CBCS SCHEME

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15ME42

# Fourth Semester B.E. Degree Examination, Dec.2019/Jan.2020
## Kinematics of Machines

Time: 3 hrs. Max. Marks: 80

**Note:** ***Answer FIVE full questions, choosing ONE full question from each module.***



### Module-1

1 a. Define the following terms with examples: (i) Kinematic chain (ii) Mechanism (iii) Lower pair and Higher pair **(06 Marks)**

b. Sketch and explain the following mechanisms :
(i) Drag link mechanism. (ii) Geneva wheel. **(10 Marks)**

**OR**

2 a. What are quick return motion mechanisms? Where are they used? Sketch and explain the functioning of Whitworth mechanism. **(08 Marks)**

b. Derive an expression for necessary condition of correct steering and explain Ackerman steering gear with neat sketch. **(08 Marks)**

### Module-2

3 A four bar mechanism ABCD is made up of four links, pin jointed at the ends. AD is a fixed link which is 180 mm long. The links AB, BC and CD are 90 mm, 120 mm and 120 mm long respectively. At certain instant, the link AB (crank) makes an angle of 60° with the link AD. If the link AB rotates at uniform speed of 100 rpm clockwise determine,
(i) Angular velocity of the links BC and CD
(ii) Angular acceleration of the links CD and CB by using Graphical method. **(16 Marks)**

**OR**

4 a. State and prove Kennedy's theorem. **(06 Marks)**

b. In a reciprocating engine, the length of crank is 250 mm and length of connecting rod is 1000 mm. The crank rotates at an uniform speed of 300 rpm in clockwise direction and the crank is inclined at 30° with inner dead centre. The $C_g$ (centre of gravity) of the connecting rod is 400 mm from the crank end. By Klein's construction determine (i) Velocity and acceleration of piston (ii) Angular velocity and angular acceleration of connecting rod (iii) Velocity and acceleration at the centre of gravity of the connecting rod. **(10 Marks)**

### Module-3

5 Using Complex algebra derive expressions for velocity and acceleration of the piston, angular acceleration of connecting rod of a reciprocating engine mechanism. With these expression determine the above quantities, if the crank length is 50 mm, connecting rod is 200 mm, crank speed is constant at 3000 rpm and crank angle is 30°. **(16 Marks)**

**OR**

6 a. Derive Freudenstein's equation for slider crank mechanism. **(08 Marks)**

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

| | |
|---|---|
| $\theta_1 = 20^\circ$ | $\phi_1 = 35^\circ$ |
| $\theta_2 = 35^\circ$ | $\phi_2 = 45^\circ$ |
| $\theta_3 = 50^\circ$ | $\phi_3 = 60^\circ$ |

Using Freudenstein's equation for four bar mechanism. **(08 Marks)**

## Module-4

7 a. Derive an expression for minimum number of teeth necessary for a gear to avoid interference. **(08 Marks)**

b. A pair of gears 40 and 30 teeth respectively are of 25° involute form. Addendum = 5 mm. Module = 2.5 mm. If the smaller wheel is the driver and rotate at 1500 rpm, find the velocity of sliding at the point of engagement at pitch and at the point of dis-engagement, length of path of contact and length of arc of contact. **(08 Marks)**

**OR**

8 a. Explain with neat sketch of an epicyclic gear train. **(04 Marks)**

b. In an epicyclic gear train, the internal wheels 'A', 'B' and the compound wheel 'C' and 'D' rotate independently about the axis 'O'. The wheels 'E' and 'F' rotates on a pin fixed to the arm 'G', 'E' gears with 'A' and 'C', and 'F' gears with 'B' and 'D'. All the wheels have same pitch and the number of teeth on 'E' and 'F' are 18, C = 28, D = 26.

(i) Sketch the arrangement.
(ii) Find the number of teeth on 'A' and 'B'.
(iii) If the arm 'G' makes 150 rpm CW and 'A' fixed, find speed of 'B'.
(iv) If the arm 'G' makes 150 rpm CW and wheel 'A' makes 15 rpm CCW, find the speed of 'B'. **(12 Marks)**

## Module-5

9 A cam with a base circle radius of 35 mm is rotating at a uniform speed of 100 rpm in anticlockwise direction. Draw the profile for the disc cam with reciprocating knife edge follower on the centre line of the cam shaft for the following follower motion:

(i) Follower to move upward 30 mm with Simple Harmonic Motion (SHM) in 0.1 sec.
(ii) Follower to dwell in next 0.15 sec.
(iii) Follower to move upward to another 30 mm with Simple Harmonic Motion (SHM) in 0.15 sec.
(iv) Follower to return to its starting position with Uniform Acceleration and Retardation (UARM) in the remaining period of one complete revolution of the cam shaft. However, the acceleration period is twice the retardation period.

Determine the maximum velocity and acceleration of the follower during its return stroke. **(16 Marks)**

**OR**

10 a. Define the terms:

(i) Base circle
(ii) Lift or Stroke
(iii) Pitch point.
(iv) Cam profile. **(04 Marks)**

b. Derive an expression, for displacement velocity and acceleration when the flat faced follower is in contact with any point on the nose. **(12 Marks)**

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