USN 1CR14CV023

10CV767

Seventh Semester B.E. Degree Examination, Dec.2017/Jan.2018
Structural Dynamics

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Explain critical damping, over damping and under damping pertaining to single degree of freedom system. **(05 Marks)**

b. Differentiate between: (i) Forced vibrations and free vibrations.
(ii) Random excitation and harmonic excitation. **(05 Marks)**

c. A machine of 80 kg mass is mounted on a spring whose total stiffness is 50 kN/m and total damping is 10 kN/m. Find the motion U(f) for initial displacement of 20 mm and initial velocity of 100 mm/sec. **(10 Marks)**

2 a. Explain the logarithmic damping and derive the expression for the same. **(05 Marks)**

b. A SDOF system consists of mass 20 kg, stiffness of the spring 2200 N/m and a dashpot with a damping coefficient of 60 N-S/m is subjected to a harmonic excitation of $F = 200 \sin 5t$. Write the complete solution of the equation of motion. **(15 Marks)**

3 a. Explain the dependence of transmissibility on frequency ratio and damping ratio with a qualitative graph relating to all the above mentioned three quantities. What is the range of frequency ratio for which isolation is effective? **(08 Marks)**

b. An engine weighing 1000 N including reciprocating parts is mounted on springs. The weights of the reciprocating parts is 22 N and the stroke is 90 mm. The engine speed is 720 rpm. Neglecting damping find the stiffness of the springs, so that the force transmitted to the foundation is 5% of the amplitude force. If under the actual working conditions the damping reduces the amplitude of successive vibration by 25% determine the force transmitted at 720 rpm. **(12 Marks)**

4 a. Derive an expression for Duhamul's integral in respect of response of single degree of freedom system to general dynamic leading. **(10 Marks)**

b. State and prove principle of orthogonality of modes. **(10 Marks)**

PART – B

5 Determine the natural frequencies and mode shapes for the structure as shown in Fig. Q5. Draw the mode shapes. **(20 Marks)**

$I = 5 \times 10^5\ mm^4$

$E = 2.5 \times 10^4\ N/mm^2$

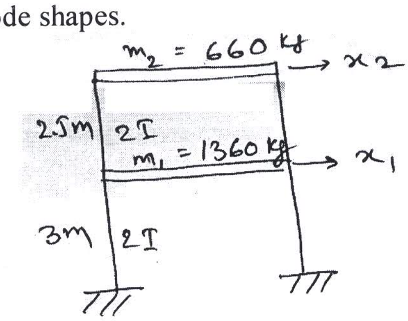
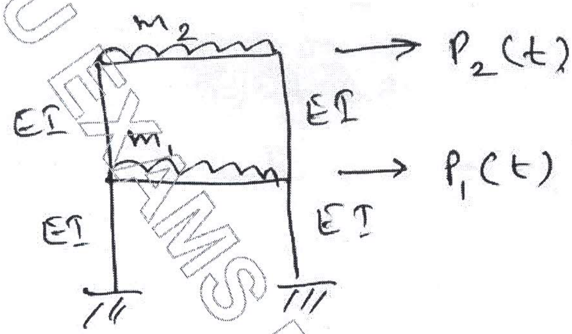


Fig. Q5

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

6 Compute the response due to harmonic loading for the shear frame shown in Fig. Q6. **(20 Marks)**



$EI = 24\times10^6$ N/m^2
$M = 500\times10^3$ NS^2/m
$P_1(t) = 0$
$P_2(t) = 10000 \sin 30t$
$m_1 = 250\times10^3$ kg
$m_2 = 500\times10^3$ kg

Fig. Q6

7 For a three storyed shear building subjected to harmonic loading. Compute the response, given the results of the free vibration analysis. Neglect axial deformation in all structural elements.

Given : Stiffness of floors

$K_1 = K_2 = 160\times10^6$ N/m

$K_3 = 240\times10^6$ N/m

$M_1 = M_2 = M_3 = 20\times10^3$ kg

Natural frequencies are $\omega_1 = 43.87$ rad/s, $\omega_2 = 120.15$ rad/s, $\omega_3 = 167$ rad/s.

Mode shapes :

$$[\phi_1]=\begin{bmatrix}1.00\\0.76\\0.34\end{bmatrix},\ [\phi_2]=\begin{bmatrix}1.00\\-0.80\\-1.16\end{bmatrix},\ [\phi_3]=\begin{bmatrix}1.00\\-2.43\\2.51\end{bmatrix}.$$ **(20 Marks)**

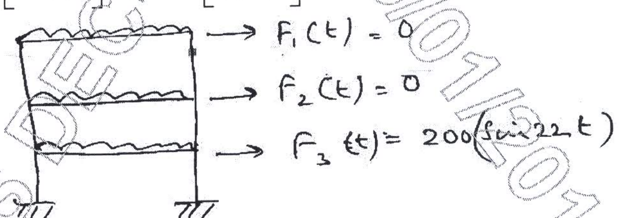


Fig. Q7

8 a. Derive the governing differential equation of motion for a free flexural vibration of beam. **(10 Marks)**

b. Explain the lumped mass and consistent mass formulation for vibration of beam. **(10 Marks)**

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