B.E. MECHANICAL ENGINEERING - SECOND YEAR - 2nd SEM EXAM 2024

KINEMATIC ANALYSIS AND SYNTHESIS

Time: 3 Hrs   Full Marks: 100

(Assume data if missing)

SECTION A

Answer all question from this section. Each question carries 01 Marks   12×01=12

1. Choose the correct answer/s.

   1. Quick return mechanism is an inversion of

      (a) Four bar chain

      (b) Single slider crank chain

      (c) Double slider crank chain

      (d) Crossed slider crank chain

   2. In a full depth 14.5^0 involute system, the smallest number of teeth in a pinion which meshes with rack without interference is

      (a) 12

      (b) 16

      (c) 25

      (d) 32

   3. Consider the following statement: Coriolis component of acceleration depends on the

      (1) Velocity of the slider

      (2) Angular velocity of the link

      (3) Acceleration of the slider

      (4) Angular acceleration of the link

      Which of these statements is/are correct?

      (a) 1 and 2 are correct

      (b) 1 and 3 are correct

      (c) 2 and 4 are correct

      (d) 1 and 4 are correct

   4. The gear train usually employed in clocks is a

      (a) Reverted gear train

      (b) Simple gear train

      (c) Sun and planet gear

      (d) Differential gear

   5. The instantaneous centre of rotation of a rigid thin disc rolling on a plane rigid surface is located at

      (a) Centre of the disc

[Turn over

(b) An infinite distance on the plane surface

(c) The point of contact

(d) The point on the circumference situated vertically opposite to the contact point

6. Which of the following is a higher pair?

   (a) Turning pair

   (b) Screw pair

   (c) Belt and pulley

   (d) Sliding pair

7. In spur gears, the circle on which the involute is generated called

   (a) Pitch circle

   (b) Clearance circle

   (c) Base circle

   (d) Addendum circle

8. The term $\omega^2 d^3 y/d\theta^3$, in a cam follower motion represents

   (a) Acceleration of the follower

   (b) Velocity of follower

   (c) Jerk

   (d) Displacement

9. Transmission angle is the angle between

   (a) Input link and coupler

   (b) Input link and fixed link

   (c) Output link and coupler

   (d) Output link and fixed link

10. A fixed gear having 200 teeth is in mesh with another gear having 50 teeth. The two gears are connected by an arm. The number of turns made by the smaller gear for one revolution of arm about the centre of bigger gear is

    (a) 2

    (b) 4

    (c) 3

    (d) None of the above

11. Which gear train is used for higher velocity ratios in a small space?

    (a) Simple gear

    (b) Compound gear train

    (c) Reverted gear train

    (d) Epicyclic gear train

12. For S.H.M. cam, the acceleration of the follower at the ends of the stroke and at the mid stroke respectively, is

   (a) Maximum and zero

   (b) Zero and maximum

   (c) Minimum and maximum

   (d) Zero and minimum

SECTION B

Answer any 05 questions from this section. Each question carries 08 Marks   05× 08=40

2. Locate all instantaneous centers of a typical slider crank mechanisms. Also, show that hand pump is an inversion of single slider crank mechanism.

3. Find the maximum and minimum transmission angles for the mechanisms shown in the figure 1. The figures indicate the dimensions in standard units of length.

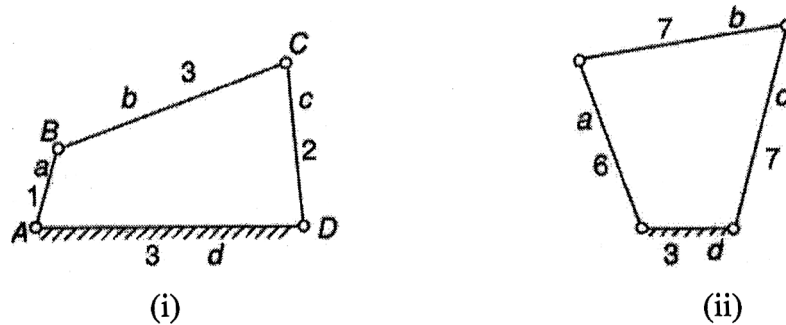(i)   (ii)

Figure 1

4. State and drive the law of gearing. Which point of tooth contact the sliding velocity is maximum.

5. Derive the expression of minimum teeth to avoid interference while two spur gears with involute profile in mesh.

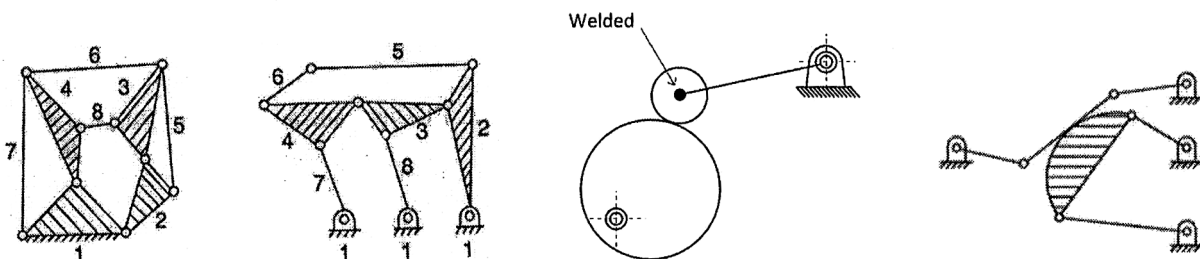6. Determine the degrees of freedom of the following mechanisms shown in the figure 2.

Figure 2

7. State different types of synthesis. Explain graphically relative pole method with respect to a four bar chain.

Write short notes on: (any two)

a) Toggle mechanism

b) Paucellier straight-line mechanism

c) Davis steering mechanism

9. Find the expression for displacement of a rising follower with constant acceleration and deceleration. Also find the maximum velocity of the follower.

SECTION C

Answer any 03 from this section. Each question carries equal mark 16.   03×16=48

10. Q_2Q_4 = 375 mm, BQ_4 = 350 mm, Q_2F = 375 mm Q_4D = 150 mm. The crank Q_4D is rotating CCW at constant 200 rpm. Find the absolute instantaneous linear velocities of point F and slider E. Solve the problem graphically (refer fig. 3).
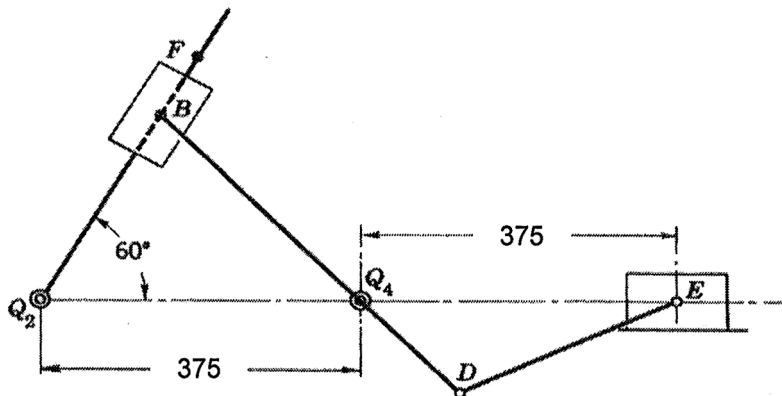

Figure 3

11. a) The Fig 4 shows an Epicyclic gear train. Wheel E is fixed and wheels C and D are integrally cast and mounted on the same pin. If arm A makes one revolution per sec (Counter clockwise) determine the speed and direction of rotation of the wheels B and F.
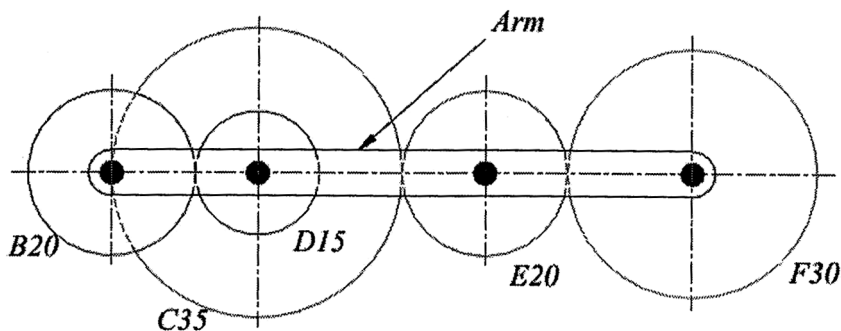

Figure 4

b) Consider that the arm 4 of the following fig. 5 rotates CCW at 50 rad /sec. Given: Teeth of gear 1 = 80, Teeth of gear 2 = 40, Teeth of gear 3 = 20. Determine ω_{21} in magnitude and direction.
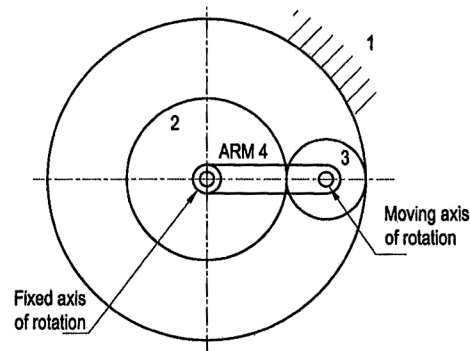

Figure 5

12. Draw the profile of a cam operating a knife-edge follower having a lift of 30 mm. The cam raises the follower with SHM for 150° of the rotation followed by a period of dwell for 60°. The follower descends for the next 100° rotation of the cam with uniform velocity, again followed by a dwell period. The cam rotates at a uniform velocity of 120 rpm and has a least radius of 20 mm. What will be the maximum velocity and acceleration of the follower during the lift and the return?

13. Two involute gears in a mesh have a module of 8 mm and a pressure angle of 20^0. The larger gear has 57 while the pinion has 23 teeth. If the addenda on pinion and gear wheels are equal to 1 module, find
   i) Contact ratio
   ii) Angle of action of the pinion and the gear wheel
   iii) Ratio of sliding to rolling velocity at the
      a. Beginning of contact
      b. Pitch point
      c. End of contact

14. Design a four link mechanism to coordinate three positions of the input and the output links as follows:

$$\theta_1 = 20^0; \quad \phi_1 = 35^0$$
$$\theta_2 = 35^0; \quad \phi_2 = 45^0$$
$$\theta_3 = 50^0; \quad \phi_3 = 60^0$$