

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) The Whitworth quick return motion mechanism formed in a single slider crank chain when the
(a) coupler link is fixed (b) longest link is fixed
(c) smallest link is fixed (d) slider is a fixed one.
- (ii) The Grubler's criterion for determining the degrees of freedom (n) of a mechanism having plane motion is
(a) $N = (L - 1) - J$ (b) $N = 2(L - 1) - 2J$
(c) $N = 3(L - 1) - 2J$ (d) $N = 4(L - 1) - 3J$
- (iii) A mechanism has 7 links with all binary pairs except one which is a ternary pair. The number of instantaneous centers of this mechanism are
(a) 14 (b) 21 (c) 28 (d) 42.
- (iv) When a slider moves on a fixed link having curved surface, their instantaneous centre lies
(a) on their point of contact (b) at the centre of curvature
(c) at the centre of slider (d) at the pin joint.
- (v) The coriolis component of acceleration is taken into account for
(a) slider crank mechanism (b) four bar chain mechanism
(c) quick return motion mechanism (d) all of the above.
- (vi) In a simple gear train, the driver gear has 40 numbers of teeth, idle gear has 20 numbers of teeth and last gear has 80 numbers of teeth. The train value of the gear train is
(a) 0.5 (b) 1.0 (c) 1.2 (d) 2.0.
- (vii) The minimum radius circle drawn to the cam profile is called
(a) Prime circle (b) Base circle
(c) Pitch circle (d) Pitch curve.

- (viii) An offset is provided in radial cam-translating follower mechanism serves to
- decrease the pressure angle during ascent of the follower
 - decrease the pressure angle during descent of the follower
 - avoid possible obstruction due to some machine parts
 - decrease the pressure angle during descent of the follower .
- (ix) Which one of the following is used to convert a rotational motion into a translational motion?
- Bevel gear
 - Worm gear
 - Double helical gear
 - Rack and pinion gears.
- (x) Function generation means designing a mechanism in which _____ are related by a function.
- output and input links
 - input and coupler links
 - output and coupler links
 - coupler and ground links

Group- B

2. (a) Determine the DOF of the following mechanisms as given in figure 1.

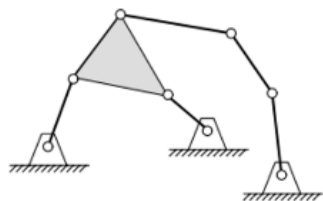


Fig. 1(a)

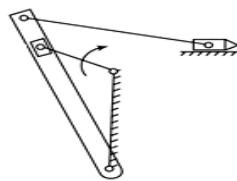


Fig. 1 (b)

[CO1][Apply/IOCQ]

- (b) In a crank and slotted lever quick return mechanism, the distance between the fixed centers is 150 mm and the driving crank is 75 mm long. Determine the ratio of the time taken on the cutting and the return strokes. [CO1][Apply/IOCQ]

(3 + 3) + 6 = 12

3. (a) In a crank and slotted lever quick return mechanism, the distance between the fixed centers is 150 mm and the driving crank is 75 mm long. Determine the ratio of the time taken on the cutting and the return strokes.

[CO1][Analyse/IOCQ]

- (b) A Whitworth quick return motion mechanism, as shown in figure.2, has the following particulars: Length of stroke = 150 mm; Driving crank length = 40 mm; Time of cutting stroke / Time of return stroke = 2. Find the lengths of CD and PD. Also determine the angles α and β . [CO1][Analyse/IOCQ]

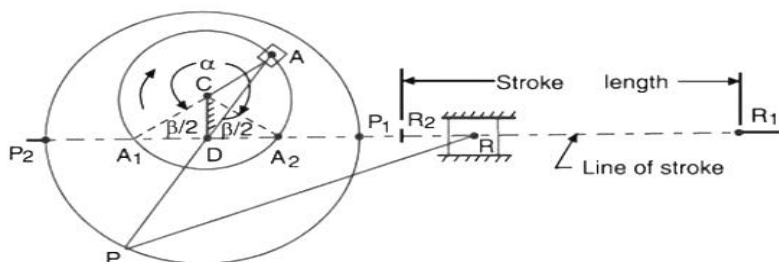


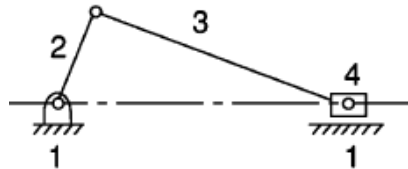
Fig. 2

(7 + 5) = 12

Group - C

4. Following is the figure of a slider crank mechanism (figure 3); the length of crank 2 and connecting rod 3 are 125 mm and 500 mm respectively. The crank speed is 600 rpm clockwise. When the crank has turned 45° from the IDC, determine the followings using both the relative velocity method and I-centre method.

- (i) Velocity of slider 4 with respect to ground.
 (ii) Angular Velocity of connecting rod 3 with respect to slider 4.

**Fig. 3**

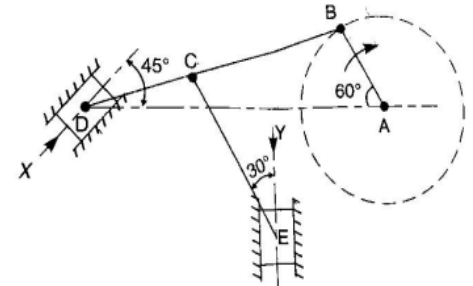
[CO2][Analyze/IOCQ]

12

5. (a) In a four-bar chain ABCD, AD is fixed and is 150mm long. The crank AB is 40 mm long and rotates at 120 r.p.m. clockwise, while the link CD = 80 mm oscillates about D. BC and AD are of equal length. Find the angular velocity of link CD when angle BAD = 60° . Use I-Centre method. Mention the scale of the drawing clearly.

[CO2][Analyse/IOCQ]

- (b) The dimensions of the mechanism, as shown in figure 4, are as follows: AB = 0.45 m; BD = 1.5 m; BC = CE = 0.9 m. The crank AB turns uniformly at 180 r.p.m. in the clockwise direction and the blocks at D and E are working in frictionless guides. Draw the velocity diagram for the mechanism and find the velocities of the sliders D and E in their guides.

**Fig. 4****6 + 6 = 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 $y = x^3$ and x varies from 2 to 4 with an interval of 1. Assume input angle to vary from 30° to 70° and output angle to be vary from 40° to 100° .

[CO4][Synthesis/HOCQ]

- (b) Divide the range of x between 1 and 6 into 5 accuracy points using Chebychev spacing.

[CO4][Synthesis/HOCQ]

9 + 3 = 12

7. (a) The following data refer to two meshing gears having 20° involute teeth:
 Number of teeth of gear wheel = 60
 Number of teeth of pinion = 20
 Speed of pinion = 360 rpm

Module = 8 mm

If the addendum of each gear is such that the path of approach and path of recess are half of their maximum possible values, determine the addendum for the gear and the pinion and the length of arc of contact. [CO5][Analyze/IOCQ]

- (b) In a reverted epicyclic train as shown in figure 5. The arm A carries two wheels B and C and a compound wheel D-E. The wheel B gears with wheel E and the wheel C gears with wheel D. The number of teeth on wheels B, C and D are 90, 70 and 60 respectively. Find the speed and direction of wheel C, if wheel B is rotating with 20 rpm anti-clockwise and the arm A makes 100 rpm clockwise. Assume same module for all the gears. [CO5][Analyze/IOCQ]

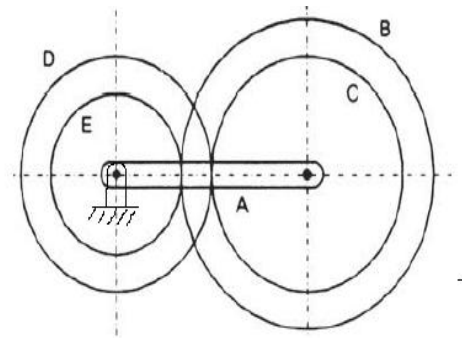


Fig. 5

5 + 7 = 12

Group – E

8. Draw the profile of a cam operating a roller reciprocating follower and with the following data:

Minimum radius of cam = 30 mm

Lift = 40 mm

Roller diameter = 20 mm

The cam lifts the follower for 180° with SHM followed by a dwell period of 30° . Then the follower lowers down during 120° of the cam rotation with uniform acceleration and deceleration followed by a dwell period. If the cam rotates at a uniform speed of 140 rpm, calculate the maximum velocity and acceleration of the follower during the ascent and descent period. [CO6][Analyze/IOCQ]

12

9. (a) A universal joint is used to connect two shafts which are inclined at 18° and the speed of the driving shaft is 800 rpm. Find the extreme angular velocities of the driven shaft and its maximum acceleration. [CO1][Analyze/IOCQ]

- (b) Sketch and describe the Peaucellier straight line. Prove geometrically that the above mechanism is capable of producing straight line. [CO1][Analyze/IOCQ]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	0	87.5	12.5

Course Outcome (CO):

- Specify a mechanism on the basis of its technical parameters.
- Analyze velocity of different components in a mechanism.
- Analyze acceleration of different components in a mechanism.
- Synthesize principle dimensions (link length, angular position etc) of a Four Bar mechanism.
- Construct different power transmission layout using gears.
- 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