| Reg. No. | | | | | | | | | | |
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# MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

## I SEMESTER M.TECH. (STRUCTURAL ENGINEERING)

## END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: STRUCTURAL DYNAMICS [CIE 5153]

**REVISED CREDIT SYSTEM**

**( / /2016)**

Time: 3 Hours MAX. MARKS: 50

**Instructions to Candidates:**
- Answer **ALL** the questions.
- Missing data may be suitably assumed

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| **1A.** | For the system. shown in Fig. Q1A, formulate the equation of motion using Hamliton's principle. | **5** |
| **1B.** | A system shown in Fig. Q1B is given an initial displacement of Vo = 30 mm and initial velocity of $\overset{0}{V}$ o = 4 m/sec. What will be the displacement and velocity after 1.0 sec, if the damping is 10 % of the critical damping? Take I = $1.5\times10^{-5}$ $m^4$, E = $210\times10^{9} N/m^2$, L = 4m, $K_1$= $6\times10^{5}$N/m and $K_2$= $3\times10^{-5}$N/m | **5** |
| **2A.** | Derive the expression for response for the free vibration of an under damped SDOF system with the following initial boundary conditions<br>i) At t=0 V=$V_o$ and $\overset{0}{V} = \overset{0}{V}_0$ ii) at t=0 V=45mm_and $\overset{0}{V}$ =6mm/sec | **5** |
| **2B.** | A simplified model of a vehicle system is shown in Fig. Q2B. The body of a 340kg vehicle is connected to the wheels through a suspension system that is modeled as a spring of stiffness 5.0 xl $0^5$ N/m parallel with a viscous damper of C = 2500 N-sec/m. The wheels are assumed to be rigid and follow the road contour assumed to be sinusoidal. If the vehicle travels at a constant speed of 40 m/sec what will be the displacement amplitude? | **5** |
| **3A.** | Using simpson's rule for numerical evaluations of Duhamel's integral determine the dynamic response of SDOF system subjected to a blast loading shown in Fig. Q3A. The physical properties are W = 70kN and K=8000kN/m. Take Take $\Delta\tau$ = 0.12 sec | **5** |
| **3B.** | A Triangular pulse of duration $t_1$ seconds (Fig. Q3B) is acting on a SDOF system. Derive expressions for the response at t < $t_1$ and t > $t_1$. Use the initial condition as at t =0, V(t) = 0 and $\overset{0}{V}$ (t) = 0. | **5** |
| **4A.** | For the three storey shear building shown in Fig. Q4A, obtain the natural frequencies and the modes of vibration. Use classical method. Take $m_1$= 1000 kg, $m_2$= 2000 kg, $m_3$= 3000 kg, $K_1$= 400 kN/m, $K_2$= 800 kN/m and $K_3$= 1200 kN/m | **7** |
| **4B.** | Write a note on orthogonality relationship. | **3** |

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| **5A.** | The physical and vibration properties of a structure are given below. Evaluate free vibration response due to initial conditions given. $$M = \begin{pmatrix} 4 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 6 \end{pmatrix} \text{ kg} \qquad K = 700\begin{pmatrix} 2 & -2 & 0 \\ -2 & 4 & -3 \\ 0 & -3 & 7 \end{pmatrix} \text{ N/m}$$ $$\phi = \begin{pmatrix} 1 & 1 & 1 \\ 0.69 & -0.682 & -2.822 \\ 0.341 & -1.041 & 1.866 \end{pmatrix} \qquad \omega = \begin{pmatrix} 10.41 \\ 24.23 \\ 36.7 \end{pmatrix} \text{ rad/sec}$$ $$Y_{t=0} = \begin{pmatrix} 0.015 \\ 0.01 \\ 0.005 \end{pmatrix} \text{ m} \qquad \dot{Y}_{t=0} = \begin{pmatrix} 0 \\ 0.2 \\ 0 \end{pmatrix} \text{ m/sec}$$ | **5** |
| **5B.** | Treating the fixed beam of uniform cross section as continuous systems obtain expression for frequency and vibration shape. | **5** |

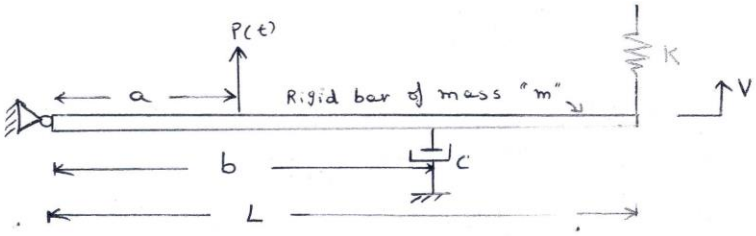


Fig. Q1A

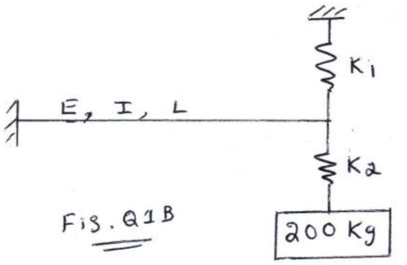


Fig. Q1B

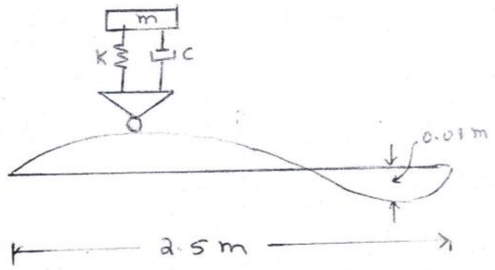


Fig. 2B

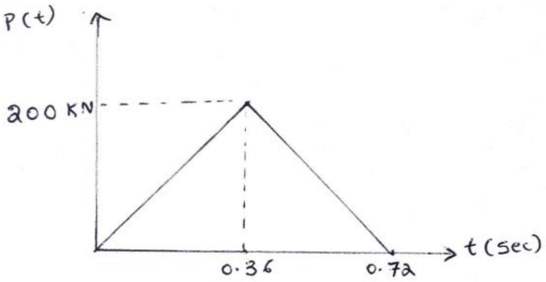


Fig. Q3A

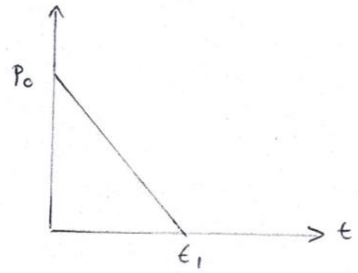


Fig. Q3B

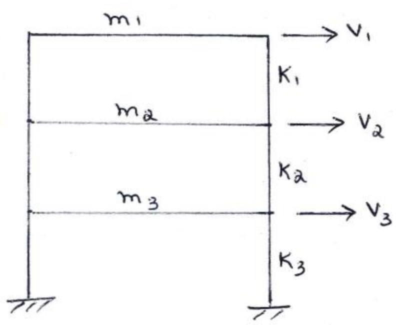


Fig. Q4A