

**24RAPC302**  
**MANUFACTURING TECHNOLOGY**

## UNIT I

Sand Casting – Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Molding sand Properties and testing – Cores –Types and applications – Molding machines – Types and applications – Melting furnaces – Principle of special casting processes- Shell, investment – Ceramic mould – Pressure die casting – low pressure, gravity- Tilt pouring, high pressure die casting- Centrifugal Casting – CO2 casting – Defects in Sand casting process - remedies

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1.	Define casting.	1	RE	2
2.	Define mould.	1	RE	2
3.	Define pattern.	1	RE	2
4.	Give any two types of pattern	1	RE	2
5.	What are the properties of moulding sand?	1	RE	2
6.	What is gating?	1	RE	2
7.	What are the different types of core?	1	RE	2
8.	Write down the ingredients of moulding sand.	1	RE	2
9	Define Lost wax Pattern.	1	RE	2
10	Write down the different types of furnaces used for casting.	1	RE	2
11	Write down the different zones in cupola furnace.	1	RE	2
12	What is Centrifugal casting?	1	RE	2
13	Give the advantages of green sand mould.	1	RE	2
14	Mention the merits and demerits of investment casting.	1	UN	2
15	What are the different types of defects found in casting process?	1	RE	2
<b>PART B</b>				
1.	Explain any four types of patterns used in foundry with neat sketches and describe their applications.	1	UN	16

2.	List the different types of moulding sand and explain any two types with their properties and applications.	1	UN	16
3.	Explain the construction and working of a Cupola furnace with a neat sketch and apply your understanding to describe how it is used for melting cast iron in foundries	1	AP	16
4.	Explain the different core making processes used in foundry with neat sketches and describe their applications	1	UN	16
5	Explain the ceramic mould casting process with a neat sketch and describe its advantages and applications.	1	UN	16
6	Explain the working principle of the investment casting process with a neat sketch.	1	UN	16
7	Explain the working of the Pressure Die Casting process with a neat sketch and apply the concept to identify its advantages and disadvantages in manufacturing applications.	1	AP	16
8	Explain the different types of casting defects with neat sketches and analyse their causes and effects on the quality of the final casting.	1	AN	16

## UNIT II

### METAL JOINING PROCESSES

Fusion welding processes – Oxy fuel welding – Filler and Flux materials—Arc welding, Electrodes, Coating and specifications – Gas Tungsten arc welding –Gas metal arc welding - Submerged arc welding – Electro slag welding— Plasma arc welding — Resistance welding Processes -Electron beam welding –Laser beam Welding Friction welding – Friction stir welding – Diffusion welding – Thermit Welding, Weld defects – inspection & remedies – Brazing - soldering – Adhesive bonding.

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1.	Define Welding.	2	RE	2
2.	What is arc welding?	2	RE	2
3.	Write the types of welding joints.	2	RE	2
4.	What are the types of welding?	2	RE	2
5.	Classify the types of electrodes.	2	UN	2
6.	What are the types of gas welding?	2	RE	2
7.	Define Brazing	2	RE	2
8.	Give the advantages of MIG welding.	2	RE	2

9	What is the working principle of plasma arc welding?	2	RE	2
10	Write the working principle of laser beam welding.	2	RE	2
11	Define Soldering.	2	RE	2
12	Write the working principle of electron beam welding.	2	RE	2
13	Give the applications of electron beam welding.	2	RE	2
14	Write the working principle of friction welding.	2	RE	2
15	List out the defects in welding process.	2	RE	2
<b>PART B</b>				
1.	Explain the Tungsten Inert Gas (TIG) welding process with a neat sketch and describe its working principle and applications.	2	UN	16
2.	Explain the advantages, disadvantages, and applications of the Submerged Arc Welding (SAW) process.	2	UN	16
3.	Explain the Thermite welding process with a neat sketch and apply the concept to describe how it is used for joining railway tracks and heavy sections	2	AP	16
4.	Explain the working principle of the Plasma Arc Welding (PAW) process with a neat sketch and analyse how variations in plasma gas flow rate and current affect weld quality and penetration.	2	AN	16
5	Explain the working principle of resistance welding with a neat sketch and apply the concept to identify its industrial applications.	2	AP	16
6	Explain the working principle of Laser Beam Welding (LBW) with a neat sketch and describe its advantages and applications.	2	UN	16
7	With a neat sketch explain the working principle of Electron Beam Welding (EBW) and analyse how process parameters such as beam current, voltage, and vacuum conditions affect weld quality.	2	AN	16
8	With a neat sketch explain the Submerged Arc Welding (SAW) process and describe its working principle, advantages, and applications.	2	UN	16

**UNIT III**  
**MECHANICS OF METAL CUTTING**

Mechanics of chip formation, forces in machining, Types of chip, cutting tools – single point cutting tool nomenclature, orthogonal and oblique metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and machinability.

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1.	Write Taylor's tool life equation.	3	RE	2
2.	Compare orthogonal and oblique cutting in lathe operation.	3	UN	2
3.	List the essential characteristics of a cutting fluid.	3	RE	2
4.	Define the term machinability	3	RE	2
5.	Define tool life.	3	RE	2
6.	List the types of cutting tool materials.	3	RE	2
7.	Explain about the types of chips.	3	RE	2
8.	What are the factors affects the surface finish?	3	RE	2
9	How the machinability can be evaluated?	3	RE	2
10	Classify the different types of chip breakers.	3	RE	2
11	What is machinability index?	3	RE	2
12	How do you classify tool wear?	3	RE	2
13	Name any two reasons for flank wear in cutting tools.	3	RE	2
14	Give two examples for orthogonal cutting.	3	RE	2
15	Why is lubrication not required while machining cast iron?	3	RE	2
<b>PART B</b>				
1.	Explain the formation of different types of chips produced during metal cutting and describe the types of cutting fluids used with their functions.	3	UN	16
2.	(i) How does temperature affects the life of a cutting tool? Why controlling temperature is important in machining.	3	UN	8
	(ii) Compare orthogonal and oblique cutting with neat sketch.	3	UN	8
3.	Explain tool wear and describe the reason for cutting tools failure during machining.	3	UN	16

4.	(i) What are the different cutting tool materials available?	3	UN	8
	(ii) Explain about the nomenclature of single point cutting tool.	3	UN	8
5	Explain the Merchant Circle Diagram with a neat sketch and describe the relations derived between cutting forces, friction angle, and shear angle.	3	UN	16
6	Define tool wear and explain the various causes of tool failure during machining operations. Apply your understanding to suggest suitable methods to reduce tool wear and improve tool life.	3	AP	16
7	Explain the role of cutting fluids in metal cutting and mention their types and advantages.	3	UN	16
8	A specimen of 100mm length along the stroke of shaper is machined with a tool with 15° rake angle. The uncut chip thickness is 1.5mm. If a chip length of 40mm is obtained during one stroke of machining, find the shear plane angle and thickness of cut-chip.	3	AN	16

#### UNIT IV TURNING MACHINES

Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, surface roughness in turning, machining time and power estimation. Special lathes - Capstan and turret lathes- tool layout – automatic lathes: semi-automatic – single spindle: Swiss type, automatic screw type – multi spindle.

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1.	Compare capstan and turret lathe in terms of machining process.	4	UN	2
2.	Compare single spindle and multi spindle lathe.	4	UN	2
3.	What is a centre lathe?	4	RE	2
4.	Explain the methods of taper turning on lathe.	4	RE	2
5.	What is a Swiss type lathe?	4	RE	2
6.	What are the operations can be performed on a lathe?	4	RE	2
7.	What are the types of chucks used in machine shop?	4	RE	2
8.	What are the advantages of automatic lathes?	4	RE	2

9	Mention different types of chucks used in a machine shop.	4	RE	2
10	Mention any two limitations of a Centre lathe	4	RE	2
11	What are programmed automatic lathes?	4	RE	2
12	What is the purpose of tumbler gear mechanism of a lathe?	4	RE	2
13	Calculate the time required for one complete cut on a piece of work having 250mm long and 40mm diameter. The cutting speed is 32 m/min and the feed is 0.4 mm/sec	4	RE	2
14	What is bar stop?	4	RE	2
15	State the advantages of Swiss type screw cutting machine	4	RE	2

**PART B**

1.	Explain about the centre lathe with neat sketch	4	UN	16
2.	Compare the working of capstan and turret lathe with neat sketch.	4	UN	16
3.	Explain the principle of operation of the Swiss-type automatic screw machine with advantages and limitations.	4	UN	16
4.	Explain the various work holding methods used in turning and machining centres.	4	UN	16
5	Explain the construction and working principles of parallel action and progressive action multi-spindle automatic machines.	4	UN	16
6	Given a work piece that requires a tapered shape, select an appropriate taper turning method and explain its working principle with a neat sketch. Justify your choice of method.	4	UN	16
7	Explain the specifications of a centre lathe and describe the various attachments used on it with neat sketches	4	UN	16
8	Analyse the constructional features of CNC machine tools and explain how each feature affects machine performance	4	AN	16

**UNIT V**  
**RECIPROCATING MACHINE TOOLS**

Reciprocating machine tools: shaper, planer, slotter: Types and operations- Hole making: Drilling, reaming, boring, tapping, type of milling operations-attachments - types of milling cutters– machining time calculation - Gear cutting, gear hobbing and gear shaping – gear finishing methods. Abrasive processes: grinding wheel – specifications and selection, types of grinding process - cylindrical grinding, surface grinding, centreless grinding, internal grinding - micro finishing methods.

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1.	Write down any four operations that can be performed in a drilling machine?	5	RE	2
2.	What is broaching process?	5	RE	2
3.	Compare shaper and planar machine.	5	UN	2
4.	What is meant by up-milling and down-milling?	5	RE	2
5.	What are the different micro finishing methods available?	5	RE	2
6.	What are the different hole making operations?	5	RE	2
7.	What is grinding process?	5	RE	2
8.	List the advantages of grinding.	5	RE	2
9	Give examples to natural abrasives and artificial abrasives.	5	RE	2
10	What are the types of surface grinders?	5	RE	2
11	What is meant by “grade” and “structure” of a grinding wheel?	5	RE	2
12	What is a tool post grinder?	5	RE	2
13	State the various methods of centre less grinding.	5	RE	2
14	What is the use of swing frame grinder?	5	RE	2
15	Name the two types of bond.	5	RE	2
<b>PART B</b>				
1.	Classify different hole making operations based on the tools or methods used.	5	AP	16

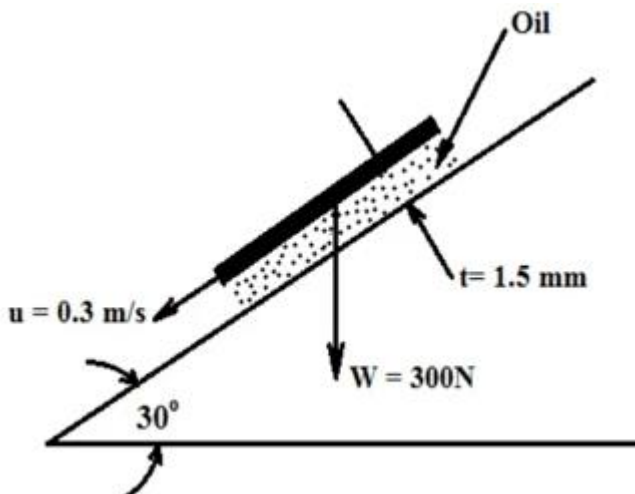
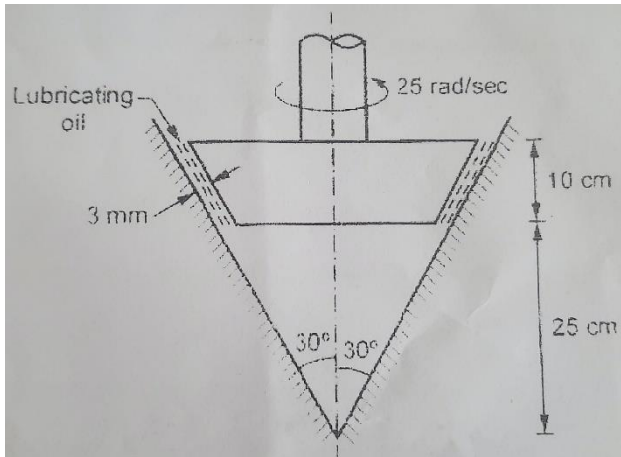
2.	Explain the construction and working principles of shaper and planer machines with neat sketches and describe their differences.	5	UN	16
3.	What are the different types of grinding processes? Classify them based on their applications.	5	AP	16
4.	With a neat sketch, Explain the construction and working principle of shaping machine.	5	UN	16
5	Explain the different types of milling cutters in detail and analyse how the selection of a cutter affects the machining operation and surface quality.	5	AN	16
6	Explain the cylindrical grinding process with a neat sketch and describe its working principle and applications.	5	UN	16
7	Explain the various gear finishing processes and apply the concept to describe how these methods improve the accuracy and surface finish of gears.	5	AP	16
8	Classify the grinding machines. Determine the factors considered to select grinding wheels.	5	UN	16

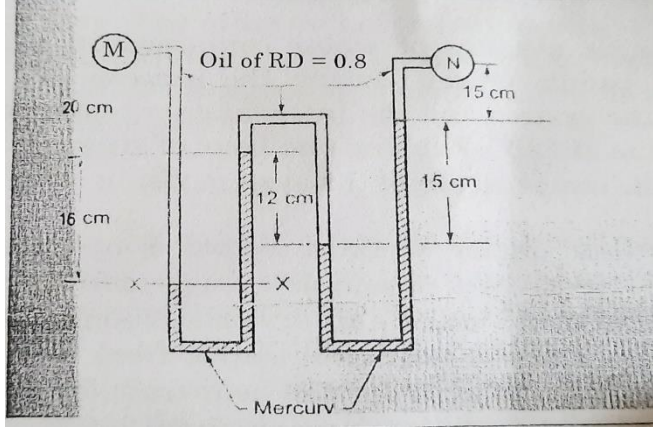
**24RAPC303**  
**FLUID MECHANICS AND THERMAL SYSTEMS**

**UNIT I**  
**FLUID PROPERTIES AND FLOW STATICS**

Fluid Definition and Classification, Properties of fluids, Concept of fluid static pressure – Pascal ‘s law –Absolute and Gauge pressures – Manometers: Types and Pressure measurement.

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1	Define density.	1	RE	2
2	Calculate a specific gravity of a liquid having a volume of 6 m <sup>3</sup> and weight of 44 kN.	1	AP	2
3	Two horizontal plates are placed 12.5 mm apart, the space between them being filled with oil of viscosity 14 poise. Calculate the shear stress in the oil if the upper plate moved with a velocity of 2.5 m/s. Define specific weight.	1	AP	2
4	What is viscosity and give its units?	1	RE	2
5	What is kinematic viscosity? State its units.	1	RE	2
6	What is the difference between dynamic Viscosity and kinematic viscosity?	1	UN	2
7	What is Bulk Modulus?	1	RE	2
8	Define surface tension.	1	RE	2
9	Define compressibility.	1	RE	2
10	Calculate the height of capillary rise for water in a glass tube of diameter 1mm	1	AP	2
11	Define – Incompressible fluid.	1	RE	2
12	Express the absolute pressure of 4 bar in the water head, if the barometer reads 760 mm of Hg.	1	UN	2
13	State Pascal’s law.	1	RE	2
14	State Archimede’s principle.	1	RE	2
15	Differentiae Buoyance and Floatation	1	UN	2
<b>PART B</b>				
1	Calculate the dynamic viscosity of an oil, which is used for lubrication between a square plate of size 0.8 m x 0.8 m and an inclined plane with angle of inclination 30° as shown in Fig. The weight of the square plate is 300 N and it slides down the inclined plane with a uniform velocity of 0.3 m/s. The thickness of oil film is 1.5 mm.	1	AP	16

	 <p>The diagram shows a plate of thickness <math>t = 1.5 \text{ mm}</math> resting on an inclined plane at an angle of <math>30^\circ</math>. A layer of oil is between the plate and the plane. The plate is moving up the incline with a velocity <math>u = 0.3 \text{ m/s}</math>. A downward force <math>W = 300 \text{ N}</math> is applied to the plate.</p>			
2	<p>A vertical gap 23.5 mm wide contains an oil specific gravity 0.95. A plate weighting 49 N and of the dimension 1.5 m x 1.5 m is lifted midway through the gap. If the force of 143 N is required to move the plate with a steady velocity of 100 m/s. Estimate the kinematic viscosity of the oil filled in the gap. Take the width of the plate as 1.5 mm. [Hint: Total force for lifting the plate is the sum of the self-weight of the plate and the viscous resistance.]</p>	1	AP	16
3	<p>Highlight the importance of viscosity in engineering domain. A 20 mm wide gap between two vertical plane surfaces is filled with oil of specific gravity 0.85 and dynamic viscosity <math>2.5 \text{ Ns/m}^2</math>. A metal plate of size 1.25 m x 1.25 m x 0.2 cm with a weight of 30 N is placed mid-way in the gap. Determine the force required to lift the plate with a constant velocity of 0.12 m/s. What is the shear stress developed in the plate?</p>	1	AP	16
4	<p>Figure shows a truncated cone which rotates at 25 rad/sec. The viscosity of oil in the gap of 3 mm between the cone and fixed surface is 5 Poise. Calculate the torque required to rotate the truncated cone</p>  <p>The diagram shows a truncated cone rotating at <math>25 \text{ rad/sec}</math> within a gap of 3 mm. The gap is filled with lubricating oil. The cone has a height of 10 cm and a total height of 25 cm. The angle of the cone's side is <math>30^\circ</math>.</p>	1	AP	16
5	<p>A simple manometer (U-tube) containing mercury is connected to a pipe in which an oil of sp. gr. = 0.8 is flowing. The pressure in the pipe is vacuum. The other end of the manometer is open to atmosphere. Find the vacuum, pressure in pipe, if the difference of mercury level in the two limbs is 20 cm and height of oil in the left limb from the centre of the pipe is 15 cm below.</p>	1	AP	16

6	<p>One end of a differential manometer is connected to a pipe carrying a liquid of specific gravity 1.2 and the other end is connected to a pipe B carrying a liquid of specific gravity 1.6. The pressure in pipeline A is 0.1 MPa. The level difference between the two pipelines is 2.5 m, with the pipeline A at a higher level. The level of mercury in the limb connected to A is 4 m below the pipeline A. The level of mercury in the limb connected to B is 0.15 m below the level of mercury in the limb connected to A. Mercury with a specific gravity 13.6 is used as the manometric liquid. Find the pressure of the liquid flowing in pipeline B.</p>	1	AP	16
7	<p>Determine the pressure difference (<math>P_m - P_n</math>) when the manometer indicates as shown figure.</p> 	1	AP	16
8	<p>Give the physical concept of Buoyancy. A solid cylinder 3 m diameter has a height of 3 m. It is made of a metal whose specific gravity is 0.8 and is floating in water with its axis placed vertically. Determine its metacentric height and state whether its equilibrium is stable or unstable.</p>	1	AP	16

**UNIT II**  
**FLUID KINEMATICS AND FLUID DYNAMICS**

Types of fluid flow – Continuity equation in two and three dimensions – Velocity and Acceleration of fluid particle – Velocity potential function and Stream function. Euler's equation along a streamline –Bernoulli's equation – Simple problems.

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1	Define fluid kinematics	2	RE	2
2	Write the Continuity equation.	2	RE	2
3	Water is flowing through a pipe of 5 cm diameter under a pressure of 29.43 N/cm <sup>2</sup> (gauge) and with mean velocity of 2.0 m/s. Find the total head or total energy per unit weight of the water at a cross section, which is 5 m above the datum line.	2	AP	2
4	Define Velocity potential function.	2	RE	2
5	Define Stream function.	2	RE	2
6	Check whether the following velocity component satisfies the Continuity equation or not $u = 2x^2 + 3y$ ; $v = -2xy + 3y^2 + 3yz$ ; $w = -1.5z^2 - 2xz - 6yz$ .	2	UN	2
7	Define streak lines.	2	RE	2
8	Write the Euler's equation along a streamline	2	RE	2
9	List the assumptions made for Euler's Equation.	2	RE	2
10	What are the applications of Bernoulli's equation.	2	RE	2
11	List the assumptions made for Bernoulli's equation.			
12	What is Venturi meter?	2	RE	2
13	What is Orifice meter	2	RE	2
14	Define pitot tube.	2	RE	2
15	Highlight the fundamental difference between Venturi meter and Orifice meter.	2	UN	2
<b>PART B</b>				
1	A pipe of 30 cm diameter carries a fluid of specific gravity 0.92 at a velocity of 2.5 m/sec. If the velocity at another section of pipe is 4.5 m/sec. Find mass flow rate of fluid and the diameter of another section of pipe.	2	AP	16
2	A pipe of 40 cm diameter conveying water, branches into two pipes of diameters 25 cm and 20 cm respectively. If the velocity in 40 cm	2	AP	16

	diameter pipe is 1.5 m/sec and that of in 20 cm diameter pipe is 2.5 m/sec determine.: (i) Discharge in pipe of 40 cm diameter and (ii) Velocity of water in pipe of 25 cm diameter.			
3	The velocity component in a 2D incompressible flow are given as: $u = y^3 + 6x - 3x^2y$ ; $v = 3yx^2 - 6y - x^3$ . Check whether the flow is rotational or irrotational. If the flow is irrotational, determine the corresponding potential and stream function. Give a case with suitable justification for which the streamline, streak line, and path line of a flow will coincide.	2	AP	16
4	Derive Euler's equation of motion. List the assumptions made for Euler's Equation.	2	UN	16
5	Derive an expression for Bernoulli's theorem from the first principle and state the assumption made for such a derivation.	2	UN	16
6	A converging pipe is 20 cm inlet and 10 cm outlet and 5 m long is lying in the vertical plane making an angle $45^\circ$ to the horizontal. The pipe is carrying the water $24 \text{ m}^3/\text{min}$ . the pressure of the water at the inlet is 500 kPa, find the pressure of the water at the exit.	2	AP	16
7	State Bernoulli's theorem in terms of energy and head. Determine the flow rate of water through a pipe of 300 mm diameter in an inclined position, where a Venturi meter is inserted, having a throat diameter of 150 mm. The pressure difference between the inlet and throat is measured by a liquid of specific gravity 0.7 in an inverted U tube gives a reading of 260 mm. The head loss between the inlet and throat is 0.3 times the kinetic head of the pipe.	2	AP	16
8	The water is flowing through a pipe having diameters 20 cm and 10 cm at sections 1 and 2 respectively. The rate of flow through pipe is 35 litres/s. The section 1 is 6 m above datum and section 2 is 4 m above datum. If the pressure at section 1 is $39.24 \text{ N/cm}^2$ , find the intensity of pressure at section 2.	2	AP	16

**UNIT III**  
**VISCOUS FLOW AND FLOW THROUGH PIPES**

Shear stress, pressure gradient relationship – Flow of viscous fluid through circular pipe.  
Loss of head due to friction – Minor head losses – Hydraulic gradient and Total energy lines  
– Flow through pipes in series and in parallel – Power transmission through pipes.

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1	Define viscous flow	3	RE	2
2	Define shear stress	3	RE	2
3	Differentiate Laminar flow and turbulent flow	3	UN	2
4	List the significance of Reynolds number.	3	RE	2
5	Air at 20°C flows at 700 cm <sup>3</sup> /s through a 8 cm diameter pipe. Determine, whether the flow is laminar or turbulent.	3	AP	2
6	Write down the Darcy formula.	3	RE	2
7	Write down the chezy's formula.	3	RE	2
8	Differentiate hydraulic gradient line and total energy line.	3	UN	2
9	Draw the velocity and shear stress profile for pipe flow.	3	RE	2
10	Give the physical significance of the friction factor and identify its dependency on Reynold number.	3	RE	2
11	What is flow through pipes?	3	RE	2
12	What are the minor losses? Under what circumstances will they be	3	RE	2
13	What do you understand about the flow through pipes in series and in parallel?	3	RE	2
14	Write the expression for calculating the loss due to sudden expansion of the pipe.	3	RE	2
15	What do you understand about power transmission through pipes?	3	RE	2
<b>PART B</b>				
1	With a neat sketch discuss the various losses in flow through in pipe flow.	3	UN	16
2	The rate of flow of water through a horizontal pipe is 0.25 m <sup>3</sup> /s. The diameter of the pipe which is 20 cm is suddenly enlarged to 40 cm. The pressure intensity in the smaller pipe is 11.772 N/cm <sup>2</sup> . Determine (i) Losses of head due to sudden enlargement, (ii) Pressure intensity in the larger pipe, (iii) Power loss due to enlargement.	3	AP	16

3	A horizontal pipe of diameter 500 mm is suddenly contracted to a diameter of 250 mm. The pressure intensities in the large and smaller pipe is given as 13.734 N/cm <sup>2</sup> and 11.772 N/cm <sup>2</sup> respectively. Find the loss of head due to contraction, if CC = 0.62. Also determine the rate of flow of water.	3	AP	16
4	Three pipes of 400 mm, 200 mm and 300 mm diameter have length of 400 m, 200 m, and 300 m, respectively. They are connected in series to make a compound pipe. The ends of this compound pipe are connected with two tanks whose difference of water levels is 16 m. If co-efficient of friction for these pipes is same and equal to 0.005, determine the discharge through the compound pipe neglecting first the minor losses and then including them.	3	AP	16
5	A main pipe divides into two parallel pipes which again forms one pipe. The length and diameter for the first parallel pipe are 2000 m and 1.0 m respectively, while the length and diameter of 2nd parallel pipe are 2000 m and 0.8 m. Find the rate of flow in each parallel pipe, if total flow in the main is 3.0 m <sup>3</sup> /s. The coefficient of friction for each parallel pipe is same and equal to .005	3	AP	16
6	List out the various major and minor losses occurring for flow through a pipe. Two pipe each of 400 mm long are available for connecting to a reservoir from which a flow of 0.10 m <sup>3</sup> /s is required. If the diameter of two pipes is 0.3 m and 0.15 m, respectively. Determine the ratio of the head loss when the pipes or connected series to the head loss when the pipe are connected in parallel. Neglect the minor losses occurring inside the pipe.	3	AP	16
7	An oil of viscosity 10 poise and specific gravity of 0.6 flows through a horizontal pipe of 30 mm diameter. If the pressure drop in 50 m length of the pipe is 3000 k N/m <sup>2</sup> , determine the following (i) The flow rate of oil (ii) The friction drag over the 50 m pipe length (iii) Power required to maintain the flow (iv) Velocity gradient in the pipe wall	3	AP	16
8	Oil flow through pipe 150 mm in diameter and 650 mm in length with a viscosity of 0.5 m/s. If the kinematic viscosity of oil is 18.7 x 10 <sup>4</sup> m <sup>2</sup> /s, find the power lost in overcoming friction. Take a specific gravity of oil as 0.9.	3	AP	16

## UNIT IV

### BASICS OF THERMODYNAMICS AND FIRST LAW OF THERMODYNAMICS

Fundamentals of thermodynamics. First law of Thermodynamics – Application to closed and open systems – Steady Flow Energy Equation (SFEE) – Simple problems.

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1	Distinguish between ‘Macroscopic energy’ and Microscopic energy’.	4	UN	2
2	Pick up the intensive properties from the following list. (a) Pressure (b) Volume (c) Density (d) Enthalpy (e) Temperature.	4	RE	2
3	Differentiate between point function and Path function.	4	UN	2
4	What is a cycle?	4	RE	2
5	What is the difference between an ideal and actual cycle?	4	UN	2
6	Define Thermodynamic equilibrium.	4	RE	2
7	What is Zeroth law of Thermodynamics? Why is it so called?	4	RE	2
8	Give the physical significance of Internal energy.	4	RE	2
9	State first law of Thermodynamics.	4	RE	2
10	List the limitations of first law of thermodynamics.	4	RE	2
11	What is meant by ‘Hyperbolic Process’?	4	RE	2
12	Compare heat transfer with work transfer.	4	UN	2
13	List any five physical properties of matter which can be used for measurement of temperature.	4	RE	2
14	What are the conditions for the steady flow process?	4	RE	2
15	Write down the equation for first law for a steady flow process.	4	RE	2
<b>PART B</b>				
1	Define an adiabatic process. Show that for a reversible adiabatic process of a given mass of perfect gas: $Pv^\gamma = \text{constant}$ .	4	UN	16
2	A closed system consists of water contained in a cylinder and being stirred by a paddle wheel. During the process, 35 kJ/hr of work was imparted to the system and the internal energy increased to 145 kJ from its initial value of 120 kJ during one hour of stirring. Determine the heat transfer. Is the temperature of the system rising or falling	4	AP	16

3	1 kg of gas is contained in a Piston cylinder assembly at 10 bar. The gas is allowed to expand reversibly until volume becomes twice the initial value, by following $PV^2=C$ . The gas is then cooled at constant pressure until the piston reaches its original position. Finally, heat is supplied to the fluid reversibly, with the piston firmly locked, and due to this the fluid pressure rises to its initial value of 10 bar. If fluid has an initial volume of $0.05 \text{ m}^3$ , determine the network done. Represent the entire process in a p-v diagram	4	AP	16
4	Determine the heat transfer and its direction for a system in which a perfect gas having molecular weight of 6 is compressed from 101.3 k Pa, $20^\circ\text{C}$ to a pressure of 600 k Pa following the law $pv^{1.3}=constant$ . Take specific heat at constant pressure of gas as $1.7 \text{ kJ/kg.K}$ .	4	AP	16
5	Air at $105 \text{ m/s}$ and $1.25 \text{ kg/m}^3$ enters a Gas Turbine with an inlet area of $0.05 \text{ m}^2$ . The air stream exits from the Gas Turbine at $135 \text{ m/s}$ and $0.67 \text{ kg/m}^3$ . During the flow process, the air losses $27 \text{ kJ/kg}$ of heat, and its specific enthalpy drops by $145 \text{ kJ/kg}$ . Determine the following (i) Mass flow rate of air through the turbine, (ii) Turbine exit area, (iii) Power developed by the turbine.	4	AP	16
6	Air at a temperature of $15^\circ\text{C}$ passes through a Heat exchanger at a velocity of $30 \text{ m/s}$ where its temperature has raised to $800^\circ\text{C}$ . It then enters a Turbine with the same velocity of $30 \text{ m/s}$ and expands until its temperature falls to $650^\circ\text{C}$ . On leaving the Turbine, the air is taken at a velocity of $60 \text{ m/s}$ to a Nozzle where it expands until its temperature has fallen to $500^\circ\text{C}$ . If the airflow rate is $2 \text{ kg/s}$ , determine the following, (i) Power output from the turbine assuming no heat loss, (ii) Rate of heat transfer to the air in heat exchanger and (iii) Velocity at the exit from nozzle assuming no heat loss. Give a schematic diagram for the arrangement.	4	AP	16
7	The nozzle is a device for increasing the velocity of a steadily flowing steam. At the inlet to a certain nozzle, the enthalpy of the fluid passing is $3000 \text{ kJ/kg}$ and the velocity is $60 \text{ m/s}$ . At the discharge end, the enthalpy is $2762 \text{ kJ/kg}$ . The nozzle is horizontal and there is negligible heat loss from it. (1) Find the velocity at exit from the nozzle. (2) If the inlet area is $0.1 \text{ m}^2$ and the specific volume at the inlet is $0.187 \text{ m}^3/\text{kg}$ , find the mass flow rate. (3) If the specific volume at the nozzle exit is $0.498 \text{ m}^3/\text{kg}$ , find the exit area of the nozzle.	4	AP	16
8	Air is compressed by an adiabatic compressor from $100 \text{ kPa}$ and $12^\circ\text{C}$ to a pressure of $800 \text{ kPa}$ at a steady rate of $0.2 \text{ kg/s}$ . If the isentropic efficiency of the compressor is 80 percent, determine the exit temperature of air and the required power input to the compressor.	4	AP	16

**UNIT V**  
**SECOND LAW OF THERMODYNAMICS AND ENTROPY**

Second Law of thermodynamics. Reversibility – Irreversibility, reversible cycle – Heat engine, heat pump and refrigerator. Principle of entropy.

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1	Write the Kelvin Plank statement.	5	RE	2
2	State Clausius statement of II law of thermodynamics.	5	RE	2
3	What do you understand about PMM-II?	5	RE	2
4	A heat engine operates between two temperature limits T1 and T2 with 40% efficiency. What will the COP of a refrigerator operating between the same temperature limits?	5	UN	2
5	A reversible heat engine operates between a source at 800°C and a sink at 30°C. What is the least rate of heat rejection per kW network output of the engine?	5	UN	2
6	A heat engine is supplied with 2512 kJ/min of heat at 650°C. heat rejection takes place at 100°C. Specify which of the following heat rejection represents a reversible, irreversible or impossible result (a) 867 kJ/min (b) 1015 kJ/min	5	UN	2
7	A domestic food freezer maintains a temperature of -15°C. The ambient air temperature is 30°C. If the heat leaks into the freezer 1.75 kJ/s continuously, what is the least power necessary to pump this heat out continuously?	5	UN	2
8	Draw a schematic of a heat pump	5	RE	2
9	Differentiate between a Refrigerator and a heat pump.	5	UN	2
10	State: Carnot theorem and its corollaries	5	RE	2
11	Define irreversibility.	5	RE	2
12	Comparison between reversibility and inconvertibility.	5	UN	2
13	In an isothermal process, 1000 kJ of work is done by the system at a temperature of 200°C. What is the entropy change of this process?	5	UN	2
14	State the principle of increase of entropy.	5	RE	2
15	Define exergy.	5	RE	2

**PART B**

1	A reversible heat engine working between two thermal reservoirs at 875 K and 315 K drives a reversible refrigerator which operates between the same 315 K reservoir and a reservoir at 260 K. The engine is supplied 2000 kJ of heat and the net work output from the composite system is 350 kJ. Make the calculation for the heat transfer to the refrigerator and the net heat interaction with the reservoir at 315 K temperature.	5	AP	16
2	Two reversible heat engines A and B are arranged in series. Engine A rejects heat directly to engine B. Engine A receives 200 kJ at a temperature of 421°C from a hot source, while engine B is in communication with cold sink at a temperature of 4.4°C. If the work output of A is twice that of B, determine the following (i) Intermediate temperature between A and B, (ii) The efficiency of heat engine and (iii) Heat rejected to the cold sink.	5	AP	16
3	A reversible heat engine operates between two reservoirs at temperatures of 600°C and 40°C, respectively. The engine drives a reversible refrigerator that operates between reservoirs at 40°C and -20°C, respectively. The heat transferred to the heat engine is 2000 kJ, and the net work output of the combined plant is 360 kJ. Determine (i) Heat transfer to the refrigerant, and the net heat transfer to the reservoir at 40°C. (ii) Reconsider case (i), using the efficiency of the heat engine, and COP of refrigerator as 40% of their maximum value.	5	AP	16
4	A heat pump working on the Carnot cycle takes in heat from a reservoir at 5°C and delivers heat to a reservoir at 60°C. The heat pump is driven by a reversible heat engine which takes heat from reservoir at 840°C and rejects heat to a reservoir at 60°C. The reversible heat engine also drives a machine that absorbs 30 kW. If the heat pump extracts 17 kJ/s from the reservoir at 5°C, determine (1) The rate of heat supply from 840°C source, and (2) The rate of heat rejection to 60°C sink.	5	AP	16
5	An inventor claims to have developed a refrigerator that maintains the refrigerated space at 35°F while operating in a room where the temperature is 75°F and that has a COP of 13.5. Is this claim reasonable?	5	AP	16
6	An Aluminum block ( $C = 400 \text{ J/kg K}$ ) with a mass of 5 kg is initially at 40°C and is kept inside a room at 20°C. It is cooled reversibly by transferring heat to a completely reversible cycle heat engine until the block reaches 200°C. The room air serves as a constant temperature sink for the engine. Determine the following, (i) Entropy change for the block, (ii) Entropy change of the room and (iii) Work done by the engine.	5	AP	16
7	Explain the term reversibility as applied to a thermodynamics process.	5	UN	16
8	Briefly discuss about the concept of entropy.	5	UN	16

**RE – Remember, UN – Understanding, AP – Apply**



# UNITED INSTITUTE OF TECHNOLOGY

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Periyanaickenpalayam, Coimbatore – 641020



## 24ECPC307- DIGITAL ELECTRONICS AND MICROPROCESSOR

**UNIT I**  
**DIGITAL FUNDAMENTALS AND COMBINATIONAL CIRCUITS**

1's and 2's complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, Karnaugh map Minimization. Binary Parallel Adder -Multiplexer, Demultiplexer, Decoder, Priority Encoder.

Q.No	Question	C O	BTL	Mar ks
<b>PART A</b>				
1.	Define Combinational Circuits.	1	RE	2
2.	What is 1's complement of a number?	1	RE	2
3.	What is 2's complement of a number?	1	RE	2
4.	Convert $(11010111)_2$ to Excess 3 and Gray codes.	1	UN	2
5.	What is the significance of BCD code?	1	RE	2
6.	What is a karnaugh map? Write the advantages and disadvantages of K-map method	1	RE	2
7.	What are called don't care conditions?	1	RE	2
8.	Explain the design procedure for combinational circuit	1	UN	2
9	What is binary parallel adder?	1	RE	2
10	Define Decoder. What is binary Decoder?	1	RE	2
11	What is priority Encoder?	1	RE	2
12	Differentiate decoder from a de multiplexer	1	UN	2
13	Define multiplexer.	1	RE	2
14	What is a prime implicant?	1	RE	2
15	Mention the application Of MUX.	1	RE	2
<b>PART B</b>				
1.	(i)Simplify the following switching functions using Karnaugh map method and realize expression using gates $F(A,B,C,D) = \sum m(0,3,5,7,8,9,10,12,15)$ . (ii) Explain in detail about 4 bit parallel adder.	1	UN	16
2	Use the K-map method to find the minimal function for $F(A,B,C,D,E) = \sum m(1,4,6,10,20,22,24,26) + \sum d(0,11,16,27)$ . Draw the circuit of the minimal expression using basic gates	1	UN	16
3	Construct a combinational circuit to convert binary to gray code.	1	AP	16
4	Design a combinational circuit to convert BCD to Excess 3.	1	AN	16
5	Explain about decoders with necessary diagrams. (2 to 4 and 3 to 8).	1	UN	16
6	Explain the logic diagram of a 4 – input priority encoder.	1	UN	16
7	(i)Implement the Boolean expression using MUX $F(A,B,C,D) = \sum m(0,1,5,6,8,10,12,15)$ . (ii)Implement 32: 1 Multiplexer using 8:1 Multiplexer.	1	AN	8+8
8	(i) Draw and explain the working of demultiplexer (ii)Make use of Demultiplexer Implement the following functions $f_1(A,B,C) = \sum m(1,5,7)$ , $f_2(A,B,C) = \sum m(3,6,7)$	1	AN	16

**UNIT II**  
**SEQUENTIAL CIRCUITS**

Flip flops – SR, JK, T, D, design of clocked sequential circuits - Shift registers, Universal Shift Register, counters. Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1.	Difference between Combinational & Sequential Circuits.	2	UN	2
2.	What are the classifications of sequential circuits?	2	RE	2
3.	Define a flip flop.	2	RE	2
4.	Compare latch and flip-flop	2	UN	2
5.	State few application of flip-flop	2	RE	2
6.	What is the operation of JK flip-flop	2	RE	2
7.	Define race around condition.	2	RE	2
8.	What is triggering? What is the need for trigger in flip-flop?	2	RE	2
9	What is the drawback of SR Flip-flop? How is this minimized?	2	RE	2
10	What is counter?	2	RE	2
11	Give the comparison between synchronous & Asynchronous counters.	2	UN	2
12	Define shift registers.	2	RE	2
13	State the applications of shift register	2	RE	2
14	Sketch the 4-bit Johnson counter.	2	RE	2
15	Interpret the significance of state assignment	2	UN	2
<b>PART B</b>				
1.	Define flip-flop and describe the operations of various types of flip-flops. Enumerate the applications where flip-flops are used.	2	AP	16
2.	Explain about JK flip-flop with truth table, characteristic equation and input & output waveforms.	2	AP	16
3	Explain the working of synchronous up and down counter	2	AP	16

4.	Realize SR flip-flop using D flip-flop and JK flip-flop.	2	AP	16
5	With a D flipflop Design a synchronous decade counter	2	AP	16
6	What is meant by universal Shift register? Explain the principle of operation 4-bit universal shift register	2	AP	16
7	Draw and explain 4 bit SISO and PIPO shift register	2	AP	16
8	Design the sequential circuit specified by the following state diagram using T flip flops 	2	AP	16

### UNIT III

#### HAZARDS AND MEMORY DEVICES

Hazards , Essential Hazards ,Pulse mode sequential circuits, Design of Hazard free circuit. Basic memory structure – ROM -PROM – EPROM – EEPROM –EAPROM, RAM – Static and dynamic RAM - Programmable Logic Devices – Programmable Logic array (PLA)-Programmable array logic (PAL).

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1.	What are Hazards?	3	RE	2
2.	Compare the Static-0 and Static-1 hazards.	3	UN	2
3.	What is the cause of essential hazard?	3	RE	2
4.	What is a PAL? How it differs from PLA?	3	UN	2
5.	List basic types of Programmable Logic Devices	3	RE	2
6.	How can the hazards in combinational circuit can be removed?	3	RE	2
7.	Define a memory cell	3	RE	2
8.	What is volatile memory? Give example	3	RE	2

9	What is PLA?	3	RE	2
10	What is the advantage of PLA over ROM	3	UN	2
11	Define PLD	3	RE	2
12	What is ROM?	3	RE	2
13	Define PROM and List its types	3	RE	2
14	Define a memory location.	3	RE	2
15	Compare static and Dynamic RAM	3	UN	2
<b>PART B</b>				
1.	Discuss hazards in digital circuits, including static hazards, dynamic hazards, and essential hazards, supported by clear diagrams.	3	UN	16
2.	Explain the various ROM organization and give the uses for each types.	3	UN	16
3	Draw a Dynamic RAM Cell. Explain its operation and also mention the advantages of DRAM over SRAM.	3	UN	16
4.	Describe the concept ,working and application of the PLD.	3	UN	16
5	Explain detail about PLA and PAL	3	UN	16
6	Design a combinational circuit using a ROM. The circuit accept a three bit number and outputs a binary no equal to the square of the input number.	3	AP	16
7	Design a BCD to Excess 3 code convertor using PLA and PAL	3	AP	16
8	Briefly explain EEPROM, EPROM and EAPROM	3	UN	16

**UNIT IV**  
**8086 PROCESSOR**

Hardware Architecture, pin diagram – Functional Building Blocks of Processor – Memory organization – I/O ports and data transfer concepts– Instruction - format and addressing modes , Interrupts Timing Diagram

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				

1.	What is microprocessor?	4	RE	2
2.	What is the function of accumulator?	4	RE	2
3.	Define interfacing	4	RE	2
4.	Define addressing mode.	4	RE	2
5.	List out the functional parts of 8086 CPU	4	RE	2
6.	What are the three groups of signals in 8086?	4	RE	2
7.	Draw the format of 8086 flag register.	4	RE	2
8.	What are the advantages of segmented memory?	4	RE	2
9	What are pointers and index registers?	4	RE	2
10	Give any four pin definitions for maximum mode.	4	RE	2
11	List the advantages and applications of microprocessor	4	RE	2
12	Write the interrupt priorities of 8086.	4	RE	2
13	Differentiate logical address and functional address	4	UN	2
14	What is the function of auxiliary carry flag in 8086?	4	RE	2
15	What are the two operating modes of 8086?	4	RE	2
<b>PART B</b>				
1.	Describe the internal architecture of 8086 microprocessor with neat diagrams	3	AN	16
2.	Explain the pin diagram of 8086	3	UN	16
3	Write briefly about interrupts and its types. Explain the control flow of the microprocessor in detail when interrupt occur	3	AP	16
4.	With suitable example, explain the various addressing modes used in instruction set of 8086	3	AP	16
5	Explain in detail about memory organization	3	UN	16
6	Explain the bus interfacing unit and execution unit of 8086	3	UN	16
7	Explain the functions of i. HLDA ii. RQ/GT0 iii. DEN iv. ALE (b) Draw and explain the minimum mode of 8086	3	UN	16
8	Draw the input and output timing diagram of maximum mode of operation in 8086	3	UN	16

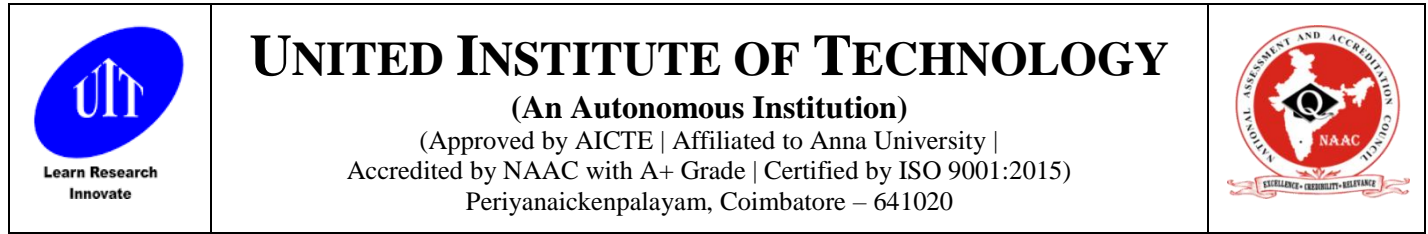
**UNIT V**  
**PROGRAMMING PROCESSOR**

Assembly language format – Data transfer, data manipulation & control instructions – Programming: Loop structure with counting & Indexing – Look up table - Subroutine instructions – stack.

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1.	Define the term assembly language in the context of the 8086 microprocessor.	5	RE	2
2.	Give comparison of assembly language , machine language and high level language	5	RE	2
3.	List any four data transfer instructions used in 8086 assembly.	5	RE	2
4.	Name the registers commonly used for indexing in 8086	5	RE	2
5.	What is the purpose of the MOV instruction?	5	RE	2
6.	Recall any two control transfer instructions in 8086	5	RE	2
7.	State the use of the PUSH and POP instructions in stack operations.	5	RE	2
8.	Label the different sections of a typical 8086 assembly language program.	5	RE	2
9	When is the LOOP instruction used in 8086?	5	RE	2
10	Explain how the LOOP instruction works with a counter register.	5	UN	2
11	Summarize the difference between near and far subroutines.	5	UN	2
12	Interpret the instruction MOV AL, [BX] and describe what it does.	5	UN	2
13	Compare CALL and JMP instructions in terms of subroutine handling.	5	UN	2
14	Classify the different types of data manipulation instructions in 8086.	5	UN	2
15	Give an example of how stack is used during a subroutine call	5	UN	2
<b>PART B</b>				
1.	Describe the different types of data transfer, data manipulation, and control instructions in 8086. Give examples and explain their syntax and purpose	5	UN	16
2.	Summarize the working of stack operations (PUSH, POP, CALL, RET) in 8086. Illustrate with timing and memory diagrams.	5	UN	16
3	(i) Explain briefly about subroutine with example. (ii) Summarize the operation of stack with suitable example.	5	UN	16

4.	(i)Distinguish between call and subroutine (ii)Describe what is meant by counting, looping and indexing.	5	UN	16
5	List the advantages of modular programming and illustrate the process by which the modules assembled separately are linked together and programs are prepared for execution	5	UN	16
6	Write an 8086 assembly language program to search for a number in a lookup table and display its position if found.	5	AP	16
7	Implement a program using 8086 assembly to copy a block of data from one memory location to another using LODSB and STOSB	5	AP	16
8	Construct a subroutine in 8086 assembly for calculating the factorial of a number using stack and call-return instructions.	5	AP	16

**\*\*\*END\*\*\***



## 24RAPC301 – ENGINEERING MECHANICS

### QUESTION BANK

**II YEAR  
ROBOTICS AND AUTOMATION**

**III SEMESTER  
ACADEMIC YEAR 2025 – 2026**

<b>PREPARED BY</b>	<b>VERIFIED BY</b>	<b>APPROVED BY</b>

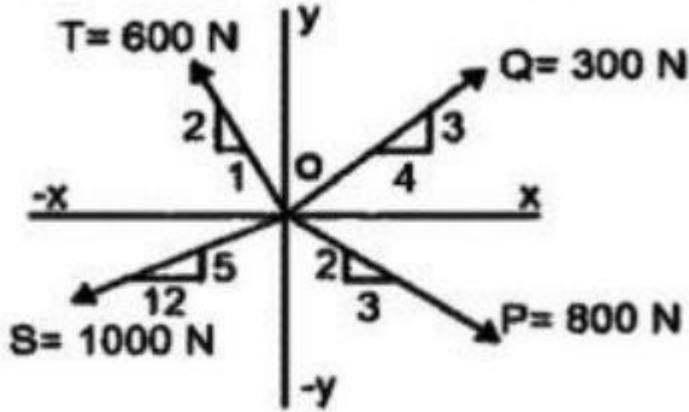
## UNIT I STATICS OF PARTICLES

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles - Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

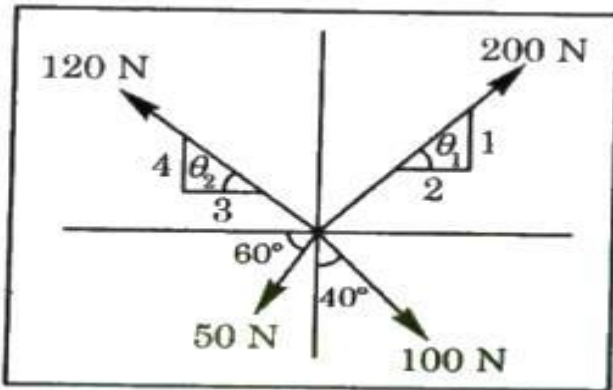
Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1.	Define Engineering Mechanics.	1	RE	2
2.	Define Force.	1	RE	2
3.	What is the difference between the resultant force and equilibrant force?	1	UN	2
4.	State law of parallelogram.	1	RE	2
5.	State the principle of transmissibility of force.	1	RE	2
6.	Define space and time.	1	RE	2
7.	What are the minimum requirements for equilibrium of a particle in space?	1	UN	2
8.	Two forces of 400 N and 600 N act at an angle $60^\circ$ to each other. Determine the resultant in magnitude and direction.	1	RE	2
9.	State triangle law of forces.	1	RE	2
10.	State Lami's theorem.	1	RE	2
11.	What is a free body diagram?	1	RE	2
12.	State the principle of resolution.	1	RE	2
13.	Define Equilibrium.	1	UN	2
14.	State Newton's third law.	1	RE	2
15.	Define unit vector.	1	RE	2

**PART B**

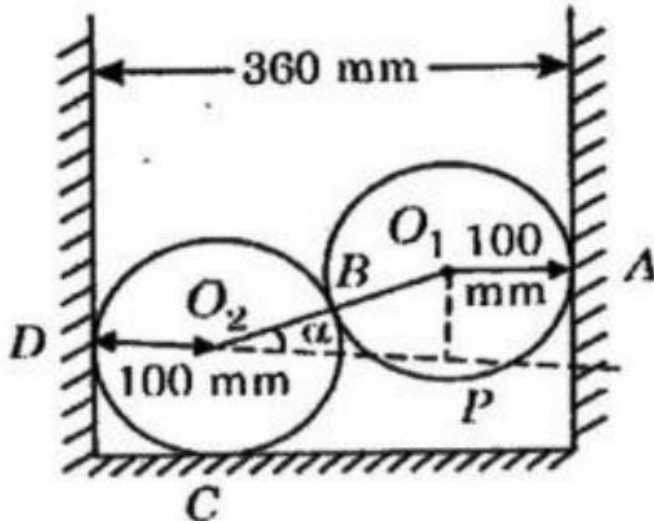
1. Calculate the resultant force and its direction. For the Fig. shown. 1 UN 16



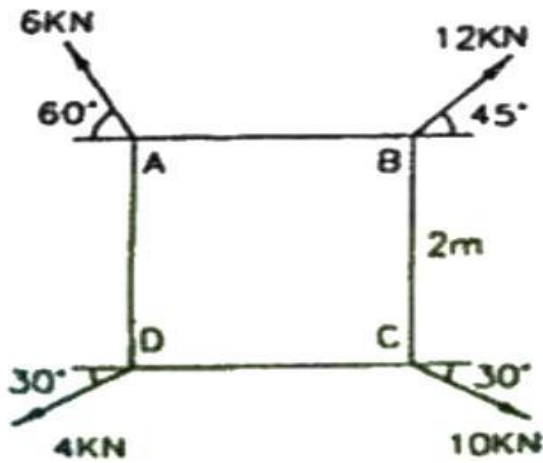
2. Coplanar concurrent forces are acting at a point as shown in fig. Find the magnitude and direction of the resultant. 1 UN 16



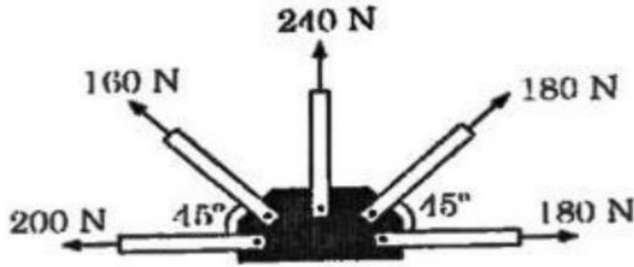
3. Two identical rollers each of 50 N are supported by an inclined plane and a vertical wall as shown in figure. Find the reactions at the point of support A, B and C, assume all the surfaces to be smooth. 1 AP 16



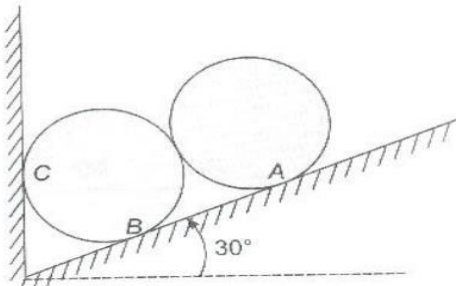
4. Four forces of magnitude and direction acting on a square ABCD of side 2m as shown in Fig. Calculate the magnitude and direction of the resultant and locate the resultant. 1 AP 16



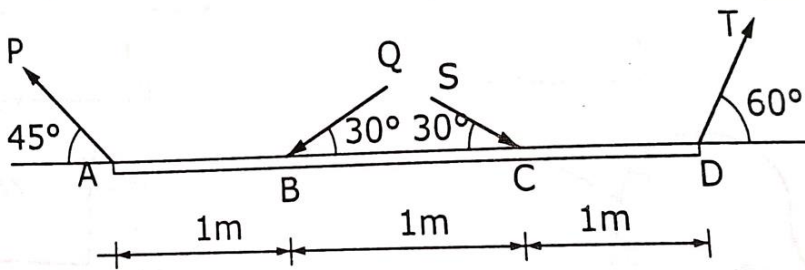
5. Calculate the resultant force and its direction. For the Fig. shown 1 AP 16



6. Two identical rollers each of weight 65N are supported by an inclined plane and a vertical wall as shown in fig. Find the reactions at the points of supports A, B, C and between the spheres. Assume all the surfaces are smooth. 1 AP 16



7. ABCD is a weightless rod under the action of four forces 10N, 4N, 8N and 12 N as shown in fig. Calculate the magnitude and direction of the resultant and locate the resultant. 1 AP 16



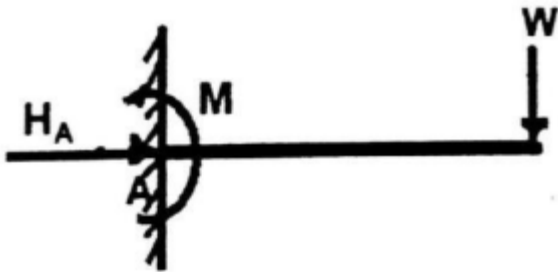
8. Five forces are acting on a particle, the magnitude of the forces are 300 N, 600 N, 700 N, 900 N and P. And their respective angle with the horizontal are  $0^\circ$ ,  $60^\circ$ ,  $135^\circ$ ,  $210^\circ$  and  $270^\circ$ . If the vertical component of all the forces is -1000 N, find the value of P. Also calculate the magnitude and direction of the resultant force assuming that first force acts towards the point, when all other forces act away from the point. 1 AP 16

**UNIT II**  
**EQUILIBRIUM OF RIGID BODIES**

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force –Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections.

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1.	State Varignon's theorem or State the principle of moments.	2	RE	2
2.	Define the term couple?	2	UN	2
3.	What are the common types of supports used in two dimensions?	2	RE	2
4.	What are the characteristics of a couple?	2	UN	2
5.	Define moment of a force?	2	UN	2
6.	List out the types of loads.	2	RE	2
7.	State polygon law of equilibrium.	2	RE	2
8.	Why the couple moment is said to be a free vector?	2	RE	2
9.	What are the reactions at a fixed support of a plane beam that are possible?	2	RE	2
10.	State the necessary and sufficient conditions for equilibrium of rigid bodies in two dimensions?	2	RE	2
11.	What is statically determinate structure?	2	RE	2
12.	Define equilibrant?	2	RE	2
13.	What are the common types of supports used in three dimensions?	2	UN	2

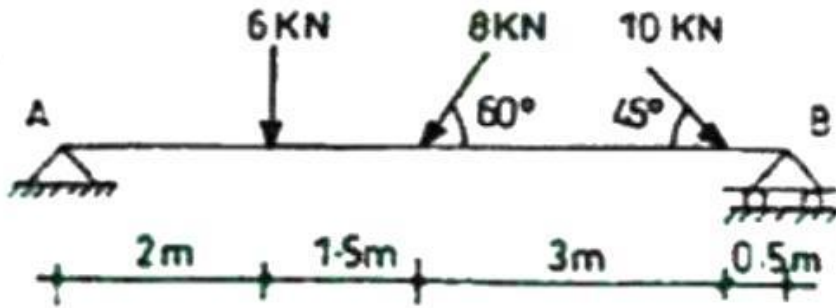
14. Sketch the idealized, graphical and reaction of a cantilever support at a point. 2 RE 2



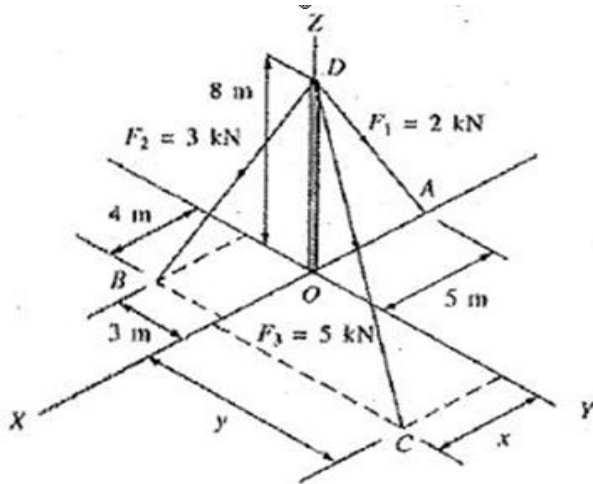
15. State the requirements for equilibrium of a body acted upon by a parallel force system? 2 UN 2

**PART B**

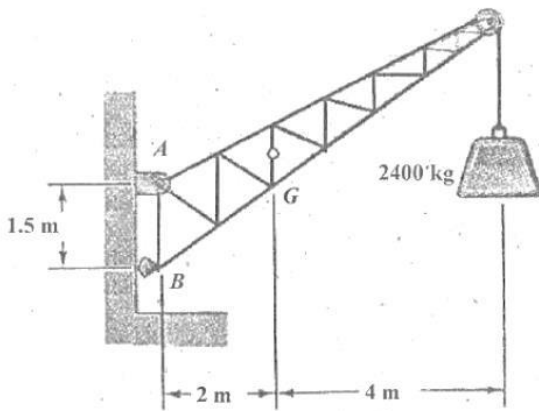
1. Determine the support reaction of the beam shown in fig. 2 App 16



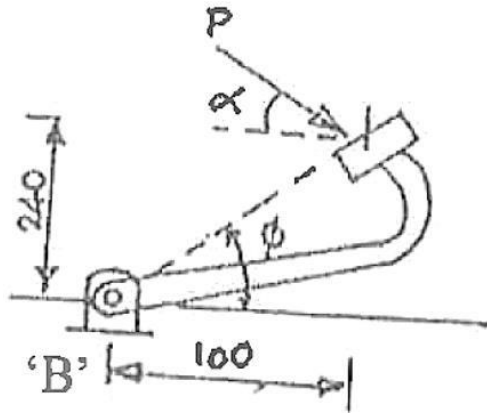
2. A pole is held in place by three cables. If the force of each cable acting on the pole is shown, determine the position  $(x, y, 0)$  for fixing cable DC so that the resultant force exerted on the pole is directed along its axis. 2 AP 16



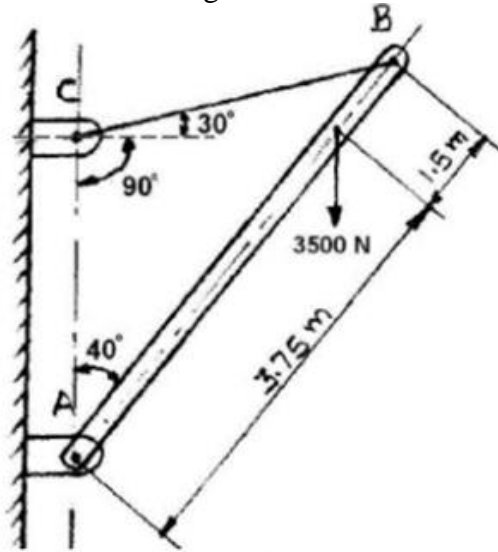
3. A fixed crane has a mass of 1000 kg and it is used to lift a 2400 kg weight. It is held in place by a pin at A and rocker at B. The centre of gravity of the crane is located at G. Determine the components of reaction at A and B. 2 AP 16



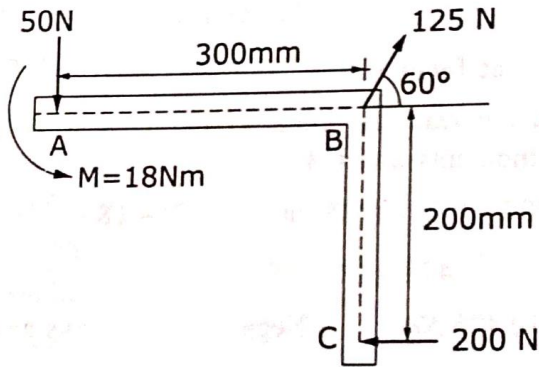
4. For the brake pedal shown in fig, determine the magnitude and direction of the smallest force P which has a 104 Nm clockwise moment about B. 2 AP 16



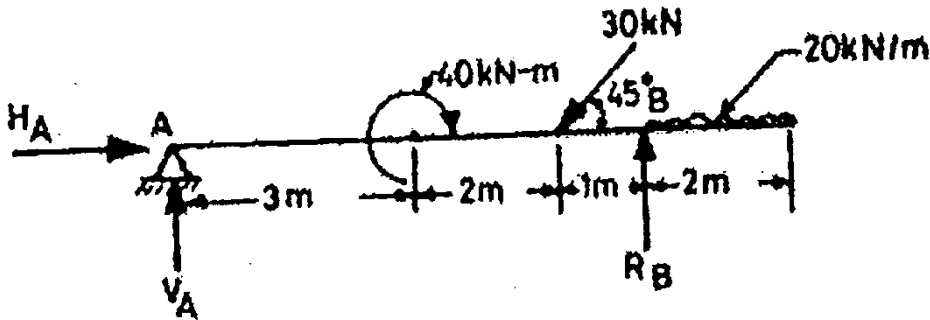
5. Determine the tension in cable BC and reaction at A as shown in fig. Neglect the self-weight AB. 2 AP 16



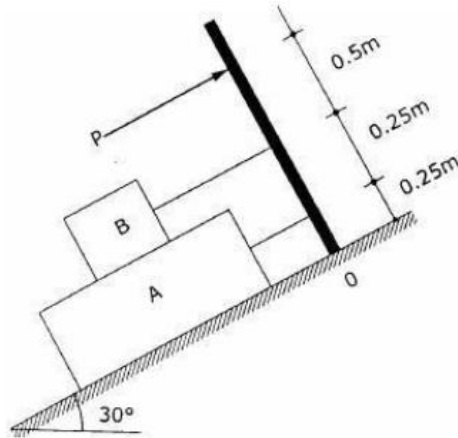
6. The three forces and a couple of magnitude,  $M = 18 \text{ Nm}$  are applied to an angled bracket as shown in fig. 2 AP 16
- (i) Find the resultant of this system of forces
- (ii) Locate the points where the line of action of the resultant intersects line AB and line BC.



7. Determine the support reactions of the beam as shown in fig. 2 AP 16



8. Blocks A and B of weight 200N and 100N respectively, rest on a 30° inclined plane and are attached to the post which is held perpendicular to the plane by force P, parallel to the plane, as shown in fig. Assume that all surfaces are smooth and that the cords are parallel to the plane. Determine the value of P. Also find the Normal reaction of Blocks A and B.



**UNIT III**  
**DISTRIBUTED FORCES**

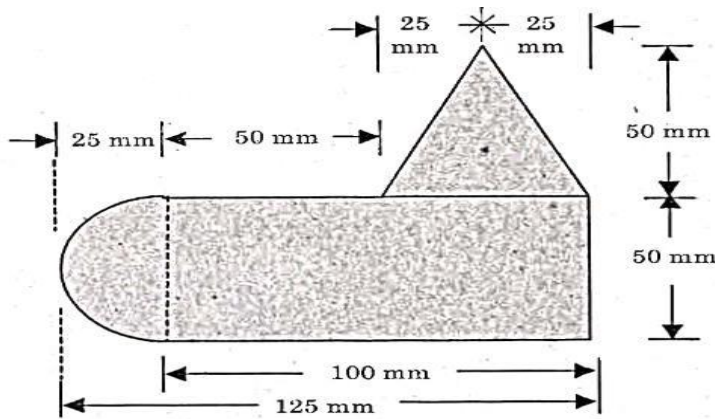
Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration, Theorems of Pappus-Guldinus, Distributed Loads on Beams. Moments of Inertia of Areas - Determination of the Moment of Inertia of an Area by Integration, Polar Moment of Inertia, Radius of Gyration of an Area, Parallel Axis Theorem, Moments of Inertia of Composite Areas.

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1.	What is meant by centre of gravity?	3	RE	2
2.	What is meant by centroid?	3	RE	2
3.	Define Radius of Gyration.	3	RE	2
4.	What is parallel axes theorem for moment of inertia?	3	RE	2

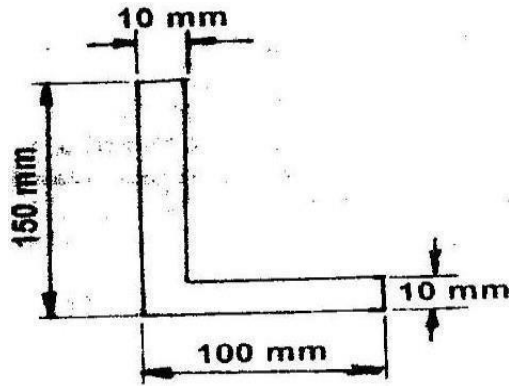
5.	What is perpendicular axes theorem for moment of inertia?	3	RE	2
6.	What is product of inertia?	3	RE	2
7.	What is principal moment of inertia?	3	RE	2
8.	What is mass moment of inertia?	3	RE	2
9.	Define Radius of Gyration	3	RE	2
10.	State Pappus theorem	3	RE	2
11.	State Guldinus theorem.	3	RE	2
12.	When will the product of inertia become zero?	3	UN	2
13.	When will the centroid and centre of mass coincides?	3	UN	2
14.	What are the various methods to find centre of gravity?	3	RE	2
15.	State the relationship between the second moment of area and mass moment of inertia for a thin uniform plate.	3	RE	2

**PART B**

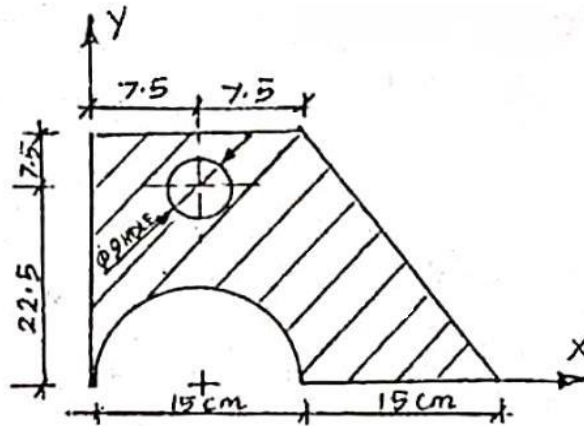
1. Find the centroid of a section shown in Fig below about the centroidal Axes. (Dimensions in mm)



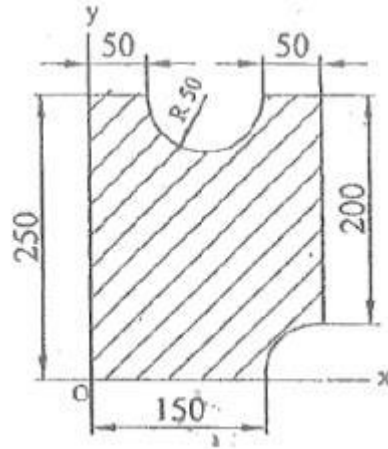
2. An area in the form of L section is shown in figure below Find the moments of Inertia  $I_{xx}$ ,  $I_{yy}$ , and  $I_{xy}$  about its centroidal axes. Also determine the principal moments of inertia. 3 AP 16



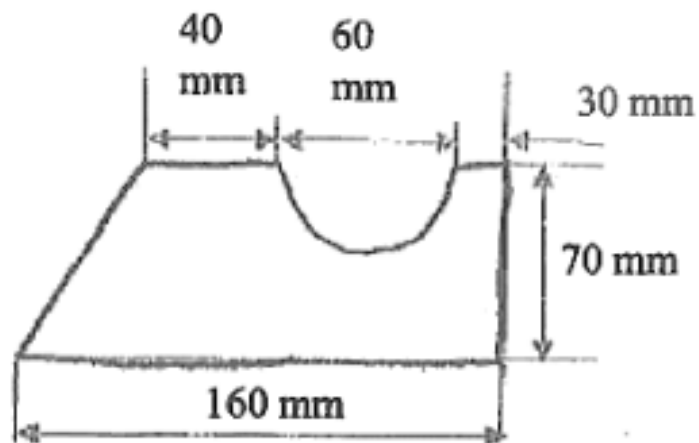
3. Locate the centroid of the area shown in figure below. The dimensions are in mm. 3 AP 16



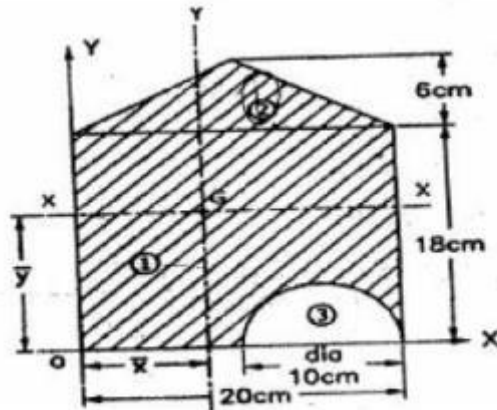
4. Locate the centroid of the shaded area shown in fig. The dimensions are in mm. 3 AP 16



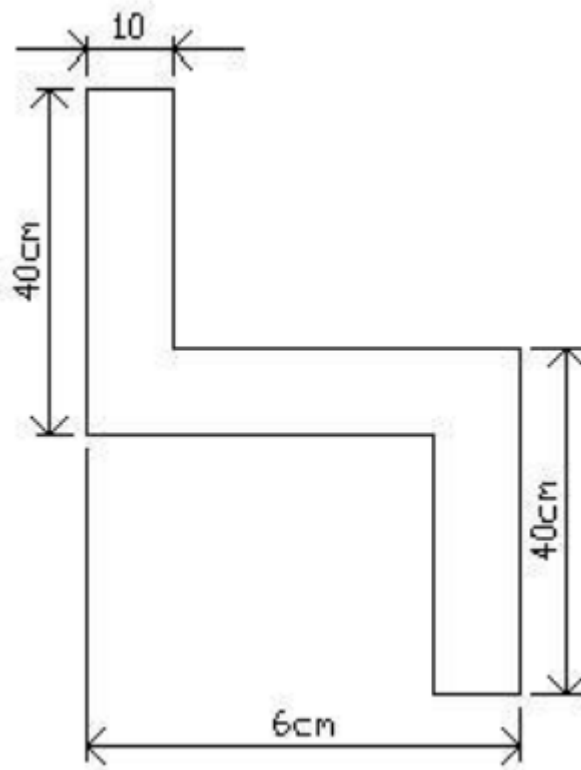
5. Find the moment of inertia of the centroidal axes for the section shown in fig. 3 AP 16



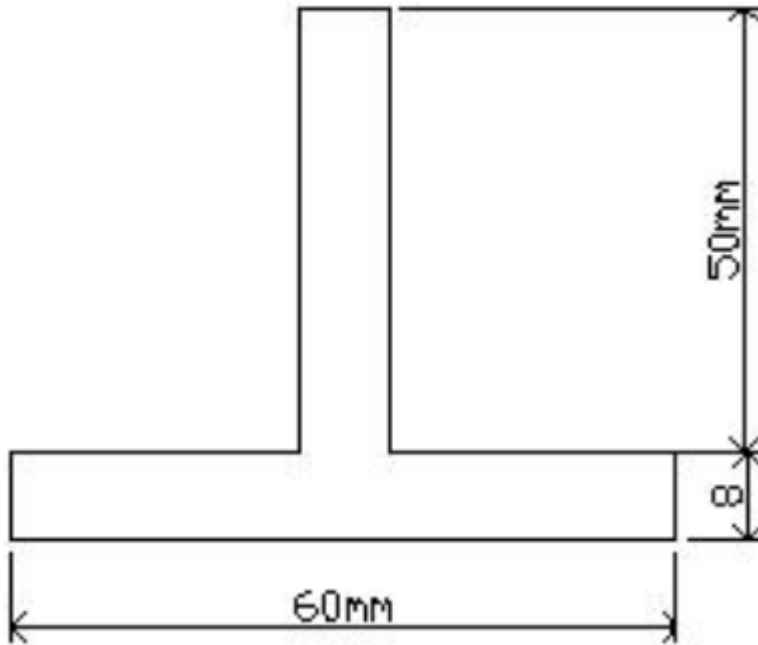
6. Locate the centroid of the shaded area shown in fig. The dimensions are in mm. 3 AP 16



7. Find Moment of Inertia about the co-ordinate axes of plane area shown in fig. 3 AP 16



8. Find the moment of inertia of the centroidal axes for the section shown in fig. 3 AP 16



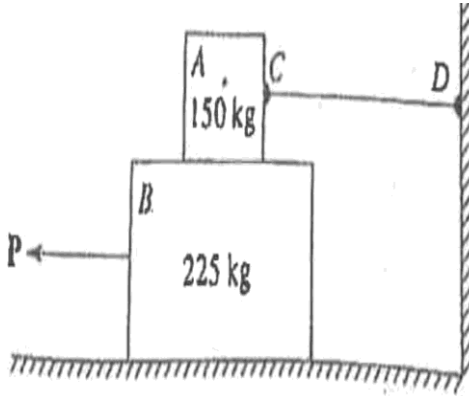
**UNIT IV**  
**FRICITION**

The Laws of Dry Friction, Coefficients of Friction, Angles of Friction, Wedge friction, Wheel Friction, Rolling Resistance, Ladder friction.

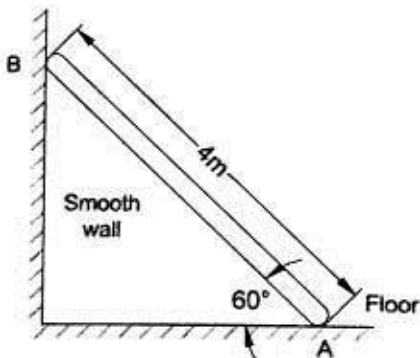
Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1.	Define Friction.	4	RE	2
2.	What are the types of Friction?	4	RE	2
3.	Write about dry friction and its types.	4	RE	2
4.	Define limiting friction.	4	UN	2
5.	Define Co-efficient of friction.	4	RE	2
6.	Define Angle of friction.	4	RE	2
7.	What is angle of repose?	4	RE	2
8.	When do we say that the motion of a body is impending?	4	RE	2
9.	Define Rolling resistance.	4	UN	2
10.	What is co-efficient of rolling resistance?	4	RE	2
11.	Name any three laws of static friction.	4	RE	2
12.	Write the relationship between the Co-efficient of friction and Angle of friction.	4	RE	2
13.	Tell us about the Sliding friction and Rolling friction.	4	RE	2
14.	Write about dry friction and its types.	4	RE	2
15.	Define Wedge friction.	4	RE	2

## PART B

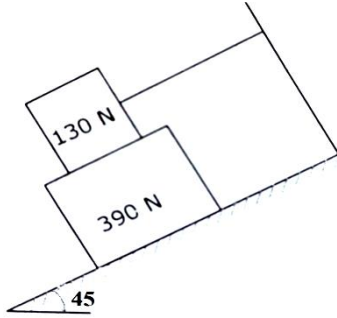
1. Determine the smallest force  $P$  required to move the block  $B$  if block  $A$  is restrained by a cable  $CD$  as shown in Fig. The co-efficient of friction between all surfaces is  $1/4$  4 AP 16



2. A ladder of weight 1000 N and length 4m rests as shown in Fig. If a 750 N weight is applied at a distance of 3m from the top of ladder, it is at the point of Sliding. Determine the coefficient of friction between ladder and the floor. 4 AP 16

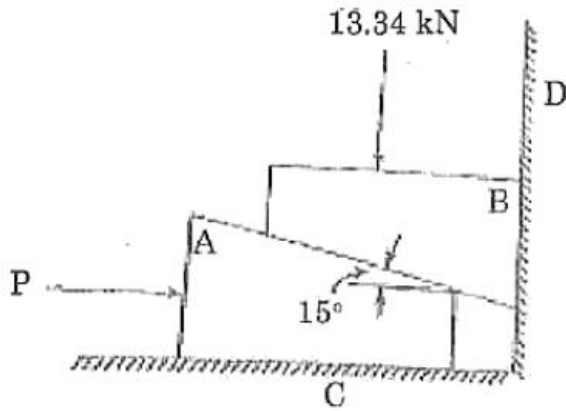


3. Find tension and normal reactions for the blocks shown in Fig. The co-efficient of friction between all surfaces is  $1/3$ . 4 AP 16



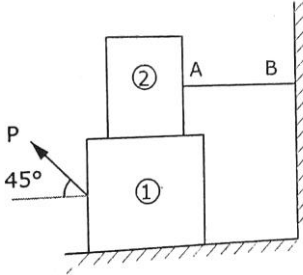
4. A ladder 5 m long rests on horizontal ground and leans against a smooth vertical wall at an angle of  $70^\circ$  with the horizontal. The weight of the ladder is 900 N and acts at the middle. The ladder is at the point of sliding, when a man is weighing 750 N stands on a rung 1.5 m from the bottom of the ladder. Calculate the coefficient of friction between the ladder and the floor. 4 AP 16

5. Determine the smallest force  $P$  required to lift the 13.34 kN load shown in fig. The coefficient of static friction between A and C and B and D is 0.3 and that between A and B is 0.4. 4 AP 16



6. A block overlying a  $10^\circ$  wedge on a horizontal floor and leaning against a vertical wall and weighing 1500 N is to be raised by applying a horizontal force to the wedge. Assuming co-efficient of friction between all the surfaces in contact to be 0.3, determine the minimum horizontal force to be applied to raise the block. 4 AP 16

7. Block (2) rests on block (1) and is attached by a horizontal rope AB to the wall as shown in fig. What force P is necessary to cause motion of block (1) to impend? The co-efficient of friction between the blocks is  $1/4$  and between the floor and block (1) is  $1/3$ . Mass of blocks (1) and (2) are 14 kg and 9 kg respectively.



8. A 100 N force acts on a 300 N block placed on an inclined plane as shown in fig. The Coefficients of friction between the block and the plane are  $\mu_s = 0.25$  and  $\mu_k = 0.20$ . Determine whether the block is in equilibrium, and find the value of the friction force.

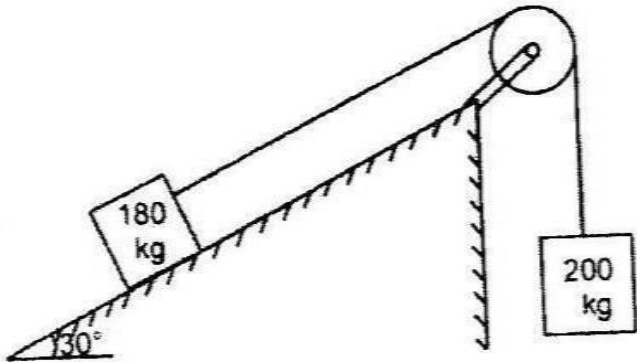
**UNIT V**  
**DYNAMICS OF PARTICLES**

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods - Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact of bodies.

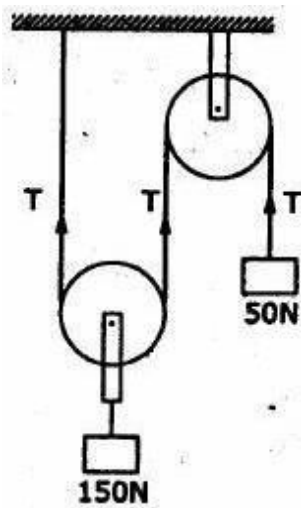
Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1.	State D' Alembert's principle.	5	UN	2
2.	Write the work energy equation of particles	5	RE	2
3.	State the principle of conservation of linear momentum.	5	UN	2
4.	Define uniformly accelerated motion.	5	RE	2
5.	What is uniform motion?	5	RE	2
6.	What is dynamic equilibrium?	5	RE	2
7.	State the principal of work and energy.	5	UN	2
8.	A train running at 80 km/h is brought to a standing halt after 50 seconds. Find retardation and the distance travelled by the train before it comes to a halt	5	UN	2
9.	Define angular acceleration.	5	RE	2
10.	Define instantaneous center of rotation.	5	RE	2
11.	Define angular displacement.	5	RE	2
12.	Explain rotation about a fixed axis.	5	RE	2
13.	What are the types of Translation in rigid body motion.	5	RE	2
14.	Name the types of Plane rigid body motion.	5	RE	2
15.	When a screw is said to be self locking?	5	UN	2

**PART B**

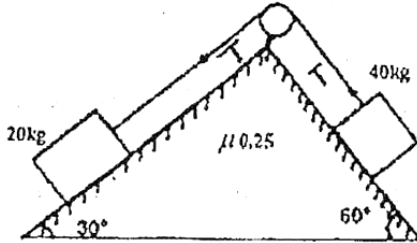
1. A block and pulley system is shown in fig below. The coefficient of kinetic friction between the block and the plane is 0.25. The pulley is frictionless. Find the acceleration of the blocks and the tension in the string when the system is just released. Also find the time required for 200kg block to come down by 2m. 5 AP 16



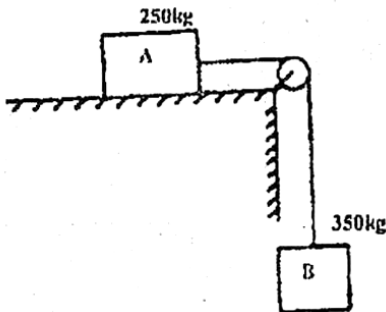
2. Two blocks of weight 150N and 50N are connected by a string, passing over a frictionless pulley as shown in fig. Predict the velocity of 150N block after 4 seconds. Also calculate the tension in the string. 5 AP 16



3. The two blocks of mass 20 kg and 40 kg are connected by a rope passing over a friction less pulley as shown in Fig. Assuming co-efficient of friction as 0.25 for all contact surfaces. Find the tension in the string, acceleration of the system. Also compute the velocity of the system after 4 second starting from the rest. 5 AP 16



4. An inextensible string passing over a smooth pulley as shown in Fig. joining two blocks. If the blocks are released simultaneously from rest, determine the velocity of block A after it has moved over 2 m and the tension in the string. Assume the co-efficient of friction at the contact surface is 0.2. Use energy principle. 5 AP 16



5. Two stones A and B are projected from the same point at inclinations of 15° and 30° respectively to the horizontal. Find the ratio of the velocities of projection of A and B if the maximum height reached by them is the same. 5 AP 16

6. A block of mass 8 kg is dragged up an inclined plane by a rope inclined at 15° to the plane while the plane is inclined at 30° to the horizontal. Find the velocity of the block after 4 seconds if dragged from rest. Take the coefficient of kinetic friction between the block and the plane as 0.2. Also assume that a force of 100 N is applied through the rope for dragging the block upwards the plane. Apply impulse momentum method. 5 AP 16

7. Two bodies one of mass 30kg, moves with a velocity of 9m/s centrally. Solve the velocity of each body after impact, if the coefficient of restitution is 0.8 5 AP 16
8. Two trains A and B leave the same station on parallel lines. A starts with a uniform acceleration of 0.15m/s<sup>2</sup> and attains the speed of 24 km/hour after which its speed remains constant. B leaves 40 seconds later with uniform acceleration of 0.30 m/s<sup>2</sup> to attain a maximum of 48 km/hour, its speed also becomes constant thereafter. When will B overtake A. 5 AP 16



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**24 RAPC304**

**ELECTRICAL DRIVES AND ACTUATORS**



## UNIT I - RELAY AND POWER SEMI-CONDUCTOR DEVICES

**Study of Switching Devices – Relay and Types, Switching characteristics -BJT, SCR, TRIAC, GTO, MOSFET, IGBT and IGCT-: SCR, MOSFET and IGBT - Triggering and commutation circuit - Introduction to Driver and snubber circuits**

### PART- A

S.No	Question	M	CO	BT
1.	What is a relay?	2	CO1	RE
2.	Name any two types of relays used in power electronics.	2	CO1	RE
3.	Define switching characteristic of a semiconductor device.	2	CO1	RE
4.	What does BJT stand for? Mention one application.	2	CO1	UN
5.	What is the function of an SCR in a circuit?	2	CO1	UN
6.	Write one key difference between SCR and TRIAC.	2	CO1	RE
7.	Expand and define GTO.	2	CO1	RE
8.	What is the full form of IGCT?	2	CO1	UN
9	Mention two characteristics of MOSFET.	2	CO1	UN
10	Write one advantage of IGBT over BJT.	2	CO1	RE
11	Define triggering in the context of SCR.	2	CO1	UN
12	What is meant by commutation of SCR?	2	CO1	UN
13	Mention the need for a snubber circuit.	2	CO1	UN
14	What is a driver circuit in power electronics?	2	CO1	UN
15	What are the basic requirements of a good switching device?	2	CO1	UN

**PART- B**

<b>S.No</b>	<b>Question</b>	<b>M</b>	<b>CO</b>	<b>BT</b>
1	Explain the construction, working, and types of relays used in power electronics applications.	16	CO1	UN
2	Compare the switching characteristics of BJT, SCR, TRIAC, GTO, MOSFET, IGBT, and IGCT.	16	CO1	AN
3	Describe in detail the commutation circuits for SCR. Include circuit diagrams.	16	CO1	UN
4	Explain the working of MOSFET with its static and switching characteristics. Also highlight its advantages.	16	CO1	UN
5	Describe the IGBT – structure, switching behavior, and typical applications in power electronics.	16	CO1	UN
6	Write a comparative analysis of SCR, MOSFET, and IGBT based on switching speed, voltage rating, and control.	16	CO1	AN
7	Explain the working and importance of snubber circuits. Give types and applications.	16	CO1	UN
8	Discuss the function of driver circuits in power semiconductor control. Explain with examples for MOSFET and IGBT.	16	CO1	UN

## UNIT II - DRIVE CHARACTERISTICS

**Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, torque, and Direction starting & stopping – Selection of motor.**

### PART- A

S.No	Question	M	CO	BT
1.	Define an electric drive.	2	CO2	RE
2.	What is meant by load torque?	2	CO2	RE
3.	Write the basic torque equation of a motor-load system.	2	CO2	UN
4.	What is steady-state stability in electric drives?	2	CO2	UN
5.	Define acceleration with respect to motor dynamics.	2	CO2	RE
6.	Define deceleration in electric drive systems.	2	CO2	RE
7.	What is meant by four-quadrant operation of a motor?	2	CO2	UN
8.	State the difference between motoring and braking modes.	2	CO2	UN
9	What is the role of inertia in drive dynamics?	2	CO2	RE
10	What are the conditions for a motor to be in steady-state operation?	2	CO2	RE
11	Define dynamic braking.	2	CO2	RE
12	What is meant by starting torque?	2	CO2	RE
13	State any two factors that affect the stopping time of a motor.	2	CO2	UN
14	Write one criterion for selecting a motor for a specific application.	2	CO2	UN
15	What is meant by torque-speed characteristics?	2	CO2	UN

**PART- B**

<b>S.No</b>	<b>Question</b>	<b>M</b>	<b>CO</b>	<b>BT</b>
1	Define electric drive. Derive and explain the equations governing motor-load dynamics including torque, speed, and inertia.	16	<b>CO2</b>	AP
2	Explain the concept of steady-state and dynamic stability in electric drives with necessary equations.	16	<b>CO2</b>	AN
3	Describe in detail the four-quadrant operation of a motor with torque-speed diagrams.	16	<b>CO2</b>	AN
4	Discuss acceleration, deceleration, starting, and stopping operations of an electric drive. How are they controlled?	16	<b>CO2</b>	AN
5	Explain different braking methods in electric drives: regenerative, dynamic, and plugging.	16	<b>CO2</b>	UN
6	What are the key factors affecting the selection of motors for various industrial and EV applications? Give examples.	16	<b>CO2</b>	UN
7	Compare and analyze the drive characteristics of DC motor vs. AC motor under dynamic conditions.	16	<b>CO2</b>	AN
8	Describe the multi-quadrant drive dynamics with reference to a typical EV application. Explain each quadrant.	16	<b>CO2</b>	AN

**UNIT III - DC MOTORS AND DRIVES****DC motor - Types of PMDC & BLDC motors - principle of operation- emf and torque equations - characteristics and control – Drives- H bridge - Single and Three Phases – 4 quadrant operation – Applications****PART- A**

<b>S.No</b>	<b>Question</b>	<b>M</b>	<b>CO</b>	<b>BT</b>
1.	Define a PMDC motor.	2	CO3	RE
2.	What is the main difference between a PMDC and a conventional DC motor?	2	CO3	UN
3.	State the working principle of a BLDC motor.	2	CO3	UN
4.	Mention two advantages of BLDC motors over brushed DC motors.	2	CO3	UN
5.	What is the purpose of an H-bridge in motor control?	2	CO3	UN
6.	Write the torque equation for a DC motor.	2	CO3	RE
7.	Define back EMF in a DC motor.	2	CO3	RE
8.	What is meant by 4-quadrant operation?	2	CO3	UN
9	List any two applications of PMDC motors.	2	CO3	RE
10	Draw the block diagram of a single-phase H-bridge inverter.	2	CO3	AP
11	What are the types of BLDC motors based on stator winding configuration?	2	CO3	RE
12	Mention two methods of speed control in BLDC motors.	2	CO3	UN
13	What is meant by regenerative braking in a motor drive?	2	CO3	UN
14	List two differences between single-phase and three-phase drives.	2	CO3	UN
15	Write any two advantages of using drives for DC motor control.	2	CO3	UN

**PART- B**

<b>S.No</b>	<b>Question</b>	<b>M</b>	<b>CO</b>	<b>BT</b>
1	Explain the construction and working principle of a PMDC motor with neat diagrams	16	CO3	UN
2	Derive the EMF and torque equations of a BLDC motor	16	CO3	AP
3	Describe in detail the characteristics and control strategies for PMDC motors.	16	CO3	UN
4	Explain the working of an H-bridge circuit used for controlling DC motors. Include switching logic and waveforms.	16	CO3	AP
5	Compare single-phase and three-phase BLDC motor drives. Illustrate with diagrams.	16	CO3	AN
6	Discuss 4-quadrant operation of a DC drive system with necessary diagrams and explanation.	16	CO3	AN
7	Describe the speed-torque characteristics of BLDC motors and explain how it differs from conventional DC motors.	16	CO3	AN
8	Explain various industrial and consumer applications of PMDC and BLDC motors in detail.	16	CO3	UN

## UNIT IV - AC MOTORS AND DRIVES

**Introduction – Induction motor drives – Speed control of 3-phase induction motor – Stator voltage control – Stator frequency control – Stator voltage and frequency control – Stator current control – Static rotor resistance control – Slip power recovery control - Single and Three Phases –VFD – Linear Motors.**

### PART- A

S.No	Question	M	CO	BT
1.	Define an induction motor.	2	CO4	RE
2.	What is the principle of operation of a 3-phase induction motor?	2	CO4	UN
3.	What do you mean by VFD (Variable Frequency Drive)?	2	CO4	UN
4.	Mention two advantages of stator voltage control.	2	CO4	RE
5.	What is slip in an induction motor?	2	CO4	RE
6.	Write the formula for synchronous speed.	2	CO4	RE
7.	What is the purpose of slip power recovery?	2	CO4	UN
8.	Mention two methods of speed control of an induction motor.	2	CO4	UN
9	State any two applications of linear motors.	2	CO4	RE
10	Differentiate between single-phase and three-phase induction motors.	2	CO4	UN
11	What is the effect of changing stator frequency on motor speed?	2	CO4	UN
12	Define stator current control.	2	CO4	UN
13	What is static rotor resistance control?	2	CO4	UN
14	What happens if only voltage is increased without frequency in a motor drive?	2	CO4	UN
15	Name the components of a basic VFD system.	2	CO4	RE

**PART- B**

<b>S.No</b>	<b>Question</b>	<b>M</b>	<b>CO</b>	<b>BT</b>
1	Explain in detail the construction, principle, and types of 3-phase induction motor drives with neat diagrams.	16	CO4	UN
2	Discuss the various methods of speed control of a 3-phase induction motor.	16	CO4	UN
3	Explain stator voltage and frequency control method with waveforms and applications.	16	CO4	AP
4	Describe the operation of a Variable Frequency Drive (VFD) and its role in motor speed control.	16	CO4	UN
5	Explain slip power recovery control with diagram and its advantages in slip ring induction motors.	16	CO4	AP
6	Compare the single-phase and three-phase induction motor drives with respect to construction, control, and applications.	16	CO4	AN
7	Illustrate the working principle and applications of linear motors.	16	CO4	UN
8	Discuss stator current control and static rotor resistance control with circuit diagrams and performance characteristics.	16	CO4	AN

**UNIT V - STEPPER AND SERVO MOTOR****Stepper Motor: Classifications- Construction and Principle of Operation – Modes of Excitation-Drive System-Logic Sequencer - Applications. Servo Mechanism – DC Servo motor-AC Servo motor – Applications.****PART- A**

<b>S.No</b>	<b>Question</b>	<b>M</b>	<b>CO</b>	<b>BT</b>
1.	What is a stepper motor?	2	CO5	RE
2.	Name any two classifications of stepper motors.	2	CO5	RE
3.	Define step angle in stepper motors.	2	CO5	RE
4.	What is meant by the holding torque of a stepper motor?	2	CO5	RE
5.	Mention one key application of stepper motors.	2	CO5	UN
6.	Define the principle of operation of a stepper motor.	2	CO5	UN
7.	What are the modes of excitation in stepper motors?	2	CO5	RE
8.	List any two types of stepper motor excitation.	2	CO5	RE
9	What is a logic sequencer in a stepper drive system?	2	CO5	UN
10	What is the function of a drive system in stepper motors?	2	CO5	UN
11	Define servo mechanism.	2	CO5	RE
12	What is a DC servo motor?	2	CO5	RE
13	What are the differences between AC and DC servo motors?	2	CO5	RE
14	List one industrial application of a servo motor.	2	CO5	UN
15	What is feedback in servo systems?	2	CO5	UN

**PART- B**

<b>S.No</b>	<b>Question</b>	<b>M</b>	<b>CO</b>	<b>BT</b>
1	Explain the classification, construction, and working principle of stepper motors with neat diagrams.	16	CO5	UN
2	Discuss the different modes of excitation in stepper motors: full step, half step, and micro stepping.	16	CO5	UN
3	Describe the complete drive system and logic sequencer used to control a stepper motor.	16	CO5	UN
4	Explain the construction, characteristics, and working of a DC servo motor. Include torque-speed curve.	16	CO5	AP
5	Explain the operation and control of AC servo motors. How are they different from DC servo motors?	16	CO5	AN
6	Compare stepper motors and servo motors based on construction, operation, and applications.	16	CO5	AN
7	Discuss servo mechanisms with feedback systems. Explain how error detection and correction are achieved.	16	CO5	AN
8	Write a detailed note on the applications of stepper and servo motors in robotics, CNC, and automation.	16	CO5	UN

----- **END** -----

**24MABS303**  
**TRANSFORMS AND PARTIAL DIFFERENTIAL**  
**EQUATIONS**

## UNIT –I

### PARTIAL DIFFERENTIAL EQUATIONS

Formation of partial differential equations – Solutions of standard types of first order partial differential equations – Lagrange’s linear equation -- Linear partial differential equations of second and higher order with constant coefficients of homogeneous.

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1	Form the PDE by eliminating the arbitrary constants a & b from $z = (x^2+a)(y^2+b)$	1	UN	2
2	When is p.d.e said to be linear	1	RE	2
3	Form the PDE by eliminating the arbitrary constants a & b from $z = ax^2+by^2$	1	UN	2
4	Eliminate the arbitrary function f from $z = f\left(\frac{y}{x}\right)$	1	UN	2
5	Mention three types of solution of p.d.e	1	RE	2
6	Solve $(D^2 - 4DD'^2 + 3D'^2) z = 0$	1	UN	2
7	Find P.I of $(D^3 - 3DD'^2 + 2D'^3) = e^{2x-y}$	1	RE	2
8	Find P.I of $(D^2 - 3DD' + 3D'^2) = e^{3x+4y}$	1	RE	2
9	Solve $(D^2 - 2DD'^2 + D'^2) z = 0$	1	UN	2
10	Find P.I of $(D^2 - 2DD' - 2D'^2) = \sin(x-y)$	1	RE	2
11	Find the general solution of $px + qy = z$	1	RE	2
12	Find the P.D.E of all spheres whose centre use on the z- axis	1	RE	2
13	Find the singular solution of the equation $z = p x + q y + p^2 + q^2$	1	RE	2
14	Find the complete solution of the equation $Z = px + qx - 2\sqrt{pq}$	1	RE	2
15	Find P.I of $(D^2+4DD')$ $z = e^x$	1	RE	2

<b>PART B</b>				
1	Solve $x(y^2 - z^2)p + y(z^2 - x^2)q = z(x^2 - y^2)$ .	1	AP	8
2	Solve $(mz - ny)p + (nx - lz)q = ly - mx$	1	AP	8
3	Solve $pq + p + q = 0$	1	AP	8
4	Solve $(D^3 - 2D^2D')z = 2e^{2x} + 3x^2y$ .	1	AP	8
5	Solve $(x-2z)p + (2z-y)q = y-x$	1	AP	8
6	Solve $(mz - ny)p + (nx - lz)q = ly - mx$	1	AP	8
7	Solve $(D^2 - 2DD' + D'^2)z = \cos(x - 3y) + e^{y-2x}$	1	AP	8
8	Solve $(D^2 + 2DD' + D'^2)z = x^2y + e^{3x+y}$	1	AP	8
9	Solve $Z = px + qx + p^2 + pq + q^2$	1	AP	8
10	Solve $\sqrt{p} + \sqrt{q} = 1$	1	AP	8

## UNIT -II

### FOURIER SERIES

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and Cosine series – Parseval's identity.

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1	Define Fourier series	2	RE	2
2	State the Dirichlet's conditions for a function $f(x)$ to be expanded as a Fourier series	2	RE	2
3	Write $a_0, a_n$ in the expansion of $x + x^3$ as a Fourier series in $(-\pi, \pi)$ .	2	RE	2

4	Find the $b_n$ expansion of $f(x) = x^2$ as a Fourier series in $(-\pi, \pi)$ .	2	RE	2
5	Find the constant term in the Fourier series of $f(x) = \cos^2 x$ in $(-\pi, \pi)$ .	2	RE	2
6	Find the sum of the Fourier Series for $f(x) = \begin{cases} x, & 0 < x < 1 \\ 2, & 1 < x < 2 \end{cases}$ at $x = 1$ .	2	RE	2
7	If $f(x) = \begin{cases} \cos x, & 0 < x < \pi \\ \cos 5x, & \pi < x < 2\pi \end{cases}$ , Find the sum of the Fourier Series for $f(x)$ at $x = \pi$	2	RE	2
8	If $f(x)$ is an odd function defined in $(-L, L)$ what are the values of $a_0$ and $a_n$ .	2	RE	2
9	If $f(x) = 2x$ in the interval $(0, 4)$ then the value of $a_2$ in the Fourier series expansion.	2	RE	2
10	Expand $f(x) = 1$ in a sine series in $0 < x < \pi$	2	RE	2
11	Find the Fourier constant $b_n$ for $x \sin x$ in $(-\pi, \pi)$	2	RE	2
12	State Parseval's identity.	2	RE	2
13	Find the value of $b_{25}$ while expanding the function $f(x) = \begin{cases} 1 + \frac{2x}{l}, & -l \leq x \leq 0 \\ 1 - \frac{2x}{l}, & 0 \leq x \leq l \end{cases}$ as a Fourier series.	2	RE	2
14	Write the formula for Fourier constants to expand $f(x)$ as a cosine series in $(0, L)$ .	2	RE	2
15	If $f(x) = x^2 + x$ is expressed as a Fourier series in the interval $(-2, 2)$ to which value this series converge at $x = 2$	2	RE	2
<b>PART B</b>				
1	Find the Fourier series $x^2$ in $(-\pi, \pi)$ . Use Parseval's identity to prove $1 + \frac{1}{2^4} + \frac{1}{3^4} + \frac{1}{4^4} + \dots = \frac{\pi^4}{90}$	2	AP	16
2	Find the Fourier series expansion of the function with period $2\pi$ $f(x) = \begin{cases} x & 0 < x < \pi \\ 2\pi - x & \pi < x < 2\pi \end{cases}$ Hence deduce that $1 + \frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \dots = \frac{\pi^2}{8}$	2	AP	16
3	Obtain the Fourier series for $f(x)$ of period $2l$ and defined as follows $f(x) = \begin{cases} l - x & 0 < x \leq l \\ l & l \leq x < 2l \end{cases}$ hence deduced that $1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \dots = \frac{\pi}{4}$ and $\frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \dots = \frac{\pi^2}{8}$	2	AP	16
4	Expand $f(x) = \frac{1}{2}(\pi - x)$ as a Fourier Series in $(0, 2\pi)$ and hence deduce the sum of $1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \dots = \frac{\pi}{4}$ .	2	AP	16
5	Expand the Fourier series of $f(x) = 2x - x^2$ for the interval $(0, 2L)$ for $0 < x < 2L$ .	2	AP	16

6	Find the half range cosine series for the function $f(x) = x(\pi - x)$ in $0 < x < \pi$ .	2	AP	16
7	Find the Half range sine series for $f(x) = x(\pi - x)$ in $(0, \pi)$ $\frac{1}{1^3} - \frac{1}{3^3} + \frac{1}{5^3} + \dots = \frac{\pi^3}{32}$	2	AP	16
8	Find the Fourier series of $f(x) = x + x^2$ in $(-\pi, \pi)$ of periodicity $2\pi$ . Hence deduce that $\sum_{n=1}^{\infty} \frac{1}{n^2} = \frac{\pi^2}{6}$	2	AP	16

### UNIT -III

#### APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS

Classification of PDE – Method of separation of variables – Fourier series solutions of one-dimensional wave equation – One dimensional equation of heat conduction.

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1	Find the nature of the partial differential equation $4u_{xx} + 4u_{xy} + u_{yy} + 2u_x - u_y = 0$ .	3	RE	2
2	Classify $u_{xx} - y^4 u_{yy} = 2y^3 u_y$	3	UN	2
3	Write the assumptions made in the derivation of one-dimensional wave equation.	3	RE	2
4	A rod 30 cm long has its ends A & B kept at $20^\circ\text{C}$ & $80^\circ\text{C}$ respectively. until steady state conditions prevail. Find this steady state temperature in the rod.	3	RE	2
5	State one dimensional heat equation with the initial and boundary conditions.	3	RE	2
6	Classify the P.D.E $u_{xx} + 2u_{xy} + u_{yy} = 0$	3	UN	2
7	Classify the P.D.E $3 \frac{\partial^2 z}{\partial x^2} - 4 \frac{\partial^2 z}{\partial x \partial y} + \frac{\partial^2 z}{\partial y^2} = 0$	3	UN	2
8	Classify the following P.D.E $x^2 \frac{\partial^2 u}{\partial x^2} + (1 - y^2) \frac{\partial^2 u}{\partial y^2} = 0$ $-\infty < x < \infty, -1 < y < 1$ .	3	UN	2

9	The ends a and b of a rod of length 10 cm have their temperature kept at 20 <sup>0</sup> C & 70 <sup>0</sup> C. find the steady state temperature distribution on the rod.	3	RE	2
10	Classify the P.D.E $u_{xx} - u_{yy} = 2Y^3u_y$	3	RE	2
11	What are the assumptions made while deriving the one dimensional heat equation?	3	RE	2
12	Write PDE of the one-dimensional heat flow	3	RE	2
13	why $\alpha^2$ is used in the heat equation $\frac{\partial u}{\partial t} = \alpha^2 \frac{\partial^2 u}{\partial x^2}$	3	RE	2
14	What is the basic difference between the solution of one-dimensional wave equation and one-dimensional heat equation?	3	RE	2
15	What is meant steady state condition in heat flow	3	RE	2
<b>PART B</b>				
1	Using the method of separation of variables solve $\frac{\partial u}{\partial t} = 2 \frac{\partial u}{\partial x} + u$ where $u(x,0) = 6 6e^{-3x}$	3	AP	16
2	A string is stretched and fastened to two points $x=0$ and $x=1$ apart. Motion is started by displacing the string into the form $y = k(1x - x^2)$ from which it is released at time $t = 0$ . find the displacement of any point on the string at a distance of $x$ from one end at time $t$ .	3	AP	16
3	If a string of length $l$ is initially at rest in its equilibrium position and each of its points is given the velocity $v_0 \sin \frac{3\pi x}{l}$ $0 < x < l$ Determine the displacement of a point distant $x$ from one end at time $t$ .	3	AP	16
4	The ends A & B of a bar 30 Cms long have this temperature kept at 20 <sup>0</sup> C and 80 <sup>0</sup> C until steady state prevails. The temperature at each end suddenly reduced to 0 <sup>0</sup> C and maintained so, find the resulting temperature distribution in the bar at time $t$	3	AP	16
5	The ends A and B of a rod 30cms long have their temperature kept at 20 <sup>0</sup> C and the other at 80 <sup>0</sup> C until steady state conditions prevail. The temperature of the end B is then suddenly reduced to 60 <sup>0</sup> C and kept so while the end A is raised to 40 <sup>0</sup> C.find the temperature distribution in the rod after time $t$ .	3	AP	16

#### UNIT -IV

## FOURIER TRANSFORMS

Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Parseval’s identity.

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1	State Fourier transform pair	4	RE	2
2	State Change of scale property	4	RE	2
3	Find the Fourier sine transform of $\frac{1}{x}$	4	RE	2
4	Find the Fourier cosine transform of $e^{-x}$	4	RE	2
5	State Parseval’s Identity	4	RE	2
6	Find the Fourier sine transform of $e^{-3x}$	4	RE	2
7	Find the Fourier cosine transform of $f(x) = \begin{cases} \cos x & \text{if } 0 < x < a \\ 0 & \text{if }  x  \geq a. \end{cases}$	4	RE	2
8	State the Fourier transform of the derivatives of a function	4	RE	2
9	Define self-reciprocal with respect to Fourier transform.	4	RE	2
10	Define Shifting property	4	RE	2
11	State Modulation property	4	RE	2
12	Define fourier Cosine transform	4	RE	2
13	Define Sine transform	4	RE	2
14	Find the Fourier sine transform of $3e^{-2x}$	4	RE	2
15	Does Fourier Sine transform of $f(x) = k, 0 \leq x < \infty$ exist. justify your answer.	4	UN	2
<b>PART B</b>				
1	Find the Fourier transform of $f(x) = \begin{cases} 1 &  x  < a \\ 0 &  x  \geq a. \end{cases}$ Where a is positive real number and hence deduce that	4	AP	16

	i) $\int_0^{\infty} \frac{\sin t}{t} dt = \frac{\pi}{2}$ and ii) $\int_0^{\infty} \frac{(\sin t)^2}{t^2} dt = \frac{\pi}{2}$ .			
2	Find the Fourier transform of the function $f(x)$ defined by $f(x) = \{1 - x^2 \text{ in }  x  \leq a \ 0 \text{ in }  x  > a > 0$ . Hence prove that $\int_0^{\infty} \frac{\sin t - t \cos t}{t^3} \cos\left(\frac{t}{2}\right) dt = \frac{3\pi}{16}$ . Also show that $\int_0^{\infty} \frac{(t \cos t - \sin t)^2}{(t^3)^2} dt = \frac{\pi}{15}$ .	4	AP	16
3	i) Show that the function $e^{-\frac{x^2}{2}}$ is self-reciprocal under Fourier transform ii) Show that the function $e^{-a^2 x^2}$ is self-reciprocal under Fourier transform	4	AP	16
4	i) Evaluate $\int_{-\infty}^{\infty} \frac{x^2 dx}{(x^2 + 4)(x^2 + 9)}$ using Fourier sine transform ii) Evaluate $\int_0^{\infty} \frac{dx}{(x^2 + a^2)(x^2 + b^2)}$ using Fourier transform.	4	AP	16
5	i) Using Parseval's identity evaluate the following integral $\int_0^{\infty} \frac{x^2 dx}{(a^2 + x^2)^2}$ ii) Using Parseval's identity evaluate the following integral $\int_0^{\infty} \frac{dx}{(a^2 + x^2)^2}$	4	AP	16
6	Find Fourier cosine transform of $\frac{e^{-ax}}{x}$ . Hence find $F_c$ $\left[\frac{e^{-ax} - e^{-bx}}{x}\right]$ .	4	AP	16
7	Find the Fourier transform of $f(x) = \{1 -  x  \quad  x  < 1 \ 0 \quad  x  \geq 1$ . Where $a$ is positive real number and hence deduce that i) $\int_0^{\infty} \left(\frac{\sin t}{t}\right)^2 dt = \frac{\pi}{2}$ and ii) $\int_0^{\infty} \left(\frac{\sin t}{t}\right)^4 dt = \frac{\pi}{3}$ .	4	AP	16
8	Find the Fourier transform of the function $f(x)$ defined by $f(x) = \{a^2 - x^2 \text{ in }  x  \leq a \ 0 \text{ in }  x  > a > 0$ . Hence prove that $\int_0^{\infty} \frac{\sin t - t \cos t}{t^3} dt = \frac{\pi}{4}$ . Also show that $\int_0^{\infty} \frac{(\sin t - t \cos t)^2}{(t^3)^2} dt = \frac{\pi}{15}$ .	4	AP	16

### UNIT -V

## Z - TRANSFORMS AND DIFFERENCE EQUATIONS

Z- transforms - Elementary properties – Convergence of Z-transforms – Inverse Z – transform using partial fraction and convolution theorem- Formation of difference equations – Solution of difference equations using Z- transforms.

Q.No	Question	CO	BTL	Marks
<b>PART A</b>				
1	Find Z[1/ n! ]	5	RE	2
2	Find Z([a <sup>n</sup> ]	5	RE	2
3	Find Z[1/ (n+1)! ]	5	RE	2
4	State convolution theorem on Z- transform	5	RE	2
5	Form the difference equation by eliminating arbitrary constant A from y <sub>n</sub> = A3 <sup>n</sup>	5	UN	2
6	Form the the difference equation from u <sub>n</sub> = a 2 <sup>n+1</sup>	5	UN	2
7	Form the difference equation from y <sub>n</sub> = a+ b3 <sup>n</sup>	5	UN	2
8	Form the difference equation by eliminating arbitrary constant A from y <sub>n</sub> = A+B(-2) <sup>n</sup>	5	UN	2
9	Find Z $\left[\frac{a^n}{n!}\right]$	5	RE	2
10	Using Convolution theorem find Z <sup>-1</sup> $\left[\frac{Z^2}{(Z-1)(Z-3)}\right]$	5	UN	2
11	Find the Z- transform of (n+2)	5	RE	2
12	Find the inverse Z transform of $\left[\frac{Z}{(z-1)^2}\right]$	5	RE	2
13	Define two-sided Z transform	5	RE	2
14	Define Linearity property	5	RE	2
15	Find Z[ e <sup>-at</sup> ]	5	RE	2
<b>PART B</b>				

1	Find the Z – transform of $\frac{2n+3}{(n+1)(n+2)}$	5	AP	8
2	Using Partial fraction method find $Z^{-1} \left[ \frac{10z}{(z-1)(z-2)} \right]$	5	AP	8
3	Using Convolution theorem find $Z^{-1} \left[ \frac{z^2}{(z-a)(z-b)} \right]$ .	5	AP	8
4	Using Convolution theorem find $Z^{-1} \left[ \frac{8Z^2}{(2Z-1)(4Z-1)} \right]$ .	5	AP	8
5	Solve using Z-transform technique the difference equation $y_{n+2} + 4y_{n+1} + 3y_n = 3^n$ with $y_0 = 0, y_1 = 1$	5	AP	16
6	Solve $y_{n+2} + 6y_{n+1} + 9y_n = 2^n$ given $y_0 = y_1 = 0$	5	AP	16
7	Solve using Z-transform technique the difference equation $u_{n+2} + 3u_{n+1} + 2u_n = 0$ with $u_0 = 1, u_1 = 2$ .	5	AP	16
8	Using partial fraction method find $Z^{-1} \left[ \frac{z^3}{(z-1)^2(z-2)} \right]$	5	AP	8