video on aluminum extraction, product demos (cans, frames), worksheet on properties	CO3
22	Properties & Uses of Copper, Tin & Lead	Copper – conductivity & ductility, Tin – soldering and coating uses, Lead – radiation shielding & softness.	Display of copper wires, tin foil, lead-based items; electrical conductivity test demo (if feasible)	CO3
23	Properties & Uses of Zinc, Magnesium, Nickel	Zinc – galvanizing, corrosion resistance; Magnesium – light weight; Nickel – strength, resistance to oxidation & high temperature.	Use of real product samples (batteries, galvanised items), thermal resistance charts	CO3
24	Copper Alloys: Brasses and Bronzes	Brass – copper + zinc; Bronzes – copper + tin; differences, typical compositions, mechanical and corrosion properties, applications.	Specimen images, comparative property table, video on casting/rolling processes	CO3
25	Aluminum Alloys	Duralumin, Hindalium, Magnelium – chemical composition, characteristics (e.g., lightweight + strength), and usage in aviation/transport.	Charts comparing alloys, physical models, case studies (aircraft, auto bodies), problem-solving activity	CO3
26	Nickel Alloys	Inconel, Monel, Nichrome – composition, heat and corrosion resistance, aerospace & marine uses.	Engineering videos, images of turbines or marine parts, table of heat-resistance ratings	CO3
27	Anti-Friction / Bearing Alloys	Bearing bronzes (e.g., leaded tin bronze, phosphor bronze): applications in machinery, wear resistance, load bearing capacity.	Real/visual samples of bushes/bearings, friction & lubrication chart, discussion on machinery components	CO3
28	Standard Commercial Grades (BIS/ASME)	BIS and ASME standards for non-ferrous and alloy metals: designation systems, significance of codes.	Chart of BIS/ASME grades, decoding exercise using example alloy codes, online catalog sample analysis	CO3

UNIT IV: Failure Analysis and Testing of Materials (9 Classes)				
Class No.	**Topic**	**Subtopic**	**Teaching Aids / Activities**	**Course Objective**
29	Introduction to Failure Analysis	Importance of failure analysis in materials engineering; common causes of failure; overview of testing and diagnostic methods.	Real-life failure case studies (bridges, machinery), introductory video, failure analysis flowchart	CO4
30	Fracture: Ductile & Brittle	Ductile fracture – necking, energy absorption; Brittle fracture – sudden, low deformation; cleavage and fracture surface features.	Fracture sample images, stress-strain diagrams, animated videos of ductile vs. brittle failure	CO4
31	Notch Sensitivity & Fatigue	Definition and significance of notch sensitivity; Fatigue – cyclic loading effects, crack initiation & growth, endurance limit, S-N curve.	Charts of S-N curves, notch impact specimens, interactive online fatigue simulation tool	CO4
32	Fatigue Fracture & Influencing Factors	Visual characteristics of fatigue failure (beach marks); variables affecting fatigue life (surface finish, size, stress concentration, environment).	Samples with fatigue failure, classroom quiz on factors, case study of aircraft fatigue failure	CO4
33	Creep and Creep Fracture	Creep – slow deformation under constant load & high temp; stages of creep curve; creep fracture mechanisms.	Animated creep curve, real examples (turbine blades), graph plotting, time-temp curve analysis	CO4

34	Destructive Testing - I: Tensile & Compression	Tensile test – yield strength, UTS, elongation; Compression test – crushing behavior; stress-strain interpretation.	Universal Testing Machine (UTM) demo video, tensile/compression test specimen images	CO4
35	Destructive Testing - II: Hardness, Bend & Torsion	Hardness tests: Brinell, Rockwell methods; Bend test – ductility evaluation; Torsion test – shear strength & angle of twist.	Equipment images, comparison charts, hands-on demo or video, quiz on hardness scales	CO4
36	Destructive Testing - III: Fatigue & Creep Tests	Fatigue test setup – rotating bending/cyclic load; Creep test setup – time-based deformation under heat.	Video/diagram of fatigue & creep testing machines, data interpretation sheet	CO4
37	Non-Destructive Testing (NDT) Methods	Visual inspection; Magnetic Particle Test; Liquid Penetrant Test; Ultrasonic Inspection; Radiographic Testing – principles, advantages & limitations.	NDT test clips, comparative NDT chart, hands-on demo with penetrant spray (if feasible), worksheet on defect types	CO4

UNIT: V Corrosion and Surface Engineering (8 Classes)

Class No.	Topic	Subtopic	Teaching Aids / Activities	Course Objective
38	Nature, Causes, and Electrochemistry of Corrosion	Definition of corrosion; mechanism of metal degradation; corrosion as an electrochemical reaction; anodic and cathodic regions; role of electrolytes.	Animated video showing rusting; corrosion cell demo; classroom explanation with whiteboard diagrams	CO5
39	Factors Affecting Corrosion	Environmental (moisture, oxygen, temperature), material (composition, grain size), and mechanical (stress, design flaws) factors influencing corrosion rate.	Chart presentation on influencing factors; discussion of real cases like marine/industrial corrosion; interactive Q&A	CO5
40	Types of Corrosion	Overview and examples of different types: Uniform, Galvanic, Pitting, Crevice, Intergranular, Erosion, Stress corrosion cracking.	Sample images of corroded parts; video showing stress corrosion in aircraft; classroom handouts	CO5
41	Corrosion Control Methods	Material selection (SS, non-ferrous alloys), use of inhibitors, design improvement, cathodic protection, protective coatings.	Inhibitor and galvanic protection demo; protective design sketches; case study on ship hull protection	CO5
42	Surface Engineering: Coatings & Treatments	Overview of surface treatment techniques: organic coatings, electroplating, mechanical cleaning (abrasive blasting), chemical cleaning (pickling).	Sample display of plated items; coating flowchart; video on electroplating process	CO5
43	Advanced Surface Engineering Processes	Conversion coatings (oxide, phosphate, chromate); PVD, CVD techniques: principle and applications; advantages in corrosion resistance and wear performance.	PVD/CVD animations; examples from tools and aerospace; comparison chart of surface techniques	CO5
44	Surface Modification & Analysis Methods	Methods like thermal spraying, hard-facing, laser surface treatment; surface analysis tools (XRD, SEM, EDS); selection of surface treatment based on service condition.	Surface treatment video; SEM image samples; interactive table for process-material-application matching	CO5
45	Pollution Norms & Environmental Aspects	BIS/ISO norms for effluent discharge; environmental concerns from plating/chemical treatments; eco-friendly surface engineering approaches.	Environmental regulation chart; video on effluent treatment plant; small group activity: design a green plating line	CO5

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Department of Mechanical Engineering

LESSON PLAN: 2025-26
Name of the Faculty: Manabhanjan Bhoi (Lecture Stage-II)
Subject: FLUID MECHANICS & FLUID POWER (EEPC207) Program: Diploma in Mechanical Engineering Semester: 3rd Total Contact Hours: 45 Total Marks: 100 Assessment: Progressive –30, End Term – 70 Credits: 3

COURSE OBJECTIVES:

After completion of the course, the students will be able to

1. Identify the properties of a fluid and hydrostatics.
2. Explain the basic kinematics and dynamics of fluid mechanics
3. Describe the flow through orifices, notches and pipes.
4. Classify different types of turbines and pumps.
5. Apply the knowledge of fluid power.

Unit I: Properties of a Fluid and Hydrostatics (Total Classes: 9)				
Class No.	**Topic**	**Subtopic Online**	**Teaching Aids / Activities**	**Course Objective**
1	Introduction to Fluids and Properties	Definition of fluid; classification (ideal, real, Newtonian); properties: density, specific weight, specific gravity.	Real-life examples (oil, water); chalkboard illustrations	CO1
2	Viscosity and Surface Tension	Concept of viscosity; dynamic & kinematic viscosity; surface tension basics with examples.	Water-oil demo; marker on board diagrams	CO1
3	Introduction to Fluid Pressure	Fluid pressure, Pascal's Law, pressure head, gauge and absolute pressure.	Plastic syringe demo; chalkboard derivation	CO1
4	Hydrostatic Forces on Surfaces	Hydrostatic force and center of pressure on vertical/horizontal/inclined planes.	Whiteboard diagrams; simple force calculation on board	CO1
5	Curved Surface Pressure Analysis	Pressure on curved surfaces; real-life uses in tanks and dams.	Sketches on board; question prompts	CO1
6	Manometers and Pressure Devices	Simple, differential, inverted manometers; Bourdon gauge working.	Manometer demo kit (or chart); diagram discussion	CO1
7	Buoyancy and Floatation	Archimedes' Principle, buoyant force, stability; floatation conditions.	Beaker and object demo; chalkboard problem	CO1
8	Numerical Problem Solving	Solving numerical problems on pressure, buoyancy, and hydrostatics.	Classroom problem solving; student board work	CO1
9	Summary and Concept Reinforcement	Recap of all key points; applications of hydrostatics in real life.	Quick revision quiz; flashcard or oral Q&A	CO1

Unit II: Kinematics and Dynamics of Fluid Mechanics (Total Classes: 6)				
Class No.	**Topic**	**Subtopic Online**	**Teaching Aids / Activities**	**Course Objective**
10	Types of Flow	Steady, unsteady, uniform, non-uniform, laminar, turbulent, compressible and incompressible flow; concept of circulation and vorticity.	Chalkboard classification; real-life water pipe examples	CO2
11	Flow Visualization Techniques	Streamline, path line, streak line – definitions and differences with sketches.	Board diagrams; paper strip flow activity	CO2
12	Energies and Conservation Laws	Various forms of fluid energy; law of conservation of mass (continuity equation); introduction to energy equation.	Derivation on board; balloon air-out demo	CO2
13	Bernoulli's Theorem	Derivation of Bernoulli's equation, its assumptions and limitations; practical applications (pipe, nozzle, airplane wing).	Chart of Bernoulli applications; simple board-based example	CO2
14	Flow Measuring Devices	Venturi meter, Pitot tube – working principles, flow and velocity equations; introduction to flowmeters (current meter).	Device sketches on board; image charts of meters	CO2
15	Numerical Applications	Solving simple numericals using Bernoulli's equation, continuity equation, venturimeter and Pitot tube.	Practice worksheet; classroom board problem solving	CO2

Unit III: Flow Through Orifices, Notches, and Pipes (Total Classes: 9)				
Class No.	**Topic**	**Subtopic Online**	**Teaching Aids / Activities**	**Course Objective**
16	Orifices and Coefficients	Definition of orifice; types of coefficients: coefficient of contraction (Cc), velocity (Cv), discharge (Cd); relationships among coefficients.	Board derivation; diagram of orifice setup	CO3
17	Notches and Weirs	Definition of weirs and notches; rectangular and triangular notch; derivation of discharge equations.	Diagrams on board; photo examples from irrigation structures	CO3
18	Numerical Practice – Notches	Simple numericals on discharge over rectangular and triangular notches.	Worksheet; step-by-step solving on blackboard	CO3
19	Introduction to Pipes	Definition of pipe; basic concepts of internal flow and pressure drop.	Everyday pipe system examples; sketch and chalk talk	CO3
20	Laws of Fluid Friction	Explanation of fluid friction in pipes; Darcy's law and Chezy's formula; derivation and meaning.	Derivation on board; concept demonstration with straws and flow	CO3
21	Head Loss and Energy Lines	Equation of head loss due to friction; concepts of hydraulic gradient line (HGL) and total energy line (TEL).	Board sketch of HGL and TEL; pipe profile drawing	CO3
22	Nozzle and Applications	Definition and function of nozzles; examples in turbines, firefighting, irrigation; introduction to power transmission through nozzles.	Nozzle images; chalkboard derivation; real-life examples	CO3
23	Maximum Power Transmission	Condition for maximum power transmission through nozzles; derivation of formula; concept of efficiency.	Mathematical derivation with numerical values on board	CO3
24	Numerical Applications	Simple numericals on orifices, notches, pipe flow, and nozzle power transmission.	Problem-solving session; students practice on worksheets	CO3

Unit IV: Turbines and Pumps (Total Classes: 12)				
Class No.	**Topic**	**Subtopic Online**	**Teaching Aids / Activities**	**Course Objective**
25	Classification of Turbines	Overview and classification of hydraulic turbines – impulse and reaction types; criteria for selection based on head and discharge.	Chart of turbine classification; video of turbine operation	CO4
26	Pelton Wheel	Construction and working principle of Pelton wheel; impulse action, components (nozzle, runner, buckets).	Diagram on board; video animation of Pelton wheel	CO4
27	Francis and Kaplan Turbines	Construction and working of Francis (reaction) and Kaplan (axial flow) turbines; differences.	Comparison chart; turbine cut-section images	CO4
28	Draft Tube & Cavitation	Draft tubes – types, functions, construction; concept of cavitation – causes, effects and prevention in turbines.	Diagram of draft tube types; classroom discussion	CO4
29	Work, Power, Efficiency	Formulas for work done, power developed and hydraulic/mechanical/overall efficiency of turbines; explanation with example.	Formula sheet; solved example on board	CO4
30	Numerical Practice – Turbines	Simple numericals on Pelton, Francis, Kaplan turbines involving power and efficiency.	Board problems; practice worksheets	CO4
31	Centrifugal Pumps – Intro	Principle of working of centrifugal pumps; applications in domestic and industrial settings.	Demo video; pump cross-sectional diagram	CO4
32	Construction & Components	Casings (volute, vortex), types of impellers (closed, semi-open, open); priming and its methods; concept of multistage pumps.	Sample models/images; sketch on board	CO4
33	Pump Efficiency	Manometric head, manometric efficiency, overall efficiency; Work done by pump – related expressions.	Chalkboard derivation; animated diagrams	CO4
34	Numerical Practice – Centrifugal Pumps	Simple numericals on centrifugal pumps (work done, efficiency).	Numericals on board; class quiz	CO4
35	Reciprocating Pumps – Intro	Construction and working principle of single and double-acting reciprocating pumps; applications.	Sketch of working mechanism; GIF/video animation	CO4
36	Slip, Cavitation & Numericals	Concept of slip, negative slip, cavitation and separation in reciprocating pumps; Simple numericals.	Board explanation with graphs; numerical worksheet	CO4

Unit V: Fluid Power (Total Classes: 9)				
Class No.	**Topic**	**Subtopic Description**	**Teaching Aids / Activities**	**Course Objective**
37	Introduction to Fluid Power	Definition of fluid power; classification into hydraulic and pneumatic systems; advantages and applications in industry.	Introductory video; chart comparing hydraulic and pneumatic systems	CO5
38	Pascal's Law	Basic principle of enclosed fluid systems; derivation and explanation of Pascal's Law with real-life examples (e.g., hydraulic jack).	Demonstration with syringe setup; Pascal's law derivation on board	CO5
39	Components of Hydraulic System I	Reservoir, filters, pressure limiting valves – functions and layout in a system.	Cut-section diagrams; classroom demonstration or model	CO5
40	Components of Hydraulic System II	Direction control valves, flow control valves; actuators – linear and rotary types.	Classroom sketches; component samples or images	CO5
41	Accumulator and Fittings	Purpose and working of accumulator; types of pipes and fittings used in hydraulic systems.	Video animation; classroom chart of pipe symbols	CO5
42	Positive Displacement Pumps	Types – gear, vane, piston pumps; their working principles with diagrams.	Board diagrams; animated working video	CO5

43	Hydraulic Circuits – Basics	Basic symbols and drawing conventions; understanding how to read and draw hydraulic circuits.	Chart of ISO hydraulic symbols; guided circuit drawing session	CO5
44	Hydraulic Circuits – Examples	Circuit diagrams for: extension/retraction of linear actuator, rotary actuator motion, holding a job, hydraulic press operation.	Board circuit drawing; worksheet with tasks	CO5
45	Review and Simple Numericals	Recap of unit; simple numericals involving pressure, force, and area calculations; application-based problems.	Problem solving on board; group Q&A activity	CO5

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Unit II: Internal Combustion Engines (9 Classes)				
Class No.	**Topic**	**Subtopic**	**Teaching Aids / Activities**	**Course Objective**
11	Air Standard Cycles	Assumptions made in air standard cycle analysis; significance in thermodynamic evaluation of engines.	Chalk and board explanation; comparative table chart	CO2
12	Carnot Cycle	Description of Carnot cycle with P-V and T-S diagrams; idealized efficiency limits.	P-V and T-S diagrams on board; chart of Carnot cycle	CO2
13	Otto Cycle	Explanation of Otto cycle with assumptions; P-V and T-S diagrams; efficiency formula and practical relevance to petrol engines.	Diagram sketches; formula derivation on board	CO2
14	Diesel Cycle	Diesel cycle principles; P-V and T-S diagrams; efficiency comparison with Otto cycle.	Diesel cycle animations; classroom notes on comparison	CO2
15	Introduction to I.C. Engines	Internal vs. external combustion engines; advantages of I.C. engines; classification based on strokes, fuel, cooling, application.	Tabular classification chart; group brainstorming	CO2
16	Components of I.C. Engines – Part I	Sketch and description of I.C. engine with labelled parts: cylinder, crankcase, crank pin, crank, crankshaft. Material used and function of each component.	Engine cross-sectional diagram; physical samples/photos	CO2
17	Components of I.C. Engines – Part II	Connecting rod, wrist pin, piston, cooling fins, cylinder head, exhaust and inlet valves – function, material and importance.	Labeling exercise on engine diagram handout	CO2
18	Working of Petrol and Diesel Engines	Working of four-stroke and two-stroke petrol and diesel engines; sequence of strokes and combustion process.	Sequential stroke chart; hand-cranked engine model	CO2
19	Valve/Port Timing & Engine Comparison	Valve and port timing diagrams; comparison between 2-stroke and 4-stroke engines; comparison of CI and SI engines – advantages/disadvantages.	Comparison table on board; diagram sketching activity	CO2

Unit III: I.C. Engine Systems (Total Classes: 9)				
Class No.	**Topic**	**Subtopic**	**Teaching Aids / Activities**	**Course Objective**
20	Fuel System of Petrol Engines	Description and working of fuel supply system in petrol engines; Principle of carburetion; working of simple and Zenith carburetors.	Diagram of Zenith carburetor; animation video; chalk & board	CO2
21	Fuel System of Diesel Engines	Description of fuel injection system; fuel pump and types of injectors; function and layout.	Line diagrams of injector and pump; physical model (if available)	CO2
22	Cooling Systems – Types	Types of engine cooling: Air cooling and water cooling; construction and working of air cooling and water cooling (thermo siphon).	Line diagram and chart comparison; group Q&A	CO2
23	Cooling Systems – Radiator	Forced circulation system with radiator; function and parts; comparison between air and water cooling systems.	Cross-sectional radiator diagram; board explanation	CO2
24	Ignition Systems	Battery coil ignition and magneto ignition – working principle, components and comparison.	Ignition circuit diagrams; board summary chart	CO2
25	Lubrication Systems	Types of lubrication systems: splash, pressure, mist, dry sump and wet sump systems; working with line diagrams.	Simple animation or board drawing; class quiz	CO2

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Department of Mechanical Engineering

LESSON PLAN: 2025-26
Name of the Faculty: Manabhanjan Bhoi (Lecture Stage-II)
Subject: THERMAL ENGINEERING-1(MEPC209) Program: Diploma in Mechanical Engineering Semester: 3rd Total Contact Hours: 45 Total Marks: 100 Assessment: Progressive –30, End Term – 70 Credits: 3

COURSE OBJECTIVES:

After completion of the course, the students will be able to

1. Describe various sources of Energy and their applications.
2. Classify I.C. engines and their working and constructional features.
3. Draw the energy flow diagram of an I.C. engine and evaluate its performance.
4. Describe the constructional features of air compressor and working of different air compressors.
5. Describe the applications of refrigeration and classify air-conditioning systems.

Unit I: Introduction to Thermodynamics & Sources of Energy (10 Classes)				
Class No.	**Topic**	**Subtopic**	**Teaching Aids / Activities**	**Course Objective**
1	Thermodynamic Systems	Definition of thermodynamic system; types – closed, open, and isolated systems; examples from daily life like cooker (closed), fan (open), and thermos (isolated).	Chalkboard drawing and verbal examples	CO1
2	Properties of a System	Explanation of system properties – pressure, volume, temperature, entropy, enthalpy, internal energy; units and physical meanings.	Tabular comparison on board	CO1
3	Intensive & Extensive Properties	Definitions with simple examples (intensive: temperature; extensive: volume); classification activity.	Group activity – students classify 10 given properties	CO1
4	Thermodynamic Terms	Definition and differences of process, path, cycle, state, path function, point function; basic PV diagram illustration.	Board diagram and class Q&A	CO1
5	Equilibrium & Quasi-static	Thermodynamic equilibrium types; meaning of quasi-static process and examples like slow piston movement.	Real-life examples; board notes	CO1
6	Laws of Thermodynamics	First law (energy conservation); Second law (Kelvin-Planck and Clausius statements); simple practical implications.	Discussion with everyday examples (fridge, heater)	CO1
7	Energy Sources Classification	Classification – renewable (solar, wind, biomass) vs non-renewable (coal, oil); environmental impact discussion.	Chart drawn on board; oral interaction	CO1
8	Fossil Fuels	Introduction to CNG and LPG; properties and common applications; advantages over coal and petrol.	Ask students to share home use cases	CO1
9	Solar and Wind Energy	Flat plate & concentrating solar collectors; photovoltaic cell, solar distillation; wind turbines – concept only.	Simple line diagrams on board	CO1
10	Other Sources of Energy	Introduction to tidal, ocean thermal, geothermal, biogas, biomass, biodiesel, hydraulic, nuclear energy, fuel cells; basic working and applications.	Chart revision; small quiz or recap oral questions	CO1

26	Governing of I.C. Engines – I	Need and objective of governing; hit and miss governing and quantitative governing – working and application.	Governing mechanism sketch; oral quiz	CO2
27	Governing of I.C. Engines – II	Qualitative governing and combination governing methods; comparison and practical relevance.	Table-based comparison; governing demo via video/diagram	CO2
28	Supercharging	Objective and basic concept of supercharging in I.C. engines; its effect on performance and efficiency.	Supercharging concept video/board sketch	CO2

Unit IV: Performance of I.C. Engines (Total Classes: 9)				
Class No.	**Topic**	**Subtopic**	**Teaching Aids / Activities**	**Course Objective**
29	Introduction to Performance Terms	Basic engine performance parameters – Brake Power (B.P.), Indicated Power (I.P.), Frictional Power (F.P.); definitions and significance.	Board explanation; visual chart summary of terms	CO3
30	Mean Effective Pressures	Brake Mean Effective Pressure (BMEP) and Indicated Mean Effective Pressure (IMEP); formula and practical relevance.	Formula breakdown on board; comparative table	CO3
31	Efficiencies	Brake Thermal Efficiency, Indicated Thermal Efficiency, Mechanical Efficiency, Relative Efficiency – definitions and equations.	Efficiency formula flashcards; class quiz	CO3
32	Performance Test	Purpose and procedure of engine performance test; data required and method of recording.	Description with schematic layout; activity: prepare observation sheet	CO3
33	Morse Test	Explanation of Morse Test – purpose, method, and interpretation of results.	Simple engine schematic; classroom explanation	CO3
34	Heat Balance Sheet – I	Importance of heat balance; preparation of heat input/output data; layout of heat balance sheet.	Board activity: fill sample heat balance sheet	CO3
35	Heat Balance Sheet – II	Solving examples of heat balance sheet from given engine data.	Practice problems in groups; board solution	CO3
36	Determining B.P., I.P., F.P.	Methods of calculating Brake Power (dynamometer), Indicated Power (indicator diagram), and Frictional Power (Morse test).	Sketches of dynamometer and indicator diagram	CO3
37	Numerical Problems	Simple numerical problems on engine performance parameters using real/measured data.	Individual worksheet; step-by-step board solution	CO3

Unit V: Air Compressors, Refrigeration & Air-conditioning (Total Classes: 8)				
Class No.	**Topic**	**Subtopic**	**Teaching Aids / Activities**	**Course Objective**
38	Introduction to Air Compressors	Function of air compressors; Industrial and domestic uses of compressed air.	Real-life use case discussion; diagram on board	CO4
39	Types of Air Compressors	Classification: Reciprocating, Rotary, Single-stage, multi-stage; basic working principle.	Tabular comparison; posters of types	CO4
40	Reciprocating Compressor	Construction and working of single-stage reciprocating compressor with line and P-V diagrams.	Board diagram of working parts and P-V curve	CO4
41	Multi-stage & Rotary Compressors	Advantages of multi-stage compressors; Construction & working of centrifugal, axial flow, and vane type rotary compressors.	Sketch and working flow diagram on board	CO4

42	Basics of Refrigeration	Concepts of Refrigeration, Refrigerant, and COP; Types and selection of refrigerants.	Charts showing refrigerants; COP formula sheet	CO5
43	Air & Vapour Compression System	Air refrigeration system: components, working & application; Vapour compression system: components, working & application.	Simple block diagrams; board explanation	CO5
44	Air Conditioning Concepts	Introduction to air-conditioning; Classification – comfort vs. industrial AC systems; Window AC unit – components and function.	Board illustrations; real-life examples	CO5
45	AC System Types	Summer, Winter, Year-round AC systems – basic principle, layout, and function.	Comparison chart; discussion of seasonal applications	CO5

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