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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

First Semester M.Tech. Degree Examination, December 2015

CIVIL ENGINEERING

(STRUCTURAL ENGINEERING)

01 CE 6105 – Structural Dynamics

Time : 3 hrs. **Max. marks : 60**

PART A

(Answer any **TWO** questions)

1. a. What are the various components of a vibratory system and develop the equation of motion for a single degree of freedom system. (5)

   b. Determine the natural frequency and natural period of vibration of a portal frame with one end fixed and other end hinged having a mass of 50 kN lumped at the floor level. $E = 2\times10^5$ N/mm^2, $I = 15\times10^7$mm^4. Storey height = 3.5 m (4)

2. a. A mass of 100 kg is subjected to vibration excited by a harmonic force of amplitude 80 N at 3 Hz. If the stiffness of the system is 30 kN/m and damping coefficient is 1000 Nsec/m, write down the differential equation of motion and find out the amplitude of displacement and phase angle. (6)

   b. Explain any one method for the evaluation of damping in a structural system. (3)

3. a. Derive the expression for the response of an undamped system subjected to a blast load varying in the form of a ramp using Duhamel integral. Hence, evaluate the deflection of the tower at 0.06 sec., if the mass and stiffness of the tower are 400 kN and 40 kN/mm respectively. The maximum value of load is 300 kN at 0.1 sec. (6)

   b. Explain how the response of a system subjected to a periodic loading can be determined. (3)

PART B

(Answer any **TWO** questions)

4. a. Explain the role of tuned mass dampers in vibration control. (3)

   b. Differentiate between lumped and consistent mass matrices for a structural system. (3)

c. Determine the mass-orthonormalised modeshape vectors for the following data.

$$[M]=\begin{bmatrix}12000 & 0 & 0\\ 0 & 18000 & 0\\ 0 & 0 & 18000\end{bmatrix}\text{kg} \quad \text{and}$$

$$\text{modal matrix, } \Phi=\begin{bmatrix}1.000 & 1.000 & 1.000\\ 0.759 & -0.805 & -2.455\\ 0.336 & -1.158 & 2.571\end{bmatrix}$$

(3)

5. a. Describe the mode superposition method for the forced vibration analysis of a multi- degree of freedom system. (6)

b. Explain the concept of shear building model for the analysis of a multi-storeyed building frame. (3)

6. A three storeyed building frame of storey height 3.2 m and beam span 8 m is loaded on the top beam with a UDL of 25 kN/m and the other beams carry a UDL of 35 kN/m. If the columns have a uniform moment of inertia of $5 \times 10^7\ mm^4$ and if $E = 2 \times 10^5\ N/mm^2$, compute the frequencies and mode shapes of the frame using Stodola's method. (9)

PART C

(Answer any **TWO** questions)

7. a. Derive the solution for the differential equation of undamped free flexural vibration of an one dimensional distributed mass system. (6)

b. Plot the first three possible modeshapes of a beam with distributed mass under the following support conditions: (i). Both ends hinged (ii). Both ends fixed (iii). One end fixed and the other end free (6)

8. a. Derive the equation of motion and the solution for the axial vibration of a prismatic member. (5)

b. Derive the differential equation of motion for the flexural vibration of beams including shear deformation and rotary inertia. (7)

9. a. Derive the equations of motion for a two degree of freedom system using Lagrange's equation. (4)

b. Determine the amplitude of the response at quarter point from the left support of a simply supported beam due to the first three modes, neglecting damping, for the beam particulars given below. $m = 200 Nsec^2/cm$ per cm of span, $EI = 500 Nmm^2$, $L = 320$ cm, $P(t) = 1000 \sin 500t$ N applied at midspan. (8)