UNITED INSTITUTE OF TECHNOLOGY

(An Autonomous Institution)

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Periyanaickenpalayam, Coimbatore – 641020

DEPARTMENT OF ROBOTICS AND AUTOMATION

QUESTION BANK

II YEAR ODD SEMESTER

ACADEMIC YEAR 2024 – 2025

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1	MR3391	Digital Electronics and Microprocessor		Ms. S. Kavitha	
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5	MA3351	Transforms and Partial Differential Equations		Ms. Abinaya	
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HEAD OF THE DEPARTMENT

ACOE PRINCIPAL CHAIRMAN

MR3391 - DIGITAL ELECTRONICS AND MICROPROCESSOR

UNIT I DIGITAL FUNDAMENTALS
Number Systems – Decimal, Binary, Octal, Hexadecimal, 1‘s and 2‘s complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map Minimization and Quine-McCluskey method of minimization.

PART- A

S.No	Question	CO	BTL	Marks
1.	Define DeMorgan’s law and write any one application.	1	2	2
2.	Implement the given function using NAND gates $F=\sum m\,(0, 6)$.	1	2	2
3.	What is the advantage of Gray codes over the binary number sequence?	1	1	2
4.	Find the octal equivalent for the given decimal number $(149)_{10}$.	1	1	2
5.	Explain subtraction using 1’s complement $(11010)_2 – (10000)_2$.	1	2	2
6.	Define demultiplexer and give its applications.	1	1	2
7.	Draw Truth table and logical expression for EXOR gate.	1	2	2
8.	Find the Hexadecimal equivalent for the given decimal number $(149)_{10}$.	1	1	2

PART- B

S.No	Question	CO	BTL	Marks
1	What are the advantages of the tabulation method? Determine the minimal sum of products for the Boolean expression $F=\sum(1,2,3,7,8,9,10,11,14,15)$ using tabulation method.	1	3	16
2	Find the MSOP representation for $F(A,B,C,D,E) = \sum m(1,4,6,10,20,22,24,26) + \sum d(0,11,16,27)$ using K-map. Draw the circuit of minimal expression using only NAND gates.	1	2	16
3	Define and Explain the gray code to binary converter with the necessary diagram.	1	2	16
4	Implement following function using Quine Mc clusky method $F = \sum m(6,7,8,9) + d(10,11,12,13,14,15)$.	1	3	16

UNIT II COMBINATIONAL & SYNCHRONOUS SEQUENTIAL CIRCUITS

Design of Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder -Multiplexer, Demultiplexer, Decoder, Priority Encoder. Flip flops – SR, JK, T, D, design of clocked sequential circuits – Design of Counters- Shift registers, Universal Shift Register

PART- A

S.No	Question	CO	BTL	Marks
1.	What is data selector and state the applications of multiplexer.	2	1	2
2.	Infer some of the combinational circuits.	2	2	2
3.	Distinguish flip flop and latch.	2	2	2
4.	What is meant by a decoder circuit?	2	1	2
5.	Differentiate combinational circuits and sequential circuits.	2	2	2
6.	Differentiate microprocessor and microcontroller.	2	2	2
7.	Write its truth table for T Flipflop	2	2	2
8.	What is the difference between a Decoder and a Demultiplexer?	2	1	2

PART- B

S.No	Question	CO	BTL	Marks
1	Explain 4 bit binary adder mention its disadvantage and how to reduce delay occur in Binary adder.	2	2	16
2	Explain Half and full subtractor with neat Diagram.	2	2	16
3	(i) Design and Implement full adder circuit using 8:1 multiplexer. (ii) Build $F(w,x,y,z) = \sum (1,4,6,7,8,9,10,11,15)$ using 4 to 1 MUX.	2 2	3 3	8 8
4	What is a Universal Shift Register and Explain modes of operation for 4 bit Universal shift register with Diag ram.	2	2	16

UNIT III ASYNCHRONOUS SEQUENTIAL CIRCUITS AND MEMORY DEVICES
Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Pulse mode sequential circuits, Design of Hazard free circuits. Basic memory structure – ROM -PROM – EPROM – EEPROM –EAPROM, RAM – Static and dynamic RAM - Programmable Logic Devices – Programmable Logic Array (PLA) - Programmable Array Logic (PAL) – Field Programmable Gate Arrays (FPGA).

PART- A

S.No	Question	CO	BTL	Marks
1.	Differentiate Static and Dynamic RAM.	3	2	2
2.	What is volatile and non volatile memory?	3	1	2
3.	What is Race around condition in JK flip flop how to overcome it ?	3	1	2
4.	What is static 1 hazard in a combinational circuit?	3	1	2
5.	What are the main differences between PLA and PAL (Programmable Array Logic)?	3	1	2
6.	Define a Field Programmable Gate Array (FPGA).	3	1	2
7.	What are the characteristics of dynamic RAM?	3	1	2
8.	How can a circuit be made hazard-free?	3	1	2

PART- B

S.No	Question	CO	BTL	Marks
1	Design a combinational circuit using a ROM. The circuit accepts a 3 bit number and generates an output binary number equal to the square of the input number?	3	6	16
2	A combinational circuit is defined by the functions F1((A,B,C) = ∑(3,5,6,7) F2(A,B,C) = ∑(0,2,4,7) Implement the circuit with PLA having three inputs, four product terms , and two outputs?	3	3	16
3	Derive the product of sums form of a 2 to 1 multiplexer and then perform the corresponding analysis to that for the sum of products form , determine whether any static hazard occur, and if they do how they may be eliminated.	3	3	16
4	Define Hazard and its types with example and Explain Essential Hazard.	3	2	16

UNIT IV 8085 PROCESSOR

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

PART- A

S.No	Question	CO	BTL	Marks
1.	What is the use of ALE?	4	1	2
2.	Mention the role of stack pointer and program counter in 8085 microprocessor.	4	1	2
3.	Differentiate machine cycle and Instruction cycle.	4	2	2
4.	Explain Interrupts and priority of interrupt in 8085	4	2	2
5.	Write an 8085 assembly language program to exchange a ten data between 4000H and 4500H memory locations.	4	1	2
6.	Mention flag register of 8085 microprocessor.	4	1	2
7.	Differentiate maskable and non maskable interrupt.	4	2	2
8.	What are the functions of the pins in the pin diagram of a microprocessor?	4	1	2

PART- B

S.No	Question	CO	BTL	Marks
1	Briefly explain the functional block diagram of 8085 miroprocessor.	4	2	16
2	Draw the architecture of 8085 and explain each block.	4	2	16
3	Explain interupts in 8085 microprocessor	4	2	16
4	Discuss the different I/O ports in a microprocessor and explain various data transfer concepts. Include details of serial and parallel communication, as well as Direct Memory Access (DMA).	4	2	16

UNIT V PROGRAMMING PROCESSOR
Instruction - format and addressing modes – Assembly language format – Data transfer, data manipulation& control instructions – Programming: Loop structure with counting & Indexing – Look up table - Subroutine instructions – stack -8255 architecture and operating modes

PART- A

S.No	Question	CO	BTL	Marks
1.	Mention Operating modes of 8255 peripheral interfacing circuit.	5	1	2
2.	Mention blocks of 8255.	5	1	2
3.	What is an instruction format in assembly language?	5	1	2
4.	What are the different types of addressing modes in assembly language?	5	1	2
5.	Define a subroutine in assembly language.	5	1	2
6.	What is data manipulation in assembly language?	5	1	2
7.	What is a stack in the context of microprocessor programming?	5	1	2
8.	What is a control instruction in assembly language? Provide an example.	5	1	2

PART- B

S.No	Question	CO	BTL	Marks
1	With a neat sketch, briefly explain the architecture of programmable peripheral interface.	5	2	16
2	Explain various operating modes of 8255.	5	2	16
3	Explain in detail different types of addressing modes with example and diagram	5	2	16
4	Explain various Data transfer , manipulation and control instructions with example	5	2	16

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MR3392 – 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	CO	BTL	Marks
1.	What are the functions of protective relays?	1	1	2
2.	Differentiate latching current and holding current.	1	2	2
3.	Define pinch off voltage of MOSFET.	1	1	2
4.	What is the use of snubber circuit?	1	1	2
5.	In TRIAC which of the modes the sensitivity of gate is high.	1	1	2
6.	How can a thyristor turned off?	1	1	2
7.	Why circuit turn off time should be greater than the thyristor turn-off time?	1	1	2
8.	Classify power semiconductor devices give examples.	1	1	2

PART- B

S.No	Question	CO	BTL	Marks
1	Explain the different types of relays and their applications in power electronics.	1	2	16
2	Describe the working, triggering methods, and commutation techniques of SCR in detail	1	2	16
3	Compare the performance and characteristics of MOSFET and IGBT in power electronics applications.	1	2	16
4	Explain the need for driver and snubber circuits. Describe their design and working principles with suitable diagrams.	1	2	16

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	CO	BTL	Marks
1.	Define an electric drive.	2	1	2
2.	Write the fundamental equation governing motor-load dynamics.	2	1	2
3.	What is steady-state stability of an electric drive?	2	1	2
4.	What are the four quadrants of operation in motor drives?	2	1	2
5.	Differentiate between acceleration and deceleration in electric drives.	2	1	2
6.	What are the factors affecting the selection of a motor for a particular application?	2	1	2
7.	Explain the significance of torque-speed characteristics in motor selection.	2	1	2
8.	What are the different methods of stopping an electric motor?	2	1	2

PART- B

S.No	Question	CO	BTL	Marks
1	Derive the equations governing motor-load dynamics and explain their significance in electric drives.	2	2	16
2	Explain steady-state stability in electric drives. Discuss the conditions required for a system to be stable.	2	2	16
3	Describe in detail the four-quadrant operation of an electric drive with relevant torque-speed characteristics.	2	2	16
4	Discuss acceleration and deceleration in electric drives. How are these parameters controlled for smooth operation?	2	2	16

UNIT III - DC MOTORS AND DRIVES
DC Servomotor - 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

S.No	Question	CO	BTL	Marks
1.	What is a DC servomotor?	3	1	2
2.	Differentiate between PMDC and BLDC motors.	3	1	2
3.	Write the EMF equation of a DC motor.	3	1	2
4.	What is the significance of the torque equation in DC motors?	3	1	2
5.	What is an H-bridge? How is it used in motor control?	3	1	2
6.	List the advantages of BLDC motors over conventional DC motors.	3	1	2
7.	Explain the four-quadrant operation of a motor.	3	1	2
8.	Mention two important applications of PMDC and BLDC motors.	3	1	2

PART- B

S.No	Question	CO	BTL	Marks
1	Explain the construction, working principle, and types of DC servomotors with neat diagrams.	3	2	16
2	Derive the EMF and torque equations of a DC motor and explain their significance.	3	2	16
3	Describe the working principle, characteristics, and control methods of PMDC and BLDC motors.	3	2	16
4	Explain the H-bridge drive for DC motor control and its role in four-quadrant operation.	3	2	16

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.

PART- A

S.No	Question	CO	BTL	Marks
1.	What are the different methods of speed control in a three-phase induction motor?	4	1	2
2.	What is stator voltage control in an induction motor?	4	1	2
3.	Define slip in an induction motor and its significance.	4	1	2
4.	What is meant by slip power recovery control?	4	1	2
5.	How does stator frequency control affect the speed of an induction motor?	4	1	2
6.	Differentiate between stator current control and stator voltage control.	4	1	2
7.	What is the purpose of static rotor resistance control?	4	1	2
8.	Why is V/f control widely used for speed control of induction motors?	4	1	2

PART- B

S.No	Question	CO	BTL	Marks
1	Explain the different speed control methods of a three-phase induction motor with necessary diagrams.	4	2	16
2	Describe the stator voltage control method for speed regulation of an induction motor and its applications.	4	2	16
3	Explain the concept of V/f (stator voltage and frequency) control and why it is widely used in AC drives.	4	2	16
4	Discuss the slip power recovery control method in detail with suitable circuit diagrams.	4	2	16

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

S.No	Question	CO	BTL	Marks
1.	What are the different classifications of stepper motors?	5	1	2
2.	Explain the principle of operation of a stepper motor.	5	1	2
3.	What are the different modes of excitation in a stepper motor?	5	1	2
4.	What is a logic sequencer in a stepper motor drive syst	5	1	2
5.	List two important applications of stepper motors.	5	1	2
6.	Differentiate between AC and DC servo motors.	5	1	2
7.	What is a servo mechanism?	5	1	2
8.	Mention two industrial applications of servo motors.	5	1	2

PART- B

S.No	Question	CO	BTL	Marks
1	Explain the classifications, construction, and working principle of stepper motors with neat diagrams.	5	2	16
2	Discuss the different modes of excitation in stepper motors and compare their performance.	5	2	16
3	Describe the stepper motor drive system, including the logic sequencer, and explain its role in motor control.	5	2	16
4	Explain the working principle, characteristics, and applications of DC and AC servo motors.	5	2	16

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ME3351

ENGINEERING MECHANICS

ME3351 ENGINEERING MECHANICS

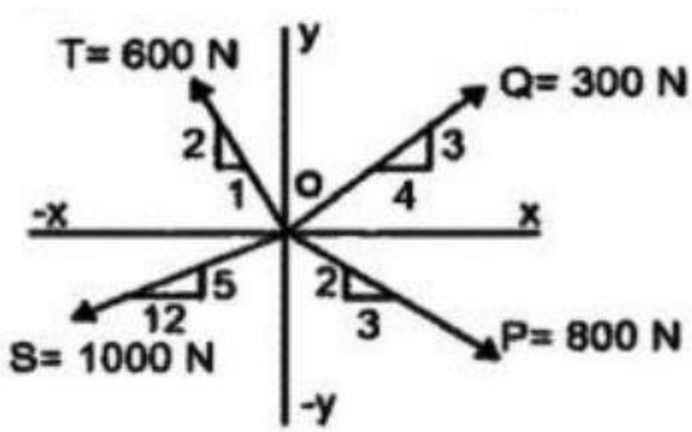
UNIT I-BASICS & STATICS OF PARTICLES
Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles -Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's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

PART- A

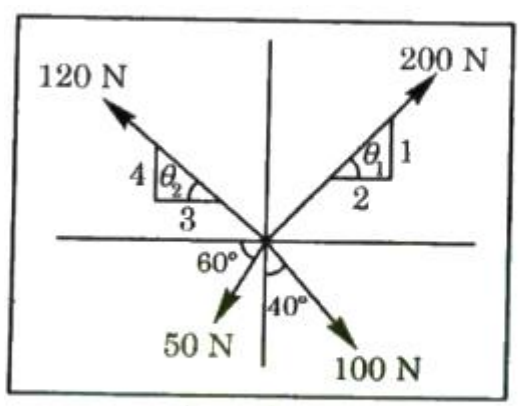
Question	CO	BTL	Marks
1. Define Engineering Mechanics.	1	1	2
2. Define Force.	1	1	2
3. What is the difference between the resultant force and equilibrant force?	1	1	2
4. State law of parallelogram.	1	1	2
5. State the principle of transmissibility of force.	1	1	2
6. Define space and time.	1	1	2
7. What are the minimum requirements for equilibrium of a particle in space?			
8. Two forces of 400 N and 600 N act at an angle 60º to each other Determine the resultant in magnitude and direction.	1	2	2
9. Why is there a need for electric vehicles?	1	1	2

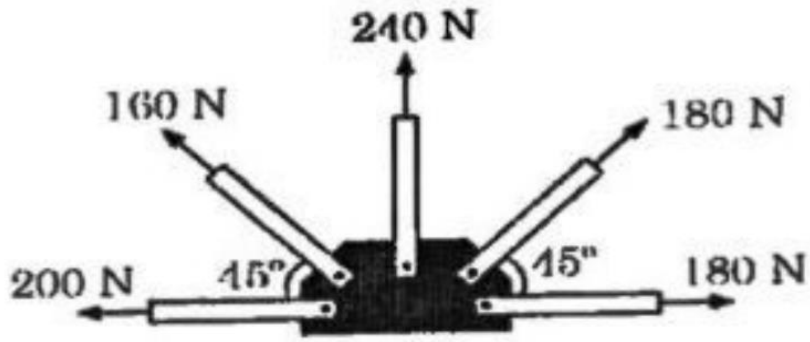
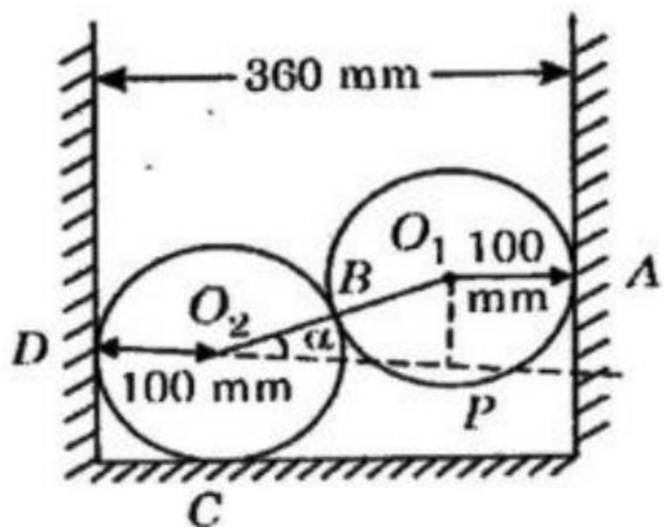
PART- B

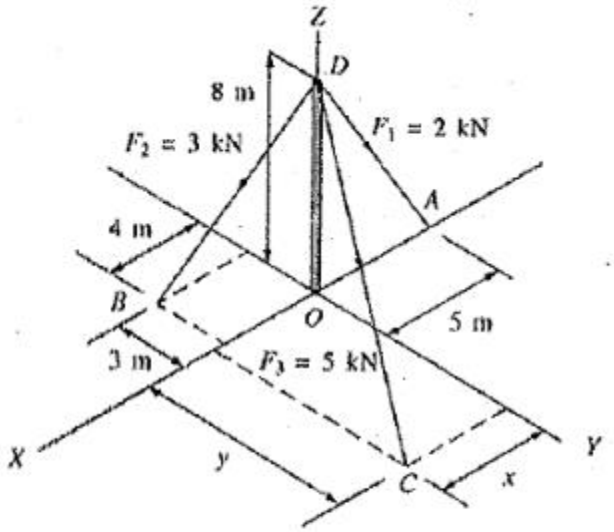
S.No	Question	CO	BTL	Marks
1	Calculate the resultant force and its direction. For the Fig. shown.	1	3	16



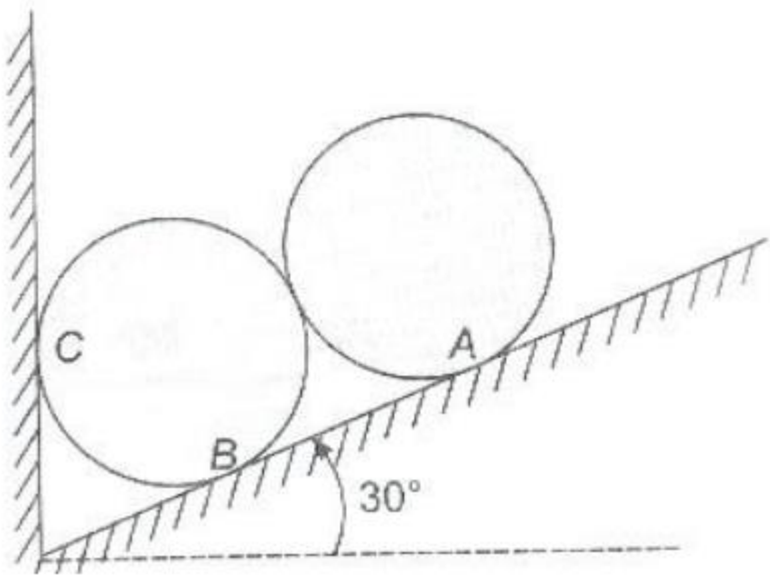
S.No	Question	CO	BTL	Marks
2	Coplanar concurrent forces are acting at a point as shown in fig. Find the magnitude and direction of the resultant.	1	3	16



3	Calculate the resultant force and its direction. For the Fig.2 shown. 	1	3	16
4	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	3	16
5	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.	1	3	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	2	16



UNIT II-EQUILIBRIUM OF RIGID BODIES

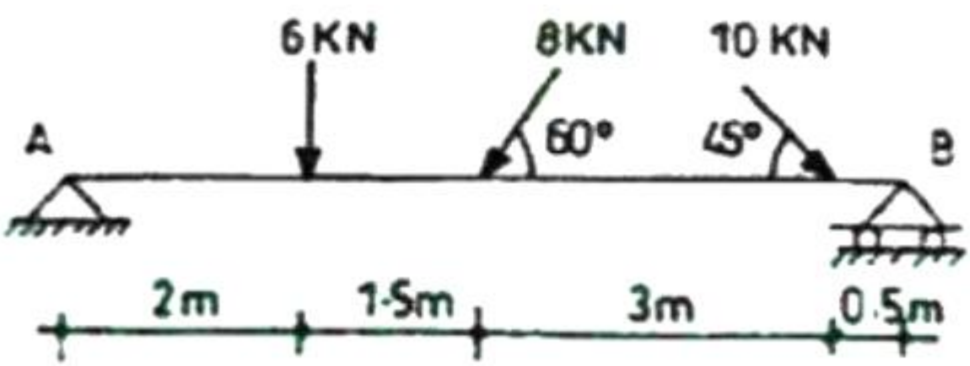
Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple – Moment 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.

PART- A

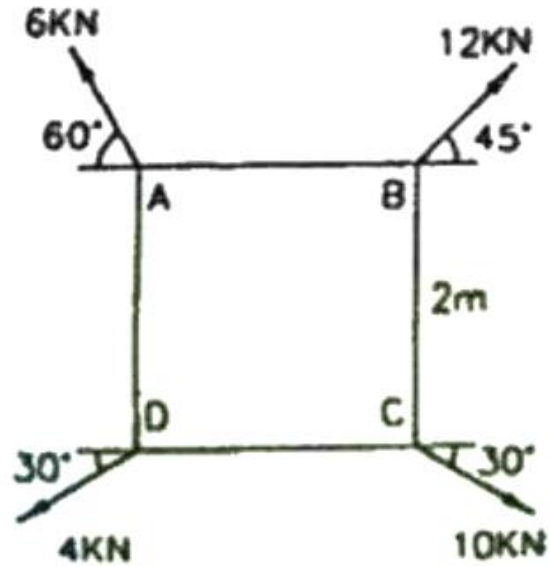
S.No	Question	CO	BTL	Marks
1.	State and prove Varignon's theorem or State the principle of moments.	2	1	2
2.	Define the term couple?	2	1	2
3.	What are the common types of supports used in two dimensions?	2	1	2
4.	What are the characteristics of a couple?	2	1	2
5.	Define moment of a force?	2	1	2
6.	List out the types of loads	2	1	2
7.	State polygon law of equilibrium.	2	1	2
8.	Why the couple moment is said to be a free vector?	2	1	2

PART- B

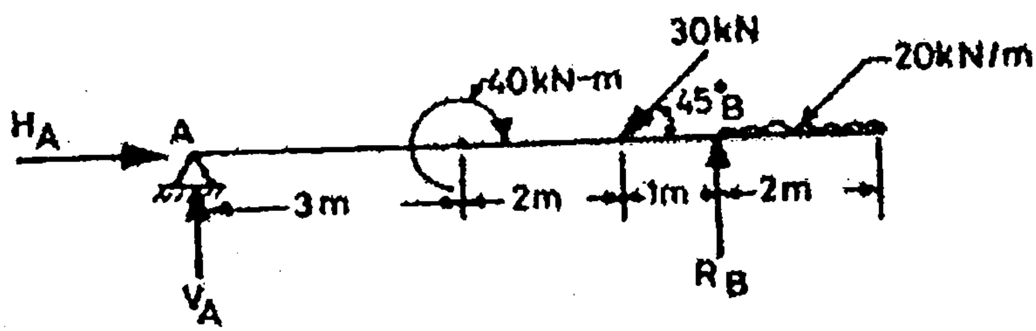
S.No	Question	CO	BTL	Marks
1	Determine the support reaction of the beam shown in fig.	2	3	16



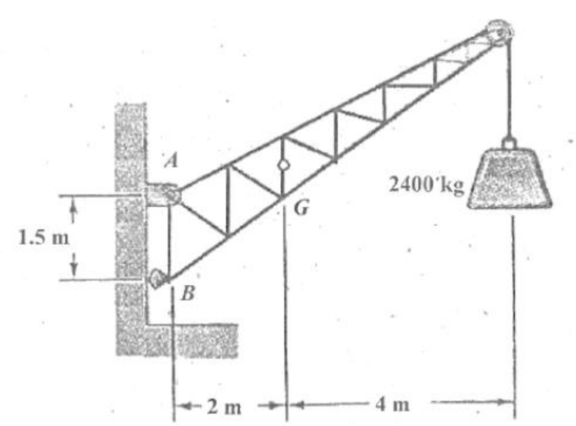
2	Four forces of magnitude and direction acting on a square ABCD of side 2m as shown in Fig. Calculate the magnitude and direction of the resultant and locate the resultant.	2	3	16



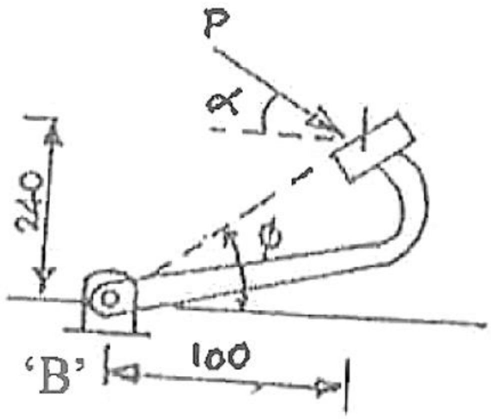
3	Determine the support reactions of the beam as shown in fig.	2	3	16



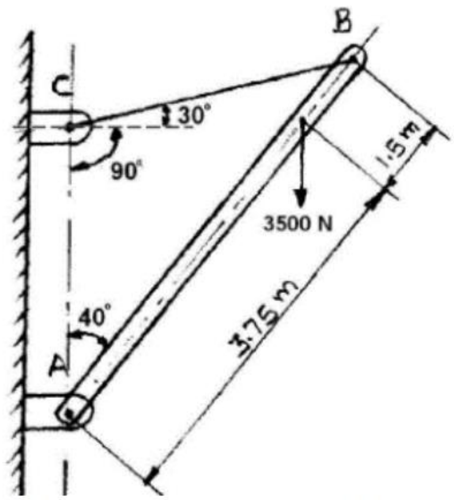
4	A fixed crane has a mass of 1000 kg and it is used to lift a 2400 kg weight. It is held in place by a pin at A and rocker at B. The centre of gravity of the crane is located at G. Determine the components of reaction at A and B.	2	3	16



5	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	3	16



6	Determine the tension in cable BC and reaction at A as shown in fig. Neglect the selfweight AB.	2	3	16



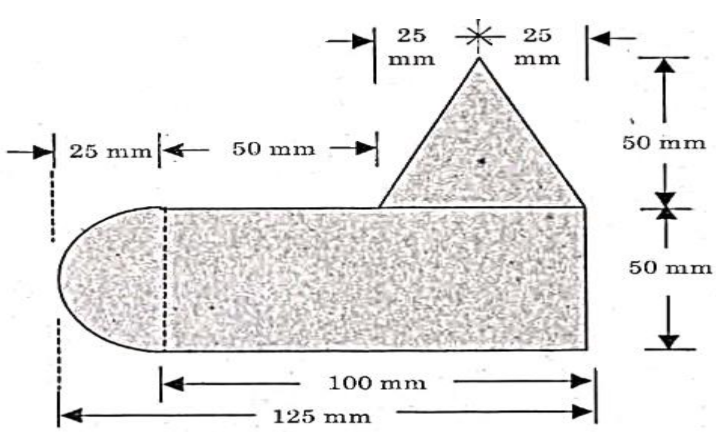
UNIT–III PROPERTIES OF SURFACES AND SOLIDS
Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration , Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies , Determination of Centroids of Volumes by Integration. Moments of Inertia of Areas and Mass – 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, Moments of Inertia of a Mass – Moments of Inertia of Thin Plates , Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

PART- A

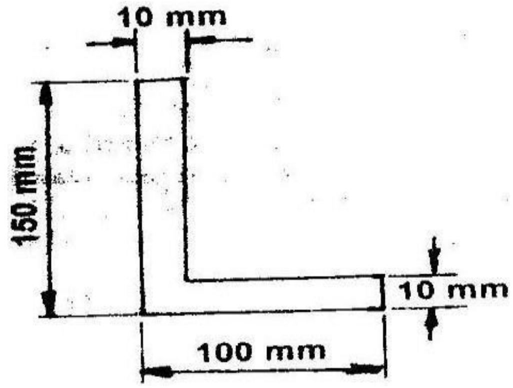
S.No	Question	CO	BTL	Marks
1.	What is meant by centre of gravity?	3	1	2
2.	What is meant by centroid?	3	1	2
3.	Define Radius of Gyration	3	1	2
4.	What is parallel axes theorem for moment of inertia?	3	1	2
5.	What are the key characteristics of an induction motor?	3	1	2
6.	What is perpendicular axes theorem for moment of inertia?	3	1	2
7.	Write an expression for the radius of gyration of an area.	3	1	2
8.	Define polar moment of inertia.	3	1	2

PART- B

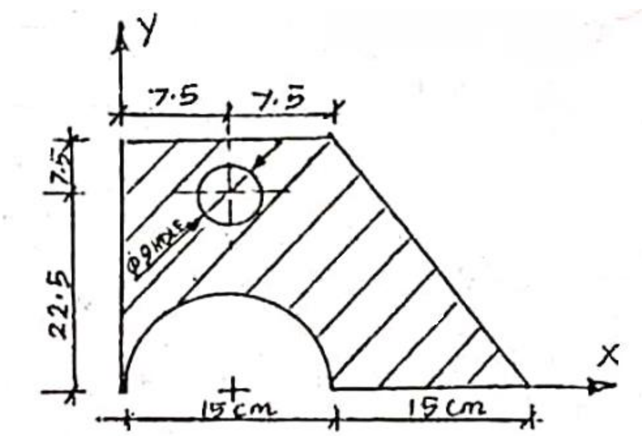
S.No	Question	CO	BTL	Marks
1	Find the centroid of a section shown in Fig below about the centroidal Axes. (Dimensions in mm)	3	3	16



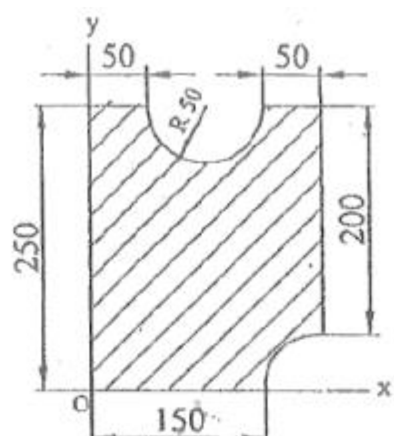
2	An area in the form of L section is shown in figure below Find the moments of Inertia Ixx, Iyy, and Ixy about its centroidal axes. Also determine the principal moments of inertia.	3	3	16



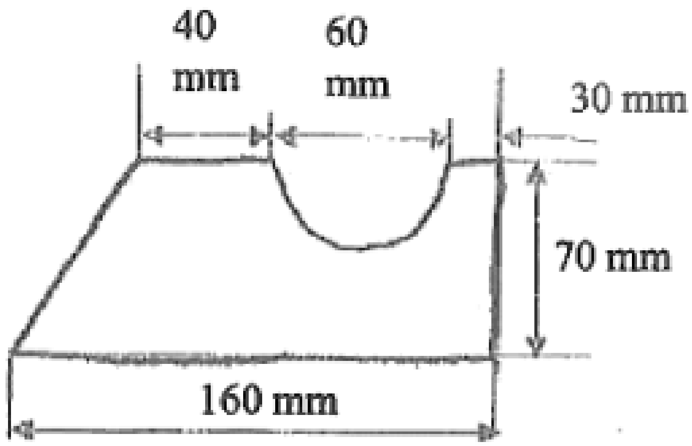
3	Locate the centroid of the area shown in figure below. The dimensions are in mm.	3	3	16



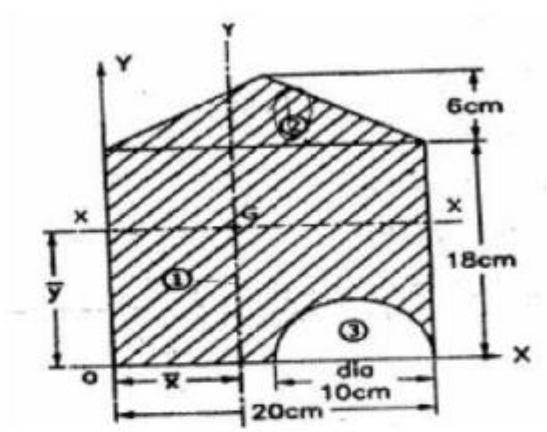
4	Locate the centroid of the shaded area shown in fig. The dimensions are in mm.	3	3	16



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



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



UNIT IV - FRICTION

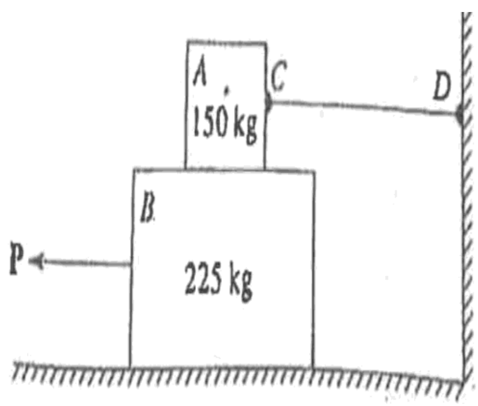
The Laws of Dry Friction, Coefficients of Friction, Angles of Friction, Wedge friction, Wheel Friction, Rolling Resistance, Ladder friction.

PART- A

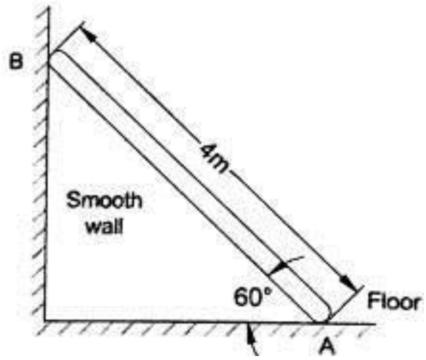
S.No	Question	CO	BTL	Marks
1.	Define Friction.	4	1	2
2.	What are the types of Friction?	4	1	2
3.	Write about dry friction and its types.	4	1	2
4.	Define limiting friction.	4	1	2
5.	Define Co-efficient of friction	4	1	2
6.	Define Angle of friction.	4	1	2
7.	What is angle of repose?	4	1	2
8.	When do we say that the motion of a body is impending?	4	1	2

PART- B

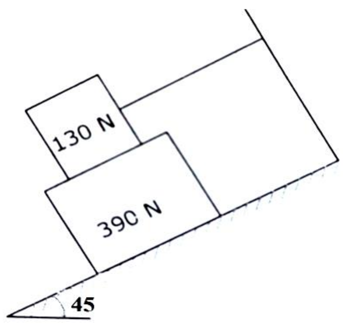
S.No	Question	CO	BTL	Marks
1	Determine the smallest force P required to move the block B is block A is restrained by a cable CD as shown in Fig. The co-efficient of friction between all surfaces is 1/4	4	3	16



S.No	Question	CO	BTL	Marks
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	3	16

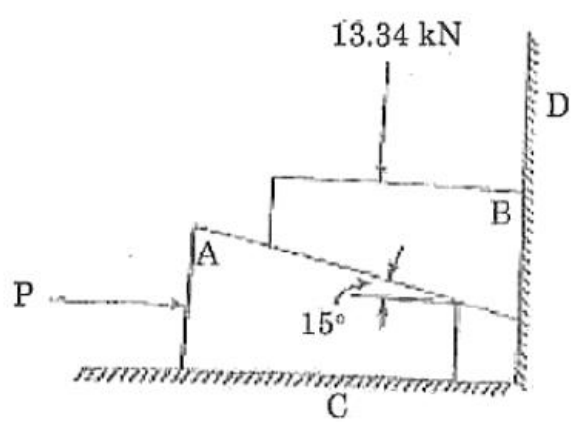


3 3. Find tension and normal reactions for the blocks shown in Fig.. The co-efficient of friction between all surfaces is 1/3. 4 3 16

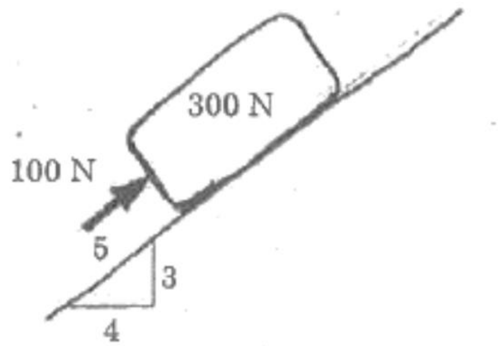


4 A ladder 5 m long rests on horizontal ground and leans against a smooth vertical wall at an angle of 70° with the horizontal. The weight of the ladder is 900 N and acts at the middle. The ladder is at the point of sliding, when a man is weighing 750 N stands on a rung 1.5 m from the bottom of the ladder. Calculate the coefficient of friction between the ladder and the floor. 4 3 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 3 16



6	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 μs = 0.25 and μk = 0.20. Determine whether the block is in equilibrium, and find the value of the friction force.	4	3	16



UNIT V - DYNAMICS OF PARTICLES

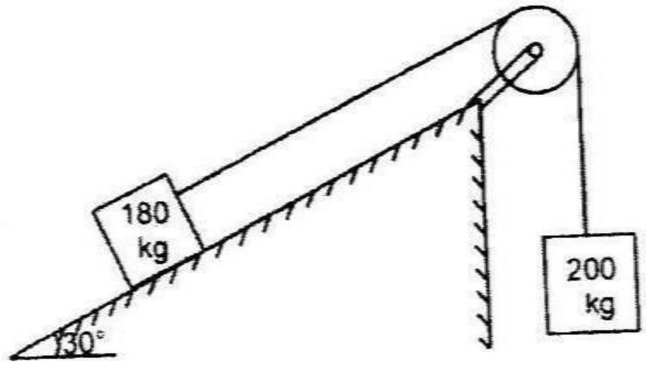
Kinematics – Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods -Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact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

PART- A

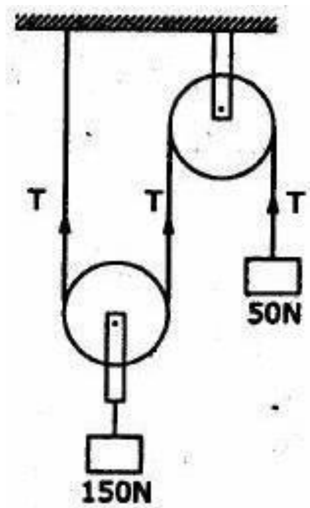
S.No	Question	CO	BTL	Marks
1.	State D' Alembert's principle.	5	1	2
2.	Write the work energy equation of particles	5	1	2
3.	State the principle of conservation of linear momentum.	5	1	2
4.	Define uniformly accelerated motion.	5	1	2
5.	What is uniform motion?	5	1	2
6.	What is dynamic equilibrium?	5	1	2
7.	State the principal of work and energy.	5	1	2
8.	A train running at 80 km/h is brought to a standing halt after 50 seconds. Find the retardation and the distance travelled by the train before it comes to a halt.	5	2	2

PART- B

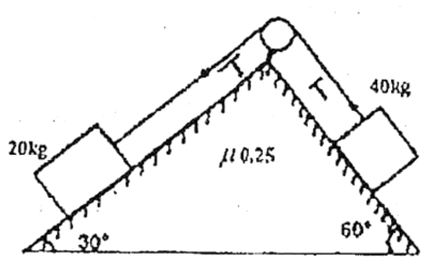
S.No	Question	CO	BTL	Marks
1	A block and pulley system is shown in figbelow. The coefficient of kinetic friction between the block and the plane is 0.25. The pulley is frictionless. Find the acceleration of the blocks and the tension in the string when the system is just released. Also find the time required for 200kg block to come down by 2m.	5	3	16



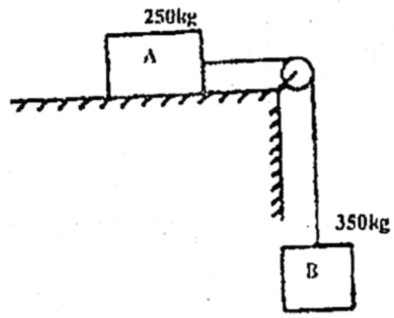
2	Two blocks of weight 150N and 50N are connected by a string, passing over a frictionless pulley as shown in fig. Predict the velocity of 150N block after 4 seconds. Also calculate the tension in the string.	5	3	16



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. 8. 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	3	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	3	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	3	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	3	16

MR3351

FLUID MECHANICS AND THERMAL SYSTEMS

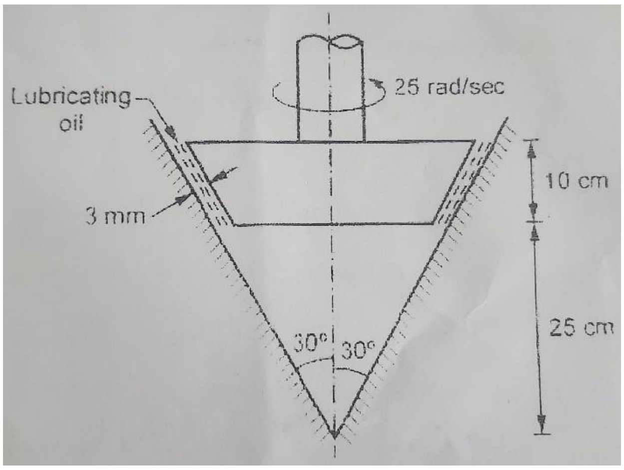
MR3351
FLUID MECHANICS AND THERMAL SYSTEMS

UNIT I

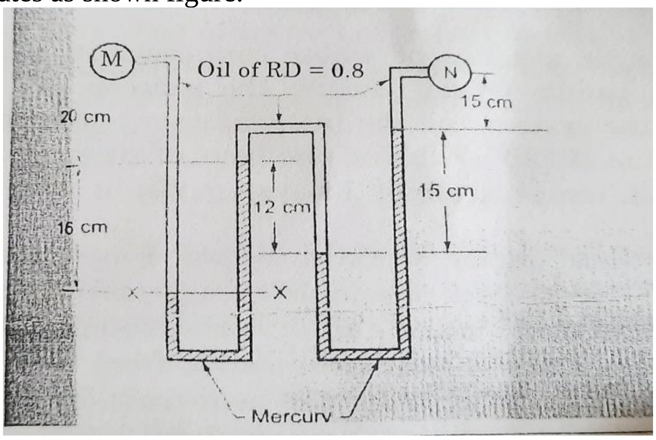
FLUID PROPERTIES AND FLOW STATICS

Fluid Definition and Classification – Properties of fluids: Density, Specific Weight, Specific Volume, Specific Gravity, Viscosity, Compressibility, Bulk Modulus, Capillary and Surface Tension – Fluid statics: Concept of fluid static pressure – Pascal‘s law –Absolute and Gauge pressures – Manometers: Types and Pressure measurement – Concept of Buoyancy and Floatation.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define density.	1	1	2
2.	Calculate a specific gravity of a liquid having a volume of 6 m^3 and weight of 44 kN.	1	3	2
3.	What is the difference between dynamic Viscosity and kinematic viscosity?	1	2	2
4.	Express the absolute pressure of 4 bar in the water head, if the barometer reads 760 mm of Hg.	1	3	2
5.	Define surface tension.	1	1	2
6.	Define compressibility.	1	1	2
7.	State Pascal’s law.	1	1	2
8.	Differentiae Buoyance and Floatation	1	2	2
	PART B			
1.	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 mm. 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.	1	3	16
2.	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	1	3	16



3.	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.	1	3	16
4.	Determine the pressure difference (Pm-Pn) when the manometer indicates as shown figure.	1	3	16



UNIT II

FLUID KINEMATICS AND FLUID DYNAMICS

Fluid Kinematics: Types of fluid flow – Continuity equation in two and three dimensions – Velocity and Acceleration of fluid particle – Velocity potential function and Stream function. Fluid dynamics: Euler's equation along a streamline –Bernoulli's equation and applications – Venturi meter, Orifice meter and Pitot tube.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Write the Continuity equation.	2	1	2
2.	Define Stream function.	2	1	2
3.	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	2	2
4.	What is the function of the ALE (Address Latch Enable) pin in 8085?	2	1	2
5.	Define Velocity potential function.	2	1	2
6.	What are the applications of Bernoulli's equation.	2	1	2
7.	Define pitot tube.	2	1	2
8.	Highlight the fundamental difference between Venturi meter and Orifice meter.	2	2	2
	PART B			
1.	The velocity component in a 2D incompressible flow are given as: $u = y^3 + 6x - 3x2y$; $v = 3yx^2 - 6y - x^3$. 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	3	16
2.	Derive Euler's equation of motion. List the assumptions made for Euler's Equation.	2	2	16
3.	Derive an expression for Bernoulli's theorem from the first principle and state the assumption made for such a derivation.	2	2	16
4.	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° to the horizontal. The pipe is carrying the water 24 m^3/min. the pressure of the water at the inlet is 500 kPa, find the pressure of the water at the exit.	2	3	16

UNIT III

VISCOUS FLOW, FLOW THROUGH PIPES AND DIMENSIONAL ANALYSIS

Viscous flow: Shear stress, pressure gradient relationship – Flow of viscous fluid through circular pipe – Flow through pipes: 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. Dimensional analysis: Buckingham's theorem.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	List the significance of Reynolds number.	3	1	2
2.	Air at 20°C flows at 700 cm^3/s through a 8 cm diameter pipe. Determine, whether the flow is laminar or turbulent.	3	3	2
3.	Differentiate hydraulic gradient line and total energy line.	3	2	2
4.	Draw the velocity and shear stress profile for pipe flow.	3	1	2
5.	Give the physical significance of the friction factor and identify its dependency on Reynold number..	3	1	2
6.	What are the minor losses? Under what circumstances will they be	3	1	2
7.	What are the uses of dimensional homogeneity?	3	1	2
8.	Give the dimensions for surface tension and dynamic viscosity.	3	1	2
	PART B			
1.	The rate of flow of water through a horizontal pipe is 0.25 m^3/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^2. Determine (i) Losses of head due to sudden enlargement, (ii) Pressure intensity in the larger pipe, (iii) Power loss due to enlargement.	3	3	16
2.	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^3/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	3	16
3.	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^2, 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	3	16

4.	Show that the power P developed in a water turbine can be expressed as $P = \rho N^3 D^5 \varphi\{D/B, \rho D^2 N/\mu, ND/\sqrt{gh}\}$ where ρ = mass density of the liquid, N = Speed in r.p.m, D = Diameter of the runner, B = Width of the runner and μ = co-efficient of dynamic viscosity.	3	3	16

UNIT IV

BASICS OF THERMODYNAMICS AND FIRST LAW OF THERMODYNAMICS

Thermodynamics – Microscopic and macroscopic point of view – Systems, properties, process, path, cycle. Thermodynamic equilibrium – Zeroth law of Thermodynamics – internal energy, enthalpy, specific heat capacities CV and CP, Relationship between CV and CP. First law of Thermodynamics – Application to closed and open systems – Steady Flow Energy Equation (SFEE) – Simple problems.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Pickup the intensive properties from the following list. (a) Pressure (b) Volume (c) Density (d) Enthalpy (e) Temperature.	4	1	2
2.	What is a cycle?	4	1	2
3.	What is the difference between an ideal and actual cycle?	4	2	2
4.	What is Zeroth law of Thermodynamics? Why is it so called?	4	1	2
5.	Give the physical significance of Internal energy.	4	1	2
6.	State first law of Thermodynamics.	4	1	2
7.	What is meant by 'Hyperbolic Process'?	4	1	2
8.	What are the conditions for the steady flow process?	4	1	2
	PART B			
1.	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	3	16
2.	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 m^3, determine the network done. Represent the entire process in a p-v diagram	4	3	16
3.	Air at 105 m/s and 1.25 kg/m^3 enters a Gas Turbine with an inlet area of 0.05 m^2. The air stream exits from the Gas Turbine at 135 m/s and 0.67 kg/m^3. During the flow process, the air losses 27 kJ/kg of heat, and its specific enthalpy drops by 145 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	3	16

4.	Air at a temperature of 15ºC passes through a Heat exchanger at a velocity of 30 m/s where its temperature has raised to 800ºC. It then enters a Turbine with the same velocity of 30 m/s and expands until its temperature falls to 650ºC. On leaving the Turbine, the air is taken at a velocity of 60 m/s to a Nozzle where it expands until its temperature has fallen to 500ºC. If the airflow rate is 2 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 not heat loss. Give a schematic diagram for the arrangement.	4	3	16

UNIT V

SECOND LAW OF THERMODYNAMICS AND ENTROPY

Second Law of thermodynamics – Kelvin Planck and Clausius Statements – Equivalents of Kelvin Planck and Clausius statements. Reversibility – Irreversibility, reversible cycle – Heat engine, heat pump and refrigerator. Carnot cycle and Clausius theorem, the property of entropy, the inequality of Clausius – Entropy principle – General expression for entropy – Simple problems in entropy.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Write the Kelvin Plank statement.	5	1	2
2.	State Clausius statement of II law of thermodynamics.	5	1	2
3.	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	2	2
4.	A heat engine is supplied with 2512 kJ/min of heat at 650ºC. heat rejection takes place at 100ºC. Specify which of the following heat rejection represents a reversible, irreversible or impossible result (a) 867 kJ/min (b) 1015 kJ/min	5	2	2
5.	Define irreversibility.	5	1	2
6.	Comparison between reversibility and inconvertibility.	5	2	2
7.	In an isothermal process 1000 kJ of work is done by the system at a temperature of 200ºC. What is the entropy change of this process?	5	2	2
8.	State the principle of increase of entropy.	5	1	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	3	16
2.	A reversible heat engine operates between two reservoirs at temperatures of 600ºC and 40ºC, respectively. The engine drives a reversible refrigerator that operates between reservoirs at 40ºC and -20ºC, 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	5	3	16

	transfer to the reservoir at 40ºC. (ii) Reconsider case (i), using the efficiency of the heat engine, and COP of refrigerator as 40% of their maximum value.			
3.	An Aluminum block (C = 400 J/kg K) with a mass of 5 kg is initially at 40ºC and is kept inside a room at 20ºC. It is cooled reversibly by transferring heat to a completely reversible cycle heat engine until the block reaches 200ºC. 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	3	16
4.	Explain the term reversibility as applied to a thermodynamics process.	5	2	16

MA3351

TRANSFORMS AND PARTIAL DIFFERNTIAL EQUATIONS

UNIT –I

PARTIAL DIFFERENTIAL EQUATIONS

Formation of partial differential equations –Solutions of standard types of first order partial differential equations – First order partial differential equations reducible to standard types - Lagrange's linear equation -- Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

Q.No	Question	CO	BTL	Marks
PART A				
1	Form the PDE by eliminating the arbitrary constants a &b from z = $(x^2+a)(y^2+b)$	1	2	2
2	Solve $(D^3 – 3DD'2 + 2D'^3) z = 0$	1	2	2
3	Find P.I of $(D^2 +3DD' +2D'^2) = e^{4x+3y}$	1	1	2
4	Solve p+ q = pq	1	2	2
5	Solve $(D^2 – 2DD'^2 + D'^2) z = 0$	1	2	2
6	Find P.I of $(D^2 – 2DD' -2D'^2) = \sin (x-y)$	1	1	2
7	Find the general solution of px +qy = z	1	2	2
8	Find the P.D.E of all spheres whose centre use on the z- axis	1	1	2
PART B				
1	Solve $x(y^2 - z^2) p + y(z^2 - x^2) q = z(x^2 – y^2)$.	1	3	8
2	Solve (mz – ny)p + (nx-lz)q = ly – mx	1	3	8
3	Solve pyz + qzx = xy	1	3	8
4	Solve $(D^3 - 2D^2D')z = 2e^{2x} + 3x^2y$.	1	3	8
5	Find the singular solution of the equation $z = p x + q y + p^2 + p q + q^2$	1	3	8
6	Solve (mz – ny)p + (nx-lz)q = ly – mx	1	3	8

7	Solve $\left(D^2 - 2DD' + D'^2\right)z = \cos(x - 3y) + e^{y-2x}$	1	3	8
8	Solve $(D^2+2DD'+D'^2)\ z = x^2y + e^{3x+y}$	1	3	8
9	Solve $Z = px + qx + p^2 + pq + q^2$	1	3	8
10	Solve $\sqrt{p}+\sqrt{q} = 1$	1	3	8

UNIT –II

FOURIER SERIES

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and Cosine series–Root mean square value – Parseval's identity – Harmonic analysis.

Q.No	Question	CO	BTL	Marks
	PART A			
1	State the Dirichlet's conditions for a function f(x) to be expanded as a Fourier series	2	1	2
2	Write a_0, a_n in the expansion of $x + x^3$ as a Fourier series in $(-\pi, \pi)$.	2	1	2
3	Find the constant term in the Fourier series of $(x) = \cos^2 x$ in $(-\pi, \pi)$.	2	1	2
4	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	1	2
5	If $f(x) = \begin{cases} \cos x, 0 < x < \pi \\ 50, \pi < x < 2\pi \end{cases}$, Find the sum of the Fourier Series for $f(x)$ at $x = \pi$	2	1	2
6	If f(x) is an odd function defined in (-L,L) whar are the values of a_0 and a_n	2	1	2
7	What do you mean by Harmonic Analysis	2	1	2
8	Find RMS value of $(x) = x^2$ in $(0,l)$.	2	1	2

PART B				
1	Find the Fourier series x^2 in $(-\pi, \pi)$. Use Parseval's identity to prove $1+\frac{1}{2^4}+\frac{1}{3^4}+\frac{1}{4^4}+\cdots=\frac{\pi^4}{90}$	2	3	16
2	Find the Fourier series expansion of the function with period 2π $f(x) = (x) = \begin{cases} x & 0 < x < \pi \\ 2\pi - x & \pi < x < 2\pi \end{cases}$ Hence deduce that $1+\frac{1}{1^2}+\frac{1}{3^2}+\frac{1}{5^2}+\cdots=\frac{\pi^4}{8}$	2	3	16
3	Find the Fourier series of $f(x) = x + x^2$ in $(-\pi, \pi)$ of periodicity 2π. Hence deduce that $\sum_{n=1}^{\infty}\frac{1}{n^2} = \frac{\pi^2}{6}$	2	3	16
4	Find the constant term and the coefficient of the first sine and cosine terms in the Fourier expansion of $y=(x)$. Given	2	3	16

x	0	1	2	3	4	5	6
y	9	18	24	28	26	20	9

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 – Steady state solution of two dimensional equation of heat conduction (Cartesian coordinates only)

Q.No	Question	CO	BTL	Marks
PART A				
1	Write the possible solutions of one dimensional heat equation	3	1	2
2	Write the assumptions made in the derivation of one dimensional wave equation	3	1	2
3	A rod 30 cm long has its ends A& B kept at 20^0C & 80^0 C resp. until steady state conditions prevail. Find this steady state temperature in the rod	3	1	2
4	Write the different solution of Laplace equation in Cartesian form	3	1	2
5	Classify the PDE $u_{xx} + 2u_{xy} + u_{yy} = 0$.	3	2	2
6	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	2	2
7	The ends a and b of a rod of length 10 cm have their temperature kept at 20^0C & 70^0 C. find the steady state temperature distribution on the rod.	3	1	2
8	State suitable solution of the one dimensional heat equation $\frac{\partial u}{\partial t} = a^2 \frac{\partial^2 u}{\partial x^2}$	3	1	2
PART B				
1	A tightly stretched string with fixed end points x=0 & x=l apart. Motion is started by displacing the string into the form y=$Asin$ $(\frac{\pi x}{l})$ from which it is released at time =0 . Find the displacement of any point on the string at a distance of x from one end at time t.	3	3	16
2	A tightly stretched string of length '2l' is fastened at x=0 and x= $2l$. The midpoint of the string is then taken to height 'b' transversely and then released from rest in that position. Find the lateral displacement of the string.	3	3	16

3	The ends A & B of a bar 30 cms long have this temperature kept at 20^oC and 80^oC until steady state prevails. The temperature at each end suddenly reduced to 0^oC and maintained so, find the resulting temperature distribution in the bar at time t	3	3	16
4	A rectangular plate with insulated surface is 10cm wide and so long compared to its width that it may be considered infinite in length. If the temperature of the other short edge y=0 is given by $u = \begin{cases} 20x, 0 \leq x \leq 5 \\ 20(10-x), 5 \leq x \leq 10 \end{cases}$ and the other edges are kept at 0^oC, find the steady state temperature distribution u(x, y) in the plate.	3	3	16

UNIT –IV

FOURIER TRANSFORMS

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

Q.No	Question	CO	BTL	Marks
PART A				
1	State Fourier integral theorem	4	1	2
2	State the convolution theorem for Fourier transforms.	4	1	2
3	Find the Fourier sine transform of $\frac{1}{x}$	4	1	2
4	Find the Fourier cosine transform of e^{-x}	4	1	2
5	State Parseval's Identity	4	1	2
6	Find the Fourier sine transform of e^{-3x}	4	1	2
7	Find the Fourier cosine transform of $f(x) = \begin{cases} cosx & if \quad 0 < x < a \\ 0 & if \quad \|x\| \geq a. \end{cases}$	4	1	2
8	State Linear property of Fourier Sine and Cosine transform.	4	1	2
PART 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 i)$\int_0^\infty \frac{sint}{t} dt = \frac{\pi}{2}$ and ii) $\int_0^\infty \frac{(sint)^2}{t^2} dt = \frac{\pi}{2}$.	4	3	16
2	Find the Fourier transform of the function f(x) defined by $f(x) = \begin{cases} 1 - x^2 \; in \; \|x\| \leq a \\ 0 \; in \; \|x\| > a > 0. \end{cases}$ Hence prove that $\int_0^\infty \frac{sint - tcost}{t^3} \cos\left(\frac{t}{2}\right) dt = \frac{3\pi}{16}$. Also show that $\int_0^\infty \frac{(tcost - sint)^2}{(t^3)^2} dt = \frac{\pi}{15}$.	4	3	16
3	Show that the function $e^{-\frac{x^2}{2}}$ is self -reciprocal under Fourier	4	3	8

	transform			
4	Evaluate $\int_{-\infty}^{\infty} \frac{x^2 dx}{(x^2+4)(x^2+9)}$ using Fourier sine transform	4	3	8
5	Using Parseval's identity evaluate the following integral $\int_0^\infty \frac{x^2 dx}{(a^2+x^2)^2}$	4	3	8
6	Find Fourier cosine transform of $\frac{e-ax}{x}$. Hence find Fc $[\frac{e^{-ax}-e^{-bx}}{x}]$.	4	3	8

UNIT –V

Z -TRANSFORMS AND DIFFERENCE EQUATIONS

Z- transforms - Elementary properties – Convergence of Z-transforms – Initial and final value theorems – 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
	PART A			
1	Find Z[1/ n!]	5	1	2
2	Find Z([a^n]	5	1	2
3	State Initial and Final value theorem	5	1	2
4	State convolution theorem on Z- transform	5	1	2
5	Form the difference equation byeliminating arbitrary constant A from $y_n=A3^n$	5	2	2
6	Form the the difference equation from u_n = a 2^{n+1}	5	2	2
7	Form the difference equation from $y_n=a+ b3^n$	5	2	2
8	Form the difference equation by eliminating arbitrary constant A from yn=A+B(-2)n	5	2	2
	PART B			
1	Find the Z – transform of $\frac{2n+3}{(n+1)(n+2)}$	5	3	8
2	Using Partial fraction method find $Z^{-1}\left[\frac{10z}{(z-1)(z-2)}\right]$	5	3	8
3	Using Convolution theorem find $Z^{-1}\left[\frac{z^2}{(z-a)(z-b)}\right]$.	5	3	8
4	Using Convolution theorem find $Z^{-1}\left[\frac{8Z^2}{(2Z-1)(4Z-1)}\right]$.	5	3	8
5	Solve using Z-transform technique the difference equation $y_{n+2} - 3y_{n+1} + 2y_n = n2^n$ with $y_0 = 0$, $y_1 = 0$	5	5	8

6	Solve $y_{n+2} + 6y_{n+1} + 9y_n = 2^n$ given $y_0=y_1=0$	5	5	8
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	5	8

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RA3301
ROBOT KINEMATICS

UNIT I

OVERVIEW OF ROBOTICS

Introduction to Robotics - History - Definitions - Law of Robotics – Terminologies – Classifications Overview – Links & Joints - Degrees of Freedoms - Coordinate Systems - Work Volume - Precision, Repeatability & Accuracy - Position and Orientation of Objects - Roll, Pitch and Yaw Angles – Joint Configuration of Five Types of Serial Manipulators - Wrist Configuration- Overview of end effector - Selection and Application of Serial Manipulators.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define Robot.	1	1	2
2.	What is wrist configuration?	1	1	2
3.	Define SCARA.	1	1	2
4.	What is the difference between vertical reach and vertical stroke in a cylindrical coordinate robot?	1	1	2
5.	Define payload.	1	1	2
6.	Define End effector.	1	1	2
7.	What are the different classifications of robots?	1	1	2
8.	Define laws of robotics.	1	1	2
	PART B			
1.	Explain the different types of joints and also explain the law of robotics.	1	2	16
2.	Classify the different types of robot configurations with neat sketch.	1	2	16
3.	Explain the terms precision, repeatability, accuracy, degree of freedom, links and joints.	1	2	16
4.	Explain the types of end effectors with neat sketch.	1	2	16

UNIT II

FORWARD KINEMATICS – GEOMETRICAL AND ALGEBRAIC APPROACH

Need for forward and Inverse Kinematics Equation – Parameters in Design and Control – Methods of forward and inverse kinematics- Geometrical and Algebraic Approach in Forward Kinematics Solution, 1 DOF - 2 DOF Planar Robot (2P and 2R); 3DOF 2RP Spatial Robot.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define forward kinematics.	2	1	2
2.	What do you understand by the term spatial robot?	2	1	2
3.	Define planar robot.	2	1	2
4.	Define degrees of freedom.	2	1	2
5.	Define inverse kinematics.	2	1	2
6.	What do you understand from algebraic approach?	2	1	2
7.	Determine the translated vector for the given vector v = 25i + 10j +20k, perform a translation by a distance of 6 units in X direction, 5 units in Y direction and 0 units in Z direction.	2	2	2
8.	Define geometric approach.	2	1	2
	PART B			
1.	Explain 3 DOF spatial robot (2RP) with neat sketch.	2	2	16
2.	Explain 2 DOF planar robot (2P) with neat sketch.	2	2	16
3.	Explain 2 DOF planar robot (2R) with neat sketch.	2	2	16
4.	Determine the position of a body point P in the local coordinate, if it is moved to $G_{rp} = [1,3,4]^T$ after global rotation. (i) A rotation of 45 deg about X-axis, 45 deg about Y-axis and 45 deg about Z-axis. (ii) A rotation of 30 deg about X-axis, 30 deg about Y-axis and 30 deg about Z-axis.	2	2	16

UNIT III

FORWARD KINEMATICS MODELING – DENAVIT-HARTEBERG (DH) APPROACH

Unit Circle Trigonometry - Translation Matrix - Rotation matrix, Euler Angles - Quaternion Fundamental - Dot and Cross Products - Frames and Joint Coordinates - Homogeneous Transformation - D-H and Modified D-H Convention and Procedures – Forward kinematics Solution using D-H Convention: 3 DOF wrist , RR Planar, 3 DOF RRP, Cartesian, Cylindrical, Spherical, SCARA and Articulated 3 DOF robots - 3 DOF robot with wrist.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is meant by Euler angle?	3	1	2
2.	Define Quaternion fundamental.	3	1	2
3.	What is D-H convention?	3	1	2
4.	Define unit circle trigonometry.	3	1	2
5.	What is homogeneous transformation?	3	1	2
6.	Define translation matrix.	3	1	2
7.	Define rotational matrix.	3	1	2
8.	Compare dot and cross product.	3	1	2
	PART B			
1.	Explain about the Quaternion fundamental and Euler angle.	3	2	16
2.	Derive the forward kinematic link for Cartesian, cylindrical and spherical robots.	3	2	16
3.	Find the forward kinematics using D-H parameter, relative transformation, total transformation and inverse kinematic equations for 3 degrees of freedom manipulator with P / -P / -P.	3	2	16
4.	Discuss the structure of the following matrix used in robotics position and orientation. (i) Homogenous transformation matrix. (ii) Rotational matrix. (iii) Dot and cross product matrix.	3	2	16

UNIT IV

INVERSE KINEMATICS MODELING

Introduction to inverse kinematics -Issues in inverse kinematics - Inverse kinematics of 2 DOF Planar robot - 2 and 3 DOF planar and Spatial robot - Tool configuration - Inverse kinematics of 3axis robot and 6 axis Robot - Inverse kinematics Computation- Closed loop solution.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What are the different methods to solve inverse kinematic problems?	4	1	2
2.	Define closed loop solution.	4	1	2
3.	What are the issues in inverse kinematics?	4	1	2
4.	Define inverse kinematics.	4	1	2
5.	What is the difference between inverse and forward kinematics?	4	1	2
6.	Compare planar and spatial robot.	4	1	2
7.	Define inverse kinematic computation.	4	1	2
8.	Define inverse kinematic computation.	4	1	2
	PART B			
1.	Discuss in detail about the issues in inverse kinematics.	4	2	16
2.	Explain about the inverse kinematics of Planar robot.	4	2	16
3.	Sketch and explain inverse kinematics of 6 axis robot.	4	2	16
4.	Explain about the inverse kinematics of Spatial robot.	4	2	16

UNIT V

KINEMATIC MODELING OF DIFFERENTIAL DRIVE ROBOT

Degree of Mobility, Steerability and Maneuverability- Mobile Robot kinematics - Kinematic model and constraints, Mobile robot workspace – Representation of robot position – Kinematic models of differential wheel drive - Fixed wheel and steered wheel - Mobile manipulators and its applications – swarm robots.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define swarm robots.	1	1	2
2.	What is degree of mobility in robotics?	1	1	2
3.	Define mobile manipulator.	1	1	2
4.	What are the applications of mobile manipulators?	1	1	2
5.	Define Maneuverability.	1	1	2
6.	What is the difference between fixed wheel and steered wheel?	1	1	2
7.	Define steerability.	1	1	2
8.	Define mobile robot workspace.	1	1	2
	PART B			
1.	Explain in detail about the concept of Steerability and Maneuverability in robots.	1	2	16
2.	Explain mobile manipulators and its applications.	1	2	16
3.	Discuss about kinematic models of differential wheel drive.	1	2	16
4.	Design a suitable sketch and explain industrial application of robot in non-manufacturing field.	1	2	16