PANJAB UNIVERSITY, CHANDIGARH

Scheme and Syllabus of
B.E. MECHANICAL ENGINEERING
3\textsuperscript{RD} TO 8\textsuperscript{TH} Semester
Examination 2012-13
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**Total:** 800

Marks* refer to mid semester evaluation and end semester evaluation

(i)
## BACHELOR OF ENGINEERING (MECHANICAL)

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Total 750

There will be four weeks vocational training after 4th Semester either in the College or in the Factories approved by the Principal / Head of the Department

Marks* refer to mid semester evaluation and end semester evaluation

(ii)
# BACHELOR OF ENGINEERING (MECHANICAL)

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*Marks* refer to mid semester evaluation and end semester evaluation.
# BACHELOR OF ENGINEERING (MECHANICAL)

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Total: 700

There will be four weeks Vocational Training in the manufacturing concerns after 6th semester.

Marks* refer to mid semester evaluation and end semester evaluation.

(iv)
Student can exercise **OPTION 1 or OPTION 2** according to the following:

A student may opt for one semester training in lieu of subjects of 8th Semester. The marks for six months training will be equal to the total marks of 8th Semester study. A student can opt for six month semester training under following conditions:

a. The student got selected for job in campus placement and the employer is willing to take that student for the training.

b. The student got offer of pursuing training from reputed government research organization/govt. sponsored projects/govt. research institution provided that student should not be paying any money to get trained. For pursuing this training student needs the prior approval from the Coordinator of the respective branch.
### SEVENTH SEMESTER

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BACHELOR OF ENGINEERING (MECHANICAL)

Scheme of Examination

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**EIGHTH SEMESTER**

**OPTION 1**

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1. The project will continue for a period of two weeks after 8th semester examinations.
2. The examination will be conducted in S.I. system of units.
3. In case of elective subject where there is no lab, project work/ seminar may be given.
4. The number of elective subjects to be offered in the 8th semester will be announced by the Branch Co-ordinator depending upon the availability of staff.

**OR** **OPTION 2**

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### 8th Semester :- Elective- II

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Part A

1. Reciprocating Air Compressors:


2. Steam Generators:


3. Boiler Draught :

Classification, Natural, Forced and Induced draught, Comparison. Estimation of height and diameter of chimney condition for maximum discharge, Chimney efficiency, Draught losses. Balanced draught, Power required to drive fan.

4. Performance of Steam Generators :


Part B

5. Nozzles and Diffusers :

6. **Impulse Steam Turbine**: (5)


7. **Reaction Turbine**: (5)

Degree of reaction, velocity diagrams, blade efficiency and its derivation, calculation of blade height etc. Requirement of an ideal working fluid, Methods of attachment of blades to turbine rotor, losses in steam turbine, Labyrinth packing and governing of steam turbine. Blade materials.

8. **Condensers**: (4)


**Books Suggested**


**MEC-302: MECHANICS OF MATERIALS-I**

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Note: Eight questions to be set in all. Candidates are required to attempt a total of five questions, selecting at least two questions from each part.

**PART – A**

1. Thermal Stresses: (2)
Longitudinal stresses in fixed bars of uniform cross-section, temperature effect in compound bars, stress calculation due to combination of longitudinal and temperature stresses.

2. Stresses and Strains at an oblique plane: (4)

2-D stress and strain systems, derivation and application of formulae in 2-D stress and strain system for: Normal stress and strain on any place, shear stress and strain on any plane, principal stress and strain, maximum shear stress and strain, position of principal planes, position of maximum shear stress/strain planes, Mohr’s stress circle.

3. Strain Energy: (4)

Strain energy, strain energy due to gradually applied loads (axial, shear, bending moment and torque), Strain energy of dilation and distortion due to three principal stresses, Stress due to suddenly applied and impact loads.

4. Theories of Elastic Failures: (4)

Maximum principal stress, maximum principal strain, maximum shear stress, total strain energy and distortion energy theories. Comparison and graphical representation of these theories for 2-Dimensional stress condition, Application of these theories of failures to 2-D stress problems such as (i) Combined bending and torsion and (ii) Combined torsion and axial loads

Part B

5. Distribution of Shear Stresses in Beams: (5)

Derivation of general formula and its application to rectangular, triangular, T, Circular and hollow circular sections, Simple Problems

6. Slope and Deflection: (7)

Relationship between bending moment, slope and deflection, Moment area method, Method of integration, Macaulay’s method, Castigliano’s theorem and Maxwell’s theorem of reciprocal deflection (proof not required for these theorems)

Use of all these methods to calculate slope and deflection for cantilever & simply supported beams with or without overhang under various types of loads and its combinations

7. Fixed Beams: (7)

Calculation of deflection, fixing moment and reactions by Macaulay’s double integration methods for beams;

a. Fixed at one end and simple supported at other end with or without overhangs
b. Fixed at both ends:
Under following loads:

i. Uniformly distributed load (UDI)

ii. Uniformly varying loads.

iii. Concentrated loads (one, two, or three etc.).

iv. Combination of the above loads.

Bending moment and Shear Force diagrams for the above cases.

BOOKS SUGGESTED:


MEC-352: MECHANICS OF MATERIALS – I

L T P
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List of Experiments:

1. Study of wood testing machine and performance of various tests on it.
2. Determine the stiffness of a spring on a spring tester.
3. Determine the hardness of various materials with Brinell, Vickers Pyramid and Rockwell hardness testing.
4. Study of creep testing machine.
5. Study of Fatigue testing machine and perform fatigue test on various materials.
7. Determine strain aging phenomenon of given metal.
8. Determine and plot shear stress distribution in various beams through interactive C/C++ computer programming or using MATLAB.
9. Determination & plot various cylindrical and spherical shells parameters through interactive C/C++ computer programming or using MATLAB.

MEC-303: THEORY OF MACHINES-I

L T P
3 1 0

Note: The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

PART-A
1. Basic concepts:
Kinematics and Dynamics of Machines, Mechanism, Pairs, Inversions of slider crank chains, Degrees of freedom, Kutzbach’s equation. Grubler criterion and Numerical problems

2. Velocity and Acceleration:
Basic concepts of machines, link, Mechanism, Kinematic chain, relative motion of parts of Mechanism, displacement, velocity, acceleration diagrams of all basic mechanisms including quick return motion mechanism. Advance problems on velocity diagrams (relative velocity method, instantaneous center method).

3: Kinematics Synthesis of Mechanism.
Movability, Number synthesis, Frudneins’s equation. Chebyshev spacing of precision points, Two and three position synthesis of Four-bar mechanism and slider crank mechanism, Overlay Method, Block’s method, Transmission angle, Limit position and Least square techniques.

4: Flywheel and Turning Movement Diagrams:
Turning moment and crank effort diagrams for steam and I.C. engine, dynamics of simple horizontal and vertical engine. Fluctuation of speed, co-efficient of fluctuation of speed and energy. Simple problems on turning moment diagrams and the determination of size of a flywheel taking centrifugal stresses into consideration.

5: Force Analysis:
Equations of equilibrium, Couple, equilibrium of three force and four force systems, Free body diagrams, Forces on slider crank mechanism, quick return mechanism, four bar mechanism and slider crank mechanism with friction at turning pairs and numerical problems.

PART-B

6: Friction
Efficiency of inclined plane, Friction in V-threads, screw-jack, pivots and collars plate and cone-clutches, Power lost in friction, friction circle and the friction axis of a link.

7: Belts, Ropes and chains.
Materials, type of drive, idle pulley, intermediate or counter shaft pulley, angle and right angle drive, quarter turn drive, velocity ratio, crowning of pulley, loose and fast pulleys, stepped or cone pulleys, ratio of tensions on tight and slack sides of belt. Power transmitted by belts with consideration of creep and slip, centrifugal tension and its effect on power transmitted. Use of gravity idler, flat, V-belts and rope material, Length of belt, rope and chain drive, types of chains.

8: Brakes and Dynamometer:
Types of brakes, principle of friction brakes, band, band and block, internal expanding shoe brakes, simple Problems of these brakes, description of vacuum brake, types of dynamometer, measurement of power by Prone brake and rope brake dynamometer, belt transmission dynamometer, Heenan and Froude’s Hydraulic dynamometer, Bevis- Gibson’s flash light torsion dynamometer.

9: Governors.
BOOKS SUGGESTED.

MEC-353: THEORY OF MACHINES-I

List of Experiments

1. (a) Find the moment of inertia of a given body with the help of Fly-wheel.
    (b) Calculate the minimum possible periods of oscillation if the point of suspension may be moved.
2. Study and draw the sketches of different inversions of single slider chain and double slider crank chain.
3. Find the coefficient of friction for different belt material on a cast iron: Pulley.
4. To perform the various practical on Universal Governor Apparatus.
   (a) Determination the characteristics of sleeve position against speed for all governors.
   (b) Determination the characteristics curves of radius of rotation against controlling force for all governors.
   (c) To study the effect of varying the mass of central sleeve for porter and proell governors.
   (d) To study the effects of varying initial spring compression for Hartnell Governor.
5. Study the working and construction of D-slide valve and piston valve. Discuss their relative merits.
6. Study and sketch the Stephenson link motion and the Gooch link motion and describe their relative merits.
7. Study and sketch the Walschaert valve gear.

MEC-354: MACHINE DRAWING

The candidates will be required to make minimum of 15 drawing sheets using the software such as AutoCAD, ProE and Inventor on the following topics as per B.I.S. SP46-2003 for General Engg. Drawing. First angle method of Projection should be used.

1. Symbols of standard tolerances, machining symbols, Surface finish and welding symbols
2. Free hand sketching of shafts, splined shafts, keys and keyways
3. Form of screw threads, conventional representations of single and multi start threads, riveted joints, bolts, studs, screw, locking devices, pipe and pipe fittings. (3 Sheets Min.)
4. Cotter joints, knuckle joints. Pulleys and brackets. (2 Sheets Min.)
5. Flange and muff coupling. Pin type flexible coupling; claw Coupling and cone friction clutch. (2 Sheets Min.)
6. Footstep bearing, Plummer block, swivel bearing (2 Sheets Min.).
7. I.C. Engine Piston, connecting rod, spark plug, atomizer, Fuel injection pump. (2 Sheets Min.)
8. Machine Tool Parts: Tail stock. (1 Sheet Min)
9. Miscellaneous: Screw jack, drill press vice, valves (1 Sheet Min.)

**Note:** Students should develop the understanding of study of drawing with reference to manufacturing processes, projections, assembly drawings and should be able to draw simple assembly drawings and projections of simple machine parts. The syllabus given above indicates the broad outlines and the scope of subject to be covered. Teacher concerned may take suitable examples to make the student understand the topic.

**Book Suggested**


**MEC-305: MANUFACTURING PROCESSES**

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Note: The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

**PART-A**

1. **Foundry:** Introduction to casting, advantages & limitations. Introduction to moulding processes. Sand moulding - materials, properties of moulding sand, sand moulding procedure, Pattern- types & materials, Pattern allowances, core prints, cores, Elementary & brief description of various melting furnaces.


**PART-B**

4. **Milling & Drilling** : Milling: principle, types of milling machines, specifications of milling machine, Introduction to indexing, Multipoint cutting tool, Types of milling cutters. Principles,
Classification of drilling machine, Different operations on drilling machine, Speed and feed in drilling.


**6. Broaching:** Broach, Nomenclature, cutting action of broach, Broaching operations and applications.

**Recommended Books**

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<th>Author(s)</th>
<th>Publisher</th>
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<tr>
<td>Workshop Technology Vol. I &amp; II</td>
<td>Hazra Chowdhry</td>
<td>Media Promotors</td>
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<tr>
<td>Manufacturing materials &amp; process</td>
<td>Lindberg</td>
<td>Prentice Hall</td>
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<td>Manufacturing processes</td>
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<td>S.K. Garg</td>
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<tr>
<td>Production Technology</td>
<td>R K Jain</td>
<td>Khanna</td>
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**MEC-355: MANUFACTURING PROCESSES**

List of Experiments

1. To prepare a mould & do casting.
2. Study of casting defects.
3. To prepare a lap joint using- electric arc welding.
4. To prepare a joint using- gas/spot welding.
5. To prepare a job on lathe machine- involves turning, grooving, drilling, boring & threading operation.
6. To prepare a job on shaper machine
7. To prepare a job on milling machine
8. To prepare a job on drill machine- involves drilling, counter sunk & reaming operation.
9. To prepare a job involves-tapping operation.

**MEC-306: COMPUTATIONAL METHODS**

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Note: The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

**Part A**

1. **Matrices and linear system of equations**

   Linear dependence of Vectors, relation between rank of a matrix and linearly independent vectors of matrix, similar matrices, characteristic vector and characteristic roots of a matrix,

2. Sequences and series (8)

PART-B

3. Numerical Methods (12)

BOOKS SUGGESTED

MEC-357: VOCATIONAL TRAINING after 2nd Semester

SYLLABUS FOR
BACHELOR OF ENGINEERING (MECHANICAL)
FOURTH SEMESTER

MEC-401: APPLIED THERMODYNAMICS-II

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Note: The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

Part-A

1. Thermodynamics of I.C. Engines:

1.2 Combustion in SI Engines: Combustion in S.I. Engines, Combustion phenomenon, flame speed, ignition delay, effect of engine variables on Delay Period, abnormal combustion, preignition, detonation, effect of various engine parameters on detonation, effect of detonation on engine performance and methods employed to reduce detonation. Combustion chamber design for S.I. Engines (3)

1.3 Combustion in CI Engines: Combustion in C.I. Engines, Combustion phenomenon, Delay period, Diesel Knock, CI engine combustion chambers, High speed cinematography for combustion visualization- a brief note (2)

1.4 Fuels: rating of SI Engines fuels; cetane ratings of CI Engine fuels, Octane and Cetane numbers (2)

1.5 Performance of IC engines: Performance curves of C.I. and S.I engines. Overall IC engine performance (engine sizing, mean effective pressure (MEP), power and torque) Effect of compression ratio and of air fuel ratio on power and efficiency of an engine: Variation of engine power with altitude, supercharging, its advantages and its applications, types of superchargers (2)

2. Gas Turbines:

Introduction; Classification of Gas turbines: on the basis of system of operation and on the basis of combustion (at constant volume, or at constant pressure). Thermodynamics of constant pressure gas turbine cycle: calculation of net output, work ratio and thermal efficiency of ideal and actual cycles; cycle air rate, temperature ratio; effect of change in Sp. heat and mass of fuel on power and efficiency. Operating variables and their effects on thermal efficiency and work ratio. Thermal refinements and their effects on gas turbine cycle .i.e. gas turbine cycle with regeneration, inter cooling and reheating; multistage compression and expansion , pressure losses in heat exchangers and combustion chambers. Comparison of gas turbine with a steam turbine and I.C. engine. Field of application of gas turbines. (6)

Part-B

3. Aircraft Propulsion using gas turbine:

Principle of propulsion thrust work and thrust power, propulsion efficiency, Overall thermal efficiency, specific fuel consumption. Intake and Propelling nozzle efficiencies. classification and comparison of ram jets, turbojets, turbo props, pulse jets and rockets Thermodynamics cycle analysis and efficiencies of propulsive devices of turbojet engine, Advantages and disadvantages of jet propulsion over other propulsion systems. Fields of application of various propulsion units. (4)

4. Rotary Compressors:

Introduction and general classification of rotary compressors: Comparison of rotary compressors with reciprocating compressor

Stagnation and static values of pressure, temperature and enthalpy etc, for flow through rotary machines.

4.1 Positive Displacement Compressors: Operation of positive displacement type of rotary Compressor like Roots Blower, Screw Compressor and Vane type Blower. (2)

4.2 Centrifugal Compressors: Principle of operation, components of a centrifugal compressor. Complete thermodynamics analysis of centrifugal compressor stage, polytropic, isentropic and Isothermal efficiencies; work done and pressure rise. Velocity vector diagrams for centrifugal compressors and power calculation, preguide vanes and prewhirl, slip factor, power input factor; degree of reaction and its
derivation, energy transfer in backward, forward and radial vanes; Pressure coefficient as a function of Slip Factor, efficiency and outcoming velocity profile from the impeller.
Non-dimensional parameters for plotting compressor characteristics; Surging and choking in centrifugal compressor.
Field of application of centrifugal compressor.

4.3 **Axial Flow compressors**

Components of axial flow compressor and their arrangement, Principle of operation, velocity vector diagrams, thermodynamics analysis and power calculation; Factors affecting stage pressure rise, work done factor; Degree of reaction and blade Efficiency and their derivation; Isentropic, polytropic and isothermal efficiencies.
Surging, choking and stalling in axial flow compressors. Characteristic curves for axial flow compressors, Flow parameters of Axial Flow Compressors like Pressure Coefficient, Flow Coefficient, Work Coefficient and Temperature rise coefficient, specific speed etc.
Comparison of Axial Flow Compressors with Centrifugal Compressors. Field of application of Axial Flow Compressors

**BOOKS SUGGESTED:**


**MEC-451: APPLIED THERMODYNAMICS-II**

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**List of Experiments.**
1. Study of constructional details, cooling system, Lubrication system and Fuel Flow system of following Engines;
   Two stroke and four stroke Diesel engine.
   Four stroke Petrol Engine.
2. To find the mechanical and thermal efficiency of a Diesel Engine.
3. To draw the valve timing diagram for a Diesel Engine.
4. Determination of B.H.P. at various loads (pump being given fixed setting not to be changed by governor) for a Diesel Engine/Semi Diesel Engine. Graphical representation of B.H.P. and torque with speed and its interpretation.
5. Trial of a Diesel Engine/Semi Diesel Engine. Determination of B.H.P., fuel consumption, I.H.P. and mechanical efficiency at various loads (speed parameters constant). Discussion on variation of thermal efficiency and specific fuel consumption with B.H.P.
6. To estimate the indicated power, friction power and mechanical efficiency of a multi cylinder petrol engine when running at constant speed under constant settings of a carburetor (Morse test).
7. To obtain a power consumption curve, thermal and mechanical efficiency curve for the four stroke diesel engine when tested over a range of power from no load to full load. Also to draw up the heat balance sheet for this range of output of power.

MEC-402: MECHANICS OF MATERIALS-II

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Note: The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

Part-A

1. Cylinders and Spheres

Thin cylindrical and spherical shells under internal pressure, Cylindrical shells with hemispherical ends, volumetric strain, Thick cylinders, Derivation of Lamé's equations, Calculation of radial and longitudinal stresses and strains in thick cylinders. Compound cylinders: Hub shrunk on solid shaft.

2. Rotational Stresses:

a. Rotating Rings. Derivation of formulae and calculations of stresses in rotating rings neglecting effects of spokes.

b. Rotating Discs- Calculation of stresses in rotating discs with central hole and without central hole. Disc of uniform strength, Temperature stress in uniform disc.

c. Rotating Cylinders- Derivation of formulae of stresses of rotating cylinders with or without central hole.

3. Columns and Struts:

Theory of columns, assumptions made in the derivation of Euler’s theory of column, Derivation of Euler’s equation for various end conditions, Rankine-Gordan’s formula, empirical formula for axially loaded column and their application.

Part-B

4. Bending of Curved Bars:

Curved beam theory and calculation of stresses in

a. Cranes and Chain Hooks
b. Rings
c. Chain links with straight sides of (i) circular (ii) Trapezoidal sections.

5. Springs:

a. Closed coiled helical springs
i. Deflection of free end and strain energy under axial load
ii. Rotation of free end and strain energy under axial couple
iii. Combination of two closed coiled springs in (i) Series (ii) Parallel

b. Leaf Springs Deflection and bending stresses.
c. Open coiled Helical Springs Deflection and rotation of free end and strain energy under (i) Axial load (ii) Axial couple.

6. Analysis of Plane Frames:  

BOOKS SUGGESTED:


MEC-403: THEORY OF MACHINES-II  

Note: The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

Part-A

1. Inertia Forces in Mechanism  
Determination of Forces and couples for a link, inertia of reciprocating parts, dynamically equivalent system. Analytical and graphical methods, inertia force analysis of basic engine mechanism (crank, connecting rod and piston etc). Torque required to overcome inertia and gravitational force of a four bar linkage.

Lower Pairs: -  
Universal Joint: - single and double, calculation of maximum torque, Oldham’s Coupling, steering mechanism including. Ackermann’s and Davis steering mechanism. Mechanisms with lower pairs, pantograph, exact and approximate straight line motion, engine indicator, elliptical trammel.

Elementary knowledge of Kinematic synthesis of linkage by graphical and analytical methods.

Gyroscope: -  
Definition, axis of spin, axis of precession gyroscope, gyroscopic couple, Gyroscope effect on the momentum of ships and vehicle, ship stabilization, stability of automobile and locomotive taking a turn.

2. Cams  
Types of cams and followers, definition – basic circle & least radius, angle of ascent, dwell, descent & action. Displacement, velocity and acceleration diagrams for the followers with uniform velocity motion, simple harmonic motion, uniform acceleration and retardation, determination of
maximum velocity, acceleration and retardation, analysis of follower motion for pre-specified cam profiles (tangent cams and convex cams).

Part-B

3. Balancing
Classification, need for balancing, balancing for simple and multiple masses, static and dynamic balancing – Primary and secondary balancing for reciprocating masses, inside and outside the cylinder locomotive balancing, swaying couple and variation of tractive effort, partial balancing of locomotive, balancing of the coupled locomotives and its advantages multicylinder in the line engines (primary and secondary balancing conditions and their applications), balancing of V-engines balancing machines (Static balancing M/c: dynamic balancing M/c, universal balancing M/c), introduction of balancing of the flexible rotors.

4. Gears
Toothed gears are their uses, types of toothed gears (spur gears, internal spur gears, spur & rack, bevel gears, helical gears, double helical gears, spiral gears, worm gears) definitions, pitch circle diameter, pitch surface, pitch point, circular pitch, diametric pitch, module pitch, addendum, dedendum, clearance addendum circle, outside diameter, internal diameter, dedendum circle, root diameter, base.
Base circle diameter, face and flank of tooth, fillet, angle of obliquity or pressure angle, path of contact, arc of contact, arc of approach, condition for correct gearing, forms of teeth, cycloid and its teeth variants epicycloids and hypocycloid, involute methods of drawing in involute and cycloidal curves, interference in involute gears and methods of its removal, comparison of involute and cycloidal gear systems.

5. Gear Trains
Types of gear trains single and compound epicyclic gear trains, Problems involving their applications, estimation of velocity ratio of worm and worm wheel, helical and spiral gears (Determination of No. of teeth, spiral angle and efficiency).

Books Suggested:-


MEC-453: THEORY OF MACHINES-II

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1. Balance experimentally the given known force by introducing two weight (forces) parallel to the given force in two different planes and verify the result by analytical method.

2. Study the dynamic balancing machine & balance of a given body i.e. rotor by different methods.
3. Study the working and construction of the two types of steering gears. Draw neat sketches of each type and measure the angle in Ackerman's steering gear fitted in different vehicles. Find the ratio of intersection of two arms from the front axle to the base of the vehicle.

4. Study the different types of mechanisms for tracing out the approximate straight line.

5. Find out the pressure distribution graph analytically & practically around a simple Journal bearing under variable load conditions on the shaft.

6. Balance as far as possible the known unbalance due to reciprocating parts by introducing two revolving weights in two different planes. Find out experimentally the fraction of the reciprocating parts which should be balanced so that the residual unbalance force may be least.

7. Find out experimentally the viscosity of the given fluid under varying conditions of temperature and pressure and draw the graphs - Viscosity Vs' temp. and Viscosity Vs pressure.

8. Study the electrical dynamometer and find out the maximum torque of the given m/c.

9. Study the whirling speed apparatus and calculate the critical speed of the given System.

10. Find out the Co-efficient of friction between two given materials with the concept of vibration that is the effect of C. & frequency on co-efficient of friction.

11. To study the model of an Epicyclical gear train and to determine the speed ratio.

12. To study the various tooth profiles and to generate the involute profile on a blank.

MEC-404: MATERIALS AND HEAT TREATMENT

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Note: The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

PART-A

1. **Structure of crystalline solids** (6)
   Fundamental concepts of unit cell space lattice, Bravais space lattices, unit cells for cubic structure & HCP, study of stacking of layers of atoms in cubic structure & HCP, calculations of radius, Coordination Number and Atomic Packing Factor for different cubic structures, Crystal directions and planes, Miller indices.

2. **Crystal Imperfections** (3)
   Point Imperfections, Line, Surface and volume imperfections- their types and significance.

3. **Engineering Materials** (7)
   Classification of materials; Types, properties and application of CI, Carbon Steels, Alloy Steel, IS code for designation of steels, Stainless Steel, High Speed Steel- properties and applications.

4. **Phase Transformations** (3)
   Types of Phase transformation; Stages of phase transformation, Homogeneous nucleation and heterogeneous nucleation, Crystal growth.
PART-B

5. **Solid solutions, Phase diagrams:** (9)
   Solid solutions, Types. **Phase diagrams:** Basic terms, phase rule, cooling curves, construction of phase diagrams, interpretation of equilibriums diagrams, Types of phase diagrams, Lever rule.

   Detailed study of Iron-Carbon equilibrium diagram and explanation of various connected terms, TTT diagram, and CCT diagram.

6. **Heat Treatment Process** (4)
   Heat treatment processes for steel – Annealing, Normalizing, Spheroidizing, Hardening, Tempering, Austempering and Martempering.

7. **Case Hardening and Surface Hardening** (4)

**Suggested Books:**

1. Introduction to Material Science for Engineering
   James F.Shackel ford. Pearson,
   Prentice Hall, New Jersy, 6th edition

2. Physical Metallurgy, Principles & Practices
   V.Raghavan, PHI, New Delhi, 2nd edition.


4. Engineering Foundation of Material Science and Engineering

5. Introduction to Physical Metallurgy

6. Elements of Machine Design
   V.B. Bhandari, Tata McGraw-Hill, New Delhi, 2nd edition

**MEC-454: MATERIALS AND HEAT TREATMENT**

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1. Study of different engineering materials and their mechanical properties.
2. To study microstructure of following materials:-
   Hypo-eutectoid steel and Hyper-eutectoid steel
   Hypo-eutectic and Hyper eutectic steel
   Grey and White Cast iron
3. Study of microstructure and hardness of steel at different rate of cooling.
6. Hardness testing of metals on Vickers scale
7. Interpretation of microstructures.
8. Evaluation of mechanical properties of metallic materials by conducting following tests: Hardness test(Vicker, Brinell and Rockwell Test)
   Charpy Impact test
   Tension Tests
Fatigue test
9. Study of testing machines.
10. Means of determining crystal structures (X-ray and Electron Diffraction method)
11. Specimen preparation and microstructure studies using Metallurgical and Scanning electron microscope.

MEC-405: MANUFACTURING TECHNOLOGY-I

Note: The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

PART-A

1. Mechanics of metal cutting:
Methods of machining, Types of chips, Tool signature, Shear angle determination, Forces in metal cutting, Merchant diagram, Tool wear, Tool life, Economics of metal cutting, machinability.

2. Analysis of Metal forming Processes:
Analytical theory of metal forming, Classification of forming processes, effect of variables, Methods of analysis, open die forging, Plain strain and axi-symmetric forging, rolling load estimation, Drawing stress in Wire/rod drawing, Calculation of extrusion pressure.

Principles of jig and fixture design, Principles of Degrees of Freedom, Method of location and clamping, Various devices for location and clamping, Indexing devices, Hydraulic and pneumatic actuation of clamping devices, Jig bushes, Use of standard parts for jig design, types of drilling jigs, Milling fixtures, Lathe fixtures, Grinding fixtures and their classification.

4. Die Design:
Components of die design, design of die blocks, punches and strippers, methods of holding punches, sketches of stock stops. Design procedure for progressive dies, compound dies and combination dies for press tool operation, Forging die design for drop and machine forging parts.

PART-B

(5): Tool Layout for Turrets.

6. Tool Layout for Automatics.
Classification of Automatics: Turret type automatic, tool layout procedure, time required for each operation, operation sheet, tool layout cam layout.

7. Tooling Costs:
Estimating costs of a product, Estimating costs of tools, Economics of tooling, Break even point analysis, Minimum cost analysis.

8. Gauges:
Limits and fits, Plain Gauges, Types of gauges, Fundamental of gauge design, Gauge makers tolerance, allowance for wear, practical application of Taylor’s principles of limit gauging, care of gauge, limitation of limit gauging.

9. Surface Finish
Elements of surface finish. Factors affecting surface finish, Effect of surface quality on functional properties of machine parts, evaluation of surface finish, Indian standards on surface finish, Measurement of surface finish, Relationship of surface finish to the production methods. Finishing operation like honing, lapping, buffing, super finishing etc.

BOOK SUGGESTED:

MEC-406: FLUID MECHANICS

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Note: - Eight questions to be set in all. Candidates are required to attempt five questions selecting at least two questions from each part. S. I. units to be strictly followed. Part A questions to be set from topics 1 and 2 while part B questions are to be set from topics 3 and 4.

Part-A

1. **Incompressible Frictionless Flow**: 

   Potential flow: Uniform flow, plane source and sink flows, potential vortex flow, flow past half body, doublet, flow around circular cylinder, flow past rankine oval body and flow past a cylinder with circulation.

2. **Incompressible Flow with Friction**: 

   Concepts of boundary layer, boundary layer parameters (thickness, displacement thickness, momentum thickness, energy thickness and shape factor), equilibrium equation, derivation of Navier Strokes equations of motion for incompressible viscous (constant viscosity), laminar flow in rectangular coordinates and their applications, Prandtl’s boundary layer equations. Details of Blassius solution of Prandl’s boundary layer equations for flat plate (no derivations) and its applications for finding drag co-efficient, local skin friction coefficient, velocity distribution and drag force for flat plate.

   Von-Karman–Momentum–integrals equation and its applications to laminar boundary layer with cubic profile. Application of Van-Karman Momentum integral equation to turbulent flow, boundary layer for smooth flat plate (Drag coefficients and drag forces), Boundary layer separation and prevention.

Part-B

3. **Compressible- Isentropic Flow in Ducts (with negligible elevation changes)**

   Propagation of small weak disturbance (velocity of sound), Mach number and Mach cone, Continuity, momentum and energy equation for steady flow (one dimensional case only), Pipe flow problems, variation of stagnation parameters with mach numbers, compressibility correction
factor, flow through nozzles & diffusers, changes of density, velocity, temperature, pressure & area with Mach number in a variable area flow duct, critical throat area related to Mach number, effect on convergent divergent nozzle parameters along the length of the nozzle with a variation of back pressure (discussion only).

4. Flow around immersed a Bodies, (Drag and Lift):-


Books Suggested:

6. Introduction to Fluid Mechanics : Fox, Wiley India Pvt Ltd, 2nd edition

SYLLABUS FOR
BACHELOR OF ENGINEERING (MECHANICAL)
FIFTH SEMESTER

MEC-501: DESIGN OF MACHINE ELEMENTS-I

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Note: The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part. Design data book is allowed in the examination hall.

PART-A

1 Introduction:
Scope and meaning of design with special reference to machine design, design process, codes and standards, economic aspects of design, safety aspects of design, introduction to computer–aided design and engineering.

2 General Design Considerations:
Mechanical behavior of materials, statistical nature of material properties, selection of materials. Concept of tearing, bearing, shearing, crushing, bending etc., stress and strength, stress concentration under static and dynamic loading, notch sensitivity, methods of avoiding stress concentration, fatigue loading, mechanism of fatigue failure, S-N diagram, endurance limit, endurance strength, design stresses for fatigue loading.
Fits, tolerances and surface finish

3 Fasteners:
Screws and bolts:
Design of screws, preloaded bolts, bolts subjected to shear, tension and torque, Design of eccentrically loaded bolted joints
Riveted Joints:
Types of failures of riveted joints, strength and efficiency of a riveted joint, design of butt and lap joints of a boiler, design of Lozenge joint, design of eccentrically loaded riveted joints
Welded Joints:
Types of failures of welded joints, strength of a welded joint, design of eccentrically loaded riveted joints
Design of cotter joint, design of knuckle joint

Riveted Joints:
Types of failures of riveted joints, strength and efficiency of a riveted joint, design of butt and lap joints of a boiler, design of Lozenge joint, design of eccentrically loaded riveted joints

4 Shafts, Keys and Couplings:
Design of shafts subjected to torsional loading, bending loading, and axial loading and combined loading, design of shafts based on rigidity concept.

Types of keys, effect of keyway on strength of shaft, design of keys under different loading conditions.

Types of couplings, design of sleeve coupling, clamp coupling, slip coupling, Oldham coupling and pin type flexible coupling.

PART-B

5 Levers:
First, second and third types of levers, Design of hand lever, foot lever, bell crank lever.

6 Pipes and Pipe Joints:
Design of pipes, design of circular, oval and square flanged pipe joints.

7 I.C. Engine Parts:
Design of Piston, cylinder and connecting rod.

8 Power Screws:
Various types of threads used in power screw drives, conditions for self-locking and overhauling, efficiency of power screw drives, stresses developed in screws, design procedure for power screw drives like screw jack etc.

Books Suggested:

MEC-502: COMPUTER AIDED DESIGN AND MANUFACTURING

**PART-A**

1. **Introduction** (2)
   The Design Process, Application of computers for design, definition of CAD, CAM and CIM, benefits of CAD, CAM, Automation and types of automation.

2. **Geometric Modeling** (3)
   Introduction & need of geometric modeling, types: wire frame, surface and solid model, coordinate systems, Geometric Modeling techniques. Use of geometric modeling.

3. **Transformations** (7)
   2D and 3D Transformations, coordinate system used in transformations, Homogeneous transformation, translation, rotation, scaling, reflection and shear transformation, concatenated transformations, 3D visualization.

4. **Curves** (8)
   curve entities, curve representation, analytic curves – lines, circles, ellipses, parabolas, hyperbolas, conics, synthetic curves, hermite cubic spline, bezier curve and B-spline curve.

**PART-B**

5. **Surfaces** (6)
   Surface entities, representation and analysis, analytic surface, surface of revolution.

6. **Solids** (4)
   Solid models and representation scheme, boundary representation, constructive solid geometry, sweep representation.

7. **NC words** (4)
   Introduction, CNC, DNC and Adaptive Control, Classification of CNC machines, Coordinate Systems, Components of CNC machine, turning and machining center.

8. **NC part programming** (6)
   Introduction and basic terms of part programming, description of codes, G code, M code, programming for 2D and 3D jobs. Canned cycles, Loops and Subroutines programming, computer aided part programming.
Books Suggested:
3. Principles of Computer Aided design and Manufacturing by Farid Amirouche - Pearson publication

MEC-552: COMPUTER AIDED DESIGN AND MANUFACTURING

1. CAD Modeling
   1. Simple machine parts and components construction using Inventor/ pro E/ other 3D modeling package
   2. Mechanical assembly of the parts.
2. Write code to generate a circle, an ellipse, a tabulated cylinder, surface of revolution.
3. Implement simple programmes for the graphics representation of
   a) Transformation,
   b) Projections,
   c) Cubic & splines curves
   d) Surfaces.
4. To generate computer aided part program and find out CL file as well as post processor file in terms of G & M code for different components.

MEC-503: ROBOTICS

Note: The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

Part-A

1. Fundamentals of Robot
   Robot degrees of freedom, robot parts: base, end effectors, drives, joints, classification, characteristics and applications of Robots.
2. Spatial Descriptions and Transformations
   Robot kinematics, Inverse of transformation matrices, Conventions for affixing frames to Links.
3. Inverse Manipulator Kinematics
   Solvability, Algebraic versus Geometric solutions, reduction to polynomial solution, Pieper’s solution, Examples of inverse manipulator kinematics.
4. Jacobians: Velocities and Static forces
   Differential relationships, Jacobians, Differential motions of a robot and its hand frame.

Part-B

5. Manipulator Dynamics
Dynamic equations for multiple degree of freedom robots, Langrangian mechanics, effective moment of inertia.

6. **Trajectory Planning**
   Joint space vs. Cartesian-space descriptions, Joint space trajectories, Cartesian space trajectories.

7. **Sensors & Manipulator Mechanism Design**
   Robot sensors: proximity, range, force, tactile, visual, auditory sensors. Kinematic configuration, actuation schemes, stiffness and deflections, position sensing, force sensing.

8. **Robot Programming**
   Methods of robot programming, Types of Programming, Robot programming Languages.

**Books Suggested:**

**MEC-553: ROBOTICS**

1. Study of different types of robots based on configuration and application.
2. Study of different type of robotics links and joints.
3. Study of components of robots with drive system and end effectors.
4. Determination of maximum and minimum position of links.
5. Verification of transformation (Position and orientation) with respect to gripper and world coordinate system.
7. Robot programming exercises on Pick and place, Painting, welding, polishing, gluing, stacking and drilling.

**MEC-504: MECHANICAL MEASUREMENT AND METROLOGY**

**Note:** The examiner shall set 8 questions four from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

**Part-A**

1. **General Concept :**
   Need and classification of measurements and instruments: basic and auxiliary functional elements of a measurement system; Mechanical vs. electrical/electronics instruments, primary, secondary and working standards.

2. **Static and Dynamic Characteristics of Instruments :**
Range and span, accuracy and precision, calibration, hysteresis and dead zone, sensitivity and linearity, threshold and resolution: speed of response, lag, fidelity and dynamic error, dead time and dead zone.
Zero, first and second order systems and their response to step, ramp and sinusoidal input signals

3. **Error in measurements**
   
   Sources of errors, systematic and random errors. Statistical analysis of test data.

4. **Functional elements**

   Review of electro-mechanical sensors and transducers – variable resistance, inductance and capacitive pickups, photo cells and piezo-electric transducers, and application of these elements for measurement of position/displacement, speed/velocity/acceleration, force and liquid level etc. Resistance strain gauges, gauge factor, bonded and unbonded gauges, surface preparation and bonding techniques, signal conditioning and bridge circuits, temperature compensation, application of strain gauges for direct, bending and torsional loads.

**Part-B**

5. **Pressure and Flow Measurement**

   Bourdon tube, diaphragm and bellows, vacuum measurement-Mecleod gauge, thermal conductivity gauge and ionization gauge; Dead weight pressure gauge tester.


6. **Temperature Measurement**

   Thermal expansion methods- bimetallic thermometers, liquid-in-glass thermometer and filled-in-system thermometers; thermo-electric sensors-common thermo couples, reference junction considerations, special materials and configurations: metal resistance thermometers and thermistors; optical and total radiation pyrometers; calibration standards.

7. **Speed, Forces, Torque and Shaft Power Measurement**

   Mechanical tachometers, vibration tachometer and stroboscope; proving ring, hydraulic and pneumatic load cells, torque on rotating shafts, Different types of Dynamometers: electrical and mechanical.

8. **Measurement Systems Applied to Micro & Nanotechnology**

   Micro scale sensors, Micro-Motion-Positioning Systems, Particle Instruments and Clean – Room Technology, Magnetic Levitation Systems for Wafer Conveyors, Scanning- Probe Microscope Bibliography

**BOOKS SUGGESTED:**
1. Measurement of the area of an object by using a planimeter.
2. Calibration of Pressure-gauge with the help of a dead weight gauge tester.
4. Measurement of speed by photoelectric pick up, electromagnetic pick up, proximity type sensors.
5. Measurement of light intensity by LDR, photo voltaic cell, photo diode.
6. Measurement of linear displacement by linear motion potentiometer, servo potentiometer, LVDT, inductive pick up, capacitive pick up.

**MEC-505: MANUFACTURING TECHNOLOGY-II**

**Note:** The examiner shall set 8 questions four from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

**PART-A**

1. **Foundry:** (a) Definition, patterns, difference between pattern and casting, type of patterns, pattern allowances, colour scheme on patterns, moulding material, types of moulds, moulding techniques, cores, core boxes, directional solidification of casting, gates, gating system and design, riser.
   (b) die-casting and shell moulding, investment casting, continuous casting, cleaning, finishing, inspection of casting, classification of defects, salvage of defective casting. Construction & working of cupola furnace, electric furnaces, induction furnace.

2. **Metal Forming:** (a) Definition and classification of metal forming, type of rolling, hot rolling, rolling mills, forging, smith forging, drop forging, machining forging and press forging, defects in forging.
   (b) pipe and tube manufacture, extrusion, hot spinning, drawing and cupping, piercing, cold rolling, wire drawing, rod and tube drawing, metal spinning, coining, embossing and shot peening, sheet metal working operations, piercing, blanking, bending and drawing, punch and die setup, presses.

**PART-B**

3. **Powder Metallurgy:** Definition and classification, of metal powder, advantages and limitation, metal powder product, method of producing powders, briquetting and sintering, hot iso-static Processing, sizing and finishing operation.
4. **Welding**: (a) Definition and classification, types of welded joints, weldability, Gas welding: oxy-acetylene welding, equipment, lighting up, type of flames, welding techniques, welding of cast iron, flame cutting, advantages and limitations Electric arc welding: principle, metal transfer in arc welding, straight & reverse polarity in AC & DC, relative merits & demerits, various electric arc welding processes, coding & selection of welding electrodes. 5
(b) TIG, MIG welding processes, electric resistance welding, spot, butt, seam, upset, projection & high frequency resistance welding, thermit welding, brazing and soldering, description of special welding techniques, choice of process for welding, defects in welding joint, their causes and remedies. 7

**Books Suggested:**


**MEC-555: MANUFACTURING TECHNOLOGY -II**

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Laboratory Work: Experimental work pertaining to study & use of sand testing equipment, Relevant shop floor exercises involving practice in pattern making, sand casting, machining (exercises on lathe, milling machine, shaper etc.), welding (Performance on any two techniques MIG/TIG /Gas/Resistance welding), Application of sheet metal fabrication techniques, fitting work.

**MEC-506: FLUID MACHINERY**

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Note: - Eight questions to be set in all with four questions in each of the part A and B. Candidates are required to attempt a total of five question selecting at least two questions from each part. S.I. System of Units to followed.

**Part-A**

1. **Principles of Hydraulic Machines & General Study of Hydro Power Plants**:
   Force of Jet on stationery, moving flat and curved plates, flow over radial, vanes, velocity triangles, Determination of power. Different types of runners, classification of Hydraulic Power and turbines (General description) 5

2. **Impulse Turbine**:
   Description of Pelton impulse turbine, design of Pelton turbines such as number of jets, number of buckets, depth and width of buckets, velocity diagrams, jet ratio, power and efficiency. 5

3. **Reaction Turbines**:
   Description of Francis, Kaplan Turbines, velocity diagrams, speed ratio, flow ratio, degree of reaction as applied to Kaplan and Francis turbines, cavitation. Governing of
Turbines: Description of oil pressure governor, double regulation of impulse and reaction turbines. Draft Tube: Description, function and simple problems.

Part-B

4. **Centrifugal Pumps**:

5. **Dimensional Analysis and Performance of Hydro Machines**:
   Derivation of equations for Reynold, Froude Euler, Mach, and Weber numbers from ratio of forces. Buckingham Theorem and its practical applications to turbines and pumps. Derivation of various dimensionless, specific and unit quantities for turbines and pumps by application of Buckingham theorem. Characteristics curves of turbine and pumps.

6. **Reciprocating Pumps**
   Slip and coefficient of discharge, Effect of acceleration on pressure in suction and delivery pipes, Air vessels (work saved by air vessel on suction and delivery pipe) Comparison with centrifugal pumps.

7. **Hydraulic Devices and Control (Description only)**:
   Basis of control system, Brief classification of control devices, symbolic representation of control system components, Example of control devices (valves) such as accumulator, Intensifier, relief valve, reversing valve and time delay valves, gear pumps and hydraulic ram controls. Brief description of hydraulic fluids used in control system.

Books Suggested:


**MEC-556: FLUID MACHINERY**

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1. Determination of various efficiencies of Hydraulic Ram.
2. To draw characteristics of Francis turbine.
3. To study the constructional features of reciprocating pump and to perform test on it for determination of pump performance.
4. To draw the characteristics of Pelton Turbine.
5. To draw the various characteristics of Centrifugal pump.
6. Determine the effect of vane shape and vane angle on the performance of centrifugal fan
MEC-557: VOCATIONAL TRAINING after 4\textsuperscript{th} Semester

Each student shall attend 4 weeks training after 4\textsuperscript{th} semester in Mechanical Industry, National/International level technical institute/research organization.

SYLLABUS FOR BACHELOR OF ENGINEERING (MECHANICAL) (SIXTH SEMESTER)

MEC-601: DESIGN OF MACHINE ELEMENTS–II

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| 1 | **Introduction:**  
Types of mechanical drives and their applications, factors influencing the choice of a mechanical drive. | (4) |
| 2 | **Belt and Rope Drives:**  
Types of belt drives, design of flat belt drive, design of V-belt drive including selection of V-belt, design of wire rope drive including selection of rope, design of pulleys for a flat belt drive. | (5) |
| 3 | **Chain Drives:**  
Design of chain drive including selection of chain. | (3) |
| 4 | **Gear Drives:**  
Design details of spur, helical and bevel gear drives, design of worm and worm wheel drive. | (6) |

PART-B

| 5 | **Bearings:**  
Classification of bearings, types of sliding contact bearings, properties requirements of sliding contact bearing materials, hydrodynamic lubricated bearings, terms used in hydrodynamic journal bearings, bearing characteristic number, bearing modulus, coefficient of friction, Sommerfield number and critical pressure for journal bearings, heat generated in a journal bearing, design of journal bearings, bearing caps and bolts, design of foot-step bearings. Types of rolling contact bearings, materials of ball and roller bearings, basic static load rating, static equivalent load, life of a bearing, basic dynamic load rating, dynamic equivalent load, dynamic load rating under variable loads, selection of radial ball bearings, lubrication of ball and roller bearings. Comparison of sliding contact bearings and rolling contact bearings. | (6) |
| 6 | **Flywheels:** | (4) |
### Books Suggested:

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<tbody>
<tr>
<td>8</td>
<td>Elements of Machine</td>
<td>V.B.Bhandari, Tata McGraw Hill, New Delhi, 2005</td>
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### MEC-651: DESIGN OF MACHINE ELEMENTS-II

**Note:** Design assignments so as to cover the principles outlined in MEC-601 such as:

1. Design of flat belt drive.
2. Design of V-belt drive.
3. Design of rope drive.
4. Design of pulleys.
5. Design of chain drive.
6. Design of spur gear drive.
7. Design of helical gear drive.
8. Design of bevel gear drive.
10. Design of journal bearings.
11. Exercise on selection of rolling bearings.
12. Design of flywheels.
15. Design of helical springs.
16. Design of leaf springs

MEC-602: MECHATRONICS AND INDUSTRIAL AUTOMATION

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Note: The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

PART-A

1. **Mechanical Actuation Systems:** Introduction to mechatronics, Measurement system, Control systems (open & closed), elements of closed loop system, Mechanical systems, types of motion, kinematic chains, cams, gear trains, ratchet and pawl, belt and chain drives, and bearings.  
   (3)

2. **Pneumatic and Hydraulic Systems:** Introduction to pneumatic and hydraulic actuation systems, directional control valves, pressure control valves, cylinders, process control valves, rotary actuators.  
   (5)

3. **Types of controllers:** Proportional, integral, derivative, PID, Hydraulic and Pneumatic controllers.  
   (3)

4. **Programmable Logic Controllers:** Basic structure of PLC, introduction to ladder programming, basic programs, industrial applications of PLC, Data acquisition system.  
   (4)

PART-B

5. **Microprocessors:** Introduction to micro-computer structure, 8085 pin diagram, architecture, Instruction set and basic program, I/O interfacing, Memory interfacing, A to D and D to A conversion fundamentals.  
   (8)

6. **Input/output systems:** Interfacing, Input/output ports, interface requirements, peripheral interface adapters, serial communication interface and examples of interfacing.  
   (5)

7. **Applications:** Applications of mechatronics to observe and control various mechanical systems: thermal systems, motion systems, pneumatic systems, Hydraulic systems. Case study of PLC based / Microprocessor based timed switch, windscreen wiper motion, bathroom scale, Pick and Place Robot, Car engine management.  
   (6)

BOOKS

1. Mechatronics by W Bolton, Pearson Education

REFERENCES:

1. Mechatronics by Dan Necsulescu, Pearson Education (Singapore) Pvt. Ltd
4. Introduction to Mechatronics & Measurement Systems by Alciatore et. al TMH
MEC-52: MECHATRONICS AND INDUSTRIAL AUTOMATION

1. To acquire signal from a sensor through A/D card on to a computer
2. To send data signal from computer to some actuator through D/A card
3. To carry out the position control of a geared DC motor using servo mechanism
4. To carry out the microprocessor based direction and speed control of a stepper motor and to observe the effect of external load
5. To study the DC speed control system built around a permanent magnet DC motor, an optical pick-up and a slotted disk to measure the speed of the motor for feedback control. To find the characteristics of the system when subjected to variable loading
6. To perform the PID control of an oven
7. To assemble a pneumatic sorting system by means of a single acting cylinder to sort a set of articles.
8. Use a pneumatic double acting cylinder to open and close the lid on a container.

MEC-603: MECHANICAL VIBRATIONS

Note: The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

Part-A

1. Fundamentals of Vibration
   Free vibration, Forced vibration, Simple harmonic motion, Combination of two simple harmonic motions, Fourier analysis, Fourier integral.

2. Single degree of freedom system-free vibration
   Natural frequency, Equivalent systems, Energy method (average energy principle, principle of conservation of energy, principle of virtual work, maximum energy principle), Response to an initial disturbance, Phase plane method, Duhamel’s integral.

3. Single degree of freedom system-damped vibrations
   Damping models (viscous damping, structural damping, and coulomb damping), Over-damped case, critically damped case, under-damped system, Logarithmic decrement.

4. Single degree of freedom system-forced vibrations
   Harmonic excitation, Mechanical impedance (analysis of system with structural damping, analysis of system with elastically coupled viscous damper), System identification from frequency response, Support motion (solution for absolute/relative motion of the system, seismometer, accelerometer), Bending critical speeds of simple shafts, Vibration isolation (viscous damper and elastically coupled viscous damper).

Part-B
5. **Two degrees of freedom systems**
   Free vibration of spring coupled systems, Two degrees of freedom mass coupled systems, Bending vibrations of two degrees of freedom systems, Forced vibration of an undamped two degrees of freedom system, Undamped vibration absorbers, Vibration isolation.

6. **Multi degree of freedom methods**
   Close coupled systems (eigen value problem upto four degree of freedom system using Graeffe’s method), Far coupled systems, Orthogonality of mode shapes, Modal analysis (Undamped analysis, damped systems), Forced vibration (modal analysis, forced vibration by matrix inversion).

7. **Numerical methods**
   Dunkerley’s lower bound approximation, Rayleigh’s upper bound approximation, Holzer method (fixed-free systems, free-free systems, branched systems), Method of matrix iteration.

8. **Continuous systems**
   Systems governed by wave equation (stretched string, axial vibrations of a bar, torsional vibration of a circular rod), Free vibration of beams.

**Books suggested:**

**MEC-653: MECHANICAL VIBRATIONS**

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1. To determine the mass moment of inertia of a body by Trifilar suspension.
2. To determine damping ratio of a vibrating body by rap test.
3. To determine damping ratio of a damper by forced vibration.
4. Investigate node and antinode position for a cantilever.
5. Find first three natural frequencies of a body from it’s time response. (using FFT algorithm of Matlab)
6. Experimentally find out different harmonic frequencies present in vibrations of an IC engine.
7. Use instrumented impact hammer to find transfer function between two given points of a structure.

**MEC-604: HEAT TRANSFER**

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Note: The Examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part. Numerical terminology must be in S.I. units only.

**PART–A**

1. **Basic Concepts**
Difference between the subject of Heat Transfer and its parent subject ‘THERMODYNAMICS’
Different methods of heat transfer – Conduction, Convection, and Radiation.

2. **Conduction**
Fourier’s law of heat conduction, coefficient of thermal conductivity, effect of temperature and pressure on thermal conductivity of solids, liquids and gases and its measurement. Definition and explanation of the term Thermal Diffusivity.

Three-dimensional most general conduction equation in rectangular, cylindrical and spherical co-ordinates involving internal heat generation and under unsteady state conditions. Derivation of equations for simple one dimensional steady state heat conduction without heat generation from three-dimensional equations through walls, cylinders and spherical shells (simple and composite). Electrical analogy of the heat transfer phenomena in the cases discussed above. Equivalent areas, shape factors. Critical thickness of insulating layers on electric wire and pipes carrying hot fluids. Influence of variable thermal conductivity on conduction through simple cases of wall, cylinder and sphere.

System with Heat Sources: Internal generation cases along with some practical cases of heat conduction, heat conduction through piston crown and case of nuclear fuel rod with cladding. Introduction to unsteady heat transfer.

3. **Extended Surfaces**
Straight rod type of fins of uniform cross-section: (e.g. of circular and rectangular cross-section). Circumferential fins of rectangular cross-section provided on the circumference of a cylinder.

Fins effectiveness and fins efficiency for straight rod fins of rectangular and circular cross-section. Application of fins in temperature measurement of flow through pipes and determination of error in its measurement.

4. **Convection**
Introduction, Processes, Newton’s law of cooling, theory of dimensional analysis as applied to free and forced convective heat transfer. Analytical formulae of heat transfer in laminar and turbulent flow, flow over vertical and horizontal tubes and plates. Hydrodynamic and Thermal boundary layers over a flat plate, Blasius solution for hydrodynamic and Thermal boundary layer (No. Derivation)

5. **Heat Exchanger**
Classification of heat exchangers, Overall coefficient of heat transfer, effect of scale formation, Log mean temperature difference for parallel and counter flow heat exchangers, Heat Exchanger effectiveness, Calculation of number and length of tubes in a heat exchange by effectiveness- NTU method.

6. **Heat Transfer with change of phase**
Boiling, Boiling Regimes, Bubble Growth and Nucleate Boiling, forced convection boiling, Theory accounting for the increased values of h.t.c. during nucleate phase of boiling of liquids; different phase of flow boiling (theory only).
Condensation and its classification, laminar filmwise condensation on a flat vertical plate and its mathematical analysis, drop-wise condensation.

7. Radiation

Derivation formula for radiation exchange between two bodies using the definition of radiosity and irradiation and its application to cases of radiation exchange between three bodies, simplification of the formula for its application to simple bodies like two parallel surfaces.

Books Suggested:

MEC-654: HEAT TRANSFER

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1. To study and compare temperature distribution, heat transfer rate, overall heat transfer in parallel flow and counter flow heat exchanger.
2. To study the parallel flow and counter flow heat exchanger.
3. To find the thermal conductivity of metal rod
4. To determine heat transfer coefficient in natural convection.
5. To determine heat transfer coefficient in forced convection for air flowing in a tube.
6. To determine heat transfer coefficient in drop wise and film wise condensation.
7. To determine the emissivity of a given plate at different temperatures.
8. Evaluate the performance of a heat pipe.
9. To determine Overall Heat Transfer coefficient in Shell and Tube heat exchanger.
10. To determine the Stefan Boltzmann’s constant in radiation heat transfer process

MEC-605: NON CONVENTIONAL MACHINING

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Note: The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

PART-A
1. **Introduction**: Overview of mechanical removal processes, Need for non-traditional machining methods, Classification of various modern machining processes. Considerations in process selection, process capabilities, Materials. Applications. Comparison between conventional and non-conventional machining process. (8 Hrs)

2. **Ultrasonic machining**: Working principles, mechanics of metal removal process parameters, applications and limitations, recent development, Hybrid Machining. (4 Hrs)

3. **Abrasives water-jet processes**: Working principles, mechanism of material removal study and selection of process parameters, machining characteristics, applications & limitations of the following processes, Abrasive jet Machining (AJM), Water jet machining (WJM), Abrasive Flow Machining Process (AFM), Abrasive water jet Machining (AWJM) (8 Hours)

**PART-B**

4. **Electro chemical processes**: Principle of operation, mechanism of material removal, study of equipment and selection of process parameters, process capabilities, tool design applications & limitations of the following processes, chemical machining (CM), Electro chemical machining (ECM). Electrochemical Honing, Electrochemical de-burring, Electro stream and shaped Tube Electrolytic Machining (10 Hrs)

5. **Thermal metal removal processes**: Thermal energy methods of material processing by Electric Discharge machining (EDM), Electron Beam machining (EBM), Ion-beam machining (IBM), and Laser Beam machining (LBM), Introduction to new concept of High Speed Machining, Ultra-Precision Machining and hard turning (10 Hrs)

6. **Plasma Arc Machining (PAM)**: Introduction, equipments, non-thermal generation of plasma, selection of gas, Mechanism of Metal removal, Process characteristics and parameters. Applications and limitations, Introduction to latest unconventional machining methods. (4 Hrs)

**Recommended Books:**

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<tr>
<th>Title</th>
<th>Author(s)</th>
<th>Publisher</th>
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<tbody>
<tr>
<td>Non conventional Machining</td>
<td>P.K. Mishra</td>
<td>Narsoa</td>
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<tr>
<td>Modern machining methods</td>
<td>Pandey &amp; Shan</td>
<td>TMH</td>
</tr>
<tr>
<td>Advanced Machining Processes</td>
<td>V. K. Jain</td>
<td>New Age</td>
</tr>
<tr>
<td>Principles of Electrochemical Machining</td>
<td>Mc Geough</td>
<td>Chapman</td>
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<tr>
<td>Plasma, Electron and Laser beam Technology</td>
<td>Arata. A</td>
<td>ASM</td>
</tr>
<tr>
<td>Laser Machining-Theory &amp; Practice</td>
<td>George Chryssolouris</td>
<td>Springer</td>
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**SYLLABUS FOR**

**BACHELOR OF ENGINEERING (MECHANICAL)**

**SEVENTH SEMESTER**

**MEC-701: REFRIGERATION & AIR CONDITIONING**

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*Note: The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

**PART - A**

1. Basic Concept
Natural and Mechanical refrigeration; Application of Refrigeration; Units of refrigeration and Coefficient of performance; Refrigeration effect, cooling capacity and COP of a refrigerator; heating effect, heating capacity and COP as heat pump; Reversed Carnot cycle and its limitations

2. Bell Coleman Cycle and Aircraft Refrigeration
Bell Coleman Cycle and its analysis; optimum COP and pressure ratio, necessity of air craft refrigeration - air cycle refrigeration systems and their comparison

3. Vapour Compression Refrigeration Cycle and Refrigeration
Vapour compression cycle on P-V, P-H and T-S diagrams; Deviation of actual cycle from theoretical cycle; Compressor capacity and volumetric efficiency, Analysis of theoretical and actual vapour compression cycles; Effect of suction pressure, discharge pressure, sub-cooling, super heating and pressure drop in valves on performance and cooling capacity. Compound compression with single and multiple expansion valves, water inter-cooling and flash inter-cooling; multiple load systems with single and multiple expansion valves

4. Vapour Absorption Refrigeration Cycle (No Mathematical Analysis)
Principle of absorption system; components of the system; Desirable properties of absorption system refrigerant and absorbent; Aqua - ammonia absorption refrigeration system; Lithium Bromide - water absorption system; Theory of mixtures; temperature concentration and enthalpy concentration diagrams; comparison between absorption and compression systems; Electrolux refrigeration system.

PART-B

5. Refrigerants
Classification and nomenclature of refrigerants; Desirable thermodynamic, chemical and physical properties of refrigerants; comparative study of commonly used refrigerants and their fields of application; Azeotropes; Effect of moisture and oil miscibility; Refrigerants dying agents and antifreeze solution; leak detection and charging of refrigerants; environmental aspects of conventional refrigerants; Eco-friendly refrigerants and action plan to reduce ecological hazards.

6. Air Conditioning Concept, Psychometric Processes and Applications;
Psychometric properties of air; Dry bulb, wet bulb and dew point temperatures; Relative and specific humidity; degree of saturation adiabatic saturation temperature, enthalpy of air and water vapours; psychometric chart. Human requirement of comforts; effective temperature and comfort charts; Industrial and comfort air conditioning. Sensible heating and cooling, cooling with dehumidification; Heating with dehumidification; by-pass factor; chemical dehumidification; adiabatic mixing, air washer.

7. Calculations for Air –Conditioning Load:
Sources of heat load; sensible and latent heat load; sensible heat factor; apparatus dew point temperature; Rate and state of supply - air for air- conditioning of different types of premises.

8. Refrigeration and Air Conditioning Equipment
Brief description of compressors, condensers, evaporators and expansion devices; Cooling towers; Ducts; dampers; grills; air filters; fans; room air conditioners; split units; Package and central air conditioning plants.

SUGGESTED BOOKS:
1. Refrigeration and Conditioning by CP Arora, Tata McGraw Hill
MEC-751: REFRIGERATION AND AIR CONDITIONING

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1. Study of various elements of a mechanical refrigerator system through cut sections models / actual apparatus
2. Study and performance of domestic refrigerator,
3. Study the performance of and Electrolux refrigerator
4. Study of an Ice plant and visit to a cold storage for study
5. Calculation/ Estimation of cooling load for large building
6. Visit to a central Air conditioning plant for study of processes for winter and summer air conditioning
7. Study and performance of window type room air conditioner
8. Study and performance of Cooling Tower.
9. Study and performance of Air conditioning Trainer (Direct and Indirect type)
10. Study and performance of Air Washer Test bench.

MEC-702: AUTOMATIC CONTROLS

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Note: The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

Part-A

1. Introduction
   Introduction, Types of control systems, Open or closed loop systems, Analog or Digital control systems, Regulators and servomechanism, Sequence control, typical block diagram, Performance analysis.

2. Representation of processes and control elements
   Mathematical modeling, Block diagram representation, Representation of systems or processes, Liquid, gas and thermal systems, Mechanical rotating systems, Geared systems, Hydraulic servomotor, Electric motors, Control valve, Comparison elements, Potentiometer-type comparator, Synchro-control transformer type error detector.

3. Representation of feedback control systems
   Block diagram and transfer function representation, Signal flow graphs, Mason’s formula.

4. Types of controllers
   Types of control action, Proportional, Integral, Derivative, On-off, Hydraulic controllers, Pneumatic controllers, Electronic controllers.
Part-B

5. Transient and steady state response
   Time domain representation, Laplace transform representation, Systems with
   proportional control, Transient response due to reference input, Steady state response,
   Response to load input, Proportional cum derivative control, Reference input, Load
   input, Proportional cum integral control, Reference input, Load input.

6. Stability of control systems
   Characteristic equation, Routh’s equation, Nyquist criterion.

7. State space analysis of control systems
   Generalised state equations, Techniques for deriving system state equations, Transfer
   function from state equations

8. Introduction to virtual instrumentation
   Graphical programming, Concept of sub-VI, Data acquisition and control using
   Labview software, Simulation of proportional, derivative, integral control actions

MEC-752: AUTOMATIC CONTROLS

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1. Perform two mode (P + I) controls on a temperature/flow control trainer.
2. Perform two mode (P + D) controls on a temperature/flow control trainer.
3. Perform three mode (P + I + D) controls on a temperature/flow control trainer.
4. Tune the temperature/flow control trainer using Zeigler-Nichols method.
5. Simulate first order system and second order systems on Labview software.
6. Acquire data from an analog sensor using PC and Labview software.
7. Control vibrations of a cantilevered beam using negative velocity feedback.

MEC-703: ROBOTICS

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Note: The examiner shall set 8 questions i.e. 4 from each part and students shall be required to
attempt a total of 5 questions with at least 2 questions from each part.

Part-A

1. Fundamentals of Robot
   Robot degrees of freedom, robot parts: base, end effectors, drives, joints,
   classification, characteristics and applications of Robots.

2. Spatial Descriptions and Transformations
   Robot kinematics, Inverse of transformation matrices, Conventions for affixing
   frames to Links.

3. Inverse Manipulator Kinematics
   Solvability, Algebraic versus Geometric solutions, reduction to polynomial solution,
   Pieper’s solution, Examples of inverse manipulator kinematics.

4. Jacobians: Velocities and Static forces
   Differential relationships, Jacobians, Differential motions of a robot and its hand frame.

Part-B
5 Manipulator Dynamics (6)
Dynamic equations for multiple degree of freedom robots, Lagrangian mechanics, effective moment of inertia.

6 Trajectory Planning (6)
Joint space vs. Cartesian-space descriptions, Joint space trajectories, Cartesian space trajectories.

7 Sensors & Manipulator Mechanism Design (6)
Robot sensors: proximity, range, force, tactile, visual, auditory sensors. Kinematic configuration, actuation schemes, stiffness and deflections, position sensing, force sensing.

8. Robot Programming (4)
Methods of robot programming, Types of Programming, Robot programming Languages.

Books Suggested:
1. Introduction to Robotics, J.J.Craig, Addison Wesley Publishing Co.
2. Robotic Engineering, Richard D. Klafter, Chmielewski, Negin Prentice-Hall
4. Fundamentals of Robotics, Robert J. Schilling, PHI.

MEC-753: ROBOTICS

1. Study of different types of robots based on configuration and application.
2. Study of different type of robotics links and joints.
3. Study of components of robots with drive system and end effectors.
4. Determination of maximum and minimum position of links.
5. Verification of transformation (Position and orientation) with respect to gripper and world coordinate system.
7. Robot programming exercises on Pick and place, Painting, welding, polishing, gluing, stacking and drilling.

MEC-704: ELECTIVE-I

Note: The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

MEC-754: ELECTIVE-I
MEC-755: MINOR PROJECT

MEC-757: VOCATIONAL TRAINING AFTER 6\textsuperscript{TH} SEMESTER

SYLLABUS FOR
BACHELOR OF ENGINEERING (MECHANICAL)
EIGHTH SEMESTER

MEC-801: AUTOMOBILE ENGINEERING

Note: The examiner shall set 8 questions i.e. 4 in each of part A & B and student shall be required to attempt total of 5 questions with at least 2 questions from each part.

PART-A

1. Introduction
Components of automobile, basic structure, classification of automobile, body styles, frame and frameless construction, power for propulsion, traction and tractive effort, relation between engine revolution and vehicle speed, road performance curves, calculation of equivalent weight, gear ratio for maximum acceleration.

2. Automobile Engine
Engine Types, Piston, Piston rings, valves, cooling system, lubrication system, turbocharger, supercharger, fuel supply system for petrol and diesel engine, throttle body and multi point fuel injection system, battery coil ignition system.

3. Clutches
Requirements of clutches, types of clutches, working of single plate, multiplate and centrifugal clutch, clutch operation, clutch plate, fluid flywheel.

4. Transmission
Functions of transmission, necessity, types of transmission, sliding mesh, constant mesh, synchromesh, selector mechanism, transfer box, automatic transmission, torque converter, overdrive, propeller shaft, universal joint, final drive, differential, rear axle, rear axle drive.

PART-B

5. Suspension
Basic classifications, types of suspension systems, leaf springs, shock absorbers, independent suspension, types of front wheel, independent suspension system, air suspension.

6. Front Axle and steering
Front axle, wheel alignment, steering geometry, under-steer and over-steer, steering linkage, steering gears, steering ratio, reversibility, power steering.

7. Brakes wheel and Tyres
Brake efficiency and stooping distance, fading of brakes, wheel skidding, types of brakes, drum and disk brakes, hydraulic and pneumatic brakes, servo brakes, antilock braking
system, types of wheels, wheel dimensions, types of tyres, cross ply, radial ply and belted-bias type, tyre designation.

8. **Emission control**
   Automotive air pollution, emission control, crank case emission, evaporative emission control, exhaust emission control, catalytic converter.

**BOOKS SUGGESTED:**


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**MEC-851: AUTOMOBILE ENGINEERING**

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1. Study of various tools and working of various systems/components from an actual automobile/working model.
2. Removing the car tyres, repairing the tubes - their testing and fitting back.
3. Valve re-facing and valve seat grinding and checking the seat for leakage.
4. Checking of the cooling system, water pump, radiator, thermostat valve and its faults.
5. Checking of cylinders for wear and finding out the next possible over-size of the Piston replacing rings and studying methods of replacing piston after re-boring.
6. Overhauling the fuel pumps, cleaning the jets and testing on the engine.
7. Overhauling of the distributor, setting C.B. Points and spark plug gaps and study of the complete ignition circuit.
8. Study of Vehicle steering system and measuring steering geometry angles.
9. Replacing of car battery and casting of plate connectors, cell connectors etc.
10. Overhauling of breaking system, adjusting the brake shoes, bleeding the system and testing.
11. Engine trouble shooting.

**MEC-802: OPERATION RESEARCH**

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**Note:** The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

**Part–A**
1. **Definition of Characteristics of O.R.**
   Decision making, scientific decision making approach for scientific decision making in O.R. need & limitation of O.R.  

2. **Definition of Models**
   Classification of models, Construction of models, Approximation in O.R. models  

3. **Allocation Models**
   Analysis of industrial situations to find characteristics like key decision, objective possible alternatives & restrictions – Three categories of allocations type situations to be considered. General mathematical formulation for linear programming, feasible and optimal solutions.  

4. Graphical and simplex techniques to solve linear models, Modification of minimization situations so as to be solvable by simplex method. Duality and degeneracy in simplex method, application and limitations of linear optimization models.  

**Part-B**

5. **Network Models**
   Transportation models, method of finding starting solution, Vogel’s approximation method to find feasible models, Hungarian method to find optimal solution in assignment models.  

6. Cyclic shortest route models, traveling salesman ‘s problem and Branch and Bound method to solve it. A cyclic short route models and their solutions.  

7. Queuing theory, various types of queuing situations and their solutions.  

8. **PERT & CPM**
   Network situations where PERT & CPM can be applied, planning, scheduling & Control, work–breakdown structure.  
   (a) PERT NETWORKS : Events and activities, constructions of network, forward & Backward planning, Fulkerson’s rule, optimistic, pessimistic & most likely time Estimates, frequency distribution, mean, variance and standard deviation, expected time , earliest expected time and latest occurrence time, definitions of slack and critical path.  
   (b) CPM NETWORKS : Similarity and difference of CPM & PERT, construction of network, earliest event time, latest occurrence time, float, total float, free float, independent float , contracting the network so as to an optimum project schedule.  

**Books Suggested:**

MEC-802: OPERATION RESEARCH

1. Projects and case studies concerning the topics in theory.

MEC-803: COMPUTATIONAL FLUID DYNAMICS

Note: The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

PART-A

1. Introduction
   History of CFD; Comparison of the three basic approaches in engineering problem solving – Analytical, Experimental and Computational Methods. Recent Advances in Computational Techniques.  \(5\) hrs

2. Problem Formulation:
   The standard procedure for formulating a problem Physical and Mathematical classification of problems; Types of governing Differential equations and Boundary conditions.  \(7\) hrs

3. Methods of Discretisation:
   Basics of Finite Difference Method; Finite Element Method, Finite volume Method and Spectral Method. Treatment of Boundary Condition.  \(5\) hrs

PART-B

4. Numerical Solution to Heat Conduction Problems:

5. Numerical Solution to Fluid Flow Problems
   Types of fluid flow and their governing equations; Viscous Incompressible flows Calculation of flow field using the stream function-vorticity method; Calculation of boundary layer flow over a flat plate; Numerical algorithms for solving complete Navier-Stokes equations- MAC method; SIMPLE algorithm; Project problem. \(13\) hrs

Books Recommended:

2. Computational Fluid Dynamics by J. Anderson Publisher, McGraw Hill:
6. Introduction to CFD by P. Niyogi, Pearson Publications.

MEC-853: COMPUTATIONAL FLUID DYNAMICS

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1. Two dimensional heat conduction in a rectangular geometry.
2. To solve the temperature distribution for a fin.
3. To solve two dimensional incompressible viscous flow in a lid driven cavity.
4. Temperature distribution for a heated plate subjected to insulated boundary condition on one side.
5. Temperature distribution for a heated plate subjected to fixed boundary conditions

MEC-804: ELECTIVE-II

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Note: The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

MEC-854: ELECTIVE-II

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MEC-855: MAJOR PROJECT

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OR

OPTION 2

MEC-856: INDUSTRIAL TRAINING FOR SIX (06) MONTHS DURATION.
SYLLABUS FOR
BACHELOR OF ENGINEERING (MECHANICAL)
(ELECTIVE SUBJECTS) FOR SEVENTH SEMESTER

MEC-704: (a) THERMAL PLANT ENGINEERING

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Note: - The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

PART-A


   (b) Stem Generators: - Principle construction and operation of high pressure boilers. Design trend in water tube boilers. Supercritical pressure systems. Steam generation for special applications. Generator selection, maintenance and operation. Boiler furnaces.

   (c) Feed Water heating and Steam Turbines: - Cycles with finite number of heaters, analysis of optimum rise in ideal cycle efficiency. Types of heater arrangements, Equations for single heater arrangement and series of heaters. Losses in various types of heater arrangements.


2. Diesel Power Plants : - Diesel plant elements, arrangements of diesel plant, diesel engine fuel injection system, air intake system, engine lubrication and engine cooling systems, superchargers. Method of starting and stopping the engines.
   Advantages and disadvantages of using diesel power plant, Economics of diesel plant over stem and hydro-electric plant.
PART-B


MEC-754: (a) THERMAL PLANT ENGINEERING

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4. Testing of a Steam Power Plant.
6. Testing of a Diesel Power Plant.

**BOOKS SUGGESTED**

1. Power Plant Engineering : T. Morse.
2. Power Station Engineering & Economy : Skrotzkiand.
5. Steam Power Stations : Gaffert.
8. Power Plant Engineering : Dr. Mahesh Verma.
9. Electric Power Plants : Domkundw

MEC-704: (b) GAS DYNAMICS

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**Note:** - The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

PART – A

1. **Basic concepts of Gas Dynamics and Gas Properties:**-
   **Definition:** - Units and dimensions. The concepts of a continuum, properties of the continuum. Methods of describing fluid motion, Lagrangian method. Eulerian Method.
The integral form of the equations of Conservation of Mass, momentum and energy as applied to control volumes, applications to the steady flow of inviscid compressible fluids.

2. **Fundamental Equation Study of One Dimension Flow**:
   - Continuity equation, the momentum equation, the dynamic equation and Euler’s equation.
   - Bernoulli’s equation, thrust function, steady flow energy equation.

3. **Isentropic Flow**:
   - Introduction, Acoustic velocity, Mach number, Mach line and mach angle. Classification of flows, Kerman’s rules of supersonic flow, flow parameter, critical condition stagnation values.

4. **Flow in Ducts with Heating or Cooling**:
   - Stagnation temp. Change governing equation, Rayleigh lines, choking due to friction.

5. **Flow in Constant-Area Ducts with friction**:
   - Friction loss, the friction parameter, Fannolines, effect of the increase of the inlet Mach number and duct length. Chocking due to friction. Isothermal flow through long ducts.

**PART-B**

6. **Normal Shock Waves**:
   - Formation of shock waves, weak waves, compression waves. Governing relation of the Normal shock, Pressure, Temperature, Density, Mach number across the shock.

7. **Oblique through Nozzles**:
   - Oblique shock equation, shock geometry, shock polars.

8. **Flow through Nozzles**:
   - The Converging diverging nozzle, area ratio for complete expansion, effect of varying back pressure on nozzle flow. Under-expansion and over-expansion in nozzle flow. Losses nozzle.

9. **Flow through Diffusers**:
   - Classification of diffusers, internal compression subsonic diffusers, velocity gradient, effect of friction and area change, the conical internal-compression Subsonic diffusers, external compression subsonic diffusers, supersonic diffusers, Normal shock supersonic diffusers, the converging diverging supersonic diffusers.

10. **Introduction to Multimedia Flow**:
    - The equation of continuity, the momentum equation, Bernoulli’s equation, the energy equation, Navier-Stocks Equation, Potential Flow.

**MEC-754: (b) GAS DYNAMICS**

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1. To Study the different methods of measuring the flowing in case of Compressible flows.
(i) Pressure  
(ii) Velocity  
(iii) Temperature  
(iv) Density  
(v) Flow direction  

2. To study different methods of dynamic flow measurement techniques.  
3. Study of low speed wind tunnel.  
4. To study to make tunnel and visualize flow around different bodies shapes.  
5. To determine the pressure and velocity variation along the length of a diffuser.  
6. To study the formation of a wave phenomenon with the help of a water table.  
7. Study of shock tube.  

**BOOKS SUGGESTED**  

**MEC-704: (c) RENEWABLE ENERGY SOURCES**  

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*(For Mechanical Engineering)*  

*Note:* The examiner shall set 8 questions i.e. 4 in each of part A & B and student shall be required to attempt total of 5 questions with at least 2 questions from each part.  

1. **Introduction to Renewable Energy Sources:** (3)  
   Introduction to Non-convectional/Renewable Energy Sources & Technologies.  
   Their Importance for Sustainable Development and Environmental Protection.  

2. **Solar Radiations:** (4)  
   Measurement and Prediction of Solar Radiation; Instruments for solar radiation;  
   Characteristics of solar spectra including Wave length Distribution; Radiation Properties and spectral Characteristics Materials; Selective Surfaces & Basis of solar Collectors.  

3. **Solar Thermal system:** (5)  
   Solar Collection Devices; their analysis; Solar Collector Characteristics; solar Pond;  
   application of solar energy to space heating etc.  

4. **Biomass:** (2)  
   Biomass as an energy Sources, Energy Plantation; conversion technologies- thermal,  
   chemical and biological; Photosynthesis, Biomass generation, Classification of  
   Biomass plants.  

5. **Biogas:** (4)  
   Principles of Bioconversion; Types of Bioreactors – Batch, Continuous, Plug-flow, Stirred  
   Sewage, Industrial Wastes, Agriculture Wastes, Animal and Human Wastes; Landfill Refuse,  
   Properties and Uses of Biogas.  

6. **Biofuels** (4)
Bioconversion Techniques- Direct Combustion, Pyrolysis, Flash Pyrolysis
Fermentation and gasification; Utilization of Industrial Wastes such as Bagasse;
Combustion systems; Gasification; Sizing: Beneficiation of Fuels, Thermodynamics
& Kinematics of gasification; Types of Gasifiers-Downdraft, Updraft, Cross flow,
fluidized. Combustion Characteristics of Biofuels; Utilization in Conventional
Engines and Power Generation including Cogeneration.

7. Other Renewable Sources of Energy :-

Waves: Nature and availability of Energy from waves Onshore & Off-shores:
Principles of Wave Converters – Raft, Duck, Oscillating Water Columns, Tapered
Channels & Buoys; Energy Conversion & Transmission; Secondary Applications of
Waves such as Harbour Wall, Seawater Pumping.

8. Wind Energy:

Basic Principles; Basic components of a Wind Energy Conversion System,
Classification of Wind Energy Conversion System, Their types, Application of Wind
Energy, Environmental aspects, Wind Energy Development in India.

Tides :- Origin & Nature of Tides, Tidal Heads & Duration; Principles of Tidal Energy
Conversion, Site Selection – Single & Multiple Bay System; Cycles & Load
Factors; Regulation and Control of Tidal Power Generations.

OTEC (Ocean Thermal Energy Conversion): Temperature & Tropical oceans:
Principles of OTEC Systems; Site Selection; Power Cycles; Selection of
Working Fluids; Pumps & Turbines; Heat Exchanger Criteria; Biofueling;
Secondary Applications such as Fresh Water Production; Maniculture, etc;
Power Transmission & System Efficiency.

8. Geothermal Energy:

Nature of Geothermal Resources; Location & Potential Assessment; Classification
& Characteristics of Geothermal Resources- Hot Rock, Hot Water& Steam, Chemical& Physical
Properties of Geothermal Brines: Control of scale Deposition, Drilling, Logging& Cycles;
Refrigeration, Operation for Geothermal Wells; principles of power production System &
Cycles; Refrigeration, Two-phase Flow Turbines; Thermal Phase Flow Turbines; Thermal
Utilization & Mineral Recovery; Ecological & Safety Consideration.

BOOKS SUGGESTED:

1. S.P. Sukhatme : Solar Energy: Principles of Thermal Collection and
McGraw Hill.

MEC-754: (c) RENEWABLE ENERGY SOURCES

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2. Study of PV Panel & determination of its Characteristics.
5. Study of Thermophysical Characteristics of Biomass Plants/ Biogas Plants.

MEC-704: (d) EXPERIMENTAL STRESS ANALYSIS

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Note: - The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

PART-A

   Strain analysis, strain equation of transformation, principle strain, Cauchy’s strain quadric, stress-strain relationship.

2. Two Dimensional Photo elasticity: Stress optic law, optics of Polaris cope, plane and circular Polaris copes, dark and light field arrangement, fringe multiplication, fringe sharp ending, compensation techniques, commonly employed photo elastic materials.


PART-B


5. Electric Resistance Strain Gauges: Gauges construction and installation, temperature compensation, gauge sensitiveness, gauges factor, correction for transverse strain effects. Factors affecting gauge relation. Rosettes, Rostre analysis, potentiometer and wheatstone bridge circuits for strain measurements.

MEC-704: (e) WORK STUDY

Note: - The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

PART – A


   General procedure for method study, formulation of the problem, analysis of problem and use of aids like flow diagram, procedure diagram, operation process chart, multiple activity chart, trip frequency chart and diagram, left hand and right hand charge, principles of motion economy.

   Search for alternatives including principles of motion economy and other aids to be used in search phase. Evaluation of alternatives.

   Implementation, follow up and feedback, resistance to change and acceptance of new Solution. Special problem-complete investigation of the problem from motion study point of view.

PART -B

2. Work Measurement: - Introduction to work measurement, work measurement equipment and procedure. Various methods of reading stop watches, operator’s performance, various rating methods.

   Relation between observed time, normal time and standard time. Calculation of Standard time for various problems.


4. Wage and Wage Incentives: - Wages and wage incentives, types of incentives, requirements of good incentive schemes, wage-incentives schemes, group incentives.

BOOKS SUGGESTED

2. Motion and Time Study : Mundell, Prentice Hall of India, N. Delhi

MEC-754: (e) WORK STUDY

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1. Work study report of college workshop.
3. Work study report of college Library.
5. Flow process Chart.

BOOKS SUGGESTED

3. Motion and Time Study : Mundell, Prentice Hall of India, N. Delhi

MEC-704: (f) INDUSTRIAL AUTOMATION

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Note: - The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part

PART- A

Total Lectures: 37

1. **Introduction:** - Concept of Automation, Reason for Automating, Argument for and against Automation Strategies, Economic Consideration; Low Cost Automation, Advantages of Automation. (4)


3. **Control System:** - Adaptive Control Sequence Control and Programmable Controllers, Computer Process Control. (4)

4. **Flexible Automation Technology:** - Introduction to Flexible Automation, Flexible Automation – A New Tool, (Computer-Aided Drafting * Design) CNC Machine Tools & their Machining, NC System & Servo Mechanism. (5)

PART-B


7. **Robotics:** - Robotic Technology, Robot Anatomy, Control System, Types of Drive system, specification, Actuators, End Effectors, (Types & Application), Sensor, Robot Programming. (5)

BOOKS SUGGESTED

2. Robotics & Flexible Automation: S.R. Deb
3. Pneumatic Control: S.R. Majundar

MEC-754: (f) INDUSTRIAL AUTOMATION

1. Design exercise on air cylinders and mountings.
2. Study of Hydraulic Servo Systems
3. Study of remote control circuits.
4. Applications of transfer devices and feeders.
5. Study of numerical adopting controls.

BOOK SUGGESTED

Fluid Logic Control and Industrial Automation: Daniell Bauteillie.

SYLLABUS FOR
BACHELOR OF ENGINEERING (MECHANICAL)
ELECTIVE SUBJECTS) FOR EIGHTH SEMESTER

MEC-804: (a) THEORY OF ELASTICITY & PLASTICITY

Note: - The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

PART – A

1. Basic Elasticity: Three dimensional stress and strain systems. Principal stresses, principal strains and principal planes. Mohr’s circle for 3 – dimensional stress and strain systems.
2. Two dimensional Elasticity: - Stress functions, plane stress and plane strain methods.
4. **Introduction to Plasticity**: - Idealized stress-strain systems, approximate equation for stress strain curves (Ramberg-Osgood, Ludwig,s and karunes equation), Bauschinger effect-yield locus, yield surface.

**PART - B**


6. **Slip Line Yield Theory**: - Two Dimensional plasticity, slip lines, basic equations, Hencky’s first theorem, Geiringer’s Velocity equation. Applications of slip line field theory to plane strain problems.

8. **Load Bounding**: - The lower bound theorem, the upper bound theorem and their corollaries. Applications of load bounding to plane strain problems.

**MEC-854: (a) THEORY OF ELASTICITY & PLASTICITY**

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1. Measurement of strains with the help of electrical strain gauges.

2. Measurement of principal strains and calculation of principle stresses in a tension member under uni-axial loading and comparison of the results with those obtained from theory.

3. Plotting of flow curve for a member subjected to uni – axial tension and fitting the suitable stress - strain relation.

4. Experimental verification of yield criteria.

**BOOKS SUGGESTED**

1. Plasticity for Mechanical Engineering : Johnson & Miller – Van Nostrand
2. Experimental Analysis : Dally & Riley
5. Engineering Plasticity : Calladina – Pergaman

**MEC-804: (b) METROLOGY**

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**Note**: - The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

**PART - A**

**Standards of Measurements**: - Line Standards, imperial standard yard, standard meter, substandards and standards; end bars, slip gauges, angular slip gauges, wave length standard.

Interchangeability:- Concept and need of interchangeability, Systems of tolerances, System of fits, Design of limit gauges. Standardization, Design Standardization and Manufacturing standardization.

Linear and angular Measurement:- Use of slip gauges, Dial indicators., Mechanical optical and electrical comparators, Pneumatic gauges, Measuring machines, sine bars & angle, gauges, levels, clinometers, auto-collimator, taper gauges.

PART-B

Straightness, Fitness and Square ness testing:- Straight edges, surface plates, straightness testing, straight edge methods, levels or auto-collimator method. Flatness testing – level or auto-collimator method, optical flatness, square ness testing, indicator method, auto-collimator methods, engineer’s squares.

Screw Thread Measurement :- Errors in threads, screw thread gauges, measurement of element of the external and internal threads, thread caliper gauges.  

Spur Gear Measurement: - Geometry of spur gear, measurement of spur gear parameters. Ram out, pitch, lead, backlash, tooth thickness, composite elements.

Surface Finish Measurement: - Definitions of spur gear, measurement of surface, finishal surf, profilometer, recorder, compariscope, microscope interference methods.

Miscellaneous:- Acceptance tests for a lathe, Alignment of bearings.

MEC-854: (b) METROLOGY

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1. To measure a gap gauge with slip gauges.
2. To measure the height of a circular spigot.
3. To calibrate a micrometer.
4. To measure a plug screw gauge.
5. To check a straight edge.
6. To check an engineer’s square.
7. To measure the angle of a taper plug gauge with sine bar.
8. To check a form gauge by projection including the construction of the projection drawing.
9. To check a sine bar.
10. To measure the pitch error of a screw gauge (plug of ring).
11. To measure the form and angle of a plug screw gauge by optical method.
12. To set and calibrate an Engineer’s block level.
13. To calibrate a dial gauge.
14. To compare two slip gauges using an optical flat.
15. To test the flatness of the surface plate using a block level.

BOOKS SUGGESTED
1. Metrology : K.G. Hume
2. Metrology : Taher

MEC-804: (c) MECHANICAL HANDLING

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Note: - The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

PART-A
1. Importance of Material Handling: - Principles of material handling, analysis of material handling problem, operation chart and flow process chart, flow diagrams.


3. Factory Planning and Material Handling: - Plant location, factory handling, the layout as key material, handling problems.

4. Production Control and Material Handling: - Types of Production control, materials control production planning, production scheduling, production dispatching and follow up as related to materials handlings.

5. Conveyors: - Belt carrier, chain and cable, roller, screw vibrating and reciprocating pneumatic tubes, load transferring machines, air operated & Hydraulic devices

PART-B

7. Industrial trucks, railways, cars, dump trucks, over head track age system.

8. Pollets and Containers: - Enclosed tight, open top and platform coil supports, strapping, industrial packing etc.

9. Mechanical Handling Equipment Used on Project Sites: - Shovels, Draglines, clamshell cranes, bulldozers, scrappers and motor graders, concrete mixture etc.

MEC-854: (c) MECHANICAL HANDLING

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1. To draw flow process chart for mechanical handling.
To prepare a plant location report for setting up a small scale industry.
To study different conveyors systems.
To study the hoisting system of a crane.
To study the transmission and revolving system of a crane.
To study transmission system of a bulldozer.
To study control system of a bulldozer.
To study a dump truck.

BOOK SUGGESTED
Construction Equipment : Mahesh Verma

MEC-804: (d) BEARINGS AND LUBRICATION

Note: - The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

PART- A

Friction and Lubrication: - Laws of dry sliding friction, characteristics of hydro dynamically lubricated surface Boundary region of lubrication, lubrication oil Vs grease oil lubrication, selection and its application. Sealing devices. Greases, oils in greases including the study of consistency, mechanical stability, bleeding and evaporation properties, synthetic grease, grease selection, specification and application.

Selection of Bearings and Requirements: - Types of bearings available, slider type bearings, roller element bearings, principle for selection of bearings, mechanical requirements, environmental condition and economical.

Sliding Bearings: - Types of journal bearings, wick- oiled bearings, pressure fed bearings, externally pressurized bearings, types of thrust bearings, pivoted shoe bearings, spring supported flexible plate thrust bearings, step thrust bearing, externally pressurized bearings, pocket thrust bearings.

PART-B

Viscosity, effect of temp. and pressure on viscosity. The Hagen-poiseuillie Law, Petroff’s equation, hydrodynamic bearings theory. Reynolds’s equation in two dimensions and limitation of the theory. The plane slider bearings, load capacity, slider bearings, load capacity, slider bearings friction, pivot-equation. The full journal bearings, load capacity, journal bearings friction, non-dimensional charts and simple numerical. Reynolds’s equation in three dimensions, effect of end flow on load factor, Kingsbury’s electrical-analogy, leakage factor. Design aspects of simple journal bearings, multiple journal Barings, pressure bearings and non-pressure bearings.

Rolling Bearing: - Elementary study of deep groove bearings, filling notch bearings, angular-contact ball bearings, magneto bearings, self-aligning ball bearings, miniature ball bearings
double row ball bearings, duplex bearings, ball thrust bearings, tapered thrust bearings, needle bearings, principle of operation, stribeck’s equation for load capacity.

MEC-854: (d) BEARINGS AND LUBRICATION

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1. To find pressure distribution around a simple journal bearings under varying loads on driven shaft.
2. Projects and case studies concerning the topics in theory.

BOOKS SUGGESTED


MEC-804: (e) PLASTIC & RUBBER TECHNOLOGY

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Note: - The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

PART–A

1. Introduction, type and properties of plastic.
2. Design Considerations for plastic components.
3. Moulding of plastic components – Compression, transfer, injection and Blow Moulding Extension.
4. Machining & joining of plastics – General Machining properties, machining operations Methods of joining plastics.

PART–B

6. Common failures and defects in plastic materials:
Defects arising during moulding and extension. Mechanical, Chemical, Electrical and thermal failures in plastic.
7. Testing of plastics – Mechanical testing of plastics. Preparation of test specimen and Procedure of testing the following properties:
(i) Tensile strength, elongation and modulus.
(ii) Compressive, shear, cross-braking, bursting and bearing strength.
(iii) Flexural properties.
(iv) Impact strength, plastic yield.
(v) Creep.
(vi) Hardness.
(vii) Abrasion.
(viii) Tear strength and fatigue.
(ix) Viscosity, Plasticity and flow.
(x) Resilience, stiffness and damping.
(xi) Friction.
(xii) Adhesion and bond strength.
(xiii) Ageing.

10. Methods of processing and testing of rubbers.

**MEC-854: (e) PLASTIC & RUBBER TECHNOLOGY**

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1. To perform the shear test on plastics and draw stress-strain curve.
2. To perform compression test on plastics.
3. To perform shear test on plastics.
4. To perform Bending test on plastics.
5. To perform Impact test on plastics.
6. To perform creep test at room temp. on plastics.
7. To perform hardness test on plastics.
8. To perform torsion test on plastics.

**BOOKS SUGGESTED**

1. Plastic in Engineering : J. Delmonta (Plantar Publishing Co.)
5. Fundamental Tools of Plastics : Hennery M. Rikardorn (McGraw Hill Book Co.)

**MEC-804: (f) ADVANCED FLUID MACHINERY**

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**Note:** The examiner shall set 8 questions i.e. 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.
PART –A

1. **One Dimensional Theory**: Euler’s theory – Relation between velocity diagrams and direction of vanes, Variation in design and operating conditions of hydrodynamics machines.


PART- B

3. Three dimensional problems in turbo machinery and its two dimensional solutions.


5. Hydrodynamic theory of cavitation in turbo machinery.

**MEC-854: (f) ADVANCED FLUID MACHINERY**

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More detailed experiments of hydraulic machines (Pelton, Francis, Kaplan and Centrifugal Pumps) – Drawing Mushhel curves in above cases.

**BOOKS SUGGESTED**


**MEC-804: (g) PRODUCTION & OPERATIONS MANAGEMENT**

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**Note**: The examiner shall set 8 questions i.e. 4 in each of part A & B and student shall be required to attempt total of 5 questions with at least 2 questions from each part.

**PART-A**

1. **Introduction**
Production and Operations functions, scope and objectives, role of operation management in productive systems, Manufacturing Vs Service operations, meeting global challenges.

2. **Product and process Design**
Need, characteristics of phases of product life cycle, Product Development process, product design vs process design, classification of a production process. Methodology for process design.

3. **Capacity planning**
Definition and basic concepts, Long term and short term capacity strategies, Aggregate planning - strategies and guidelines, capacity planning models and linear programming

4. **Facility location and layout**
Facility location and procedure, principles and types of layouts, layout planning, CRAFT, Line balancing.

PART-B

5. Demand forecasting
Introduction, forecasting methods, time series components, forecasting errors and economics of forecasting.

6. Operation scheduling
Scheduling concept and its need, factors effecting scheduling, Job Shop scheduling, sequencing, batch scheduling,

7. Inventory control
Introduction and need of the inventory control, various inventory costs, basic EOQ model, selective inventory controls-ABC, FSN, VED. Fixed order quantity and fixed order interval system. Material requirement planning.

8. Quality Management
Concept of Quality, quality cost, inspection, type of inspection, statistical quality control, control charts, concept of TQM & ISO Certification.

Books Suggested:
1. “Production and operation management”, Adam EE, RJ Ebert, Prentice Hall.

MEC-854: (g) PRODUCTION AND OPERATIONS MANAGEMENT

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The students are required to presents seminars on various advance topics relating to the subject.