

**KINEMATICS OF MACHINES  
(MECH 2205)**

**Time Allotted : 3 hrs**

**Full Marks : 70**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and  
any 5 (five) from Group B to E, taking at least one from each group.*

*Candidates are required to give answer in their own words as far as practicable.*

**Group – A  
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following:

**10 × 1 = 10**

- (i) A chain comprises of 5 links and 5 joints. Is it a kinematic chain?
  - (a) Yes
  - (b) No
  - (c) It Is A Marginal Case
  - (d) Data Are Insufficient.
- (ii) In a four-link mechanism, mechanical advantage is maximum when transmission angle is
  - (a) 0°
  - (b) 45°
  - (c) 180°
  - (d) Close to 90°.
- (iii) Whitworth quick return mechanism is obtained by inversion of
  - (a) slider crank mechanism
  - (b) kinematic chain
  - (c) five link mechanism
  - (d) roller cam mechanism.
- (iv) The total number of instantaneous centres of a mechanism having 5 links is
  - (a) 5
  - (b) 10
  - (c) 15
  - (d) 20.
- (v) Klein's construction gives a graphical construction for
  - (a) slider-crank mechanism
  - (b) velocity polygon
  - (c) acceleration polygon
  - (d) four bar chain mechanism.
- (vi) Correlating the motion of a input to the output motion is called
  - (a) function generation
  - (b) path generation
  - (c) motion generation
  - (d) all of the above.
- (vii) For the same lift and same angle of ascent, a smaller base circle will give
  - (a) a small value of pressure angle
  - (b) a large value of pressure angle
  - (c) no such relation with pressure angle
  - (d) infinite value of pressure angle.
- (viii) Intermediate gears are used for
  - (a) obtaining rotation in desired direction
  - (b) bridging the gap between the first and last wheels of the train
  - (c) driving auxiliaries incidental to the main drive
  - (d) any one of the above.
- (ix) The maximum value of the pressure angle in case of cam is kept as
  - (a) 10
  - (b) 14
  - (c) 20
  - (d) 30.

- (x) Corioli's component of acceleration of a slider which is sliding at 10 cm/s in a link rotating at 60 rpm will be  
 (a)  $0.4\pi$  cm/Sec<sup>2</sup>  
 (b)  $4\pi$  cm/Sec<sup>2</sup>  
 (c)  $40\pi$  cm/Sec<sup>2</sup>  
 (d)  $40\pi^2$  cm/Sec<sup>2</sup>.

**Group - B**

2. (a) Find out the degrees of freedom of following mechanisms shown in Fig.1 and Fig.2.

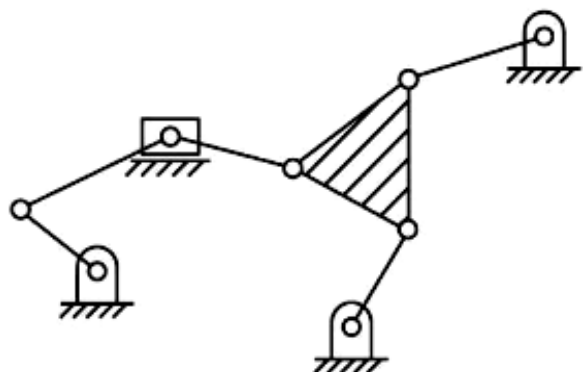


Fig.1

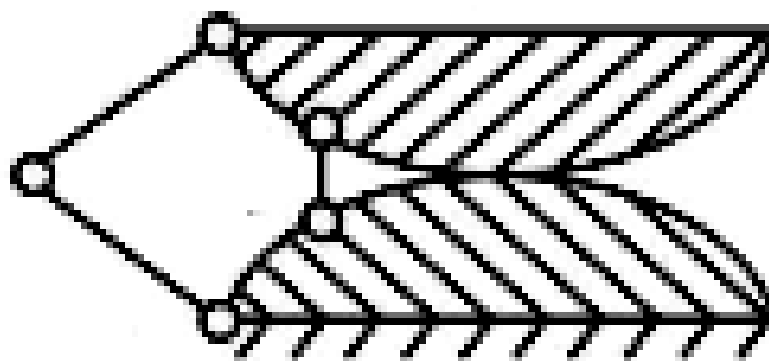


Fig.2

- (b) In a crank and slotted lever quick return motion mechanism, the distance between the fixed centres is 240 mm and the length of the driving crank is 120 mm. Find the inclination of the slotted lever with the vertical in the extreme position and the quick return ratio. If the length of the slotted bar is 450 mm, find the length of the stroke if the line of stroke passes through the extreme positions of the free end of the lever.

CO1 [Apply/IOCQ]

CO1 [Apply/IOCQ]  
**(3 + 3) + 6 = 12**

3. (a) What is meant by inversions of mechanism? Describe various inversions of four bar mechanism when sum of shorter and longer link is equal to sum of other two links.  
 (b) Find the nature of the mechanism as shown in Fig.3 and also determine the maximum and minimum transmission angles.

CO1 [Understand / LOCQ]

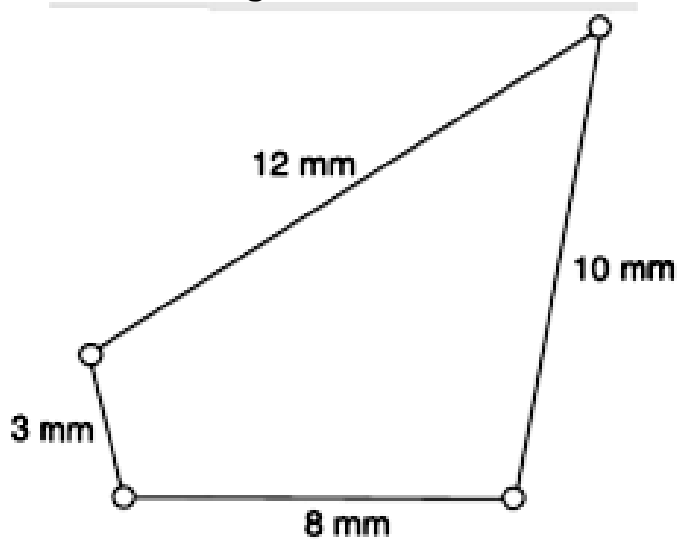


Fig.3

CO1 [Analyze / IOCQ]  
**(2 + 4) + 6 = 12**

**Group - C**

4. (a) What is Coriolis component of acceleration?  
 (b) In a whitworth quick return mechanism, as shown in Fig.4. OA is a crank rotating at 30 rpm in a clockwise direction. The dimensions of various links are: OA = 150 mm; OC = 100 mm; CD = 125 mm; and DR = 500 mm. Determine the acceleration of the sliding block R and the angular acceleration of the slotted lever CA.

CO2 [Remember/LOCQ]

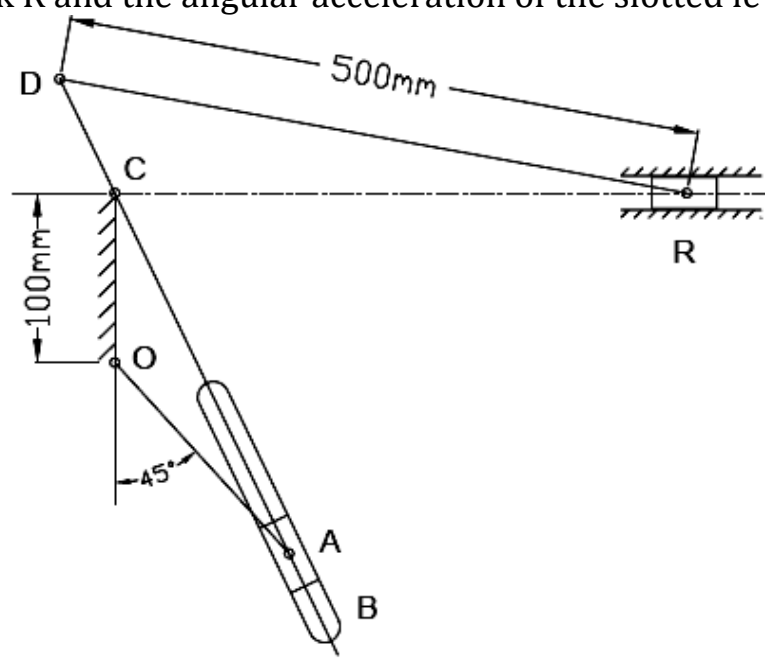


Fig.4

CO2 [Analyze/IOCQ]  
**2 + 10 = 12**

5. (a) What is I-centre? Show all the I-centres in a four bar mechanism with neat sketch. CO2 [Understand/LOCQ]  
 (b) The crank and connecting rod of the theoretical steam engine are 0.5 m and 2 m respectively. The crank makes 180 rpm in the clockwise direction. When, it is turned 45° from the inner dead centre position. Determine  
 (i) velocity of the piston,  
 (ii) angular velocity of connecting rod, and  
 (iii) velocity of a point E on the connecting rod 1.5 m from the gudgeon pin. [Analyze/IOCQ]

**(1 + 3) + 8 = 12**

### Group - D

6. (a) Design a four link mechanism when the motions of the input and the output links are governed by a function  $y = x^2$  and  $x$  varies from 0 to 2 with an interval of 1. Assume the input angle varying from 40° to 120° and output angle from 60° to 130°. CO4 [Design/HOCQ]  
 (b) What do you understand by function generation, path generation and motion generation? CO4 [Understand/LOCQ]
7. (a) In an epicyclic gear train shown in Fig.5, an arm carries two gears A and B having 36 and 45 teeth, respectively. If the arm rotates at 150 rpm. in the anticlockwise direction about the centre of the gear A which is fixed, determine the speed of gear B. If the gear A instead of being fixed makes 300 rpm in the clockwise direction, what will be the speed of gear B?

**9 + 3 = 12**

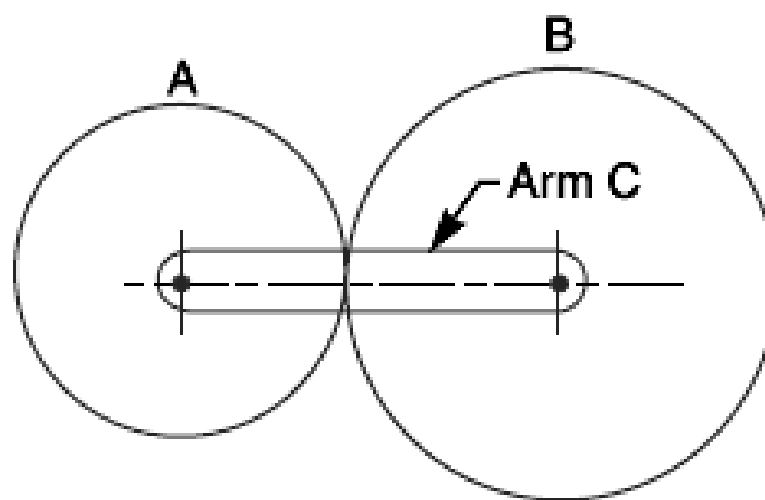


Fig.5

CO5 [Analyze/IOCQ]

- (b) In a reverted epicyclic gear train shown in Fig.6, the arm A carries two gears B and C and a compound gear D-E. The gear B meshes with gear E and the gear C meshes with gear D. The number of teeth on gears B, C and D are 75, 30 and 90 respectively. Find the speed and direction of gear C when gear B is fixed and the arm A makes 100 rpm clockwise.

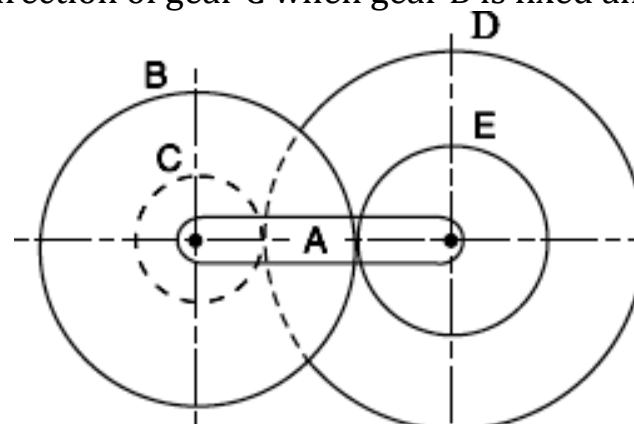


Fig.6

CO5 [Analyze/IOCQ]

**6 + 6 = 12**

### Group - E

8. Design the profile of a cam operating with 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 140 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? CO6 [Analyze/IOCQ]
9. (a) Two shafts with an included angle of 160° are connected by a Hooke's joint. The driving shaft runs at a uniform speed of 1500 rpm. The driven shaft carries a flywheel of mass 12 kg and 100 mm radius of gyration. Find the maximum angular acceleration of the driven shaft and the maximum torque required. CO1 [Analyze/IOCQ]  
 (b) Draw and explain elliptical trammel mechanism. What is the condition for drawing a circle using elliptical trammel? CO1 [Analyze/IOCQ]

**12**

**7 + 5 = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	15.63	75	9.37

**Course Outcome (CO):**

1. Specify a mechanism on the basis of its technical parameters.
2. Analyze velocity of different components in a mechanism.
3. Analyze acceleration of different components in a mechanism.
4. Synthesize principle dimensions (link length, angular position etc) of a Four Bar mechanism.
5. Construct different power transmission layout using gears.
6. Design layouts of a cam drive for specified follower motion.

*\*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*