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Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

SECOND SEMESTER M.TECH (STRUCTURAL ENGINEERING)

END SEMESTER EXAMINATIONS, MAY /JUNE 2016

ELECTIVE – III: EARTHQUAKE RESISTANT DESIGN OF STRUCTURES (CIE- 590)

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- *Answer any **FIVE FULL** questions.*
- **Missing data may be suitable assumed.**
- ***Use of IS -1893 – 2002 & IS -1893 – 1984 is permitted***

1A.	Derive the expression for displacement, elastic force vector, base shear and overturning moment of a MDOF system subjected to earthquake ground motion.	**6**
1B.	Determine the earthquake response of a generalized SDOF system of uniform cantilever beam of height 52 m subjected to base displacement of Vg (t) for which velocity response spectrum is shown in figure Q1B. The properties of the system are m (x) = 22000 kg/m, EI (x) = 74×10^9 N-m^2 , $\zeta = 5\%$. $\psi(x) = \dfrac{12x^2L - 5x^3}{3L^3}$ Determine the maximum base shear	**6.5**
2A.	What is the difference between the following? (i) Epicenter and hypocenter (ii) Body waves and Surface waves ?	**2**
2B.	The mass, frequency, mode shapes and response integral of a three storey shear building are shown below. Evaluate the resulting displacements, elastic force vector, maximum shear and overturning moment. Height of each storey is 3.2 m. Use SRSS method. $\omega = \begin{Bmatrix} 12 \\ 26 \\ 40 \end{Bmatrix}$ rad/sec $\quad \Phi = \begin{pmatrix} 1 & 1 & 1 \\ 0.8 & -0.5 & -2.5 \\ 0.4 & -0.9 & 3.0 \end{pmatrix}$ $m = \begin{pmatrix} 3 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & 6 \end{pmatrix} 10^3$ kg $\quad V_n(t) = \begin{pmatrix} 500 \\ 60 \\ 300 \end{pmatrix}$ mm/sec	**10.5**

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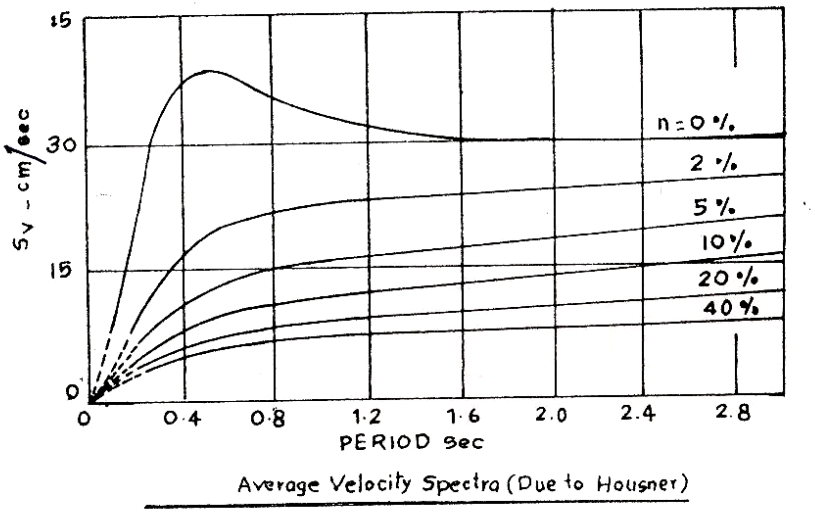
3.	Using Linear acceleration method, determine the response of a structure modeled as a two degree of freedom system. The mass, stiffness, damping properties and forces acting on structure are as shown below. Take $\Delta t = 0.1$ sec. $m = \begin{pmatrix} 5 & 0 \\ 0 & 9 \end{pmatrix} 10^4$ kg $\quad k = \begin{pmatrix} 5 & -5 \\ -5 & 10 \end{pmatrix} 10^6$ N/m $c = \begin{pmatrix} 1.0 & -1.0 \\ -1.0 & 2.0 \end{pmatrix} 10^5$ N sec/m $\quad \begin{pmatrix} P_1(t) \\ P_2(t \end{pmatrix} = \begin{pmatrix} 200 \\ 100 \end{pmatrix}$ kN	**12.5**
4.	A three storey shear building has four transverse and three longitudinal frames. The location and relative stiffness of these frames is shown in Fig. Q4. If the design seismic force in transverse and longitudinal direction is 760 kN, calculate the same for different frames. Assume center of mass at geometric center of the building	**12.5**
5.	An elevated water tank has a capacity of 500 m^3. The tank is circular with an internal diameter of 10 m and height of 6 m. It is supported on a concrete staging consisting of 8 columns located on circumference of a circle of 9 m diameter. The height of staging is 16 m and horizontal bracings are provided at 4 m spacing. The circular columns are 50 cm in diameter. Diagonal steel bracing in the form of 2 cm diameter is provided in all bays. The structure is located in Sadiya and founded on medium type of soil. The footing consists of an angular circular raft. The mass of the empty tank is 2500 kN. The weight of the staging is 1500 kN. The mass of water in the tank when it is full is 4500 kN. Take Ec = 2×10^7 kN/m^2, Es = 2.1×10^8 kN/m^2, I = 1.5 and R = 3. (Fig. Q5)	**12.5**

Fig Q1B



Average Velocity Spectra (Due to Housner)

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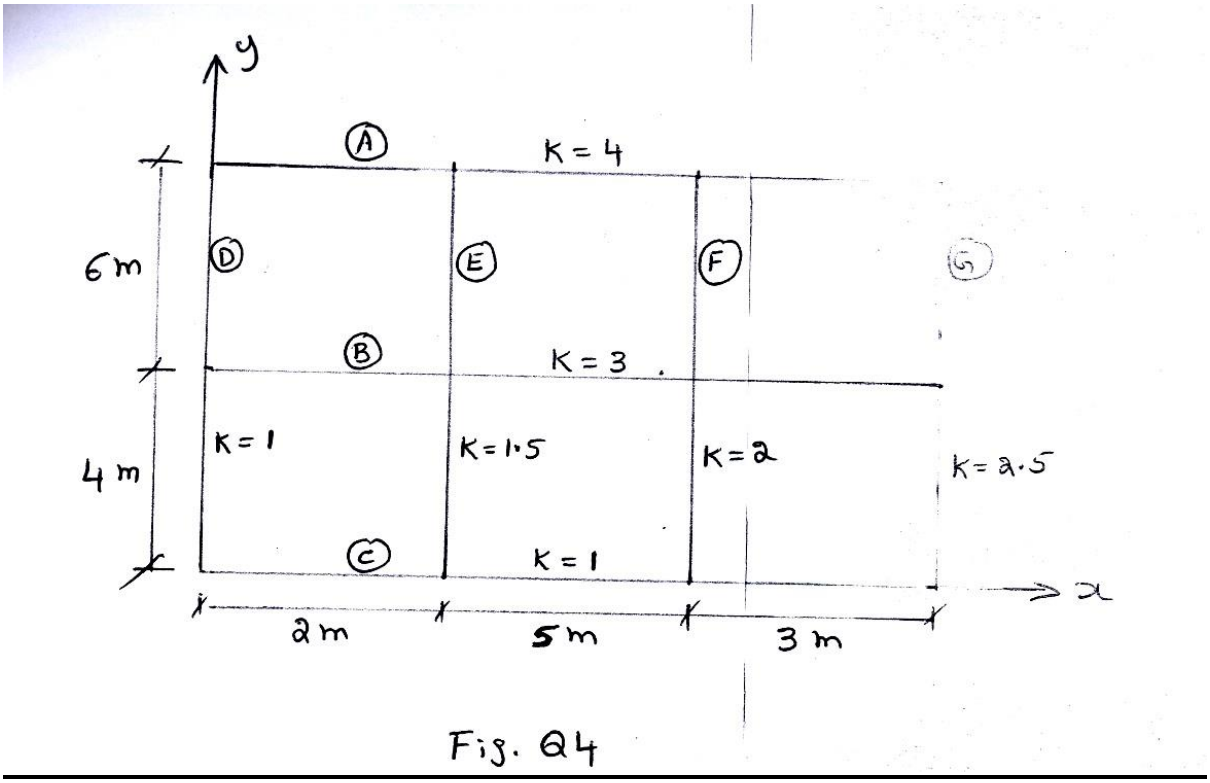

Fig. Q4

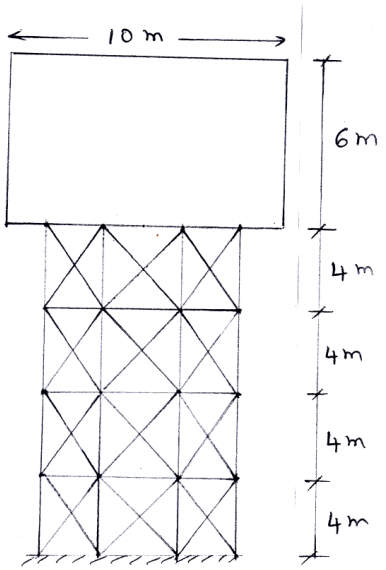

Fig. Q5