T.E. (SEM.-VI) (CBSGS) (MECHANICAL ENGG.) 20th May. 2016
MECHANICAL VIBRATIONS 3.00 pm to 6.00 pm

Mechanical/Automobile

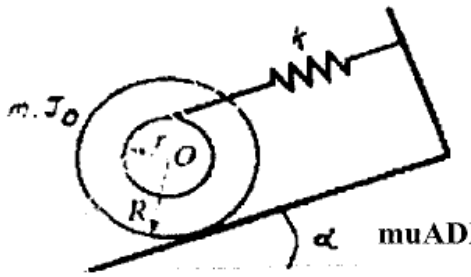
QP Code : 601202

(REVISED COURSE)
(3 Hours) **[Total Marks : 80**

N.B.: (1) Question No.1 is compulsory.
(2) Answer **any three** questions from remaining questions.
(3) Assume suitable data if required. **muADDA.com**
(4) Figures to the right indicate full marks.

1. Attempt **any 4** of the following.
   (a) Briefly explain the steps involved in vibration analysis. **5**
   (b) Compare Viscous and Coulomb dampings. Mention at least 5 points of difference. **5**
   (c) Draw Displacement vs. Time plots for Overdamped, Critically-damped, Underdamped and Undamped cases, all superimposed to a common scale. Comment on the nature of time period of oscillations for increasing values of damping. **5**
   (d) Explain the meaning of Vibration isolation and Transmissibility. List at least 4 vibration isolation materials. **5**
   (e) Compare Vibrometer and Accelerometer on the basis of the following: parameters of measurement, mass of device, natural frequency of device, practical applicability and error estimation. **5**
   (f) Explain why an unbalanced rotating mass on a shaft cannot be balanced completely by using a single balancing mass in a different transverse plane. What is the minimum number of balancing masses required if they are to be attached in different transverse planes, so that the system is completely balanced? **5**

2. (a) Figure below shows a mass consisting of concentric attached cylinders. Derive the natural frequency of undamped free vibrations. **10**



   (b) One of the solution forms for free underdamped 1 d.o.f. vibration systems is given as: $x(t) = Ae^{-\xi\omega_n t}\sin(\omega_d t + \phi)$ where displacement amplitude A and phase angle ϕ are unknown constants. Given initial disturbances in the form of displacement x_0 and velocity v_0, derive the expressions for A and ϕ. **5**

[TURN OVER

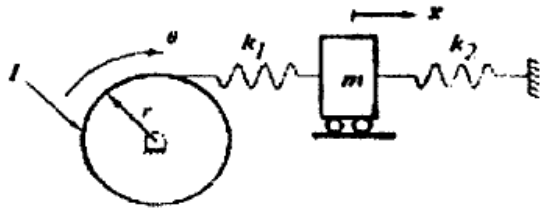
(c) Define whirling speed. Derive the equation for the critical speed of a light shaft with a single disc without damping. **5**

3. (a) Draw a plot of Magnification Factor versus Frequency Ratio curves for various Damping Factor values. **5**
Write the expression consisting of the three parameters. State the conclusions that may be drawn from the plot.

(b) 40 N at 20 cm, 30 N at 40 cm and 20 N at 60 cm from the fixed end are the loading on a cantilever. The deflection under 20 N due to all the loads is 5 mm. Find the natural frequency of the system. What would be the new frequency if 20 N is added at 20 cm from the fixed end? Also, compare the new frequency obtained using Dunkerley's method. **15**
Note: The deflection at section i due to unit load at section j is given by-

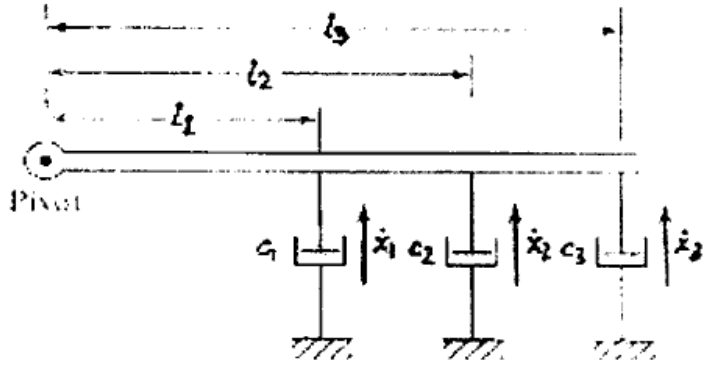
$$U_{ij} = \frac{S_i^{\,2}(3S_j - S_i)}{\text{Constant}} \text{ for } S_i < S_j,\ U_{ij} = U_{ji}$$

4. (a) Using Lagrange's method, derive the equations of motion for the following system. **10**



(b) An air-conditioner weighs 200 kg. and is driven by a motor at 500 r.p.m. What is the required static deflection of an undamped isolator to achieve 80% isolation? **10**

5. (a) Find a single equivalent damping constant for the following cases: **10**
(i) when three dampers are parallel (ii) when three dampers are in series (iii) when three dampers are connected to a rigid bar (as shown in figure below) and the equivalent damper is at site c_1.



(b) A vibrometer having a natural frequency of 4 rad/s and damping ratio of 0.2 is attached to a structure that performs a harmonic motion. If the difference between the maximum and minimum recorded values is 8 mm, find the amplitude of motion of the vibrating structure when its frequency is 40 rad/s. **10**

6. (a) A 10-kg mass is connected to a spring of stiffness 3,000 N/m and is released after giving an initial displacement of 100 mm. Assuming that the mass moves on a horizontal dry surface, determine the position at which the mass comes to rest. Assume the coefficient of friction between the mass and the surface to be 0.12. **10**

(b) Investigate the state of primary and secondary balancing of four stroke cycle, four cylinder engine with a firing order I-II-III-IV. **10**
