Ref. No.: Ex/ME/5/T/221/2025

BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING) SECOND YEAR SECOND SEMESTER - 2025

Subject: KINEMATIC ANALYSIS AND SYNTHESIS

Time: 3 Hrs **Full Marks: 100**

Question 1 is compulsory and answer any three from the rest

Assume any missing data if any

1 Answer any **Eight** of the following **8 x 5 = 40**

i. Discuss various types of constrained motion.

ii. Describe various inversions of a slider crank mechanism giving examples.

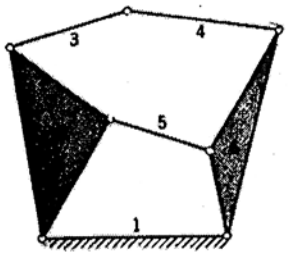
iii. State and prove the 'Aronhold Kennedy's Theorem' of three instantaneous centres.

iv. What is the Coriolis acceleration component? In which cases does it occur? How is it determined?

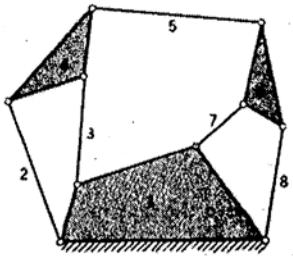
v. What are quick-return mechanisms? Where are they used? Discuss the functioning of any one of them.

vi. What is Kutzback's criterion for degree of freedom of plane mechanisms? In what way is Grubler's criterion different from it?

vii. Find the number of binary links, ternary links, other links, total links, Loops, joints and pairs, and degree of freedom.



(a)



(b)

viii. Define: (i) base circle, (ii) pitch circle, (iii) pitch curve and (iv) pressure angle of a cam.

ix. Compare the performances of knife-edge, roller and mushroom followers.

x. Define: (i) involute tooth profile, (ii) path of contact, (iii) pitch circle, and (iv) module of a gear.

xi. Explain the terms 'Interference' and 'Undercutting'.

xii. Sketch a sliding gear box and explain its working.

2. A cam, with a minimum radius of 20 mm, rotating clockwise at a uniform speed is to be designed to give a roller follower, at the end of a valve rod, motion is described below

(i) To raise the valve through 40 mm during 100° rotation of the cam;

(ii) To keep the valve fully raised through next 60°;

(iii) To lower the valve during next 80°;

(iv) To keep the valve closed during rest of the revolution i.e. 120°;

The diameter of the roller is 20 mm and the diameter of the cam shaft is 25 mm. Draw the profile of the cam when **(a)** the line of stroke of the valve rod passes through the axis of the cam shaft. The displacement of the valve, while being raised and lowered, is to take place with simple harmonic motion. Draw the displacement, the velocity and the acceleration diagrams for one complete revolution of the cam. Determine the maximum acceleration of the valve rod when the cam shaft rotates at 80 r.p.m

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3. Locate all the instantaneous centres of the mechanism as shown in Fig. Determine the velocities of points C, E and F. Find angular velocities of the links BC, CDE and EF

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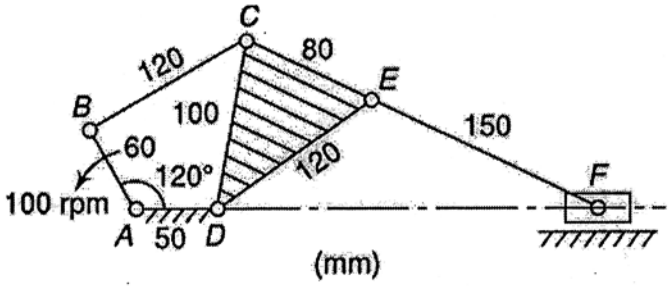
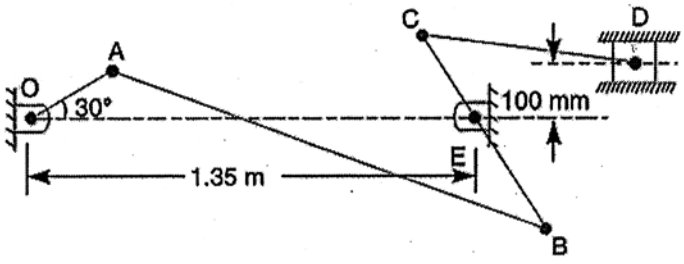


4. A four bar mechanism has the following dimensions: DA =300 mm; CB = AB = 360 mm; DC = 600 mm. The link DC is fixed and the angle ADC is 60°. The driving link DA rotates uniformly at a speed of 100 r.p.m. clockwise and the constant driving torque has the magnitude of 50 N-m. Determine the velocity of the point B and angular velocity of the driven link CB. Also find the actual mechanical advantage and the resisting torque if the efficiency of the mechanism is 70 per cent **[20]**

5. A pair of involute spur gears with 16° pressure angle and pitch of module 6 mm is in mesh. The number of teeth on pinion is 16 and its rotational speed is 240 r.p.m. The gear ratio is 1. 75. In order to avoid interference, find; **(i).** The addendum of pinion and gear wheel; **(ii).** The length of path of contact; **(iii).** The maximum velocity of sliding of teeth on either side of the pitch point. **[20]**

6. A mechanism, as shown in Fig. 6.15, has the following dimensions: OA = 200 mm; AB = 1.5 m; BC = 600 mm; CD = 500 mm and BE = 400 mm. Locate all the instantaneous centres. If crank OA rotates uniformly at 120 r.p.m. clockwise, Find: **(i)** the velocity of B, C and D, **(ii)** the angular velocity of the links AB, BC and CD.



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