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

Mechanical/Automobile

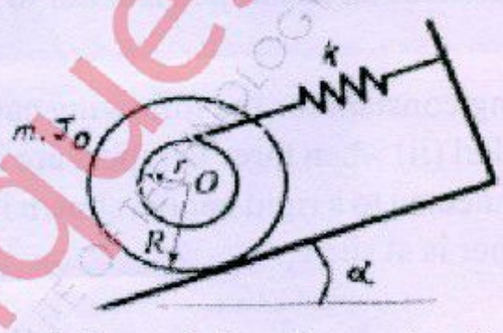
QP Code : 601202

(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.
(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**

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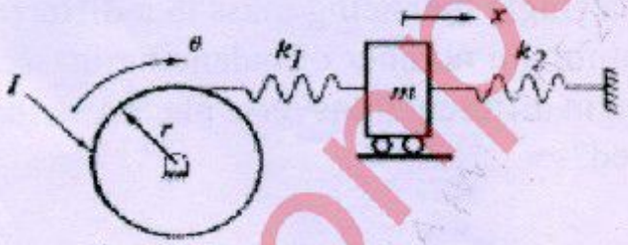
(c) Define whirling speed. Derive the equation for the critical speed of a light shaft with a single disc without damping. 5

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-

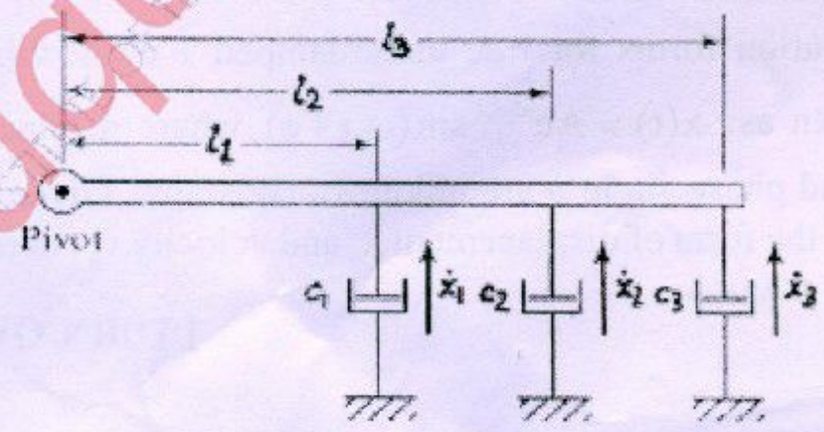
$$U_{ij} = \frac{S_i^{\,2}(3S_j - S_i)}{\text{Constant}} \text{ for } S_i < S_j,\ U_{ij} = U_{ji}$$

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
