CBCS SCHEME

USN

15CV744

Seventh Semester B.E. Degree Examination, Aug./Sept. 2020
Structural Dynamics

Time: 3 hrs. Max. Marks: 80

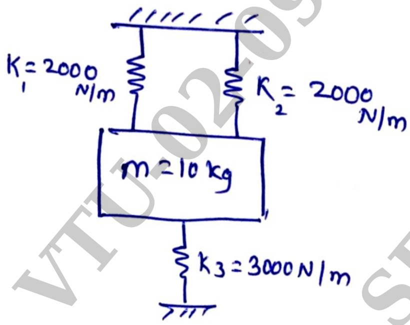
Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

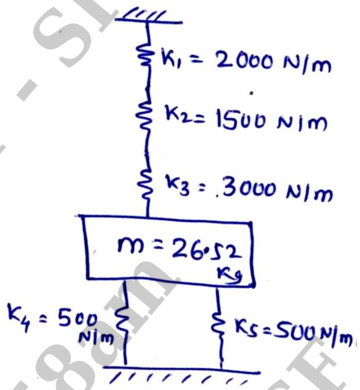
1 a. What are the various sources of dynamic loads in civil engineering practice? **(04 Marks)**

b. Find the natural frequency of the following systems:

i)



ii)



(12 Marks)

OR

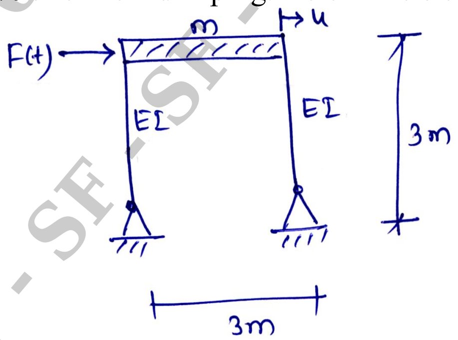
2 a. Explain "Free Vibration" and "Degree of Freedom" of a dynamic system. **(04 Marks)**

b. A platform weighing 7×10^2 kN is supported on four columns. The columns are identical and are clamped at both ends. It has been determined experimentally that a force of 1.75×10^5 N horizontally applied to the platform produces a displacement of 2.54 mm. Damping is 5 percent of critical damping. Determine from the structure the following:

(i) Undamped natural frequency
(ii) Absolute damping coefficient
(iii) Logarithmic decrement
(iv) The number of cycles and time required for the amplitude of motion to be reduced from an initial value of 2.54 mm to 0.254 mm. **(12 Marks)**

Module-2

3 a. The frame is subjected to an exciting force $F(t) = (200 \sin 20t)$N as shown in Fig.Q3(a). Assuming 6% of critical damping. Determine steady state response of vibration.



$E = 2 \times 10^5$ N/mm^2
$I = 3 \times 10^5$ mm^4
m = 50 kg

Fig.Q3(a)

(08 Marks)

b. A machine of weight 80 kN is mounted on a simply supported beam as shown in Fig.Q3(b) produces a harmonic force of magnitude F = 140 kN at frequency ω = 60 rad/s. Neglect the weight of the beam and assume 15% of critical damping. Determine the amplitude of the motion of machine and the force transmitted to support. Take, $E = 2 \times 10^5$ N/mm^2 and $I = 30 \times 10^6$ mm^4.

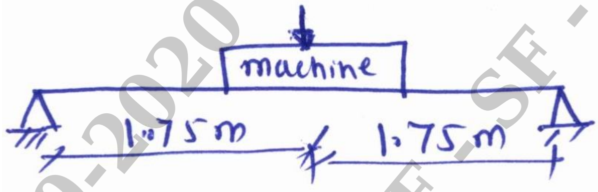


Fig.Q3(b) **(08 Marks)**

OR

4 a. In a forced vibration test under harmonic excitation it was noted that the amplitude of motion at resonance was exactly four times at an excitation frequency 20% higher than resonant frequency. Determine the damping ratio of the system. **(08 Marks)**

b. Determine the response of rectangular pulse force in a undamped SDOF system as shown in Fig.Q4(b).

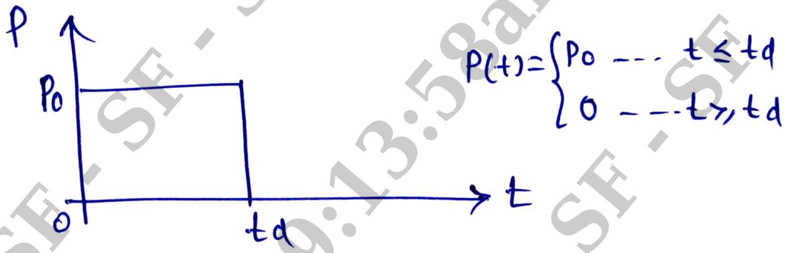


Fig.Q4(b) **(08 Marks)**

Module-3

5 Compute the natural frequency and modes for the shear building shown in Fig.Q5 and prove the orthogonality of modes. Take $EI = 5 \times 10^6$ N-m^2, $m = 500 \times 10^3$ kg, storey height = 3 m, span = 5m.

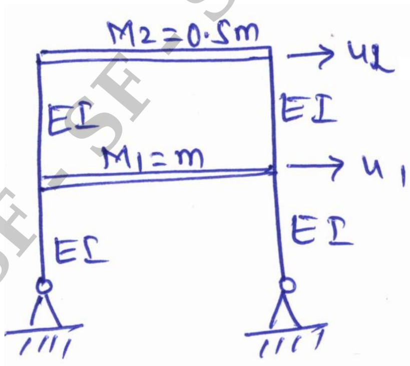


Fig.Q5 **(16 Marks)**

OR

6 For a three storeyed shear building as shown in Fig.Q6 computes the natural frequencies, natural periods and mode shapes. Plot the mode shapes. Neglect axial deformations in all structural elements. Given the mass and stiffness of each floor are mass of floor; $M_1 = 2 \times 10^3$ kg, $M_2 = 1.5 \times 10^3$ kg, $M_3 = 1 \times 10^3$ kg stiffness of floor; $K_1 = 3 \times 10^6$ N/m, $K_2 = K_3 = 4 \times 10^6$ N/m.

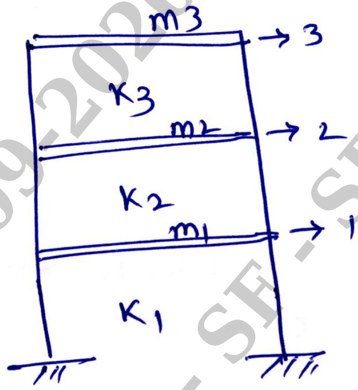


Fig.Q6 **(16 Marks)**

Module-4

7 A three-storeyed shear building subjected to harmonic loading as shown in Fig.Q7. Compute the response, for a given results of free-vibration analysis. Neglect axial deformations in all structural elements. The mass of the floor; $M_1 = M_2 = M_3 = 20 \times 10^3$ kg. The stiffness of floor; $K_1 = K_2 = 160 \times 10^6$ N/m, $K_3 = 240 \times 10^6$ N/m. The natural frequencies are; $\omega_1 = 43.87$ rad/s, $\omega_2 = 120.15$ rad/s, $\omega_3 = 167$ rad/s. The mode shapes; $\phi_1 = \begin{Bmatrix} 1.0 \\ 0.76 \\ 0.34 \end{Bmatrix}$,

$\phi_2 = \begin{Bmatrix} 1.0 \\ -0.80 \\ -1.16 \end{Bmatrix}$, $\phi_3 = \begin{Bmatrix} 1.0 \\ -2.43 \\ 2.51 \end{Bmatrix}$.

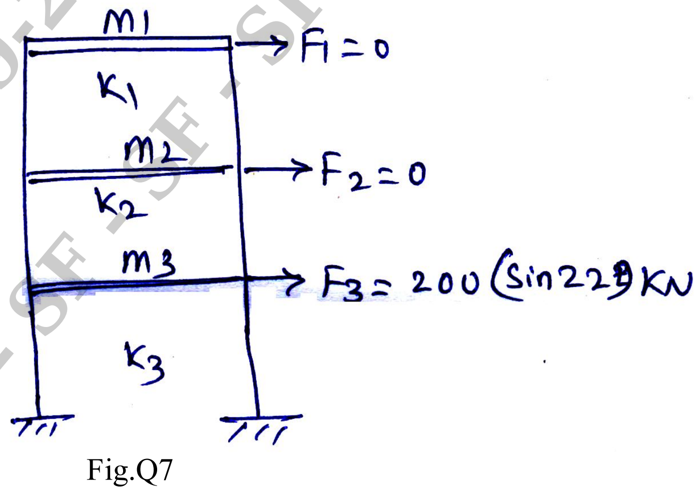


Fig.Q7 **(16 Marks)**

OR

8 Compute the response due to harmonic loading for the shear building as shown in Fig.Q8. The stiffness of floor; $K_1 = 7.5 \times 10^6$ N/m, $K_2 = 15 \times 10^6$ N/m, mass of floor; $m_1 = 85 \times 10^3$ kg, $m_2 = 60 \times 10^3$ kg. The damping matrix is; $[c] = \begin{bmatrix} 175.23 & -75 \\ -75 & 118.25 \end{bmatrix} \times 10^3$ N-s/m. The results of free vibration analysis, the natural frequencies $\omega_1 = 9.17$ rad/s, $\omega_2 = 30.58$ rad/s. The mode shapes, $\phi_1 = \begin{Bmatrix} 0.81 \\ 1.0 \end{Bmatrix}$, $\phi_2 = \begin{Bmatrix} -0.87 \\ 1.0 \end{Bmatrix}$.

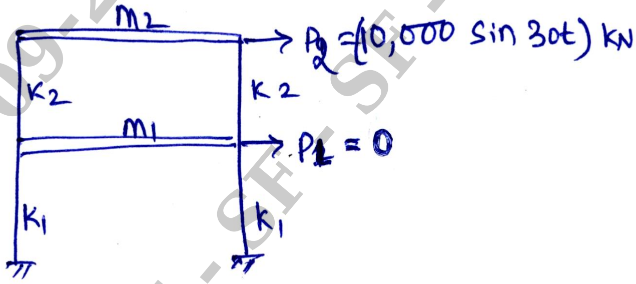


Fig.Q8 **(16 Marks)**

Module-5

9 A simply supported beam with distributed mass system, derive the first three frequencies and plot the mode shapes. **(16 Marks)**

OR

10 A cantilever beam with distributed mass system, derive the first three frequencies and plot the mode shapes. **(16 Marks)**

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