Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – III • EXAMINATION – WINTER • 2014

Subject code: 734703 Date: 27-11-2014

Subject Name: Dynamics of Machines

Time: 02:30 pm - 05:00 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)** Derive the equation of motion and solution for longitudinal vibration of bar or rod. **07**

(b) Find the natural frequencies and free vibration solution of a bar fixed at one end and free at the other. **07**

Q:2 **(a)** Explain the phase plane method to obtain response of single degree of freedom system due to sudden disturbance. **07**

(b) What do you understand by equivalent stiffness of the spring system? Determine the equivalent stiffness of the springs for following cases: **01**

1. Spring inclined to the direction of the motion. **01**
2. Parallel springs. **01**
3. Series springs. **01**
4. Geared torsional systems. **03**

OR

(b) A mass m is resting on a heavy spring stiffness K. the spring mass is m_s and in mean equilibrium position, it occupies a length l. Determine the natural frequency considering the mass of the spring also. **07**

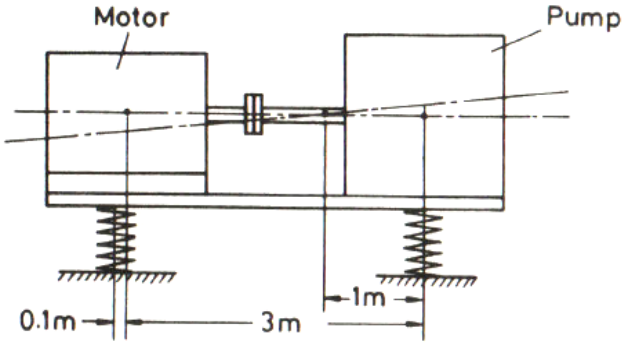
Q:3 Explain different damping model used in vibratory systems. Derive all necessary equations for each damping model. **14**

OR

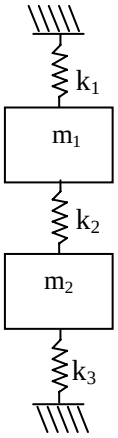
Q:3 **(a)** The static deflection of an automobile on its springs is 10 cm. Find the critical speed when the automobile is travelling on a road, which can be approximated by a sine wave of amplitude 8 cm and wavelength 15 m. Assume the damping to be given by $\xi = 0.05$. Also determine the amplitude of vibration at 75kmph. **07**

(b) A rotating machine of mass 600 kg, operating at a constant speed of 1500 rpm, has an unbalanced of 0.12 kgm. If the damping in the isolators is given by damping ratio of $\xi = 0.08$, determine the stiffness of the isolators so that the transmissibility at the operating speed is less than or equal to 0.15. Also determine the magnitude of the force transmitted. **07**

Q:4 **(a)** Following figure shows schematically an induction motor driving a reciprocating pump. The mass of the motor and pump are 1000 kg and 3000 kg respectively. Their mass moment of inertia about their respective CG's are 60 kgm^2 and 200 kgm^2 respectively. The motor and the compressor are mounted on a rigid base. The supporting structure is best represented by two springs each having constant of 2 MN/m. The stiffness in the lateral direction can be assumed to be large. Determine the two natural frequencies and corresponding frequency ratios. **07**



(b) Find the natural frequencies and mode shape for the following two degree of freedom system. **07**



OR

Q:4 **(a)** Explain the Rayleigh's method to find approximate value of fundamental natural frequency of a discrete system. **07**

(b) Explain the different types of instruments those are used in conducting the vibration tests. **07**

Q:5 **(a)** Calculate the solution of given two degree of freedom system by Modal analysis **10**

$$M = \begin{bmatrix} 9 & 0 \\ 0 & 1 \end{bmatrix}, \quad K = \begin{bmatrix} 27 & -3 \\ -3 & 3 \end{bmatrix}, \quad x(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}, \quad \dot{x}(0) = 0$$

(b) Discuss the autocorrelation function and spectral density related to random vibration. **04**

OR

Q:5 **(a)** What do you understand by Modal Analysis of vibratory system? Write various steps of Modal analysis to analyze the motion of undamped vibratory system. **07**

(b) Explain the following terms related to multi degree of freedom system:

1. Closed coupled systems **02**
2. Far coupled systems **02**
3. Orthogonality of mode shapes **03**

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