Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME- SEMESTER II– EXAMINATION – SUMMER 2015

Subject Code: 2720817 **Date: 01/06/2015**

Subject Name: NOISE AND VIBRATIONS ANALYSIS

Time: 2:30 PM – 5:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** A portion of an automobile suspension system consists of an elastic spring and a viscous damper. If the spring is chosen such that k/m = 40 sec^{-2}, determine the minimum ratio C/m so that any oscillations that occur will decay by a factor of 95% within 1 cycle. If system is initially the system is at rest, determine the maximum vertical displacement of the system when it is impacted, imparting an initial vertical velocity of 0.5 m/sec. **07**

(b) Use Lagrangeôs equations to derive the equations of motion for the system of Fig. 1 using x_1, the displacement of the mass centre of the cart and x_2, the absolute displacement of the mass centre of the disk as the chosen generalized coordinates. Assume the disk rolls without slip. **07**

Q.2 **(a)** A damped springï mass system with values of C =100 kg/s, m=100 kg, and k = 910 N/m, is subject to a force of 10 cos (3t) N. The system is also subject to initial conditions: x_0 =1 mm and v_0 =20 mm/s. Compute the total response, x(t), of the system. **07**

(b) A machine weighing 2000 N rests on a support as illustrated in Fig 2. The support deflects about 50 mm as a result of the weight of the machine. The floor under the support is somewhat flexible and moves, because of the motion of a nearby machine, harmonically near resonance (r =1) with an amplitude of 2 mm. Model the floor as base motion, and assume a damping ratio of 0.01, and calculate the transmitted force and the amplitude of the transmitted displacement. **07**

OR

(b) Consider the following system and determine if the driving frequency will cause the system to experience resonance. If so, which mode experiences resonance? **07**

$$\begin{bmatrix} 4 & 0 \\ 0 & 9 \end{bmatrix} \ddot{x} + \begin{bmatrix} 30 & -5 \\ -5 & 5 \end{bmatrix} x(t) = \begin{bmatrix} 1 \\ 0 \end{bmatrix} \sin(2.757\,t)$$

Q.3 **(a)** Consider the system of Fig. 3. Write the dynamic equations in matrix form, calculate, its eigenvalues and hence determine the natural frequencies of the system (use m_1 =1 kg, m_2 =4 kg, k_1 = k_3 = 10 N/m, and k_2 = 2 N/m). **07**

(b) Derive the equations of motion of the system of Fig. 4. using the Lagrange equation. **07**

OR

Q.3 **(a)** A two-degree-of-freedom model is used for a vehicle that allows for bounce and pitch motion. This model can be determined from the schematic of Fig. 5. Determine the equations of motion and natural frequencies. Take radius of gyration of vehicle as 0.8 m, mass as 4000 kg, $C_1 = C_2 = 2000$ N.s/m, $k_1 = k_2 = 20{,}000$ N/m, $l_1 = 0.9$ m, $l_2 = 1.2$ m. Impulse moment applied to d(t) of 10^3 Nm. **07**

(b) During its operation, a punch press is subject to impulses of magnitude 5 N.s at t = 0 and at t=1.5sec. The mass of the press is 10 kg, and it is mounted on an elastic pad witha stiffness of 2 x10^4 N/m and damping ratio of 0.1. Determine the response of the press. **07**

Q.4 **(a)** A machine of mass 150 kg with a rotating unbalance of 0.5 kg.m is paced at the mid-span of a 2-m-long simply supported beam. The machine operates at a speed of 1200 rpm. The beam has an elastic modulus of 210x10^9 N/m^2 and a moment of inertia of 2.1x10-^{6} m^4. **07**

(a) What is the steady-state amplitude of the primary system without an absorber?

(b) Design the dynamic vibration absorber of minimum mass such that, when attached to the mid-span of the beam, the vibrations of the beam will cease and the steady-state amplitude of the absorber will be less than 20 mm.

(c) What are the systemôs natural frequencies when the absorber is in place?

(b) Use Lagrangeôs equations to derive the differential equations governing the motion of the system shown Fig. 6, for x_1, x_2, and x_3 as generalized coordinates. **07**

OR

Q.4 **(a)** Derive the equation of transverse vibrations of a beam using Euler-Bernoulli beam theory. **07**

(b) Derive the equation of transverse vibrations of a beam using Timoshenko beam theory. **07**

Q.5 **(a)** A radial saw base has a mass of 73.16 kg and is driven harmonically by a motor that turns the sawôs blade as illustrated in Fig. 7. The motor runs at constant speed and produces a 13-N force at 180 cycles/min because of a small unbalance in the motor. The resulting forced vibration was not detected until after the saw had been manufactured. The manufacturer wants a vibration absorber designed to drive the table oscillation to zero simply by retrofitting an absorber onto the base. Design the absorber assuming that the effective stiffness provided by the table legs is 2600 N/m. In addition, the absorber must fit inside the table base and hence has a maximum deflection of 2 mm. Calculate the bandwidth of operation of the absorber designed. Assume that the useful range of an absorber is defined such that $|Xk/F_o| < 1$. **07**

(b) For the following components, enlist typical faults and defects that can be detected with noise and vibration analysis: Gears, Rolling element Bearings, Rotors and Shafts. **07**

OR

Q.5 **(a)** With the help of neat sketch, explain working principle of a typical sound level meter. **07**

(b) Enlist various techniques for active and passive control of vibrations and explain any one in detail. **07**

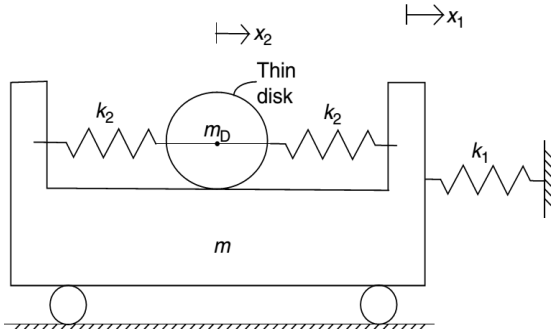

Fig. 1

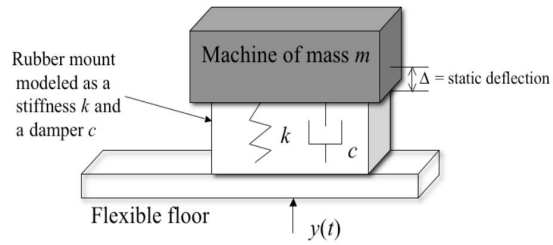

Fig. 2

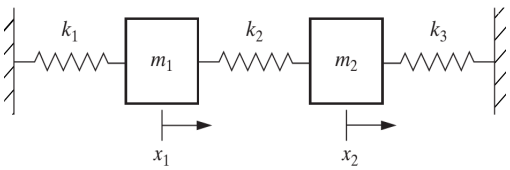

Fig. 3

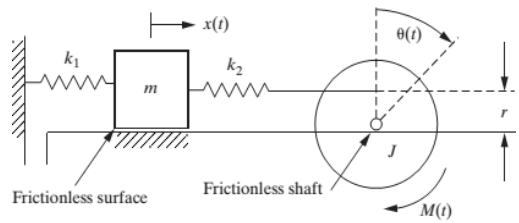

Fig. 4

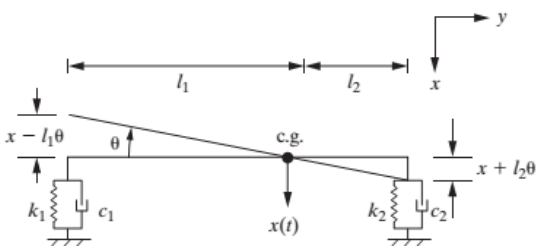

Fig. 5

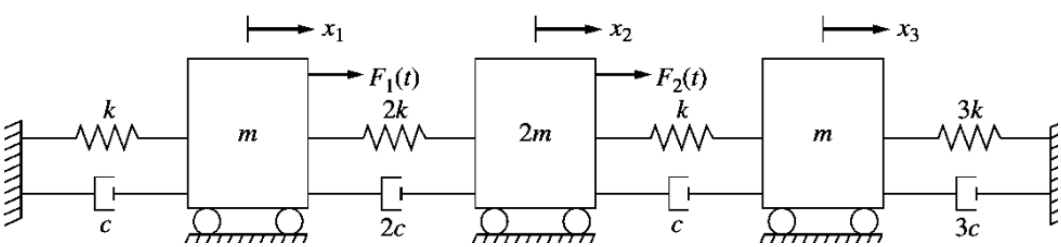

Fig. 6

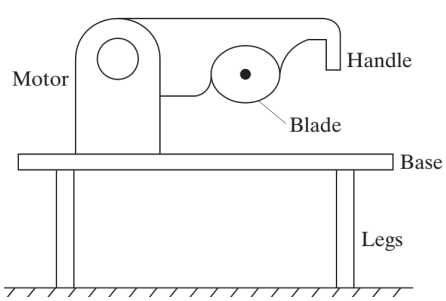

Fig. 7

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