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 having 5 joints. Is it kinematic chain?
(a) Yes (b) No
(c) It is a marginal case (d) Data are insufficient to determine it

(ii) The degree of freedom of a body in space is
(a) 1 (b) 2 (c) 3 (d) 6.

(iii) The C.G. of a link in any mechanism would experience
(a) Zero acceleration (b) Linear acceleration
(c) Angular acceleration (d) Both angular and linear accelerations.

(iv) A mechanism has 7 links with all binary pairs except one which is a ternary pair. The number of instantaneous centres is
(a) 14 (b) 21 (c) 28 (d) 35.

(v) The equivalent number of binary links of a spring are:
(a) 1 (b) 2 (c) 3 (d) 4.

(vi) Correlating the motion of an input to the motion of output is called
(a) Function generation (b) Path generation
(c) Motion generation (d) All of the above.

(vii) Mitre gears are used for
(a) Great speed reduction
(b) Transmitting motion between two intersecting shafts
(c) Equal speed
(d) Minimum axial thrust.

(viii) In a simple gear train, if number of idlers is odd, then the direction of rotation of first and last gear shall be
(a) Same (b) Opposite
(c) Depends on gear types (d) Depends on number of teeth.

(ix) In its simplest form, a cam mechanism consists of following number of links
(a) 1 (b) 2 (c) 3 (d) 4.

(x) A pantograph consists of
(a) 4 links (b) 6 links (c) 8 links (d) 10 links.

Group – B

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

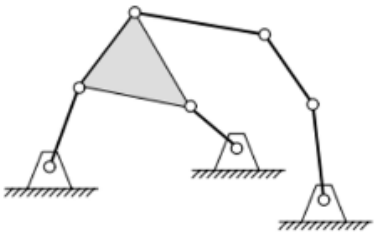

Fig.1

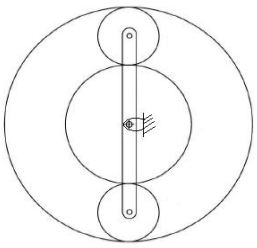

Fig.2

(b) Fig.3 shows the layout of a quick return mechanism of the oscillating link type, for a special purpose machine. The driving crank BC is 30 mm long and time ratio of the working stroke to the return stroke is to be 1.7. If the length of the working stroke of R is 120 mm, determine the dimensions of AC and AP.

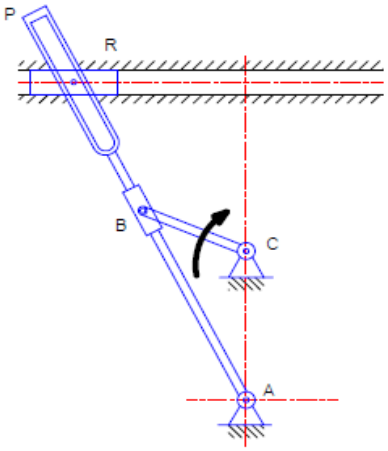

Fig.3

(3 + 3) + 6 = 12

3. (a) Find out the equivalent mechanism and find the degree of freedom of different mechanisms given below in figure 4 and figure 5.

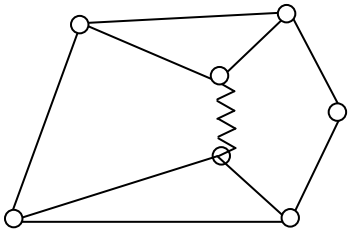

Fig.4

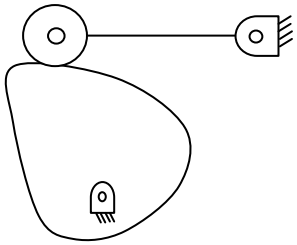

Fig.5

(b) Classify the motion of the four-bar mechanism shown in figure 6, L_1 = 80 cm, L_2 = 30 cm, L_3 = 75 cm, L_4 = 65 cm

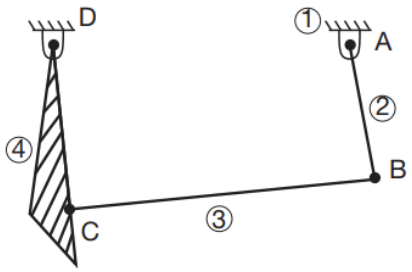

Fig.6

(4 + 4) + 4 = 12

Group – C

4. (a) The crank of a slider crank mechanism rotates clockwise at a constant speed of 300 rpm. The crank is 150 mm and the connecting rod is 600 mm long. At crank angle of 45° from inner dead centre position, determine
   (i) Linear velocity of midpoint of the connecting rod and angular velocity
   (ii) Angular velocity of the connecting rod about crank pin.

   (b) A quick return mechanism of the crank and slotted lever type shaping machine is shown in Fig.7. The dimensions of the various links are as follows: O_1O_2 = 800 mm; O_1B = 300 mm; O_2D = 1300 mm; DR = 400 mm. The crank O_1B makes an angle of 45° with the vertical and rotates at 40 r.p.m. in the counter clockwise direction. Find:
   (i) Velocity of the ram R, or the velocity of the cutting tool, and
   (ii) Angular velocity of link O_2D.

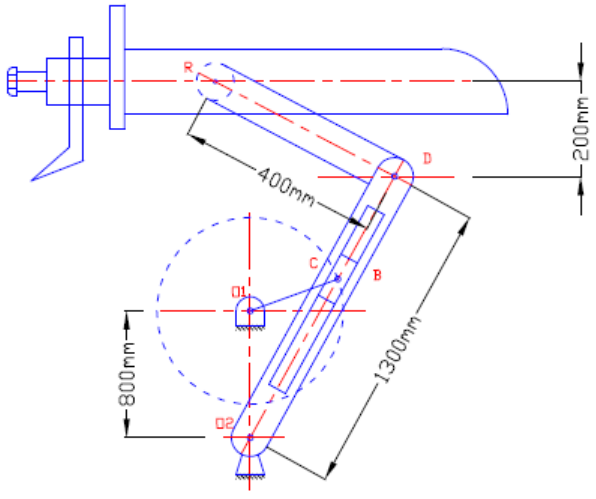

Fig.7

4 + 8 = 12

5. (a) What is the use of Klein's construction?

   (b) A mechanism of a crank and slotted lever quick return motion is shown in Fig.8. If the crank rotates counter clockwise at 120 r.p.m., determine for the configuration shown, the velocity and acceleration of the ram D. Also determine the angular acceleration of the slotted lever. Crank, AB = 150 mm; Slotted arm, OC = 700 mm and link CD = 200 mm.

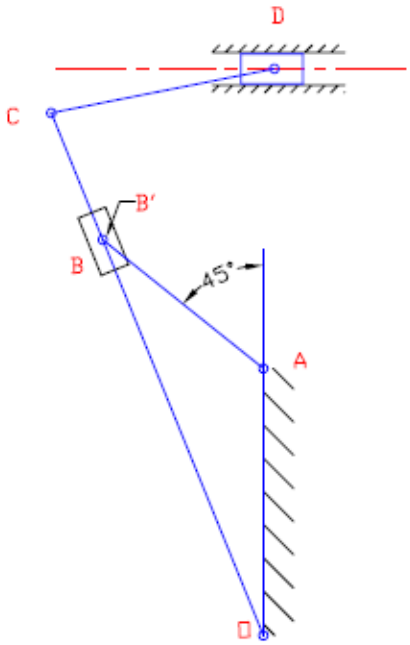

Fig.8

2 + 10 = 12

Group – D

6. (a) Design a four-link mechanism if the motions of the input and the output links are governed by a function $y=x^{1.4}$ and x varies from 1 to 5. Assume input angle to vary from 30^{o} to 120^{o} and output angle from 50^{o} to 120^{o}. The length of the fixed link is 30 mm. Use Chebyshev spacing of accuracy points.

(b) What is Chebyshev spacing? Explain its significance?

9 + 3 = 12

7. (a) A pair of spur gears with involute teeth is to give a gear ratio of 4: 1. The arc of approach is not to be less than the circular pitch and smaller wheel is the driver. The pressure angle is 14.5°. Find:
(i) The least number of teeth that can be used on each wheel and
(ii) The addendum of the wheel in terms of the circular pitch?

(b) An epicyclic gear train shown in Fig.9, consists of a sun wheel S, a stationary internal gear E and three identical planet wheels P carried on a star- shaped planet carrier C. The sizes of different toothed wheels are such that the planet carrier C rotates at 1/5th of the speed of the sun wheel S. The minimum number of teeth on any wheel is 16. The driving torque on the sun wheel is 100 N-m. Determine:
(i) Number of teeth on different wheels of the train, and
(ii) Torque necessary to keep the internal gear stationary.

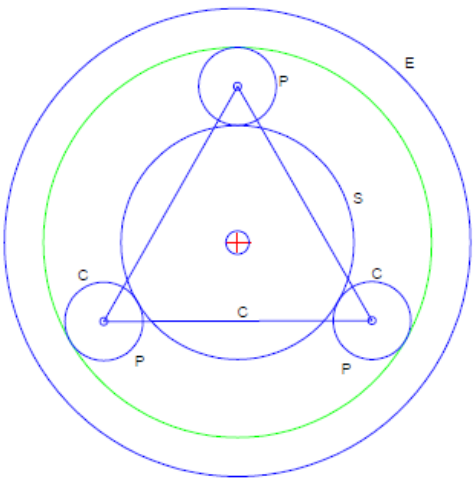

Fig.9

5 + 7 = 12

Group – E

8. A cam rotating clockwise at a uniform speed of 1000 r.p.m. is required to give a roller follower the motion defined below:
   - Follower to move outwards through 50 mm during 120° of cam rotation,
   - Follower to dwell for next 60° of cam rotation,
   - Follower to return to its starting position during next 90° of cam rotation,
   - Follower to dwell for the rest of the cam rotation.

   The minimum radius of the cam is 50 mm and the diameter of roller is 10 mm. The line of stroke of the follower is off-set by 20 mm from the axis of the cam shaft. If the displacement of the follower takes place with uniform and equal acceleration and retardation on both the outward and return strokes, draw profile of the cam and find the maximum velocity and acceleration during out stroke and return stroke.

12

9. (a) The driving shaft of a Hooke's joint rotates at a uniform speed of 400 rpm. If the maximum variation in speed of the driven shaft is 10% of the mean speed, determine the greatest permissible angle between the axes of the shafts. What are the maximum and the minimum speeds of the driven shaft?

   (b) A car with a track of 2 m and a wheel base of 3.5 m has a steering gear mechanism of the Ackermann type. The distance between the front stub axle pivots is 1.6 m. The length of each track arm is 250 mm and the length of track rod is 1.5 m. Find the angle turned through by the outer wheel if the angle turned through by the inner wheel is 40°.

7 + 5 = 12

Department & Section	Submission Link
ME-A	https://docs.google.com/forms/d/e/1FAIpQLSc7yWL0DfbCJz86Ex_Yf8UlZUcdFKAtPH9QjqoPrAhKIjBHRw/viewform?usp=pp_url
ME-B	https://forms.gle/AH14YtMdcNb22jsU6