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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Second Semester, M. Tech - Mechanical Engineering (MMDN)

Semester End Examination; June - 2017

Dynamics and Mechanism Design

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Assume suitable missing data, if any.
iii) Tracing Sheets has to be supplied.

UNIT - I

1 a. Explain the following :

(i) Degrees of freedom (ii) Generalized Coordinates (iii) Holonomic Constraint (iv) Non holonomic constraint. — 12

b. Two frictionless blocks of equal mass *m* are connected by a mass less rigid rod as shown in Fig. Q1(b). Obtain the force F_2, if the system is in static equilibrium. — 8

2 a. Write notes on generalized force and generalized momentum. — 10

b. Three particles are connected by two rigid rods having a joint between them to form the system shown in Fig. Q2(b). The configuration of the system is given by the ordinary coordinates (x_1, x_2, x_3) or by the generalized coordinates (q_1, q_2, q_3), where — 10

$$x_1 = q_1 + q_2 + \frac{1}{2}q_3;\ x_2 = q_1 - q_3; x_3 = q_1 - q_2 + \frac{1}{2}q_3.$$

Find the expressions for the kinetic energy and the generalized momenta.

UNIT - II

3 a. A simple pendulum of length *L* and weight *mg* is pivoted to the mass *M* which slides without friction on a horizontal plane as shown in Fig. Q3(a). Use Lagrange's equation to determine the equations to motion of the system. — 10

b. Derive Hamilton's equation from Lagrange's equation. — 10

4 a. Derive Euler's equation of motion. — 8

b. An aeroplane flying at 240 km/h turns towards the left and completes a quarter circle of 60 m radius. The mass of the rotary engine and the propeller of the plane is 450 kg with radius of gyration 320 mm. The engine speed is 2000 rpm clockwise when viewed from the rear. Determine the gyroscopic couple on the aircraft and state its effect. In what way is the effect changed when the aeroplane turns towards right? — 12

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UNIT - III

5 a. Determine the number of roots in the right half of s-plane for the following polynomial, $s^5 + 4s^2 + 5s^3 + 28s^2 + 6s + 5 = 0$. 8

b. Explain the following controller and mention their characteristics :
(i) Proportional plus derivative controller
(ii) Proportional plus integral controller. 12

6 a. Define the following :
(i) Rigid body and resistant body
(ii) Kinematic link and kinematic pair
(iii) Mechanism and machine
(iv) Planar and spherical mechanisms. 8

b. Determine the mobility of the mechanisms shown in Fig. Q6(b) using Kutzbach criterion. 6

c. Find the dof of the mechanism shown in Fig. Q6(c) and draw equivalent kinematic chain with turning pairs. 6

UNIT - IV

7 a. Explain type, number and dimensional synthesis. 6

b. Determine Chebychev's spacing for the function $y = 2x^2 - 1$ in the range of $1 \le x \le 2$, where four precision points are prescribed. 6

c. The rocker of a crank rocker linkage is to have a length of 70 mm and swing through a total angle of 60º with time ratio of 1.5. Determine the suitable set of dimensions for the links. 8

8. Derive Frudensten's equation for three point function of a 4-link mechanism and hence synthesize $y = \sin x \; for \; 0^o \le x \le 90^o$. The range of input link is 120º and that of output link is 60º. 20

UNIT - V

9 a. Design a four-bar mechanism to coordinate three positions of the input and output links for the following angular displacement by inversion method :
$\theta_{12} = 35^o$, $\theta_{13} = 80^o$ and $\phi_{12} = 50^o$, $\phi_{13} = 80^o$,
Input and output links rotates counter clock wise direction. 8

b. Using point position reduction, design a four-bar mechanism so that the input and output links have the following angular displacements:
$\theta_{12} = 20^o$, $\theta_{23} = 30^o$, $\theta_{34} = 20^o$ and $\phi_{12} = 40^o$, $\phi_{23} = 30^o$, $\phi_{34} = 20^o$. 12

10 a. Synthesize a four-link mechanism to match the following three positions using overlay technique: $\theta_{12} = 25^o$, $\theta_{23} = 30^o$ and $\phi_{12} = 30^o$, $\phi_{23} = 35^o$. 10

b. Write short notes on :
(i) Coupler curve synthesis (ii) Cognate linkages. 10

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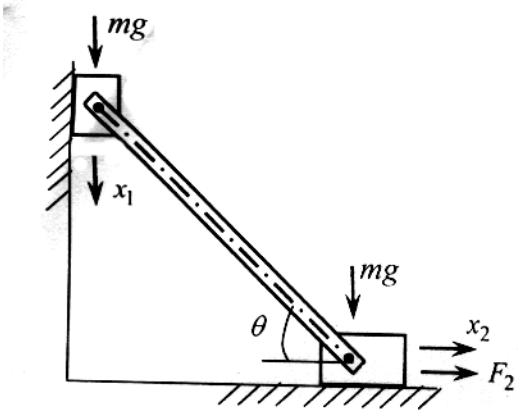

Fig. Q 1(b)

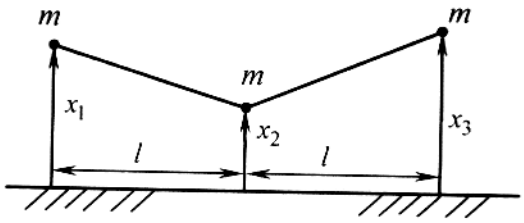

Fig. Q 2(b)

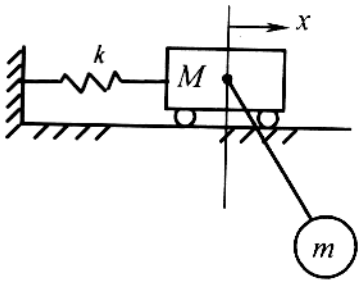

Fig. Q 3(a)

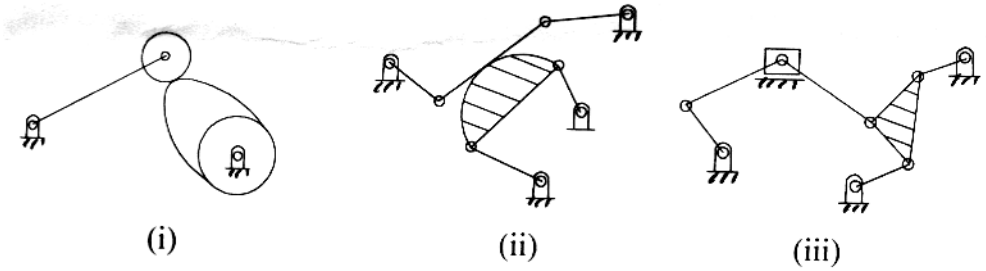

Fig. Q 6(b)

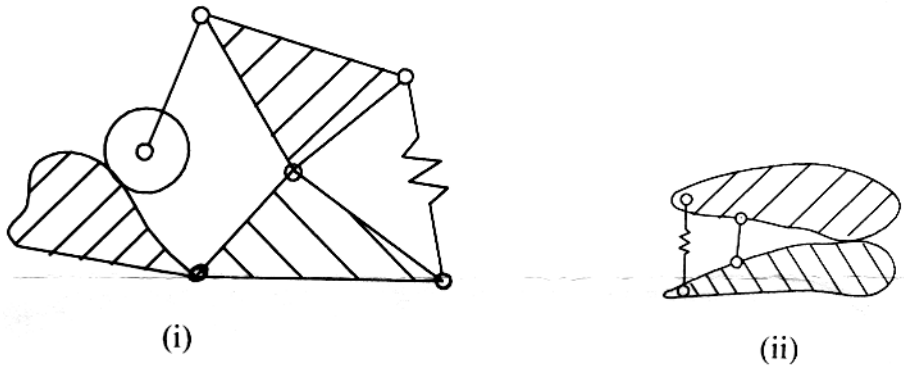

Fig. Q 6(c)

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