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

***(An Autonomous Institution affiliated to VTU, Belgaum)***

**Second Semester, M. Tech – Mechanical Engineering (MMDN)**

**Semester End Examination; June - 2016**

**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.*

**UNIT - I**

1 a. Explain the Holonomic and Non-holonomic constraints with examples. 8

b. What is virtual work? Explain the concept of principle of virtual work. 6

c. A particle of mass 'm' is suspended by a massless wire of length $r = a+b\cos\omega t$, where $a > b > 0$ to form a spherical pendulum as shown in Fig. Q1(c). Find the equation of motion. 6

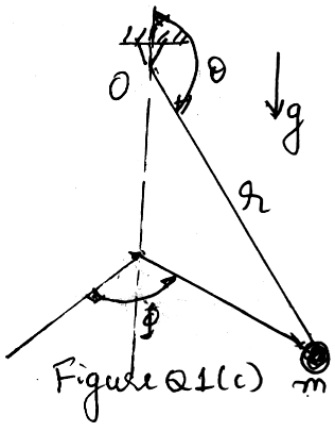

Figure Q1(c)

2 a. What are generalized co-ordinates? Deduce the necessary and sufficient condition for transformation from Cartesian co-ordinates to generalized co-ordinates. 8

b. Determine the external constant forces $R_1$ and $R_2$ for the system consisting of a cube of mass 'm' which is resting at static equilibrium at a corner formed two frictionless mutual perpendicular planes. Assume that any motion restricted to the vertical plane as shown in Fig. Q2(b) 12

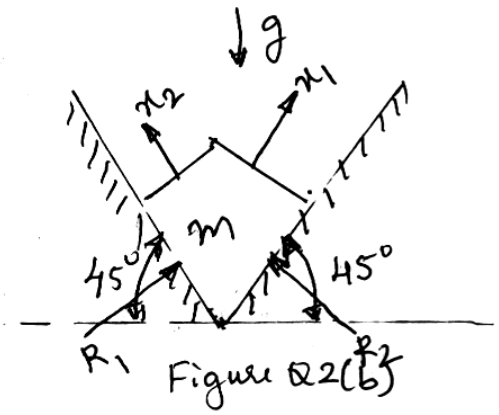

Figure Q2(b)

Contd…2

**UNIT - II**

3 a. Derive the Lagrange's equations of motion. 8

b. A particle of mass *m* can slide without friction on the inside of a small tube which is bent in the form of a circle of radius *r*. The tube rotates about a vertical diameter with a constant angular velocity 'ω' as shown in the Fig. Q3(b). Write the differential equation of motion. 12

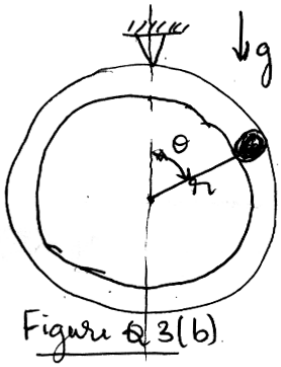

Figure Q3(b)

4 a. Derive Hamilton's equation. 8

b. Find the equation of motion using Hamilton principle for the system shown in Fig. Q4(b). 12

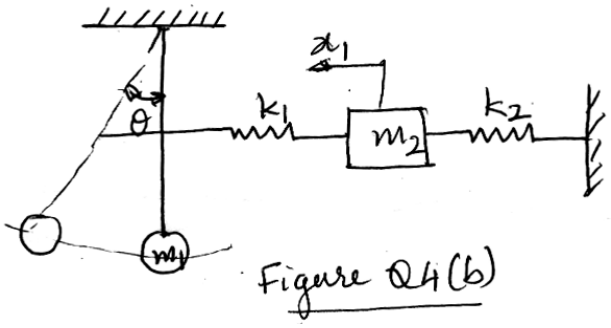

Figure Q4(b)

**UNIT - III**

5 a. The natural frequency of spring mass system is 15 Hz. It is subjected to pulse as shown in Fig. Q5(a). Draw the phase-plane plot and find the maximum displacement of the system. 10

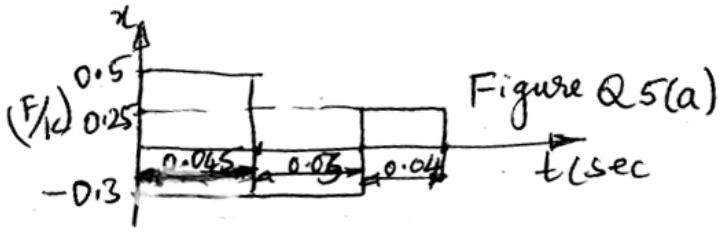

Figure Q5(a)

b. Explain the following controller and mention their characteristics : 10

(i) Proportional plus derivative controller

(ii) Proportional plus integral controller.

6 a. Define the following : 6

(i) Mechanism (ii) Machine (iii) Structure

(iv) Planar Mechanism (v) Spherical mechanism (vi) Spatial mechanism

Contd…3

b. What is Grashaf's law? What are the inversions of Grashaf's chain? Explain with sketches. 8

c. What is an equivalent mechanism? Write the equivalent mechanism for the linkages shown in Fig. Q6(c) 6

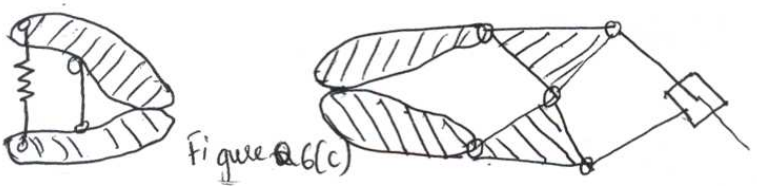

Figure Q6(c)

**UNIT - IV**

7 a. Explain the following with examples :
(i) Function generation
(ii) Path generation
(iii) Body guidance. 6

b. Explain the two portion synthesis of slider crank mechanism with neat sketch. 6

c. Write equations to obtain optimum transmission angles with crank rocker mechanism. 8

8 a. Derive Frudensten's equation for the synthesis of four bar mechanism. 10

b. Synthesis a 4-bar linkage to give the following values for the angular velocities and angular accelerations.
Draw the mechanism, 10
$\omega_2 = 200$ rad/sec, $\omega_3 = 85$ rad/sec, $\omega_4 = 130$ rad/sec
$\alpha_2 = 0$ rad/ sec$^2$ , $\alpha_3 = -1000$ rad/sec$^2$ , $\alpha_4 = 1600$ rad/sec$^2$

**UNIT - V**

9. Synthesis a 4-bar linkage to generate the function $y = x^{1.5}$ for the interval $1 \leq x \leq 4$.The input crank is to start from $\Phi s = 30^o$ and have a range of 90°. The output follower is to start $\Psi = 0^o$ and a range of 90º. Take three accuracy points and length of fixed link as 5 cm. 20

10 a. Explain cognate linkages and Cayley diagram. 8

b. Using, overlay method, synthesis a 4-bar mechanisms to generate a function $y = x^{0.8}$ for $1 \leq x \leq 3$ Use 6 positions for this system. 12

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