

KINEMATICS OF MACHINES
(MECH 2205)

Time Allotted: 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 4 (four) from Group B to E, taking one from each group.*

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

Group – A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) A pinion drives a gear. If both have same size of addendum, interference can occur
 - (a) tip of pinion and flank of gear
 - (b) tip of gear and flank of pinion
 - (c) tips of both pinion and gear
 - (d) flanks of both pinion and gear.
- (ii) Inversion of a mechanism is
 - (a) changing of a higher pair to lower pair
 - (b) obtained by fixing different links in a kinematic chain
 - (c) turning it upside down
 - (d) obtained by reversing the input and output motion.
- (iii) The radial distance of a tooth from the pitch circle to the bottom of the tooth, is called
 - (a) Addendum
 - (b) Dedendum
 - (c) Clearance
 - (d) Working depth.
- (iv) Which of the following are inversions of a double slider crank chain?
 - (a) Whitworth quick return mechanism
 - (b) Handpump
 - (c) Oldham's Coupling
 - (d) Rotary engine.
- (v) Minimum number of teeth in pinion with 14.5° full depth involute tooth profile avoiding interference is
 - (a) 18
 - (b) 20
 - (c) 22
 - (d) 40.
- (vi) According to Kennedy's theorem, the instantaneous centres of three bodies having relative motion lie on a
 - (a) straight line
 - (b) point
 - (c) curved path
 - (d) circle
- (vii) Coriolis components of acceleration exists whenever a point moves along a path that has
 - (a) linear displacement
 - (b) rotational motion
 - (c) tangential acceleration
 - (d) centripetal acceleration
- (viii) The point on the cam with the maximum pressure angle is known as the
 - (a) cam centre
 - (b) trace point
 - (c) pitch point
 - (d) prime point

- (ix) Watt mechanism is capable of generating
 (a) approximate straight line (b) exact straight line
 (c) approximate circular path (d) exact circular path.
- (x) Correlating the motion of an input link to the motion of output is called
 (a) function generation (b) motion generation
 (c) path generation (d) all of these.

Fill in the blanks with the correct word

- (xi) Davis mechanism is a type of _____ mechanism
- (xii) In a simple gear train, if number of idlers is odd, then the direction of rotation of first and last gear shall be _____.
- (xiii) A rotating link in a mechanism is called _____.
- (xiv) A mechanism having 6 nos. of links have _____ nos. of instantaneous centre.
- (xv) When shortest link is fixed in a class I four bar mechanism, the mechanism is _____.

Group - B

2. (a) Find the degrees of freedom of the following kinematic chains as shown in the following diagrams.

[[CO1](Apply/IOCQ)]

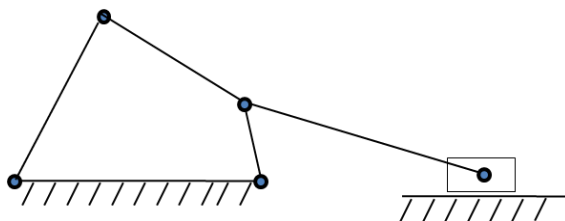


Fig. 2 (a) (i)

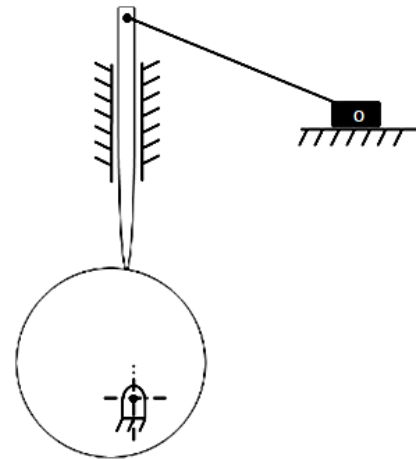


Fig. 2 (a) (ii)

- (b) Find the inversion of four bar mechanisms.

[[CO1](Apply/IOCQ)]

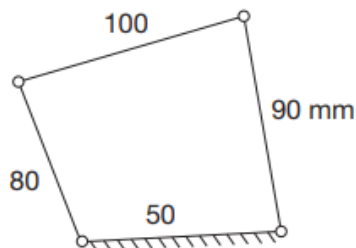


Fig. 2 (b) (i)

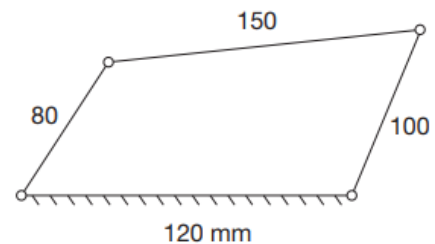


Fig. 2 (b) (ii)

$$(3 + 3) + (3 + 3) = 12$$

3. (a) The length of crank; slotted lever and fixed link of a quick return mechanism is 50 mm, 100 mm and 200 mm, respectively, as shown in Fig. 3 (a). Find the quick return ratio and stroke length.

[[CO1](Apply/IOCQ)]

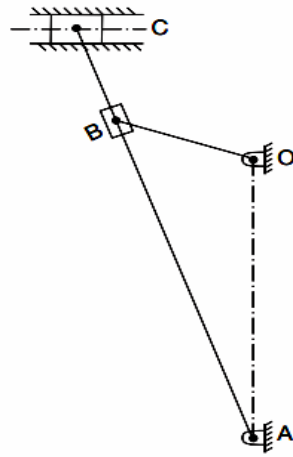


Fig. 3 (a)

- (b) Draw the four inversions of single slider crank mechanism with one use of them. [[CO1](Understand/LOCQ)]

6 + 6 = 12

Group - C

4. Locate the instantaneous centers of the slider crank mechanism shown in Fig. 4. Find the velocity of the slider. If OA 160 mm, AB 470 mm, and OB 600 mm, angular velocity of crank OA is 12 rad/s clockwise. [[CO3] (Analyse/IOCQ)]

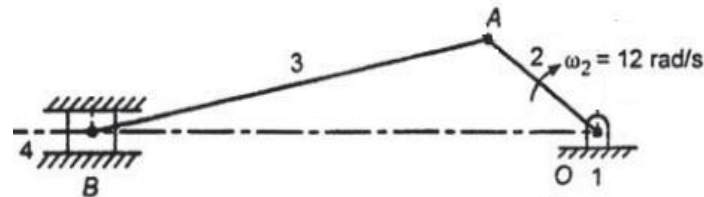


Fig. 4

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5. In the four-bar mechanism shown in Fig. 5, the lengths of the various links are: AB = 190 mm, BC = CD = 280 mm, AD = 500 mm, $\angle BAD = 55^\circ$. The crank AB rotates at 10 rad/s in the clockwise direction. Determine (a) the acceleration of the links BC and CD, and (b) angular accelerations of BC and CD. [[CO3](Analyse/IOCQ)]

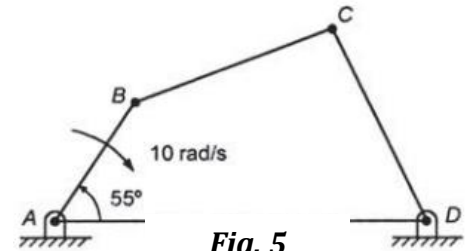


Fig. 5

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Group - D

6. (a) A pinion of 25 involute teeth and 150 mm pitch circle diameter drives a rack. The addendum of both pinion and rack is 8.25 mm. What is the least pressure angle which can be used to avoid interference? With this pressure angle, find the length of the arc of contact and the minimum number of teeth in contact at a time. [[CO5](Analyse/IOCQ)]
- (b) A four bar mechanism is to be designed, by using three precision points, to generate the function

$$y = x^{1.5} \quad \text{for the range } 1 \leq x \leq 4$$

Assuming 30° starting position and 150° finishing position for the input link and 90° starting position and 210° finishing position for the output link, find the values of x , y , θ and ϕ corresponding to the three precision points. [[CO4](Apply/IOCQ)]

7 + 5 = 12

7. (a) In an epicyclic gear train, an arm carries two gears A and B as shown in Fig. 7 (a), having 36 and 45 teeth respectively. If the arm rotates at 150 r.p.m. 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 r.p.m. in the clockwise direction, what will be the speed of gear B? [[CO5](Apply/IOCQ)]

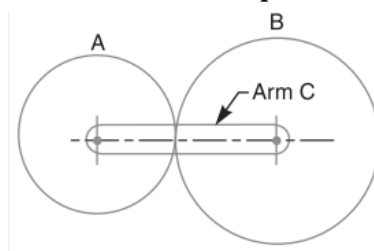


Fig. 7 (a)

- (b) What do you understand by function generation, path generation and motion generation? [[CO4](Understand/LOCQ)]

7 + 5 = 12

Group - E

8. A cam is to give the following motion to a knife-edged follower:
 Raise the follower through 30 mm with uniform acceleration and deceleration
 The follower ascent during the cam rotation angle of 120°
 The follower remains stable for next 60° cam rotation angle
 The follower lowers for next 120° with SHM
 The follower remained stable again for rest of the cam rotation angle
 The cam has a minimum radius of 40 mm and rotates with a constant speed of 1000 rpm in CCW. Draw the cam profile if the line stroke of follower is passing through the axis of the cam shaft. Also, determine the maximum velocity and acceleration of the follower during ascent and descent. [[CO6](Create/HOCQ)]

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9. (a) Name and draw different approximate straight line generating mechanisms. [[CO1](Understand /LOCQ)]
 (b) Draw a Hooke's joint and find the relation between input shaft and output shaft of a Hooke's joint. [[CO1](Understand /LOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	17.71	69.79	12.5

Course Outcome (CO):

After the completion of the course students will be able to

1. Explain the construction working and function of different mechanisms.
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.