24MABS303
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 – Lagrange's linear equation -- Linear partial differential equations of second and higher order with constant coefficients of homogeneous.

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	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	Identify the P.I of $(D^3 -3DD'^2 +2D'^3) = e^{2x-y}$	1	RE	2
8	Determine the P.I of $(D^2 -3DD' +3D'^2) = e^{3x+4y}$	1	RE	2
9	Show how to solve the p.d.e $(D^2 – 2DD'^2 + D'^2) z = 0$	1	UN	2
10	Find P.I of $(D^2 – 2DD' -2D'^2) = \sin(x-y)$	1	RE	2
11	Obtain the general solution of px +qy = z	1	RE	2
12	Determine 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	Obtain the complete solution of the equation $Z = px + qx - 2\sqrt{pq}$	1	RE	2
15	How to find P.I of $(D^2+4DD') z = e^x$	1	RE	2

PART B				
1	Resolve the P.D.E $x(y^2 - z^2)p + y(z^2 - x^2)q = z(x^2 - y^2)$.	1	AP	8
2	Work out the P.D.E $(mz - ny)p + (nx - lz)q = ly - mx$	1	AP	8
3	Deduce the Partial Differential equation $pq + p + q = 0$	1	AP	8
4	Elucidate the P.D.E $(D^3 - 2D^2D')z = 2e^{2x} + 3x^2y$.	1	AP	8
5	Resolve the equation $(x-2z)p + (2z-y)q = y-x$	1	AP	8
6	Deduce the Partial Differential equation P $(mz - ny)p + (nx - lz)q = ly - mx$	1	AP	8
7	Find the Soluion of $(D^2 - 2DD' + D'^2)z = cos(x - 3y) + e^{y-2x}$	1	AP	8
8	Solve the P.D.e$(D^2+2DD'+D'^2)\ z = x^2y + e^{3x+y}$	1	AP	8
9	Obtain the Complete solution of the equation $Z = px + qx + p^2 + pq + q^2$	1	AP	8
10	Conclude the solution of this P.D.E $\sqrt{p}+\sqrt{q} = 1$	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
PART A				
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 (- π, π).	2	RE	2
4	Determine the b_n expansion of $f(x) = x^2$as a Fourier series in (- π, π).	2	RE	2
5	Identify the constant term in the Fourier series of (x) =$\cos^2$x in (- π, π).	2	RE	2
6	Find the sum of the Fourier Series for $f(x) = \{x, 0 < x < 1\ 2, 1 < x < 2$ at $x = 1$.	2	RE	2
7	If $f(x) = \{cos\ cos\ x\ , 0 < x < \pi\ 50, \pi < x < 2\pi$, 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< π	2	RE	2
11	Find the Fourier constant b_n for x sinx in $(-\pi, \pi)$	2	RE	2
12	Write the Parseval's identity.	2	RE	2
13	Detemine the value of b_{25} while expanding the function $f(x) = \{1 + \frac{2x}{l}, -l \le x \le 0\ 1 - \frac{2x}{l}, 0 \le x \le l$ as a fourirer 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
	PART B			
1	Identify 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	AP	16
2	Find the Fourier series expansion of the function with period 2π $f(x) = (x) = \{x \quad 0 < x < \pi\ 2\pi - x \quad \pi < x < 2\pi$ Hence deduce that $1 + \frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \cdots = \frac{\pi^4}{8}$	2	AP	16
3	Obtain the Fourier series for f(x) of period 2l and defined as follows f(x) = $\{l - x \quad 0 < x \le l\ 0 \quad l \le x < 2l$ hence deduced that $1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \cdots = \frac{\pi}{4}$ and $\frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \cdots = \frac{\pi^2}{8}$	2	AP	16
4	Express $f(x) = \frac{1}{2}(\pi - x)$ as a Fourier Series in (0, 2 π) and hence deduce the sum of $1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \cdots = \frac{\pi}{4}$.	2	AP	16

5	Expand the Fourier series of $f(x) = 2x - x^2$ for the interval (0, 2L) for $0<x<3$.	2	AP	16
6	Determine 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 $(0,\pi)$ $\frac{1}{1^3} - \frac{1}{3^3} + \frac{1}{5^3} + \cdots = \frac{\pi^3}{32}$	2	AP	16
8	Expand 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	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
	PART A			
1	Identify the nature of the partial differential equation $4u_{xx}+4u_{xy}+u_{yy}+2u_x - u_y =0$.	3	RE	2
2	Classify $u_{xx} - y^4u_{yy} = 2y^3 u_y$	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 20^0C & 80^0 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	Categorize 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	Categorize 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 20^0C & 70^0 C. find the steady state temperature distribution on the rod.	3	RE	2
10	Categorize the P.D.E $u_{xx} - u_{yy} = 2Y^3 u_y$	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 α^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
	PART B			
1	Use the method of separation of variables to solve $\frac{\partial u}{\partial t} = 2\frac{\partial u}{\partial t} + u$ where u(x,0) = 6 $6e^{-3x}$	3	AP	16
2	A string is stretched and fastened to two points x= 0 and x= l apart. Motion is started by displacing the string into the form $y = k(lx - x^2)$ 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 is initially at rest in its equilibrium position and each of its points is given the velocity $v_0 \sin\frac{3\pi x}{l}$ $0 < x <$ Determine the displacement of a point distant x from one at time t.	3	AP	16
4	The ends A & B of a bar 30 Cms long have this temperature kept at 20ºC and 80ºC until steady state prevails. The temperature at each end suddenly reduced to 0ºC 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 20º C and the other at 80ºC until steady state conditions prevail. The temperature of the end B is then suddenly reduced to 60º C and kept so while the end A is raised to 40ºC.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
	PART A			
1	State Fourier transform pair	4	RE	2
2	Write the Change of scale property	4	RE	2
3	Find the Fourier sine transform of $\frac{1}{x}$	4	RE	2
4	identify the Fourier cosine transform of e^{-x}	4	RE	2
5	Define Parseval's Identity	4	RE	2
6	Determine the Fourier sine transform of e^{-3x}	4	RE	2
7	Find the Fourier cosine transform of $f(x) = \{cosx \ \ if \ \ 0 < x < a \ 0 \ \ if \ \ \|x\| \geq a.$	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	State Shifting property	4	RE	2
11	Write the 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
	PART B			
1	Determine the Fourier transform of $f(x) = \{1 \quad \|x\| < a \ 0 \quad \|x\| \geq a.$ Where a is positive real number and hence	4	AP	16

	deduce that i)$\int_0^\infty \frac{sint}{t}dt = \frac{\pi}{2}$ and ii) $\int_0^\infty \frac{(sint)^2}{t^2}dt = \frac{\pi}{2}$.			
2	Identify the Fourier transform of the function f(x) defined by $f(x) = \{1 - x^2\ in\ |x| \le a\ 0\ in\ |x| > a > 0$. Hence prove that $\int_0^\infty \frac{sint-tcost}{t^3}cos(\frac{t}{2})dt = \frac{3\pi}{16}$. Also show that $\int_0^\infty \frac{(tcost-sint)^2}{(t^3)^2}dt = \frac{\pi}{15}$.	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 $e^{-a^2x^2}$ is self -reciprocal under Fourier transform	4	AP	16
4	i)Evaluate $\int_{-\infty}^{\infty} \frac{x^2dx}{(x^2+4)(x^2+9)}$ 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)Use Parseval's identity to evaluate the following integral$\int_0^\infty \frac{x^2dx}{(a^2+x^2)^2}$ ii)Use Parseval's identity to evaluate the following integral$\int_0^\infty \frac{dx}{(a^2+x^2)^2}$	4	AP	16
6	Identify the Fourier cosine transform of $\frac{e-ax}{x}$. Hence find $F_C[\frac{e^{-ax}-e^{-bx}}{x}]$.	4	AP	16
7	Find the Fourier transform of $f(x) = \{1 - |x| \quad |x| < 1\ 0 \quad |x| \ge 1$. Where a is positive real number and hence deduce that i)$\int_0^\infty (\frac{sint}{t})^2dt = \frac{\pi}{2}$ and ii) $\int_0^\infty (\frac{sint}{t})^4dt = \frac{\pi}{3}$.	4	AP	16
8	Determine the Fourier transform of the function f(x) defined by $f(x) = \{a^2 - x^2\ in\ |x| \le a\ 0\ in\ |x| > a > 0$. Hence prove that $\int_0^\infty \frac{sint-tcost}{t^3}dt = \frac{\pi}{4}$. Also show that $\int_0^\infty \frac{(sint-tcost)^2}{(t^3)^2}dt = \frac{\pi}{15}$.	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
	PART A			
1	Find Z[1/ $n!$]	5	RE	2
2	Identify Z($[a^n]$	5	RE	2
3	Determine Z[1/ $(n+1)!$]	5	RE	2
4	State convolution theorem on Z- transform	5	RE	2
5	Form the difference equation byeliminating arbitrary constant A from $y_n = A3^n$	5	UN	2
6	Form the the difference equation from u_n = a 2^{n+1}	5	UN	2
7	Form the difference equation generated by $y_n = a + b3^n$	5	UN	2
8	Form the difference equation by eliminating arbitrary constant A from $y_n = A+B(-2)n$	5	UN	2
9	Identify Z$\left[\frac{a^n}{n!}\right]$	5	RE	2
10	Use Convolution theorem to Solve $Z^{-1}\left[\frac{Z^2}{(Z-1)(Z-3)}\right]$	5	UN	2
11	Find the Z- transform of (n+2)	5	RE	2
12	Determine the inverse Z transform of $\left[\frac{Z}{(z-1)^2}\right]$	5	RE	2
13	Write two-sided Z transform	5	RE	2
14	State Linearity property	5	RE	2
15	Identify Z[e^{-at}]	5	RE	2

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

UNITED INSTITUTE OF TECHNOLOGY

(An Autonomous Institution)

(Approved by AICTE | Affiliated to Anna University |
Accredited by NAAC with A+ Grade | Certified by ISO 9001:2015)
Periyanaickenpalayam, Coimbatore – 641020

24RAPC301 – ENGINEERING MECHANICS

QUESTION BANK

II YEAR
ROBOTICS AND AUTOMATION

III SEMESTER

ACADEMIC YEAR 2025 – 2026

PREPARED BY	**VERIFIED BY**	**APPROVED BY**

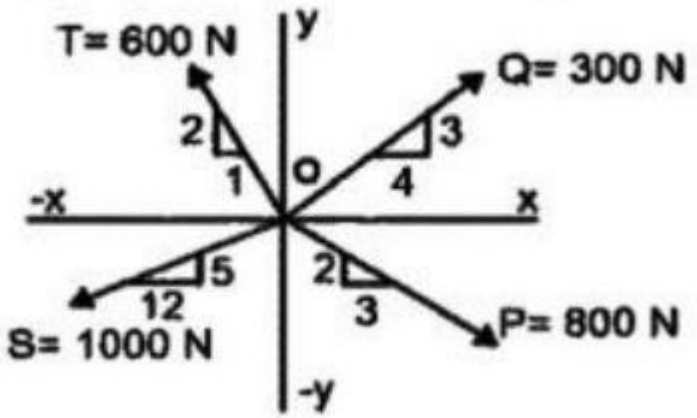
UNIT I
STATICS OF PARTICLES

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.

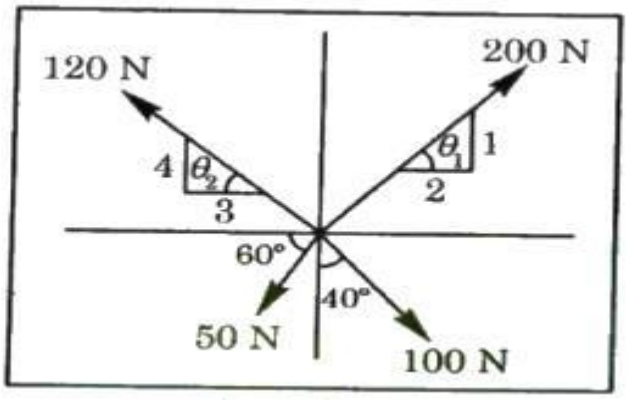
Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define Engineering Mechanics.	1	RE	2
2.	Define Force.	1	RE	2
3.	What is the difference between the resultant force and equilibrant force?	1	UN	2
4.	State law of parallelogram.	1	RE	2
5.	State the principle of transmissibility of force.	1	RE	2
6.	Define space and 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 60º 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

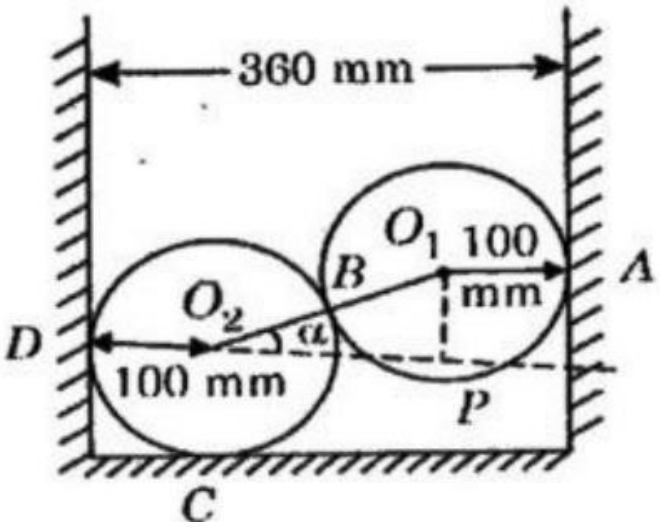
1.	Calculate the resultant force and its direction. For the Fig. shown.	1	UN	16



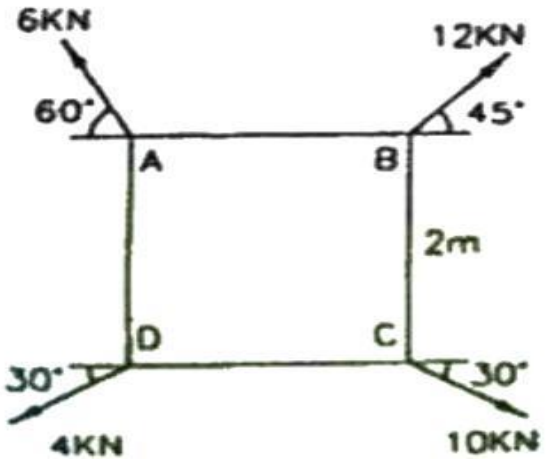
2.	Coplanar concurrent forces are acting at a point as shown in fig. Find the magnitude and direction of the resultant.	1	UN	16



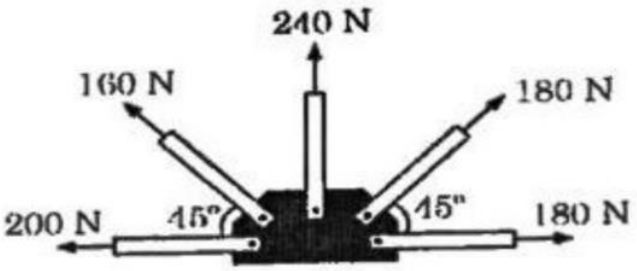
3.	Two identical rollers each of 50 N are supported by an inclined plane and a vertical wall as shown in figure. Find the reactions at the point of support A, B and C, assume all the surfaces to be smooth.	1	AP	16



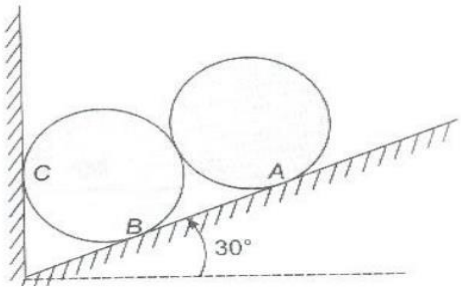
4.	Four forces of magnitude and direction acting on a square ABCD of side 2m as shown in Fig. Calculate the magnitude and direction of the resultant and locate the resultant.	1	AP	16



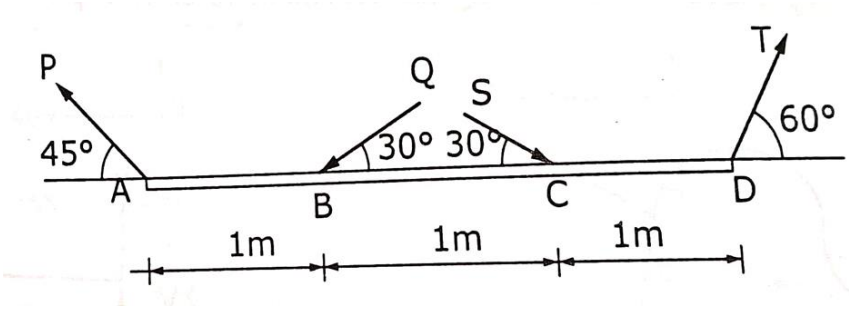
5.	Calculate the resultant force and its direction. For the Fig. shown	1	AP	16



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°, 60°, 135°, 210° and 270°. 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

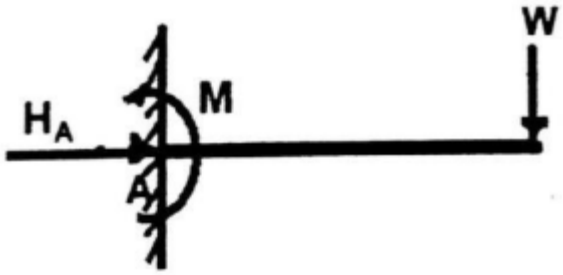
UNIT II

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
	PART A			
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

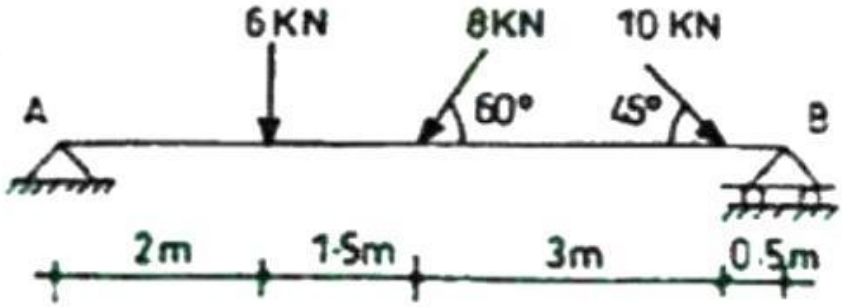
14.	Sketch the idealized, graphical and reaction of a cantilever support at a point.	2	RE	2



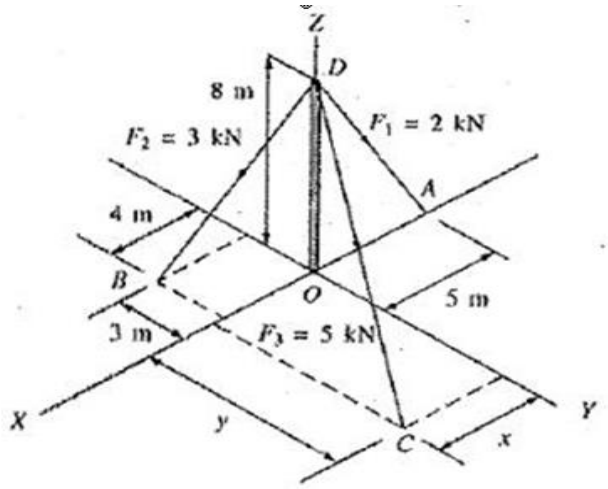
15.	State the requirements for equilibrium of a body acted upon by a parallel force system?	2	UN	2

PART B

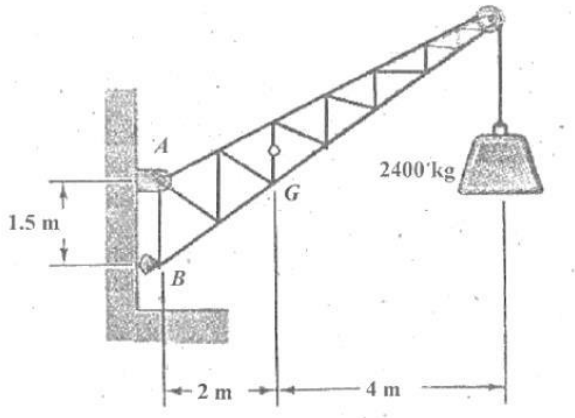
1.	Determine the support reaction of the beam shown in fig.	2	App	16



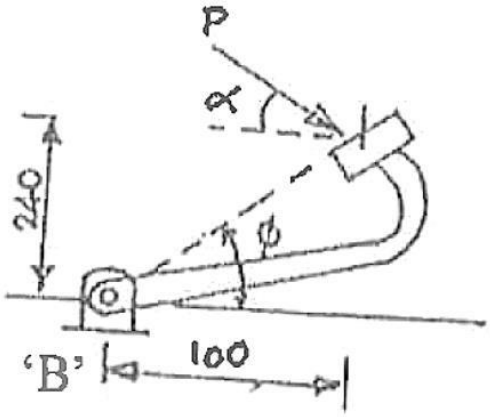
2.	A pole is held in place by three cables. If the force of each cable acting on the pole is shown, determine the position (x, y, 0) for fixing cable DC so that the resultant force exerted on the pole is directed along its axis.	2	AP	16



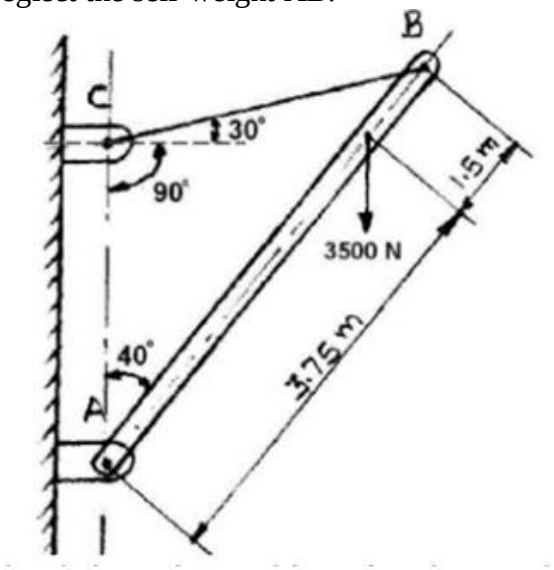
3.	A fixed crane has a mass of 1000 kg and it is used to lift a 2400 kg weight. It is held in place by a pin at A and rocker at B. The centre of gravity of the crane is located at G. Determine the components of reaction at A and B.	2	AP	16



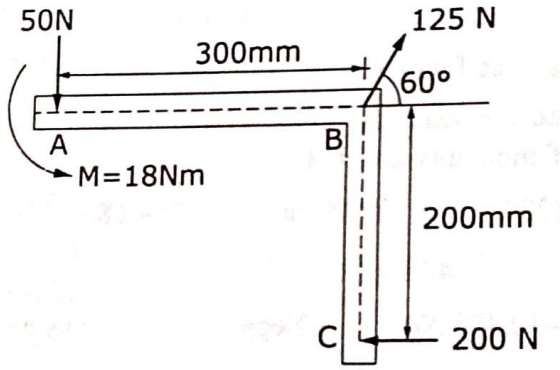
4.	For the brake pedal shown in fig, determine the magnitude and direction of the smallest force P which has a 104 Nm clockwise moment about B.	2	AP	16



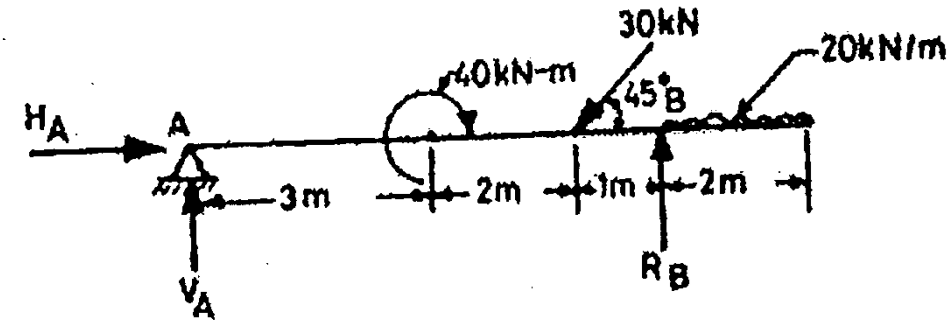
5.	Determine the tension in cable BC and reaction at A as shown in fig. Neglect the self-weight AB.	2	AP	16

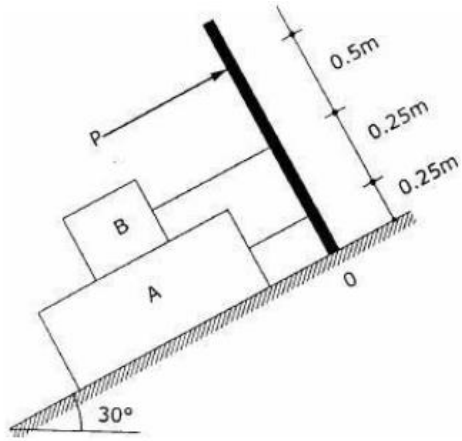


6.	The three forces and a couple of magnitude, M = 18 Nm are applied to an angled bracket as shown in fig. (i) Find the resultant of this system of forces (ii) Locate the points where the line of action of the resultant intersects line AB and line BC.	2	AP	16



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. 	2	AP	16

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

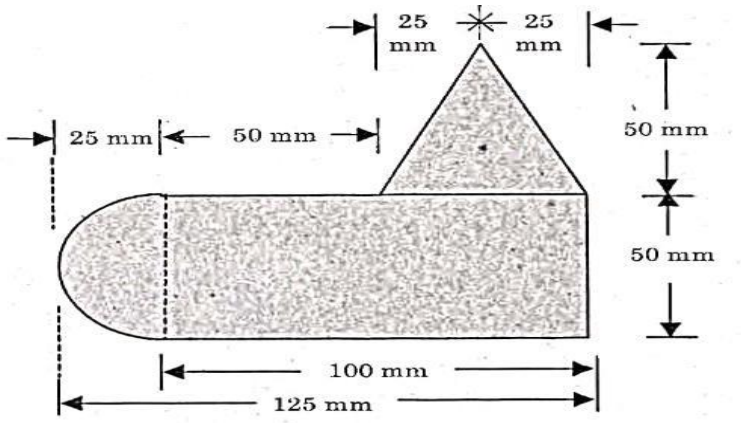
PART A

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

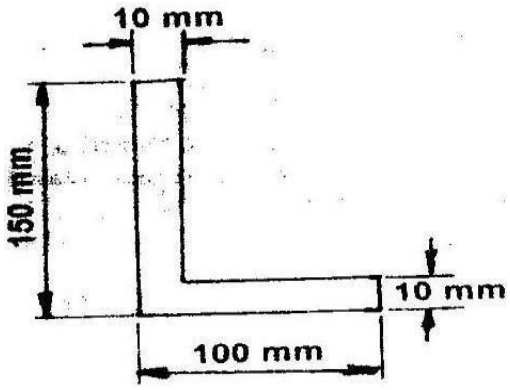
5.	What is perpendicular axes theorem for moment of inertia?	3	RE	2
6.	What is product of inertia?	3	RE	2
7.	What is principal moment of inertia?	3	RE	2
8.	What is mass moment of inertia?	3	RE	2
9.	Define Radius of Gyration	3	RE	2
10.	State Pappus theorem	3	RE	2
11.	State Guldinus theorem.	3	RE	2
12.	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

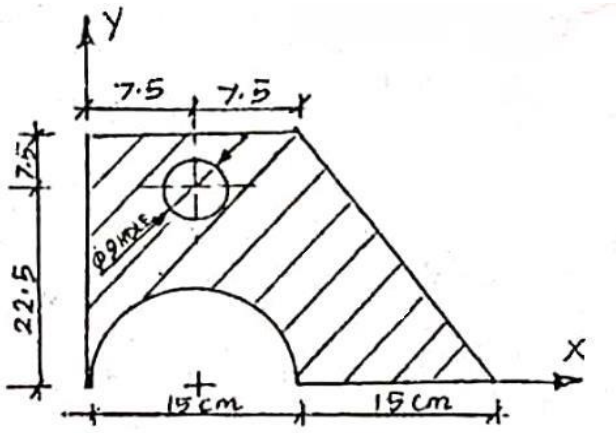
1.	Find the centroid of a section shown in Fig below about the centroidal Axes. (Dimensions in mm)	3	AP	16



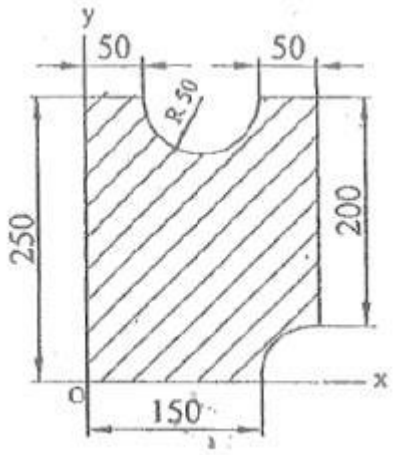
2.	An area in the form of L section is shown in figure below Find the moments of Inertia Ixx, Iyy, and Ixy about its centroidal axes. Also determine the principal moments of inertia.	3	AP	16



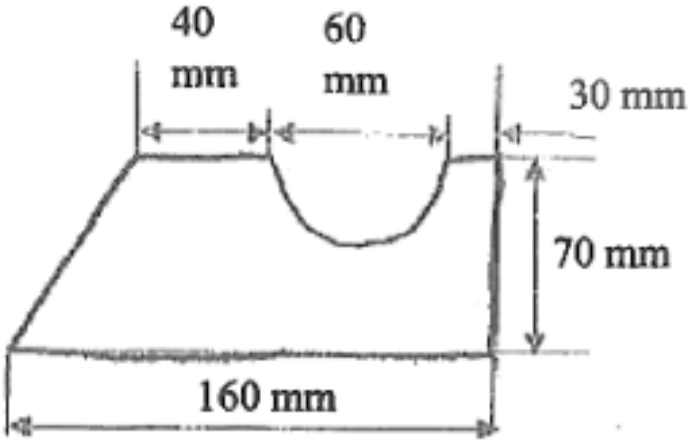
3.	Locate the centroid of the area shown in figure below. The dimensions are in mm.	3	AP	16



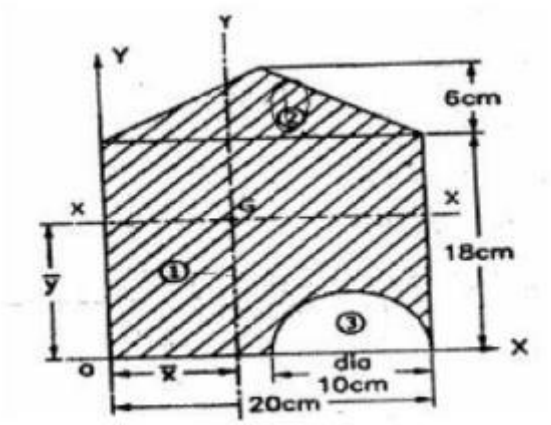
4.	Locate the centroid of the shaded area shown in fig. The dimensions are in mm.	3	AP	16



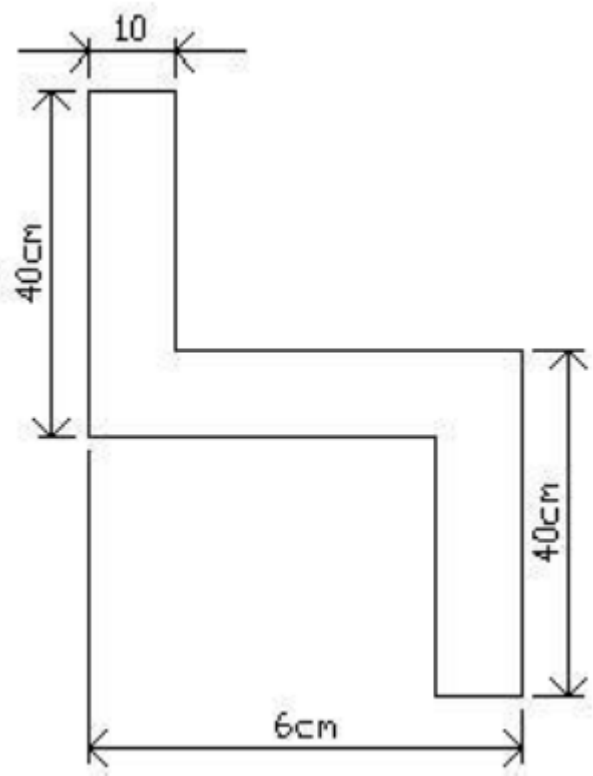
5.	Find the moment of inertia of the centroidal axes for the section shown in fig.	3	AP	16



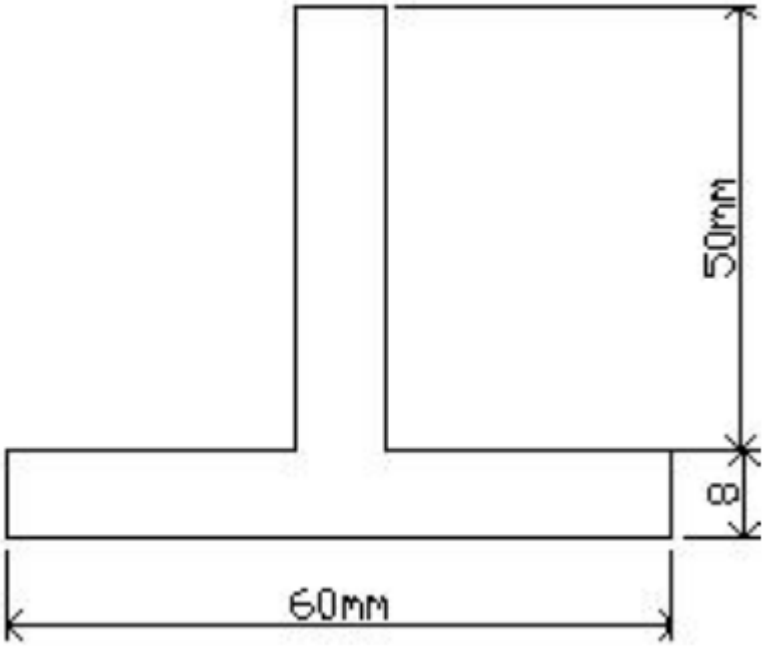
6.	Locate the centroid of the shaded area shown in fig. The dimensions are in mm.	3	AP	16



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

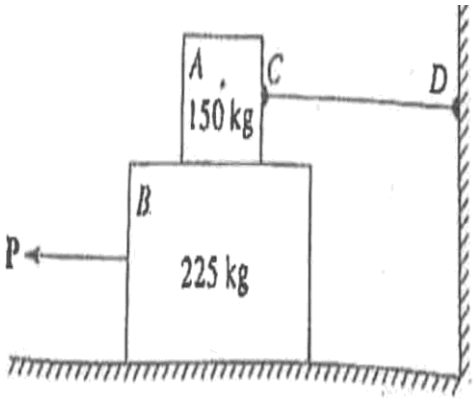
FRICTION

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

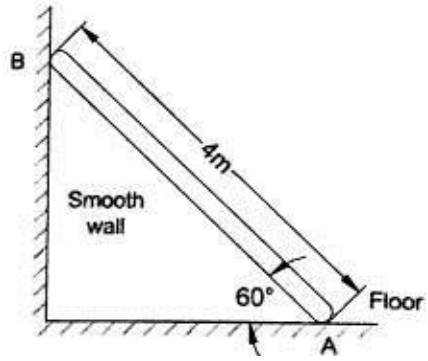
Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define Friction.	4	RE	2
2.	What are the types of Friction?	4	RE	2
3.	Write about dry friction and its types.	4	RE	2
4.	Define limiting friction.	4	UN	2
5.	Define Co-efficient of friction.	4	RE	2
6.	Define Angle of friction.	4	RE	2
7.	What is angle of repose?	4	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

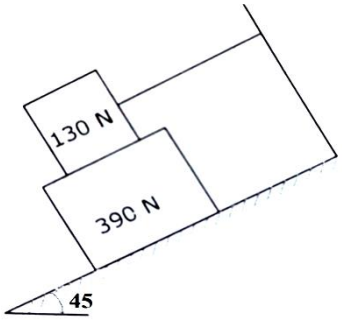
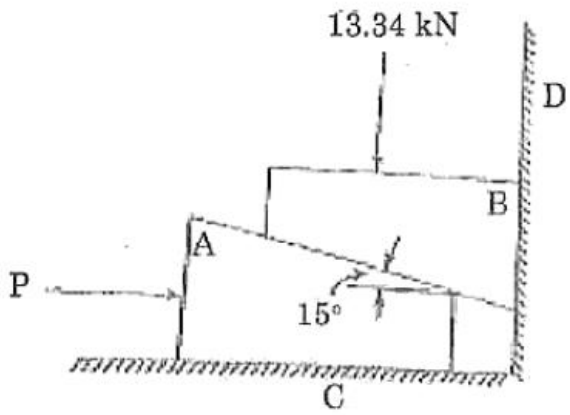
PART B

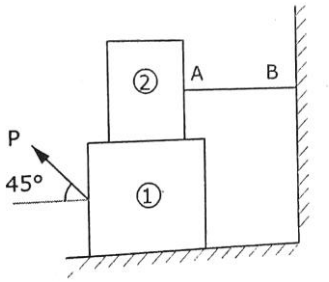
1.	Determine the smallest force P required to move the block B is block A is restrained by a cable CD as shown in Fig. The co-efficient of friction between all surfaces is 1/4	4	AP	16



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

UNIT V

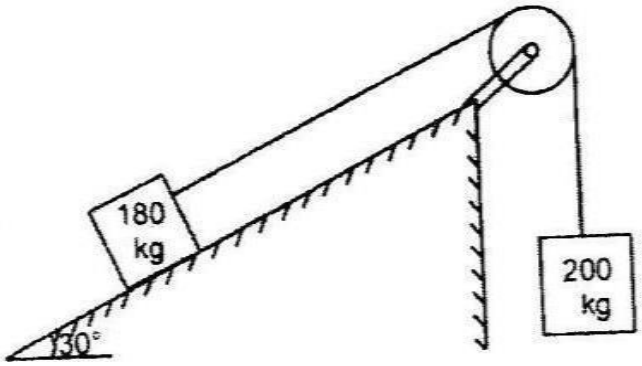
DYNAMICS OF PARTICLES

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.

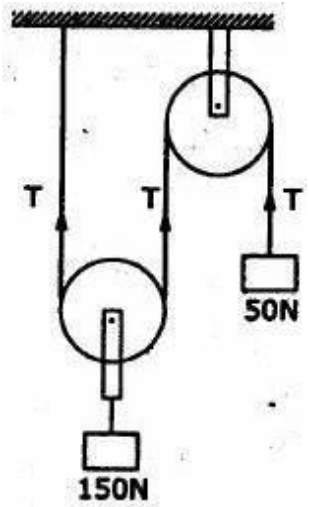
Q.No	Question	CO	BTL	Marks
	PART A			
1.	State D' Alembert's principle.	5	UN	2
2.	Write the work energy equation of particles	5	RE	2
3.	State the principle of conservation of linear momentum.	5	UN	2
4.	Define uniformly accelerated motion.	5	RE	2
5.	What is uniform motion?	5	RE	2
6.	What is dynamic equilibrium?	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

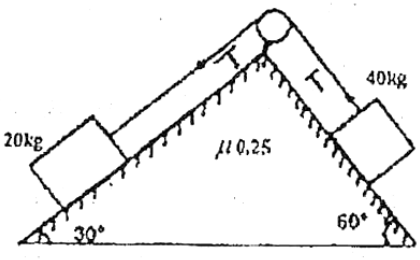
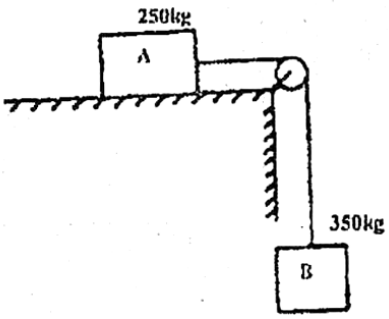
PART B

1.	A block and pulley system is shown in 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	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/s2 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/s2 to attain a maximum of 48 km/hour, its speed also becomes constant thereafter. When will B overtake A.	5	AP	16

UNITED INSTITUTE OF TECHNOLOGY
(An Autonomous Institution)
(Approved by AICTE | Affiliated to Anna University |
Accredited by NAAC with A+ Grade | Certified by ISO 9001:2015)
Periyanaickenpalayam, Coimbatore – 641020

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	AN
7.	Expand and define GTO.	2	CO1	RE
8.	What is the full form of IGCT?	2	CO1	RE
9	List any two switching characteristics of MOSFET.	2	CO1	RE
10	Write one advantage of IGBT over BJT.	2	CO1	UN
11	Define triggering in the context of SCR.	2	CO1	RE
12	Explain the meaning of commutation in SCR operation.	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	List the basic requirements of a good switching device.	2	CO1	RE

PART- B

S.No	Question	M	CO	BT
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	Illustrate the commutation circuits of SCR with neat diagrams and explanations.	16	CO1	AP
4	Explain the operation of MOSFET with static and switching characteristics. Highlight its advantages.	16	CO1	UN
5	Describe the structure, switching behavior, and typical applications of IGBT 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	RE
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	AN
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	Identify any two factors that affect the stopping time of a motor.	2	CO2	UN
14	State one criterion for selecting a motor for a specific application	2	CO2	RE
15	Explain the meaning of torque-speed characteristics.	2	CO2	UN

PART- B

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

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

S.No	Question	M	CO	BT
1.	Define a PMDC motor.	2	CO3	RE
2.	What is the main difference between a PMDC and a conventional DC motor?	2	CO3	AN
3.	State the working principle of a BLDC motor.	2	CO3	RE
4.	Mention two advantages of BLDC motors over brushed DC motors.	2	CO3	RE
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	RE
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	AN
15	State any two advantages of using drives for DC motor control.	2	CO3	RE

PART- B

S.No	Question	M	CO	BT
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	Analyze the four-quadrant operation of a DC drive system with diagrams	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	Discuss industrial and consumer applications of PMDC and BLDC motors..	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.	State the principle of operation of a 3-phase induction motor.	2	CO4	RE
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.	Define 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	RE
9	State any two applications of linear motors.	2	CO4	RE
10	Differentiate between single-phase and three-phase induction motors.	2	CO4	AN
11	What is the effect of changing stator frequency on motor speed?	2	CO4	UN
12	Define stator current control.	2	CO4	RE
13	Explain 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

S.No	Question	M	CO	BT
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	Illustrate 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	Demonstrate slip power recovery control with diagrams and explain its advantages.	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	Analyze stator current control and static rotor resistance control with diagrams.	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

S.No	Question	M	CO	BT
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	AN
14	Identify one industrial application of a servo motor.	2	CO5	UN
15	What is feedback in servo systems?	2	CO5	UN

PART- B

S.No	Question	M	CO	BT
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	Illustrate the drive system and logic sequencer used to control a stepper motor.	16	CO5	AP
4	Demonstrate the construction, characteristics, and working of a DC servo motor with torque-speed curve.	16	CO5	AP
5	Compare the operation and control of AC and 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 ----------

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.

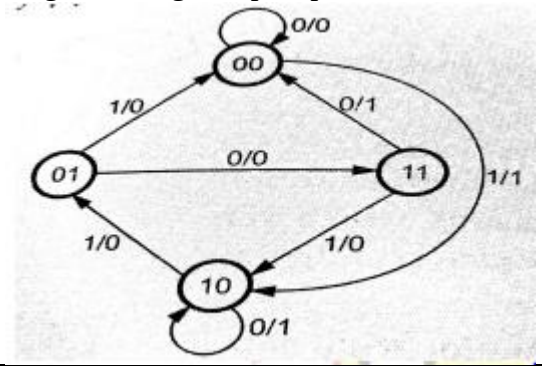
Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define Combinational Circuits.	1	RE	2
2.	What is 1’s complement of a number?	1	RE	2
3.	What is 2’s complement of a number?	1	RE	2
4.	Convert $(11010111)_2$ to Excess 3 and Gray codes.	1	UN	2
5.	What is the significance of BCD code?	1	RE	2
6.	What is a karnaugh 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
	PART B			
1.	(i)Simplify the following switching functions using Karnaugh map method and realize expression using gates $F(A,B,C,D) = \Sigma m(0,3,5,7,8,9,10,12,15)$. (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) = ∑m(1,4,6,10,20,22,24,26) + ∑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	AP	16
5	Explain about decoders with necessary diagrams. (2 to 4 and 3 to 8).	1	AP	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) = ∑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 f1 (A,B,C) = ∑m(1,5,7), f2 (A,B,C) = ∑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
	PART A			
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
	PART 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	AN	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
	PART A			
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
PART 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
PART A				

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 in8086?	4	RE	2
15	What are the two operating modes of 8086?	4	RE	2
	PART B			
1.	Describe the internal architecture of 8086 microprocessor with neat diagrams	3	AP	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

ROGRAMMING 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
	PART A			
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
	PART 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

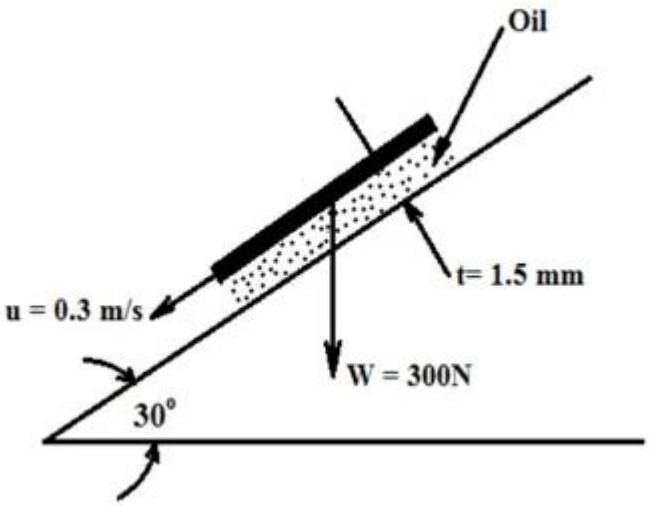
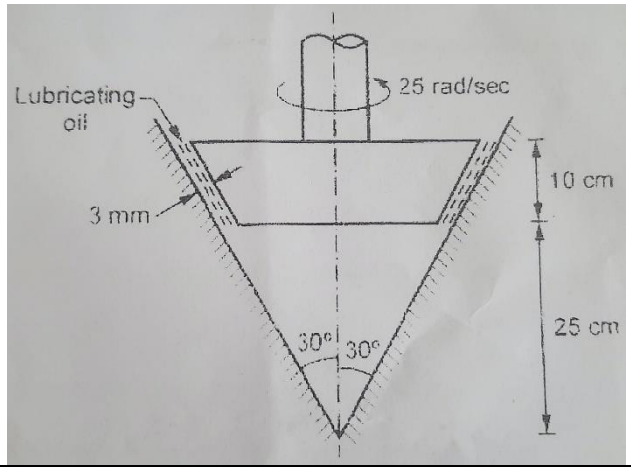
24RAPC303
FLUID MECHANICS AND THERMAL SYSTEMS

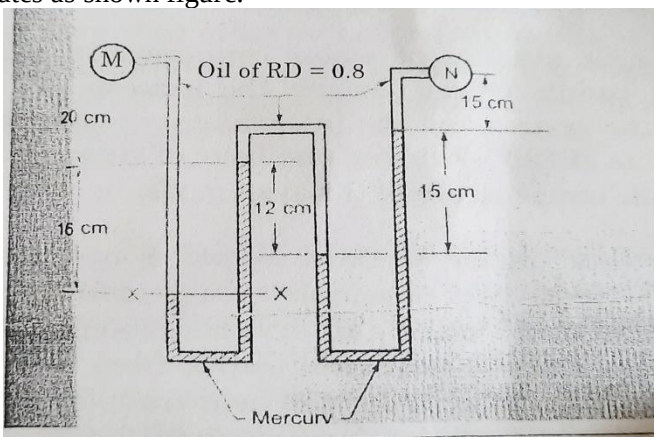
UNIT I

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
	PART A			
1	Define density.	1	RE	2
2	Calculate a specific gravity of a liquid having a volume of 6 m^3 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
	PART 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^o 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

				
2	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.	1	AP	16
3	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 2.5 Ns/m^2. 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?	1	AP	16
4	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	AP	16
5	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	AP	16

6	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. Th 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.	1	AP	16
7	Determine the pressure difference (Pm-Pn) when the manometer indicates as shown figure. 	1	AP	16
8	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.	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
	PART A			
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^2 (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
	PART 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^o 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	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 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
	PART A			
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^{o}C flows at 700 cm^3/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
	PART 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^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	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^2 and 11.772 N/cm^2 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^3/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^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	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^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	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 10^4 m^2/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
	PART A			
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
	PART B			
1	Define an adiabatic process. Show that for a reversible adiabatic process of a given mass of perfect gas: Pv^r = 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 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^{o}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 kJ/kg.K.	4	AP	16
5	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	AP	16
6	Air at a temperature of 15^{o}C passes through a Heat exchanger at a velocity of 30 m/s where its temperature has raised to 800^{o}C. It then enters a Turbine with the same velocity of 30 m/s and expands until its temperature falls to 650^{o}C. 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 500^{o}C. 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	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 kJ/kg and the velocity is 60 m/s. At the discharge end, the enthalpy is 2762 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 m^2 and the specific volume at the inlet is 0.187 m^3/kg, find the mass flow rate. (3) If the specific volume at the nozzle exit is 0.498 m^3/kg, find the exit area of the nozzle.	4	AP	16
8	Air is compressed by an adiabatic compressor from 100 kPa and 12^{o}C to a pressure of 800 kPa at a steady rate of 0.2 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
	PART A			
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^{o}C and a sink at 30^{o}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^{o}C. heat rejection takes place at 100^{o}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^{o}C. The ambient air temperature is 30^{o}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^{o}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 rejecting heat directly to engine. Engine A receives 200 kJ at a temperature of 421^{o}C from a hot source, while engine B is in communication with cold sink at a temperature of 4.4^{o}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^{o}C and 40^{o}C, respectively. The engine drives a reversible refrigerator that operates between reservoirs at 40^{o}C and -20^{o}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^{o}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^{0}C and delivers heat to a reservoir at 60^{0}C. The heat pump is driven by a reversible heat engine which takes heat from reservoir at 840^{0}C and rejects heat to a reservoir at 60^{0}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^{0}C, determine (1) The rate of heat supply from 840^{0}C source, and (2) The rate of heat rejection to 60^{0}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 J/kg K) with a mass of 5 kg is initially at 40^{o}C and is kept inside a room at 20^{o}C. It is cooled reversibly by transferring heat to a completely reversible cycle heat engine until the block reaches 200^{o}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