

***B.Tech. Degree IV Semester Supplementary Examination in  
Marine Engineering June 2024***

**MRE 1401 MECHANICS OF MACHINERY  
(2013 Scheme)**

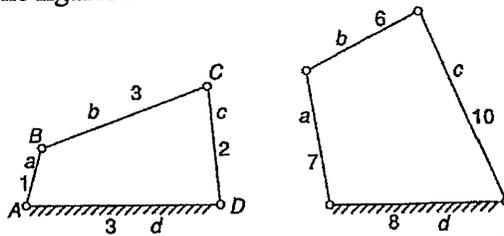
(Answer *ALL* questions)

Time: 3 Hours

Maximum Marks: 100

(5 × 20 = 100)

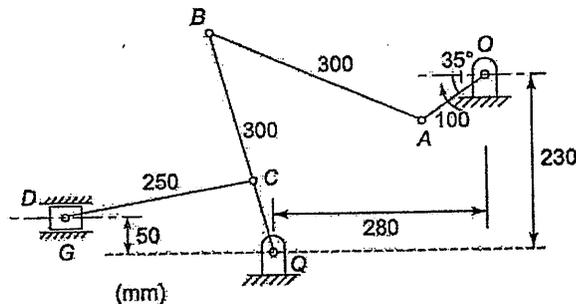
- I. (a) Define transmission angle of a mechanism. Find the maximum and minimum transmission angles for the two mechanisms shown in figure. The figures indicate the dimensions in standard units of length. (5)



- (b) Enumerate the inversions of a slider-crank chain. Give examples. (15)

OR

- II. (a) Figure shows a mechanism in which  $OA = QC = 100$  mm,  $AB = QB = 300$  mm and  $CD = 250$  mm. The crank  $OA$  rotates at 150 rpm in the clockwise direction. Draw the velocity polygon of the mechanism. (10)



- (b) What is the velocity of the slider at D? (1)
- (c) Angular velocities of links QB and AB. (2)
- (d) Rubbing velocity at the pin B, which is 40 mm in diameter. (2)
- (e) State and prove Kennedy's theorem as applicable to instantaneous centres of rotation of three bodies. (5)
- III. (a) What do you mean by kinematic and physical derivatives of the follower motions? (5)
- (b) Draw the displacement diagram of the follower with the following data of a cam-follower pair: (3)
- Minimum radius of cam = 25 mm  
Lift = 30 mm  
Roller diameter = 15 mm  
The cam lifts the follower for  $120^\circ$  with SHM followed by a dwell period of  $30^\circ$ . Then the follower lowers down during  $150^\circ$  of the cam rotation with uniform acceleration and deceleration followed by a dwell period.
- (c) Draw the cam profile and pitch curve for the above motion of the follower. (10)
- (d) Calculate the maximum velocity and acceleration of the follower during the ascent and descent. (2)

OR

(P.T.O.)

BT MRE-IV(S)-06-24-3246

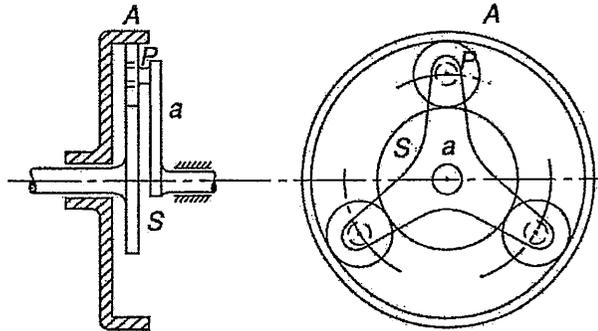
- IV. (a) Calculate the main dimensions of the cam for a tangent cam with a base circle diameter of 50 mm which operates a roller follower of 20 mm in diameter. The line of stroke of the roller follower passes through the axis of the cam. The angle between the tangential faces of the cam is  $60^\circ$ , speed of the cam shaft is 200 rpm and the lift of the follower is 15 mm. (5)
- (b) Acceleration of the follower at: (9)
- (i) The beginning of lift.
- (ii) Where the roller just touches the nose.
- (iii) The apex of the circular nose.
- (c) Why is a cycloidal motion programme most suitable for high-speed cams? (6)
- V. (a) Sketch a Hartnell governor. Describe its functions and deduce a relation to find the stiffness of the spring. (8)
- (b) In a spring-loaded governor of the Hartnell type, the lengths of the horizontal and vertical arms of the bell-crank lever are 40 mm and 80 mm respectively. The mass of each ball is 1.2 kg. The extreme radii of rotation of the balls are 70 mm and 105 mm. The distance of the fulcrum of each bell-crank lever is 75 mm from the axis of rotation of the governor. The minimum equilibrium speed is 420 rpm and the maximum equilibrium speed is 4% higher than this. Neglecting the obliquity of the arms, determine the stiffness of the spring. (4)
- (c) Determine the initial compression of the spring in the above case. (4)
- (d) Determine the equilibrium speed corresponding to radius of rotation of 95 mm of the above governor. (4)
- OR**
- VI. (a) Explain the terms sensitiveness, hunting, isochronisms and stability relating to governors. (6)
- (b) Each ball of a porter governor has a mass of 3 kg and the mass of the sleeve is 15 kg. The governor has equal arms, each of 200 mm length and pivoted on the axis of rotation. The sleeve begins to float when the radius of rotation of the balls is 120 mm. The maximum equilibrium speed of the governor occurs at 160 mm ball radius. Determine the (7)
- (i) range of speed.
- (ii) lift of the sleeve.
- (iii) effort of the governor.
- (iv) power of the governor.
- (c) What will be the effect of friction (on above 4 factors) at the sleeve if it is equivalent to 8 N. (7)
- VII. (a) Sketch two teeth of a gear and show the following. Also define the terms. Face, flank, top land, bottom land, addendum, dedendum, tooth thickness, space width, face width and circular pitch. (10)
- (b) The centre distance between two spur gears in a mesh is to be approximately 275 mm. The velocity ratio is 10:1. The pinion transmits 360 kW at 1,800 rpm. The pressure angle of the involute teeth is  $20^\circ$  and the addendum is equal to one module. The limiting value of normal tooth pressure is 1 kN/mm of width. Determine the nearest standard module so that interference does not occur. (3)
- (c) Determine the number of teeth on gear wheel. (2)
- (d) Determine the number of teeth on pinion. (1)
- (e) Determine width of pinion. (4)

**OR**

(Continued)

BT MRE-IV(S)-06-24-3246

- VIII. (a) With neat sketches explain the constructions of any four types of gear trains. (8)
- (b) The annulus A in the gear shown in figure rotates at 300 rpm about the axis of the fixed wheel S which has 80 teeth. The three armed spider is driven at 180 rpm. Determine the number of teeth required on the wheel P. (12)



- IX. (a) Two parallel shafts, connected by a crossed belt, are provided with pulleys 480 mm and 640 mm in diameters. The distance between the centres lines of the shafts is 3 m. Find by how much the length of the belt should be changed if it is desired to alter the direction of rotation of the driven shaft. (6)
- (b) A belt drive transmits 8 kW of power from a shaft rotating at 240 rpm to another shaft rotating at 160 rpm. The belt is 8 mm thick. The diameter of the smaller pulley is 600 mm and the two shafts are 5 m apart. The coefficient of friction is 0.25. If the maximum stress in the belt is limited to  $3 \text{ N/mm}^2$ , find the width of the belt for an open belt drive. (7)
- (c) Find the width of the belt for a cross-belt drive in the above case. (7)

OR

- X. (a) With a neat sketch, explain the construction and working of a belt transmission type dynamometer. (6)
- (b) A vehicle having a wheel base of 3.2 m has its centre of mass at 1.4 m from the rear wheels and 55 mm from the ground level. It moves on a level ground at a speed of 54 kmph. Determine the distance moved by the car before coming to rest on applying the brakes to the  
 (i) rear wheels.  
 (ii) front wheels.  
 (iii) all the four wheels. (6)
- (c) A spring operated pivoted shoe brake shown in figure is used for a wheel of diameter of 500 mm. The angle of contact is  $90^\circ$  and the coefficient of friction is 0.3. The force applied by the spring on each arm is 5 kN. Determine the brake torque on the wheel. (8)

