Roll No

Total Pages : 09

Jan-21-R-16

B. Tech. EXAMINATION, Jan. 2021

Semester V (CBS)

KINEMATICS OF MACHINES

ME-501

Time : 3 Hours *Maximum Marks : 60*

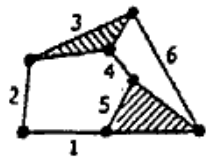
The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : Attempt *Five* questions in all, selecting *one* question from each Sections A, B, C and D. Q. No. **9** is compulsory. Use of scientific calculator is permitted during the examination.

Section A

1. (a) Find the degrees of freedom of the linkages shown in Fig. 1. **5**

(i)



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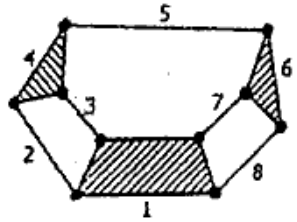

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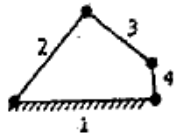

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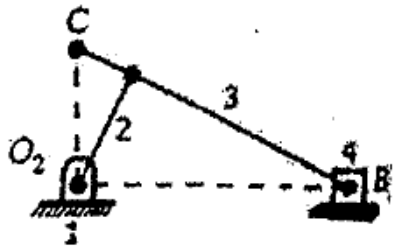

(v)

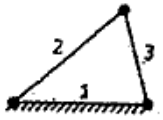

Fig. 1

(b) For the mechanism shown in Fig. 2, find the velocities of points C, E and F and the angular velocities of the links BC, CDE and EF. **5**

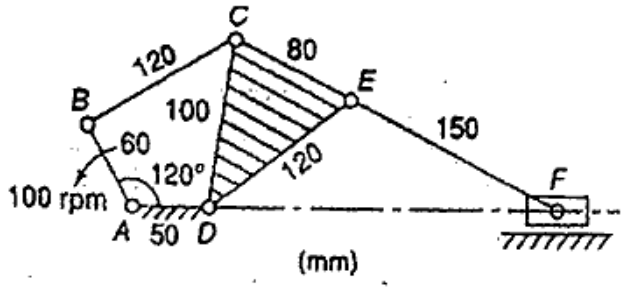

Fig. 2

2. (a) An offset slider crank mechanism is shown in Fig. 3. The crank is driven by the slider B at a speed of 15 m/s towards the left at given instant. Find the velocity of the offset point D on the coupler AB and the angular velocities of links OA and AB. **5**

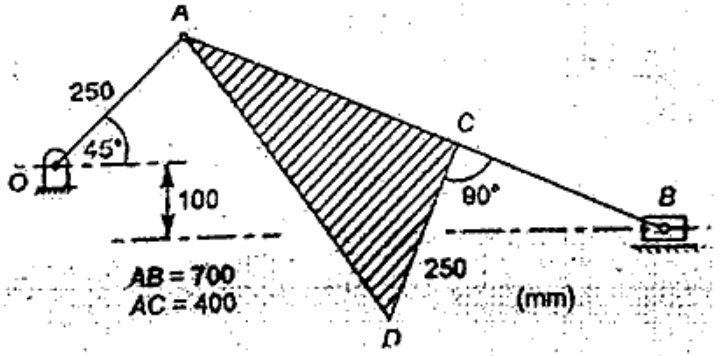

Fig. 3

(b) Fig. 4 shows a toggle mechanism in which the crank OA rotates at 120 rpm. Find the acceleration of the slider at D. **5**

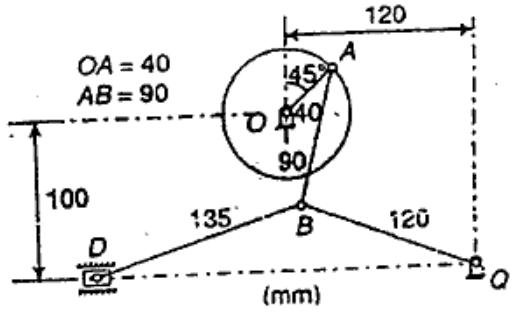

Fig. 4

Section B

3. Lay out the profile of a cam so that the follower :

(a) is moved outwards through 30 mm during 180° of cam rotation with cycloidal motion

(b) dwells for 200 of the cam rotation

(c) returns with uniform velocity during the remaining 160° of the cam rotation.

The base circle diameter of the cam is 28 mm and the roller diameter 8 mm. The axis of the follower is offset by 6 mm to the left. What will be the maximum velocity and acceleration of the follower during the outstroke if the cam rotates at 1500 rpm counter-clockwise ? **10**

4. In a four-stroke petrol engine, the crank angle is 5° after t.d.c. when the suction valve opens and 53° after b.d.c when the suction valve closes. The lift is 8 mm, the nose radius is 3 mm and the least radius of cam is 18 mm. The shaft rotates at 800 rpm. The cam is of the circular type with a circular nose and flanks while the follower is flat-faced. Determine the maximum velocity and the maximum acceleration and retardation of the valve. What is the minimum force exerted by the springs to overcome the inertia of moving parts weighting 250 g. **10**

Section C

5. (a) Power is transmitted between two shafts, 3 metres apart by an open wire rope passing round two pulleys of 3 metres and 2 metres diameters respectively, the groove angle being 40°. If the rope has a mass of 3.7 kg per metre length and the maximum working tension in rope is 20 kN, determine the maximum power that rope can transmit and the corresponding speed of the smaller pulley. The coefficient of friction being 0.15. **5**

(b) An epicyclic gear consists of a pinion, a wheel of 40 teeth and an annulus with 84 internal teeth concentric with the wheel. The pinion gears with the wheel and the annulus. The arm that carries the axis of the pinion rotates at 100 rpm. If the annulus is fixed, find the speed of the wheel; if the wheel is fixed, find the speed of the annulus. **5**

6. (a) The angle between two shafts is 90°. They are joined by two spiral gears having a normal circular pitch of 6 mm and a gear ratio of 2. If the approximate distance between the shafts is 200 mm and the friction angle is 6°, determine the following for the maximum efficiency of the drive :

(i) number of teeth

(ii) centre distance (exact)

(iii) pitch diameters

(iv) efficiency. **5**

(b) In an epicyclic gear shown in Fig. 5, the pitch circle diameter of the annulus A is to be approximately 324 mm and the module is to be 6 mm. When the annulus is stationary, the three armed spider makes one revolution for every five revolutions of the wheel S. Find the number of teeth for all the wheels and exact pitch circle diameter of the annulus. If a torque of 30 Nm is applied to the shaft carrying S, determine the fixing torque of the annulus. **5**

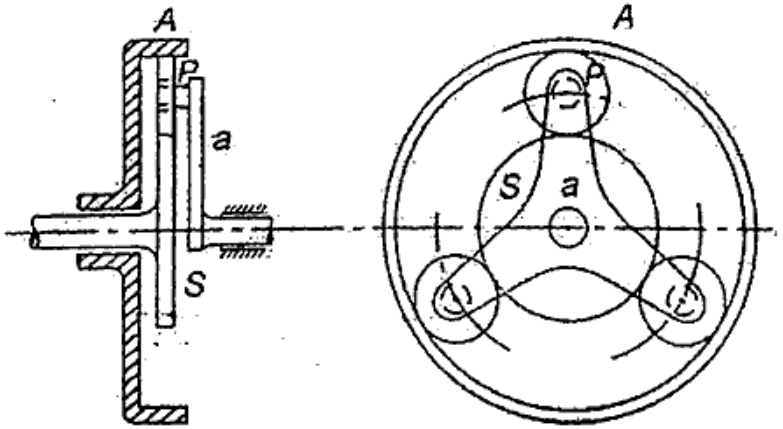

Fig. 5

Section D

7. Design a 4 link mechanism if the motions of the input and the output links are governed by a function $y = x1.5$ and x varies from 1 to 4. Assume θ to vary from 30° to 120° and ϕ from 60° to 130°. The length of the fixed link is 30 mm. Use Chebychev spacing of accuracy points. **10**

8. Design a slider crank mechanism to coordinate three positions of the input link and the slider for the following angular and linear displacements of the input link and the slider respectively :

   $\theta_{12} = 30°$ $\quad s_{12} = 100$ mm

   $\theta_{13} = 90°$ $\quad s_{13} = 200$ mm

   Take eccentricity of the slider as 10 mm. **10**

(Compulsory Question)

9. (a) What is Freudenstein's equation ? How is it helpful in designing a 4 link mechanism when three positions of the input and the three positions of the output are known ?

   (b) What is Chebychev Spacing ? What is its significance ?

(c) Explain the following terms :

(i) Function generation

(ii) Path generation

(iii) Motion generation.

(d) What is a Gear Train ? What are its main types ?

(e) Give a detailed classification of gears.

(f) State and derive the law of gearing.

(g) Define and elaborate the law of belting.

(h) How are the cams classified ? Describe in detail.

(i) State and explain angular velocity ratio theorem as applicable to mechanisms.

(j) Explain the following terms :

(i) Kinematic link

(ii) Kinematic pair

(iii) Kinematic chain

(iv) Redundant link. **10×2=20**