(3 Hours) Total Marks: 80

Instructions:

i. Question No.1 is compulsory
ii. Attempt any 3 out of the remaining questions
iii. Use your judgement for unspecified data, if any but justify the assumption.
iv. Numbers to the right indicate marks.

Q1. Attempt any four of the following sub questions: (20)

a. Explain Dunkerley's method and Rayleigh's Method to calculate the frequency of transverse vibration of shaft carrying number of point loads. (5)

b. Explain with suitable example how condition monitoring can be used to avoid catastrophic failures. (5)

c. Show that the inertia effect of a heavy spring under absolute deformation is accounted by transferring 1/3rd of its mass at the free end. (5)

d. What are the steps involved in vibration analysis? Explain with suitable example. (5)

e. The block of 10kg resting on an inclined plane, is attached on one of its end to a spring of 10KN/m as shown in Figure 1. The inclination of the plane with respect to the horizontal is 25 degrees. The mass is displaced 25 mm and released. It is observed that the amplitude decreases 1.2 mm in each cycle. What is the coefficient of friction between the block and surface? (5)

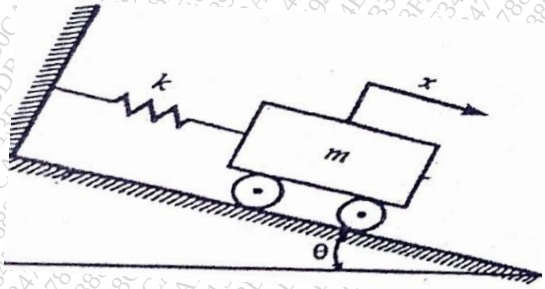

Figure 1

Q2.a A machine weighs 15 kg and is supported on springs and dashpot. The total stiffness of the spring is 10 N/mm and damping coefficient is 0.2 N-s/mm .The system is initially at rest, a velocity of 100 mm/sec is imparted to the mass. Determine : (15)

i) The displacement and velocity of mass as a function of time.

ii) the displacement and velocity of the mass after 0.5 sec

Now if an excitation force of 24sin15t is applied to the mass find the steady state response of the system.

Q2.b Determine the equivalent stiffness and equivalent inertia for the system shown in Figure 2. (5)

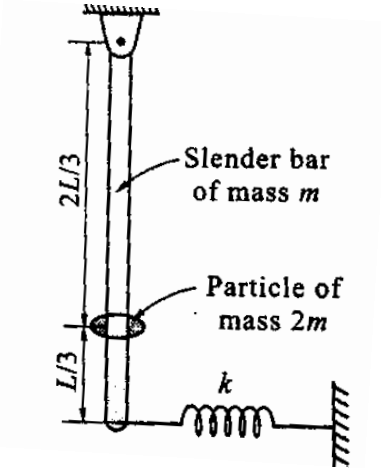

Figure.2

Q3.a Derive the equations of motion using Lagrange's method for the system shown in Figure 3 below. (8)

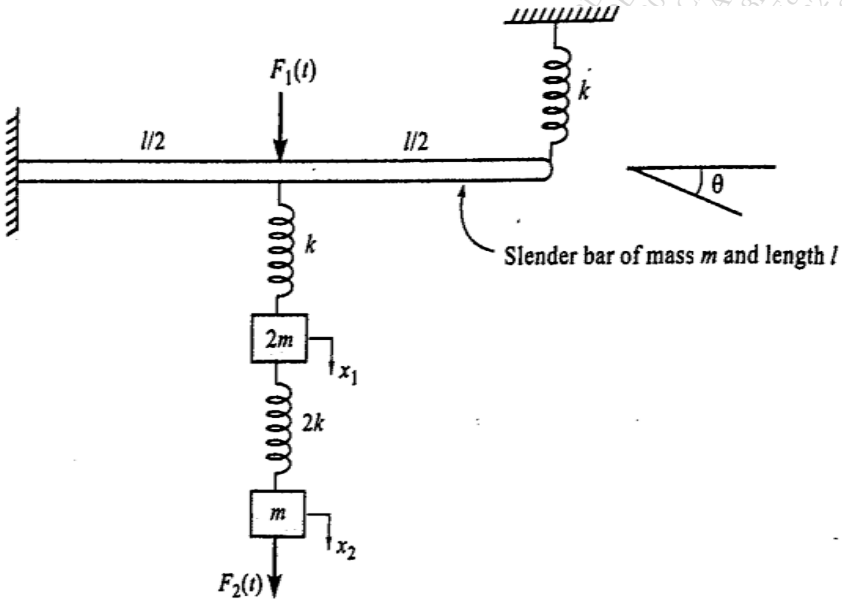

Figure 3

Q3.b A vertical steel shaft 15mm diameter is held in long bearings 1m apart and carries a disc of mass 15kg at its centre. The eccentricity of disc mass is 0.30mm .The modulus of elasticity of the disc material is 200GPa and permissible stress is 70Mpa. Neglect the mass of the shaft and determine the critical speed of the shaft. Also find the unsafe range of the speed of the shaft. (8)

Q3.c Explain the terms : Logarithmic decrement, Magnification factor. (4)

Q4.a 20N at 30Cm, 30N at 60cm and 10N at 100cm from fixed end are the loading on a cantilever. The deflection under 30N due to all loads is 2mm. What would be the natural frequency of transverse vibration if 20N is added at 80cm from fixed end? The deflection at a section i due to unit load at section j is given by (15)

$$u_{ij} = u_{ji} = \frac{s_i^2 \times \left(3s_j - s_i\right)}{\text{Constant of cantilever}} \quad \text{for } s_i < s_j$$

Q4.b A block of circular section having a diameter d and mass m floats vertically in a liquid of mass density ρ. A small displacement is given vertically to the mass in downward direction and released. Find the time period of oscillations of the mass. (5)

Q5.a. The piston of 45^0 Twin V-engine has strokes 125mm. The connecting rods driving a common crank has a length of 200mm. The mass of the reciprocating parts per cylinder is 1.2kg and the speed of the crank shaft is 2400 rpm. Determine the maximum and minimum magnitude of primary and secondary forces. (10)

Q5.b A spring mass damper system, having undamped natural frequency of 100Hz and a damping constant 20N-s/m, is used as an accelerometer to measure the vibration of a machine operating at a speed of 3000 rpm. If the actual acceleration is $10m/s^2$ and the recorded acceleration is $9m/s^2$. Determine the mass and spring constant of the accelerometer. (10)

Q6.a Explain why only a part of the unbalance force in reciprocating force is balanced by rotating mass. Derive resultant unbalance primary force if C% balancing is achieved. (6)

Q6.b A machine component of mass 2.5kg vibrates in a viscous medium. Determine the damping coefficient when the dynamic excitation force of 25N results in a resonant amplitude of 20mm with a period of 0.1sec. if excitation frequency is 8Hz and if damper is removed what will be the amplitude of forced vibration (6)

Q6.c A V-tube of constant cross sectional area is filled with a liquid of total column length L as shown in Figure 4 below. If both the arms are open to atmosphere, determine the natural frequency of oscillation of the liquid column. (8)

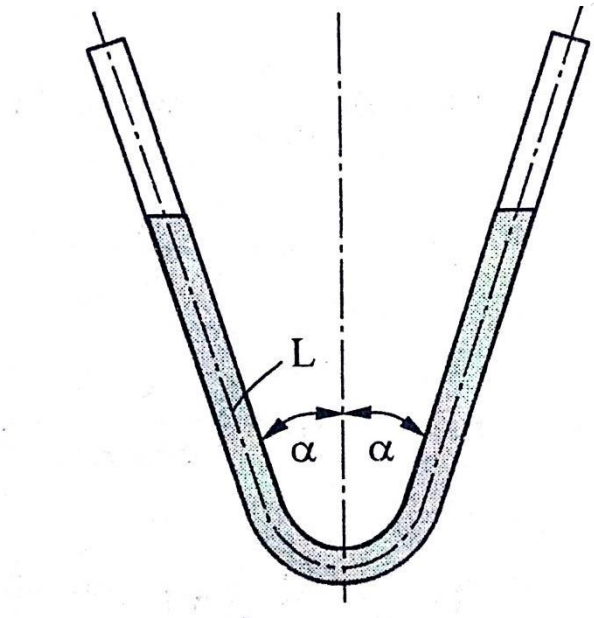

Figure.4

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