Exam Date & Time: 08-Jan-2024 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

Department of Mechanical and Industrial Engineering
THIRD SEMESTER B.TECH END SEMESTER MAKE-UP EXAMINATIONS, JAN 2024
THEORY OF MACHINES [MIE 2121]

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Marks: 50 **Duration: 180 mins.**

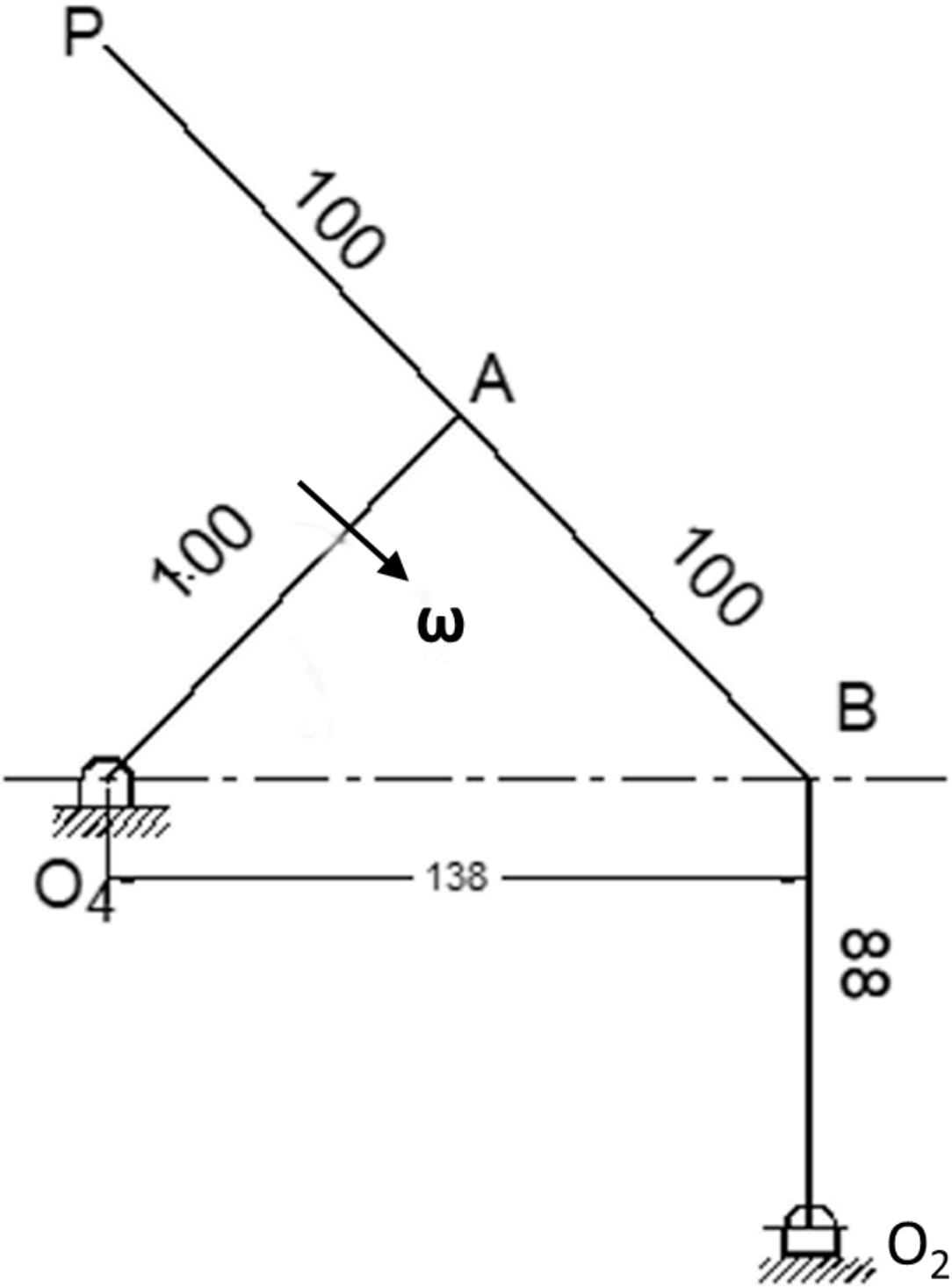
Descriptive

Answer all the questions. Section Duration: 180 mins

1A) Identify the inversion in a kinematic chain that is employed for sketching an ellipse. Provide the name of this inversion and specify the kinematic chain it pertains to. Explain the construction and working of this inversion. (3)

1B) Explain the different types of kinematics pairs according to the nature of contacts with examples. (2)

1C) The mechanism shown in the figure, the point P moves in a vertical straight line. In the figure the link O_2B is vertical. If the velocity of link O_4A is 45 m/s in a clockwise sense, **Using the relative velocity method** determine the velocity of point P. (5)



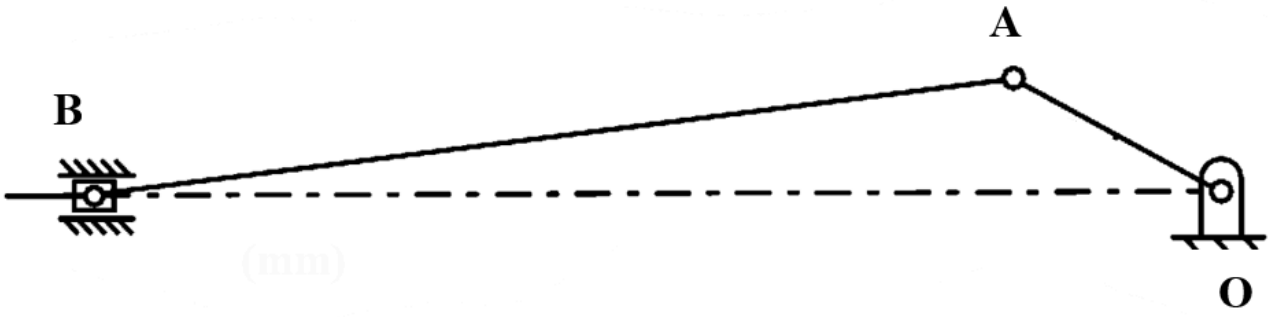
2A) Finding the minimum number of teeth on the gear or pinion wheel plays an important role in avoiding interference. Hence, suggest and derive the suitable expression for calculating the minimum number of teeth on the gear wheel with a suitable diagram. (3)

2B) Explain the function of an offset follower in cams and differentiate between (a) base circle and pitch circle (b) cam angle and pressure angle (c) trace point and pitch point. (2)

2C) Two gears wheels mesh externally and are to give a velocity ratio of 3 to 1. The teeth are of involute form and have a module of 6 mm. The addendum is equal to one module, and the pressure angle is 20˚. The pinion rotates at 90 rpm. Determine (a) The number of teeth on the pinion to avoid interference on it and the corresponding number of teeth on the wheel, (b) The length of path and arc of contact, and (c) The number of pairs of teeth in contact. Show the calculation using standard formulae. (5)

3A) (5)

In the working apparatus of a toy car, a slider-crank mechanism is employed. Locate the instantaneous centres of this mechanism (shown in the figure) and find the velocity of the slider **using the instantaneous centre method**. The dimensions of the linkages are OA = 160 mm, AB = 470 mm, OB = 600 mm, and ω_{OA} = 12 rad/s clockwise.



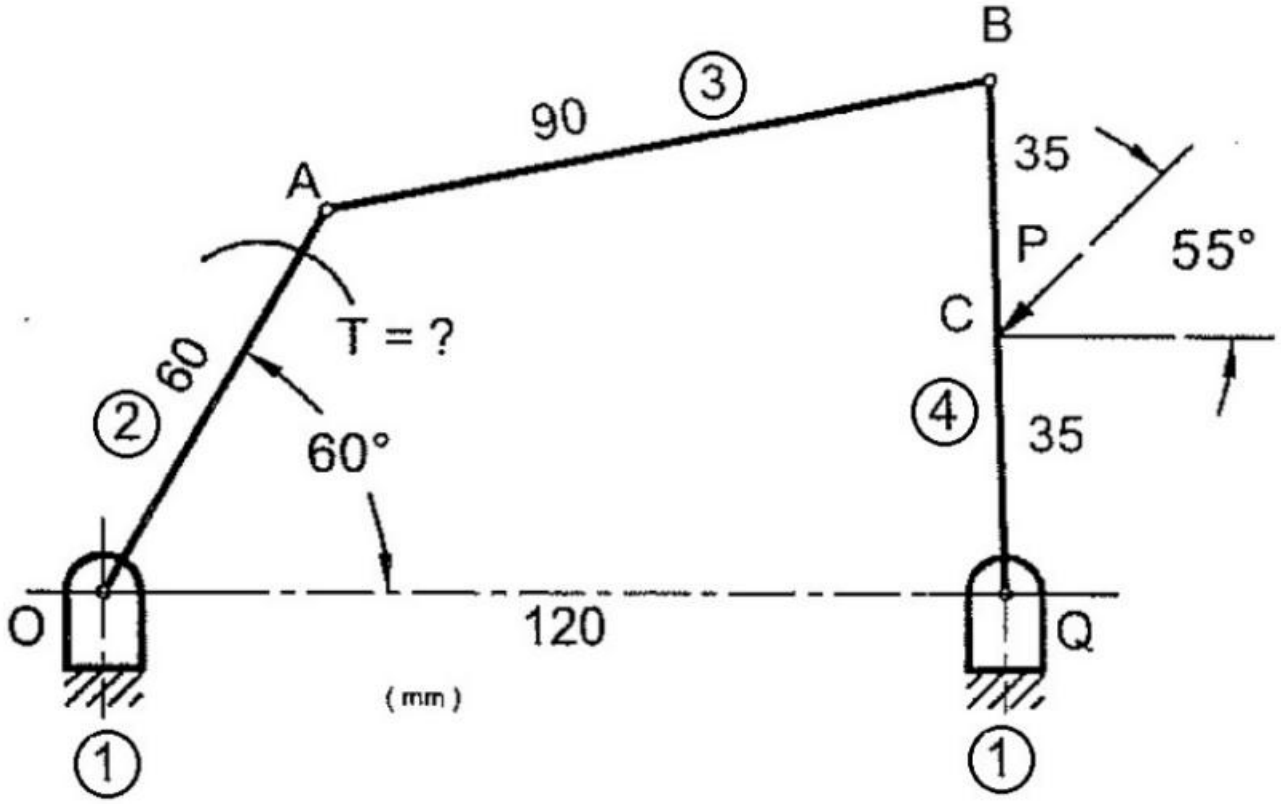
3B) In the textile industry, a cam is to be designed to control the movements of the needle and shuttle during the weaving process according to the following requirements:

- To raise the follower through 30 mm with uniform acceleration and deceleration during 120° cam rotation
- Dwell for the next 30° cam rotation
- To lower the follower with simple harmonic motion during the next 90° cam rotation (5)
- Dwell for the rest of the cam rotation

The cam has a minimum radius of 30 mm and rotates at 800 rpm. Draw the profile of the cam if the line of stroke of the follower passes through the axis of the camshaft.

What is the maximum velocity and acceleration of the follower during the ascent.

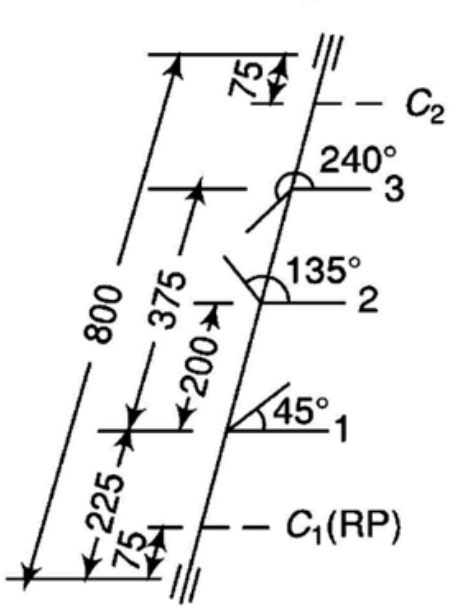
4A) Figure shows a four-bar mechanism in which a force, P = 500 N is acting at the midpoint of the output crank. Determine the torque that must be applied on the input crank to maintain static equilibrium. Additionally, instead of torque 'T' acting on Link 2, if a horizontal force 'F' is applied at the midpoint of Link 2. Determine the magnitude and direction of the horizontal force 'F'.



(5)

4B) A rotating shaft carries three unbalanced masses of 4 kg, 3 kg and 2.5 kg at radial distances of 75 mm, 85 mm and 50 mm and at the angular positions of 45°, 135° and 240° respectively. The second and the third masses are in the planes at 200 mm and 375 mm from the plane of the first mass. The angular positions are measured counter-clockwise from the reference line along x-axis and viewing the shaft from the first mass end. The shaft length is 800 mm between bearings and the distance between the plane of the first mass and the bearing at that end is 225 mm.

Determine the amount of the counter masses and their angular positions **using the analytical method** If masses are placed at the radial distance of 40 mm and planes at 75 mm from the bearings for the complete shaft balance. The first counter mass is to be in a plane between the first mass and the bearing and the second mass is in a plane between the third mass and the bearing at that end. (5)



5A) A twin-cylinder V-engine has centre lines of the cylinders at 90° to each other and connecting rods are connected to a common crank. The length of each connecting rod is 300 mm and the stroke length is 120 mm. The crank pin and crank webs are equivalent to a mass of 1.2 Kg at the crank radius. The mass of each piston is 1 Kg. The mass of each connecting rod is 1.5 Kg. The Centre of gravity of the connecting rod is 80 mm from the crank pin. Show that the effect of rotating masses and the primary effect of reciprocating masses can be balanced by a single revolving mass. Find out the magnitude of this balancing mass at a radius of 80 mm. The speed of the engine is 1800 rpm. Show the calculation using standard formulae. (4)

5B) Explain the gyroscopic effect on four-wheeled vehicles. (3)

5C) What are quick-return mechanisms? Where are they used? Draw a neat sketch of any one of the quick-return mechanism. (3)

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