Seat No.: ________ Enrolment No.______________

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – III • EXAMINATION – WINTER • 2013

Subject code: 734703 **Date: 28-11-2013**

Subject Name: Dynamics of Machines

Time: 10.30 am – 01.00 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 Explain the concept of modal analysis to determine the vibration response of multi degree of freedom system. Determine the vibration response by modal analysis for the following data: **14**

mass $[M]=\begin{bmatrix}55 & 0\\ 0 & 15\end{bmatrix}$, natural frequencies $p_1 = 81.1$ rad/s, $p_2 = 173.52$ rad/s

corresponding modes are $\{U^1\}^T = \{1 \quad -2.845\}, \{U^2\}^T = \{1 \quad 1.289\}$

Excitation Force $\{Q(t)\} = \begin{Bmatrix}68.54\cos 52.36t\\ 0\end{Bmatrix}$

Q:2 **(a)** Derive the Equation of motion for the lateral vibration of the beams. **07**

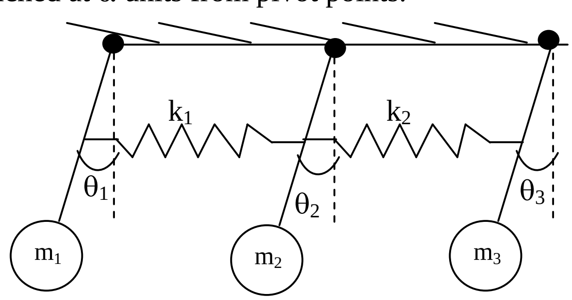
(b) Find the natural frequency of axial vibration for a bar with one end fixed and a mass M attached at the other end. Mass density of bar is ρ, cross section area is A, Young's modulus is E, length of bar is l. **07**

OR

(b) Derive the equations of motion for the transverse vibration of a string. **07**

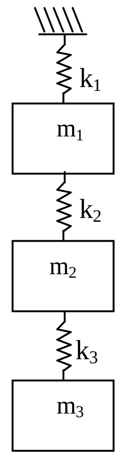
Q:3 **(a)** Estimate the fundamental natural frequency using Dunkerley's method for a simply supported beam having length l, carrying three identical equally spaced masses ($m_1 = m_2 = m_3 = m$, each placed at distance $l/4$). **07**

(b) The following figure shows free body diagram of machine part consisting three levers, connected by light weight linkages. Obtain the equation of motion using Lagrange method. Assume the length of levers is l and the springs are attached at α units from pivot points. **07**

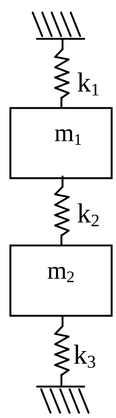


OR

Q:3 **(a)** Estimate the fundamental frequency of vibration of the system shown in the following figure. Assume that $m_1 = m_2 = m_3 = m$, $k_1 = k_2 = k_3 = k$ and mode shape is $\vec{X} = \begin{Bmatrix} 1 \\ 2 \\ 3 \end{Bmatrix}$. Use Rayleigh's Quotient. **07**



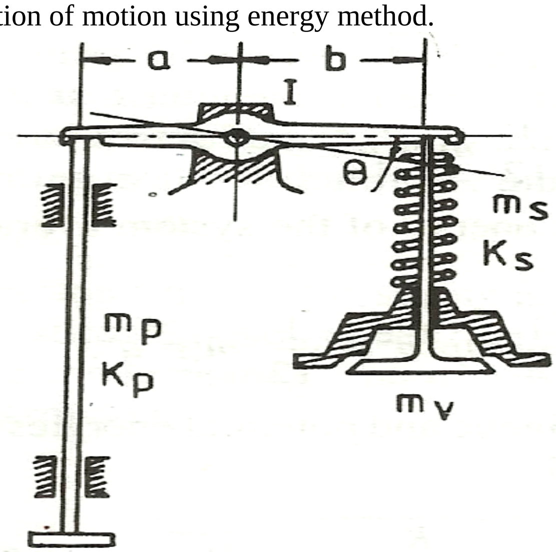
(b) Find the natural frequency and mode shape for the following two degree of freedom system. Assume that $k_1 = k_3 = k$; $k_2 = 2k$ and $m_1 = m_2 = m$. **07**



Q:4 **(a)** Derive the equations for the viscous damping factor in following cases: **07**

1. Viscous damper based friction in a pipe (Linear motion)
2. Viscous damper based on two coaxial cylinder (Angular motion)

(b) Draw the vibration model for the following valve gear mechanism and derive the equation of motion using energy method. **07**

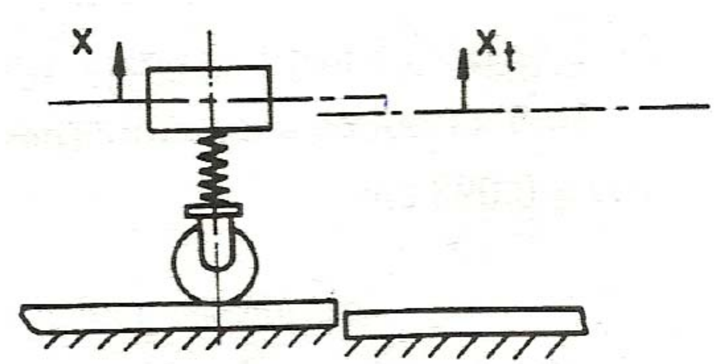


OR

Q:4 **(a)** Derive the equations for the stiffness in following cases: **07**

1. Rubber mounts for linear stiffness
2. Rubber mounts for torsional stiffness

(b) An overhead travelling crane is shown in the following figure. For simplicity the crane is modelled as a single degree of freedom system with mass 1000 kg and stiffness 10^6 N/m. A section of the rails, 6 m long of the crane travel, is improperly laid as a result of which this section is 0.5 cm below the rest of the crane travel. If the crane is travelling at a uniform speed of 3 m/s. Assume the damping in the system is given by c = 632.5 Ns/m. Determine the response of the crane on depressed rail and after that on the level rail. **07**



Q:5 **(a)** A reciprocating pump 200 kg is driven through a belt by an electric motor at 3000 rpm. The pump is mounted on isolators with total stiffness 5 MN/m and damping 3.125 kNs/m. Determine the vibratory amplitude of the pump at the running speed due to fundamental harmonic force of excitation 1 kN. Also determine the maximum vibratory amplitude when pump is switched on and the motor speed passes through resonant condition. **07**

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

OR

Q:5 **(a)** Explain the undamped vibration absorber with all necessary equations. **07**

(b)

1. Discuss Correlation and Power spectral density terms related to random vibrations. **03**
2. Explain the Campbell diagram and its applications. **04**

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