Exam Date & Time: 02-Dec-2023 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

Department of Mechanical and Industrial Engineering
THIRD SEMESTER B.TECH END SEMESTER EXAMINATIONS, DEC 2023
THEORY OF MACHINES [MIE 2121]

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

A

**Answer all the questions.**   Section Duration: 180 mins

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1)

A) Propose a mechanism to efficiently transmit power from the driver shaft to the driven shaft in a machine, where the shafts' axes are parallel and the distance between them is both minimal (5 mm Max) and variable. Provide an explanation of the working of this suggested mechanism, accompanied by illustrative sketches.   (3)

B) Apply Grubler's criterion and find the degrees of freedom (DOF) for the following cases

Case (a) - A planar mechanism has 8 links and 10 rotary joints.

Case (b) - for the figure shown below, find DOF
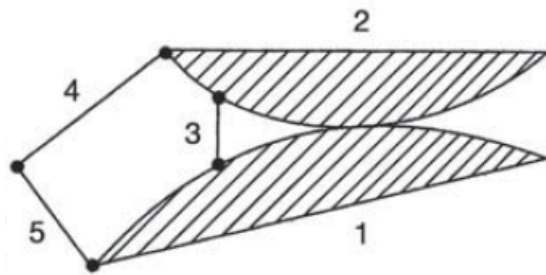
(2)

C) In the figure, the angular velocity of the crank OA is 600 rpm. **Using the relative velocity method,** determine the linear velocity of the slider 6 and the angular velocity of the link 5, when the crank is inclined at an angle of 75 deg to the vertical. The dimensions of various links are OA = 28 mm, AB = 44 mm, BC = 49 mm, BD = 46 mm and the centre distance between the centres of rotation O and C is 65 mm. The path of the travel of the slider is 11 mm vertically below fixed point C.
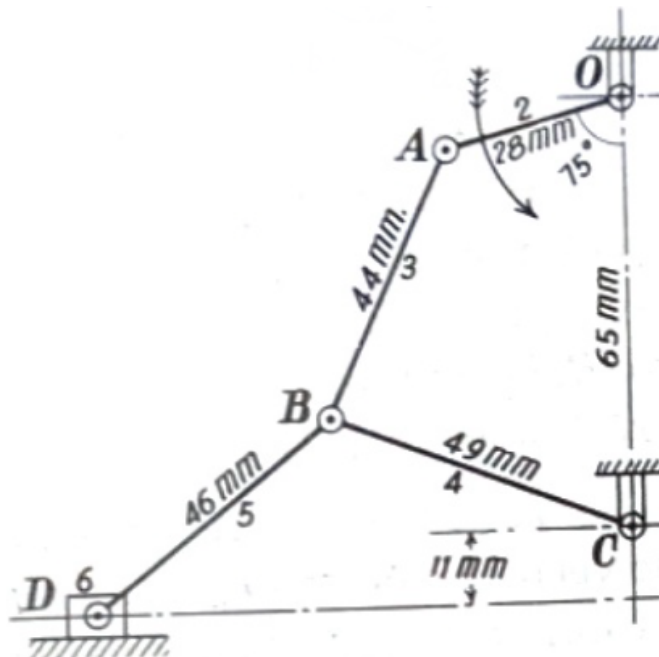
(5)

2)   What are the distinguishing characteristics and differences between spur gear and helical gear?   (3)

A)

B)   With schematic representation, interpret the working concept of following cam and follower
      mechanisms (a) Wedge and Flat Cams (b) Radial and Offset Cams   (2)

C)   A team comprising of final-year students from AIM Institute of Technology is currently engaged in the
      development of a project titled 'Low-Cost Automatic Sugarcane Juice Machine.' As part of this project,
      they are required to assess the contact ratio for two involute profile spur gears, namely Gear A and Gear
      B, as illustrated in the figure.

      The number of teeth on Gear A and Gear B is 24 and 60 respectively. Module = 10 mm, pressure angle
      of 20° and Addendum = 10 mm. Is it possible to find the number of pairs of teeth in contact for a given
      specification? If yes, how much is the contact ratio for the given condition? Find the angle of action of
      both pinion and gear. Show the calculation using standard formulae.

                                                                                                      (5)

3)   An industrial press consists of a four-bar mechanism, in which the lengths of the crank and the connecting rod are 200 mm
      and 800 mm, respectively. Locate all the instantaneous centres of the mechanism for the position of the crank when it has
      turned 30° from the inner dead centre. Also, find the velocity of the slider and the angular velocity of the connecting rod if
A)   the crank rotates at 40 rad/s **using the instantaneous centre method**.
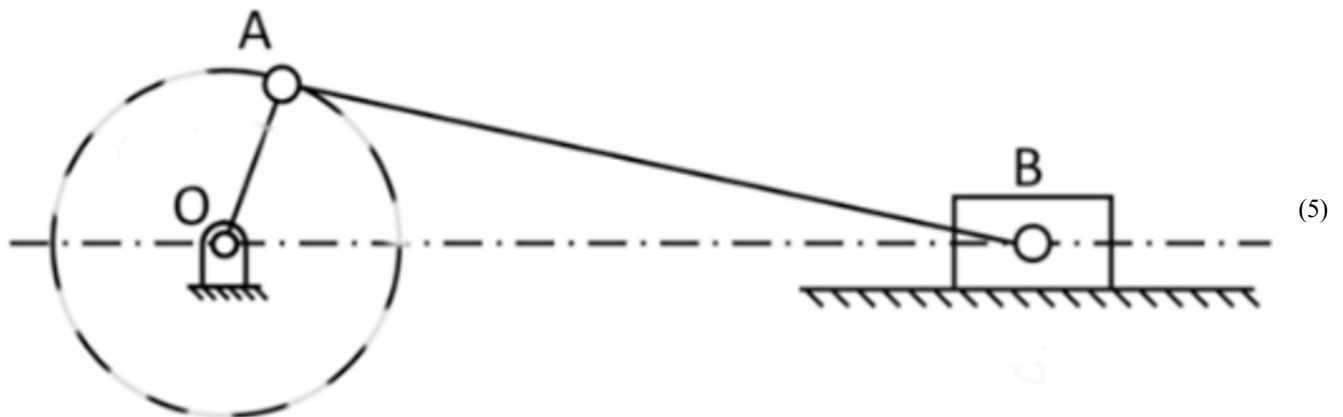
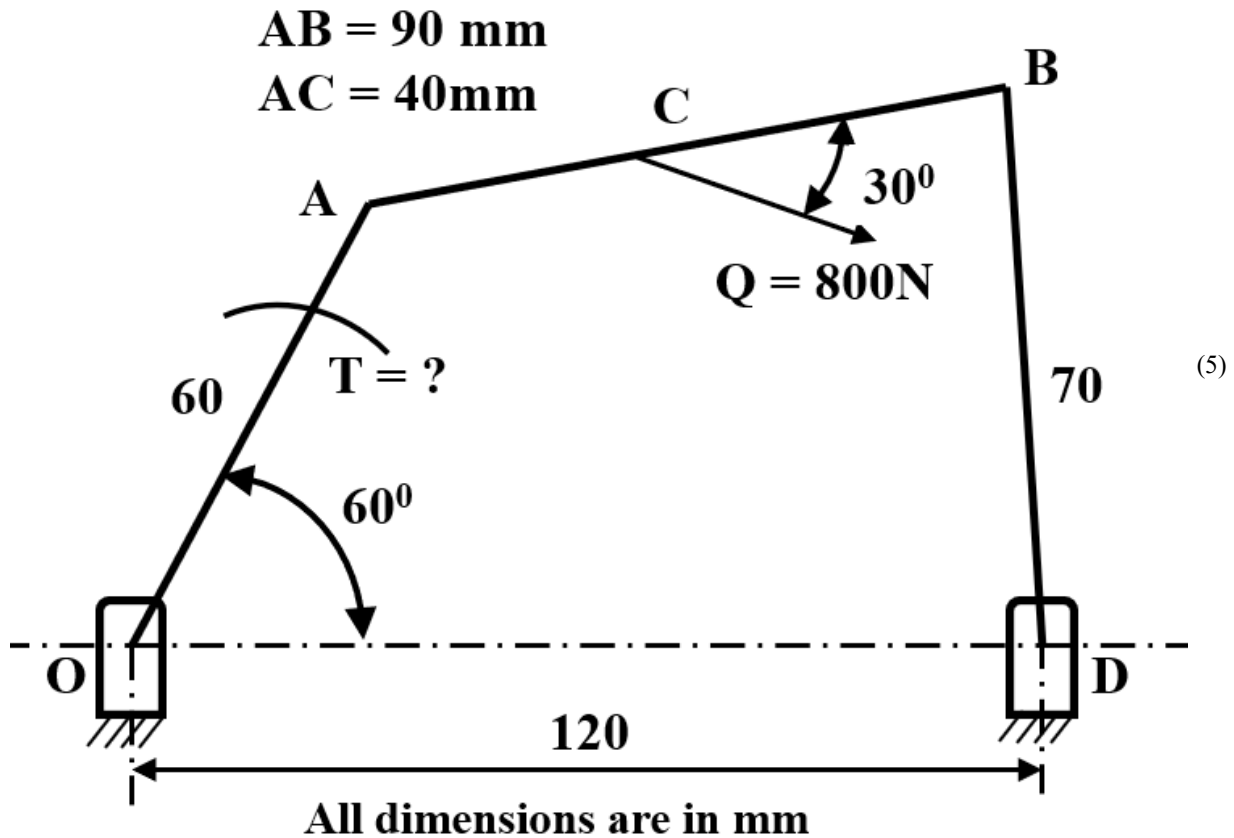   (5)

All dimensions are in mm

B)   In the printing press, a cam roller mechanism is required to control the movement of the ink rollers for   (5)
      precise operation. With the minimum radius of the cam being 25 mm, it needs to be designed for a
      knife-edge follower with the following data:

            a. To raise the follower through 35 mm during 60° rotation of the cam

            b. Dwell for the next 40° cam rotation

            c. Descending of the follower during the next 90° cam rotation

d. Dwell during the rest of the cam rotation

Draw the profile of the cam if the ascending and descending of the cam is with simple harmonic motion and the line of stroke is in-line with the axis of the camshaft.

What is the maximum velocity and acceleration of the follower during the ascent if the cam rotates at 150 rpm?

4)   A robotic arm comprising of a four-bar linkage for material handling application is illustrated in Figure below. Determine the torque 'T' to overcome a force Q = 800N acting at point C on the connecting rod AB. Draw a detailed configuration diagram, free body diagram, and analysis diagram as per the selected scale factor for the

A)   mechanism shown in Figure.

AB = 90 mm
AC = 40mm

B

C

A

30⁰

Q = 800N

T = ?

60

70   (5)

60⁰

O

D

120

All dimensions are in mm

B)   A shaft carries three disturbing masses A, B and C in this order along its axis. The mass of each disturbing mass is 1 kg. Mass A, B and C may be assumed to be concentrated at a radius of 20mm, 30 mm and 20 mm respectively. Their angular positions are 120 degrees apart. If the shaft is balanced by adding two balancing masses in plane L and plane M at a radius of 70 mm and at a distance from the central plane of the disturbing mass as shown below, determine the magnitude and angular positions of the balancing masses required **using the analytical method.**

(5)

L   **A**   **B**   **C**   **M**

50 mm   **50 mm**

100 mm   **100 mm**
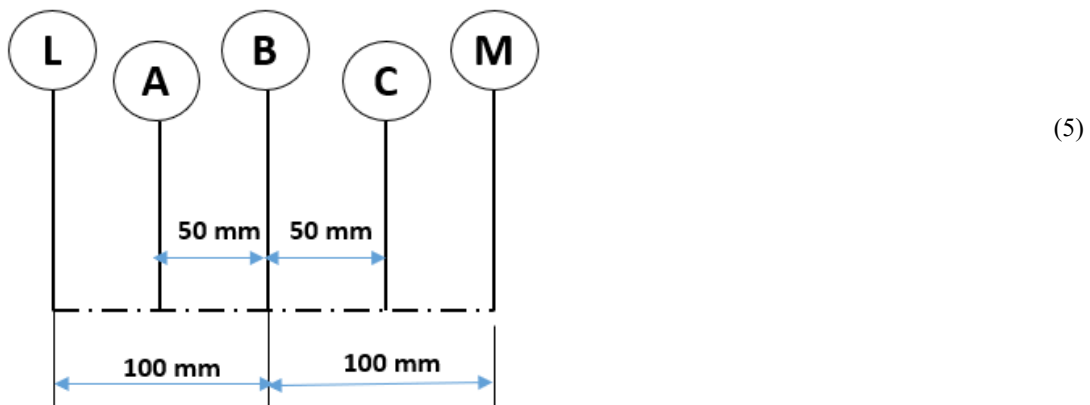
5)   (4)

A) 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 weight of the reciprocating mass of each cylinder is 15N. The radius of the crank is 0.08 m and the length of the connecting rod is 0.4 m. Show that the engine may be balanced for primary forces, by means of a revolving balancing mass. If the engine is running at 2000 rpm, what is the maximum value of the resultant secondary force? Show the calculation using standard formulae.

B) Explain how the gyroscopic couple influences the movement of a ship.

(3)

C) The shaping machine is used to machine flat metal surfaces, especially where a large amount of metal has to be removed. There is a reciprocating motion of the mechanism inside the shaping machine and it requires that the ram moves at a comparatively slower speed during the forward cutting stroke and during the return stroke, the mechanism should be designed to make the tool move at a faster rate to reduce the idle return time. For this to happen suggest a suitable mechanism & explain it briefly with a neat sketch.

(3)

-----End-----