TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

EXAMINATION CONTROL DIVISION

2083 Bhadra

Examination	Regular	√	Back		
Level	BE	**Full Marks**	60		
Programme	BME	**Pass Marks**	24		
Year/Part	III/II	**Time**	3 hrs		

Subject: Machine Dynamics (ENME354) – Model Question

√ Candidates are required to give their answers in their own words as far as practicable.
√ Attempt ***All*** questions.
√ The figures in the margin indicate ***Full Marks***.

1. Derive an expression for amplitude of a single degree of freedom system subjected to an external motion. **[3]**

2. In a slider crank mechanism, the length of the crank and connecting rod are 100 mm and 400 mm respectively. The crank rotates uniformly at 600 r.p.m. clockwise. When the crank has turned through 45° from the inner dead centre, determine
(a) Velocity and acceleration of the slider,
(b) Angular velocity and angular acceleration of the connecting rod. **[5]**

3. An aeroplane makes a complete half circle of 60 metres radius, towards left, when flying at 250 km per hr. The rotary engine and the propeller of the plane has a mass of 450 kg and a radius of gyration of 0.3 m. The engine rotates at 2400 r.p.m. clockwise when viewed from the rear. Find the gyroscopic couple on the aircraft. **[5]**

4. The lower arms are pivoted to the sleeve at a distance of 30 mm from the axis of rotation. The length of the upper arms is 280 mm and that of the lower arms is 300 mm. The mass of each ball is 6 kg. If the equilibrium speed is 200 rpm, when the radius of rotation is 200 mm, determine the required mass of the sleeve. **[5]**

5. A steel cantilever beam of length $1.2\ m$ carries a mass of $60\ kg$ at its free end. The beam has a cross section of $40\ mm$ (depth) $\times$ $30\ mm$ (width). Determine the natural frequency of transverse vibration of the mass by modeling it as a single degree of freedom system. Neglect the mass of the beam. Take $E = 210\ GPa$ for steel. **[5]**

6. A block of mass $5\ kg$ is traveling on a frictionless horizontal surface with a velocity of $16\ m/s$ and engages a spring ($k = 35\ kN/m$) and viscous damper ($c = 200\ N.s/m$), as shown in F**igure P.6**. Determine:
(a) the maximum displacement of the block after engaging the springs and damper and
(b) the time taken to reach the maximum displacement. **[5]**

7. Determine the two natural frequencies and the modes of vibration of the system shown in **Figure P.7**. Determine the response of the system when it is subject to the following initial conditions: $x_1(0) = 0.1\ m, \dot{x}_1(0) = 0, x_2(0) = 0, \dot{x}_2(0) = 0$. **[8]**

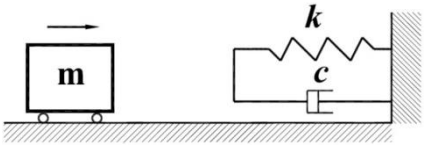

Figure P.6

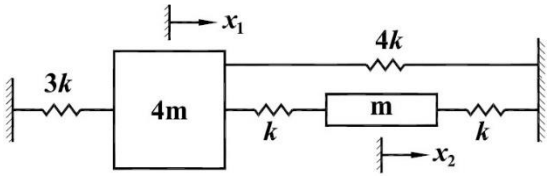

Figure P.7

8. Determine the natural frequencies and the corresponding mode shapes of the three

degree of freedom systems shown in **Figure P.8**. **[10]**

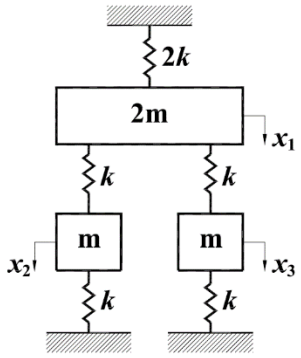

Figure P.8

9. Mass and flexibility matrices of a three degree of freedom system are given as

$$M = \begin{bmatrix} 2m & 0 & 0 \\ 0 & m & 0 \\ 0 & 0 & 2m \end{bmatrix} \quad [A] = \begin{bmatrix} \frac{7}{24k} & \frac{1}{6k} & \frac{1}{24k} \\ \frac{1}{6k} & \frac{2}{3k} & \frac{1}{6k} \\ \frac{1}{24k} & \frac{1}{6k} & \frac{7}{24k} \end{bmatrix}$$

Determine its fundamental natural frequency and the corresponding mode shape using matrix iteration method. **[6]**

10. Determine the frequency equation for longitudinal vibration of a bar fixed at both ends. **[3]**

11. Explain the concept of active vibration control and compare it with passive vibration control. **[5]**