Printed Page:- 05 **Subject Code:- AME0502**

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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: V -THEORY EXAMINATION (2023- 2024)

Subject: Theory of Machines

Time: 3 Hours **Max. Marks: 100**

General Instructions:

IMP: *Verify that you have received the question paper with the correct course, code, branch etc.*

1. *This Question paper comprises of* ***three Sections -A, B, & C.*** *It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.*

2. *Maximum marks for each question are indicated on right -hand side of each question.*

3. *Illustrate your answers with neat sketches wherever necessary.*

4. *Assume suitable data if necessary.*

5. *Preferably, write the answers in sequential order.*

6. *No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.*

SECTION-A 20

1. Attempt all parts:-

1-a. Which of the following are the inversions of double slider crank mechanism?(CO1) 1

1. Oldham coupling 2. Whitworth quick return mechanism
3. Beam engine mechanism 4. Elliptic trammel mechanism

Select the correct answer from the codes given below. -

(a) 1 and 2

(b) 1 and 4

(c) 1, 2 and 3

(d) 2, 3 and 4

1-b. The number degrees of freedom of a planar linkage with 4 links and 4 simple revolute joints are (CO1) 1

(a) 1

(b) 2

(c) 3

(d) 4

1-c. A radial cam is one (CO2) 1

(a) that reciprocates in the guides

(b) in which the follower translates/reciprocate along an axis passing through the cam centre of rotation.

(c) in which axis of follower and cam are perpendicular to each other

(d) none of the above

1-d. The angle between the direction of the follower motion and a normal to the pitch curve is called (CO2) 1

(a) Pitch angle
(b) Prime angle
(c) Base angle
(d) Pressure angle

1-e. What are crank effort diagrams? (CO3) 1

(a) Turning moment diagram is drawn on cartesian co-ordinates
(b) Turning moment (T) is plotted against crank angle θ for various crank positions
(c) Turning moment diagram is drawn on polar co-ordinates
(d) All of the above

1-f. The resultant force is equal to the _____ of all the forces. (CO3) 1

(a) algebraic Sum
(b) Product
(c) Substraction
(d) Division

1-g. Which of the following is true for centrifugal force causing unbalance? (CO4) 1

(a) Direction changes with rotation
(b) Magnitude changes with rotation
(c) Direction and magnitude both change with rotation
(d) Direction and magnitude both remain unchanged with rotation

1-h. Often an unbalance of forces is produced in rotary or reciprocating machinery due to the _____ (CO4) 1

(a) Centripetal forces
(b) Centrifugal forces
(c) Friction forces
(d) Inertia forces

1-i. What is the effect of reactive gyroscopic couple when aeroplane takes right turn and propeller rotates in clockwise direction? (CO5) 1

(a) The tail of the aeroplane is dipped and nose is raised
(b) The tail of the aeroplane is raised and nose is dipped
(c) Reactive gyroscopic couple has no effect when propeller rotates in clockwise direction
(d) None of the above

1-j. The pitching effect of a naval-ship produces force(s) on which of the following components of the ship? (CO5) 1

(a) Bearings

(b) Lubricant

(c) Seals

(d) Springs

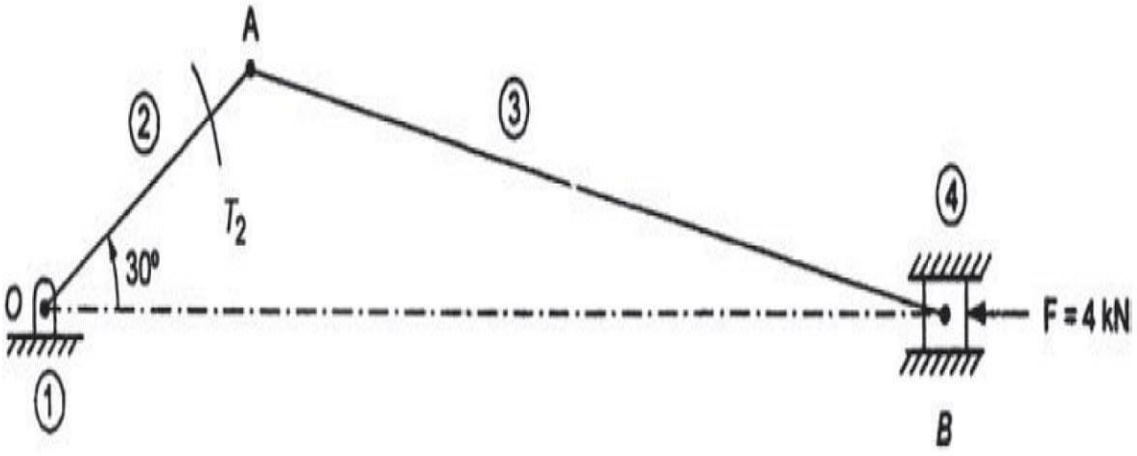
2. Attempt all parts:-

2.a.	Define the following: Kinematic links, Kinematic chain. (CO1)	2
2.b.	Classify the different types followers. (CO2)	2
2.c.	What do you mean by applied and constraint forces? (CO3)	2
2.d.	State the necessary conditions for dynamic balancing. (CO4)	2
2.e.	Explain the application of gyroscopic principles to aircrafts. (CO5)	2

SECTION-B 30

3. Answer any five of the following:-

3-a.	What are the inversions of four bar chain and also explain the double crank, crank rocker and double rocker mechanism with their kinematic link diagram. (CO1)	6
3-b.	Explain the working of Whitworth's QRMM with kinematic link diagram. Also explain why it is a type of quick return motion mechanism? (CO1)	6
3-c.	Define the following terminology of cam with neat sketch: Pressure angle, Pitch point, and Pitch circle. (CO2)	6
3-d.	A disc cam is to give SHM to a knife edge follower with stroke of 50 mm. The angle of ascent is 120°, and angle of descent 90°.Calculate the maximum velocity of follower during ascent and descent when the camshaft revolves at 240 rpm. (CO2)	6
3.e.	The value of force applied to slider in a four-bar mechanism shown in figure is 4 kN. Determine the forces in various links and driving torque T_2. (CO3)	6



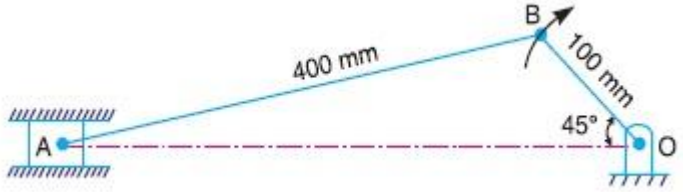
3.f.	A Porter governor has equal arms each 250 mm long and pivoted on the axis of rotation. Each ball has a mass of 5 kg and the mass of the central load on the sleeve is 25 kg. The radius of rotation of the ball is 150 mm when the governor begins to lift and 200 mm when the governor is at maximum speed. Find the minimum and maximum speeds and range of speed of the governor. (CO4)	6
3.g.	Derive an expression for gyroscopic couple when the disc is rotating with angular	6

velocity ω. (CO5)
$C = I\omega\omega_P$

SECTION-C 50

4. Answer any one of the following:-

4-a. Locate all the instantaneous centers of the slider crank mechanism as shown in figure. The lengths of crank OB and connecting rod AB are 100 mm and 400 mm respectively. If the crank rotates clockwise with an angular velocity of 10 rad/s, find: (i). Velocity of the slider A, and (ii). Angular velocity of the connecting rod AB. (CO1) 10



4-b. In a four-bar chain ABCD, AD is the fixed link 12 cm long, crank AB is 3 cm long and rotates uniformly at 100 rpm clockwise while the link CD is 6 cm long and oscillate about D. Link BC is equal to the link AD. Find the angular velocity of link DC when angle BAD is 60°. (CO1) 10

5. Answer any one of the following:-

5-a. A cam drives a flat reciprocating follower in the following manner: 10
During first 120° rotation of the cam, follower moves outwards through a distance of 20 mm with simple harmonic motion. The follower dwells during next 30° of cam rotation. During next 120° of cam rotation, the follower moves inwards with simple harmonic motion. The follower dwells for the next 90° of cam rotation. The minimum radius of the cam is 25 mm. Draw the profile of the cam. (CO2)

5-b. Two mating gears have 20 and 40 involute teeth of module 10 mm and 20° pressure angle. The addendum on each wheel is to be made of such a length that the line of contact on each side of the pitch point has half the maximum possible length. Determine the addendum height for each gear wheel, length of the path of contact, arc of contact and contact ratio. (CO2) 10

6. Answer any one of the following:-

6-a. Derive an expression for displacement, velocity and acceleration of piston in single slider crank chain. (CO3) 10

6-b. Define and derive an expression for the following terms due to reciprocating mass in reciprocating engine, neglecting the mass of the connecting rod: - Piston effort, Force acing along connecting rod, thrust on the sides of the cylinder walls, Crank-pin effort and thrust on crank shaft bearings. (CO3) 10

7. Answer any one of the following:-

7-a. The arms of a Porter governor are 300 mm long. The upper arms are pivoted on the axis of rotation. The lower arms are attached to a sleeve at a distance of 40 mm from the axis of rotation. The mass of the load on the sleeve is 70 kg and the mass of each ball is 10 kg. Determine the equilibrium speed when the radius of rotation 10

of the balls is 200 mm. If the friction is equivalent to a load of 20 N at the sleeve, what will be the range of speed for this position? (CO4)

7-b. A shaft carries four masses in parallel planes A, B, C and D in this order along its length. The masses at B and C are 18 kg and 12.5 kg respectively, and each has an eccentricity of 60 mm. The masses at A and D have an eccentricity of 80 mm. The angle between the masses at B and C is 100° and that between the masses at B and A is 190°, both being measured in the same direction. The axial distance between the planes A and B is 100 mm and that between B and C is 200 mm. If the shaft is in complete dynamic balance, determine: 1. The magnitude of the masses at A and D; 2. the distance between planes A and D; and 3. the angular position of the mass at D. (CO4) 10

8. Answer any <u>one</u> of the following:-

8-a. An aeroplane flying at 240 km/h turns towards the left and completes a quarter circle of 60 m radius. The mass of the rotary engine and the propeller of the plane is 450 kg with a radius of gyration of 320 mm. The engine speed is 2000 rpm clockwise when viewed from the rear. Determine the gyroscopic couple on the aircraft and state its effect. In what way is the effects changed when the: (a) aeroplane turns towards right, (b) engine rotates clockwise when viewed from the front (nose end) and the aeroplane turns left. (CO5) 10

8-b. Derive an expression for angle of heel of a two-wheeler automobile in stability condition when taking a turn. If the engine rotates in the same direction as that of wheel. (CO5) 10