

**BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING)
SECOND YEAR SECOND SEMESTER EXAM 2019**

KINEMATIC ANALYSIS AND SYNTHESIS

Time: 3 hours

Full Marks: 100

(Answer any five)

(Assume data if required)

1. a) Explain Kutzbach's criteria. Determine the degrees of freedom of the following mechanisms shown in the figure 1.

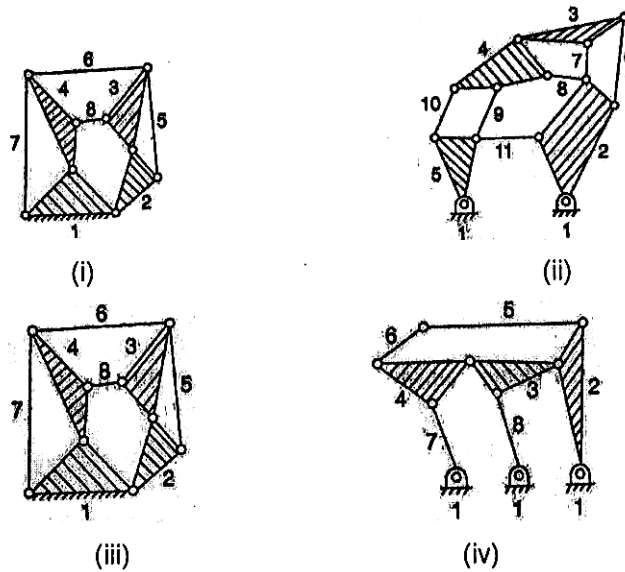


Figure 1

- b) Derive the relation between input crank angle and transmission angle of a four bar linkage. Explain the significance of transmission angle.

10+10=20

2. a) State and explain Grashoff's criteria.

- b) Indicate the type of each mechanism given in the figure 2. Dimensions are given in standard units of length.

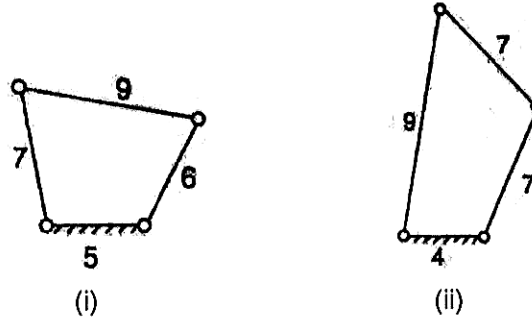


Figure 2

- c) Give examples with sketches of inversions of single slider crank mechanism.

$$4+4+12=20$$

3. a) Derive Kennedy's theorem. Locate all instantaneous centers of a typical four bar chain.
 b) In figure 3, Q2B is 37.5 mm; Q2Q4 is 87.5 mm; Q4C is 44 mm; BC is 50 mm. Angular speed of the crank Q2B is 1 rad/sec CCW. Find velocities of C and P.

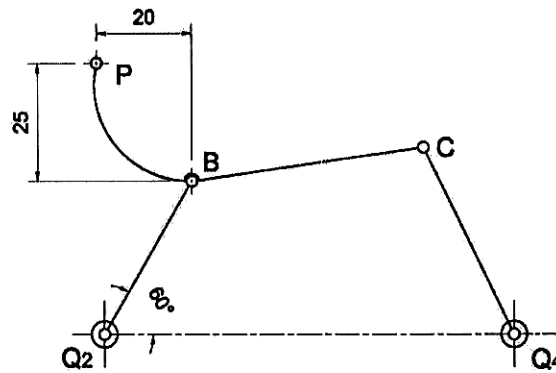


Figure 3

$$8+12=20$$

4. a) Derive Freudenstein's equation for four bar chain.
b) Find out the expression of acceleration for a typical four bar chain by vector polygon method.

10+10=20

5. a) State and derive the laws of gearing.
b) The number of teeth on the gear and the pinion of two spur gears in mesh are 30 and 18 respectively. Both the gears have a module of 6 mm and a pressure angle of 20° . If the pinion rotates at 400 rpm, what will be the sliding velocity at the moment, the tip of the tooth of pinion has contact with the gear flank? Take addendum equal to one module. Also, find the maximum velocity of sliding.

10+10=20

6. a) Consider that the arm 4 of the following figure 4 rotates CCW at 50 rad /sec. Given: Teeth of gear 1 = 80, Teeth of gear 2 = 40, Teeth of gear 3 = 20. Determine angular speed of gear 2 (figure 4).

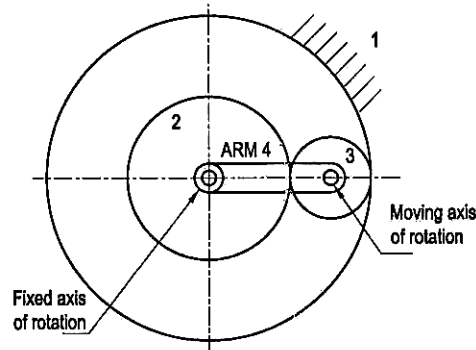


Figure 4

- b) Explain with sketches different types of gear trains.

10+10=20

7. a) Describe different types of plate cam.

- b) For the gear train in the figure 5, shaft A rotates at 300 rpm and shaft B at 600 rpm in the directions shown. Determine the speed and the direction of rotation of shaft C.

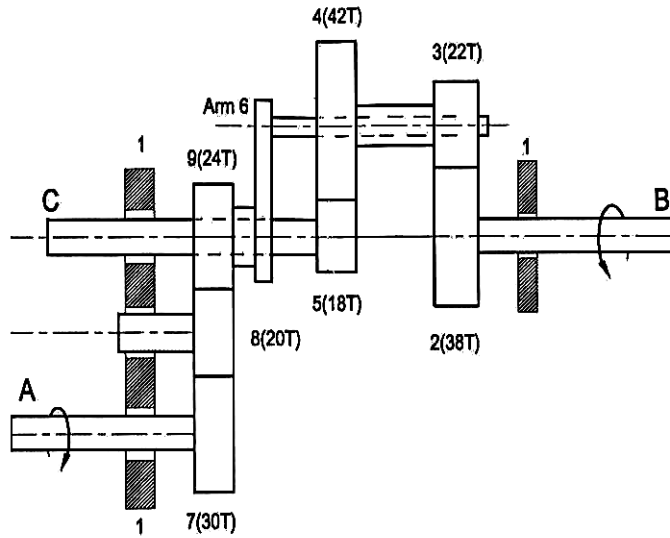


Figure 5

10+10=20

8. a) Discuss different types of dimensional synthesis.
 b) Design a four link mechanism to coordinate three positions of the input and the output links as follows:

$$\theta_1 = 20^\circ; \quad \phi_1 = 35^\circ$$

$$\theta_2 = 35^\circ; \quad \phi_2 = 45^\circ$$

$$\theta_3 = 50^\circ; \quad \phi_3 = 60^\circ$$

6+14=20