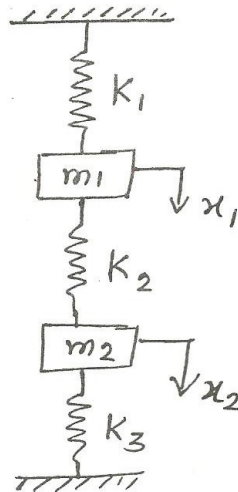


- N.B.:** (1) Question No. 1 is **compulsory**.
 (2) Attempt any **four** questions from remaining **six** questions.
 (3) Assume **suitable** data wherever required with **justification**.
 (4) **Figures** to the right indicate **full** marks.

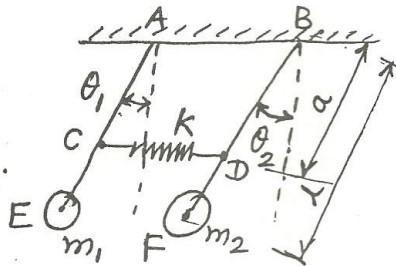
1. (a) Determine the frequency of the system shown in figure.

10



if $K_1 = K_3 = 40 \text{ N/m}$
 $K_2 = 60 \text{ N/m}$
 $m_1 = m_2 = 10 \text{ kg}$
 (both end fixed)

- (b) Use Lagrange's equation to find the equation of motion for the system as shown. 10
 Using θ_1 and θ_2 as generalise coordinate.
 $AE = BF = l, AC = BD = a$



2. (a) 20 N at 30 cm, 30 N at 60 cm and 10 N at 100 cm from the fixed end are the loading on a cantilever. The diflection under 30 N due to all loads is 2 mm. What would be the natural frequency of transverse vibration if 20 N is added at 80 cm from fixed end.

The deflection at a section 'i' due to unit load at section 'j' is given by —

$$u_{ij} = u_{ji} = \frac{s_i^2 (3s_j - s_i)}{\text{const of cantilever}}$$

for $s_i \neq s_j$, where 's' is the distance of the section from the fixed end.

- (b) What is basic principle used in Holzer's method ?

5

3. (a) Prove that for finding the natural frequency of a spring mass system, the mass of the spring can be taken in to account by adding one third of its mass to the main mass. 10
- (b) A vertical helical spring of Length 'L' and stiffness 'K' has both ends securely fixed. A mass 'm' is attached to the spring at a distance 'y' from the one end. Determine the natural frequency of small longitudinal vibration and show that the frequency is minimum when $y = 0.5 L$. 10
4. (a) In a single degree viscously damped vibrating system, the suspended mass 20 kg makes 50 oscillations in 30 sec. The amplitude of vibration decreases to one fourth of its initial value after 4 oscillations. Determine :— (i) stiffness of the spring (ii) logarithmic decrement (iii) damping coefficient. (c) 10
- (b) Prove that the loss of amplitude per cycle = $\frac{4F}{K}$ in the case of coulomb damping. 6
Where F = Friction force
K = Spring stiffness.
- (c) State the difference between coulomb damping and viscous damping. 4
5. (a) A machine 100 kg mass has a 20 kg rotor with 0.5 mm eccentricity. The mounting springs have $K = 85 \times 10^3 \text{ N/m}$. $\xi = 0.02$ (damping ratio). The operating speed of machine is 600 rpm and the unit is constrained to move vertically. Find — (i) Amplitude of machine (ii) Force transmitted to the support. 10
- (b) A vehicle has mass of 1200 kg. The suspension system has a spring constant of 400 kN/m and damping ratio of 0.5. If the vehicle speed is 100 km/hr. determine the displacement amplitude of the vehicle. The road surface varies sinusoidally with an amplitude of 0.05 m. and a wavelength of 6m. 10
6. (a) Two identical rotors are attached to the two ends of a stepped shaft. Each rotor mass 450 kg and has radius of gyration of 0.38 m. The diameter of shaft is 750 mm for the first 2.5 m length, 100 mm diameter for next 1.0 m length and for remaining length 87.5 mm in diameter. The total length of the shaft is 5 m. Find the frequency of free torsional vibration of the system and position of the node from either masses. Assume modulus of rigidity $G = 80 \times 10^9 \text{ N/m}^2$. 12
- (b) How is the critical speed of shaft determined? 4
- (c) Explain jump phenomenon of cam. 4
7. (a) Explain partial primary balancing of reciprocating mass. 5
- (b) Discuss the balancing of V-Engine as compared to In line engine. 5
- (c) Investigate the state of primary and secondary balancing of four stroke-cycle, four cylinder engine with a firing order I – II – III – IV. What will be the change in this state when the firing order is altered to I – II – IV – III? 10