Ref. No.: Ex/ME/5/T/221/2024

BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING) SECOND YEAR SECOND SEMESTER – 2024

Subject: KINEMATIC ANALYSIS AND SYNTHESIS

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

Question 1 is compulsory and answer any three from the rest

1 Answer any **TEN** of the following **10 x 4 = 40**

a. Explain the terms: (i). Lower pair, (ii). Higher pair, (iii). Kinematic pair and (iv) Inversion

b. Sketch and explain any two inversions of a double slider crank chain.

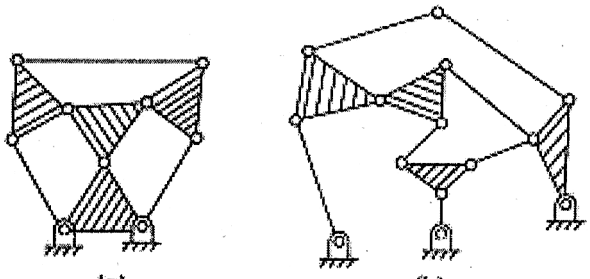
c. State and prove the 'Aronhold Kennedy's Theorem' of three instantaneous centres.

d. Explain how the velocities of a slider and the connecting rod are obtained in a slider crank mechanism.

e. Draw and explain the acceleration diagram of slider crank mechanism.

f. Define Grashof's Law. State how is it helpful in classifying the four-link mechanisms into different types.

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



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

i. State and explain the different types of followers.

j. Define: (i) pressure angle, (ii) circular pitch, (iii) pitch circle, and (iv) module of a gear.

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

l. 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

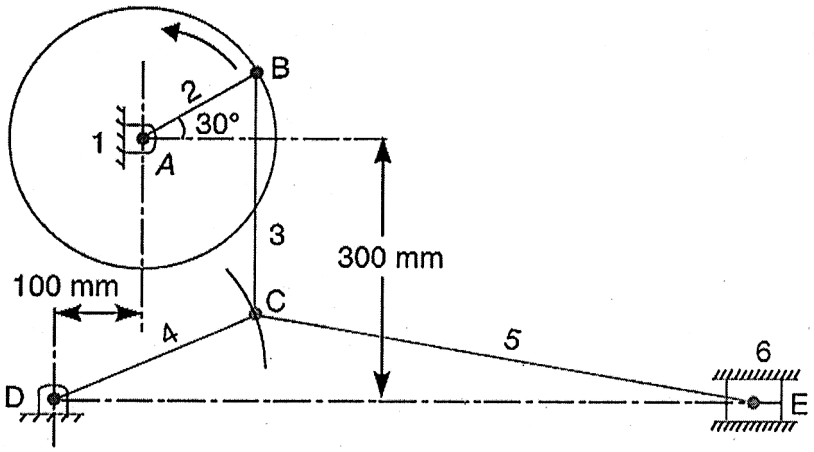
(a) the line of stroke of the valve rod passes through the axis of the cam shaft. The displacement of the valve, while being raised and lowered, is to take place with simple harmonic motion.

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 **[20]**

3. Locate all the instantaneous centres of the mechanism as shown in Fig. The lengths of various links are: AB= 150 mm; BC = 300 mm; CD = 225 mm; and CE = 500 mm. When the crank A B rotates in the anticlockwise direction at a uniform speed of 240 r.p.m.;

Find: (i). Velocity of the slider E,

(ii). Angular velocity of the links BC and CE. **[20]**



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. Fig. shows a quick return motion mechanism in which the driving crank OA rotates at 120 r.p.m. in a clockwise direction. For the position shown, Determine the magnitude and direction of

1 the acceleration of the block D

2. the angular acceleration of the slotted bar QB. **[20]**