Reg. No.

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

II SEMESTER M.TECH. (STRUCTURAL ENGINEERING)
END SEMESTER EXAMINATIONS, APRIL/MAY 2024
SUBJECT: **EARTHQUAKE RESISTANT DESIGN OF STRUCTURES (CIE- 5218)**
REVISED CREDIT SYSTEM
(/ / 2024)

Time: 3 HRS. MAX. MARKS: 50

Instructions to Candidates:
- ❖ Answer ALL the questions.
- ❖ Missing data may be suitably assumed.
- ❖ Use of IS -1893 – 2016, IS -1893 – 1984, IS 13920-2016 & IS 456-2000 is permitted.

Q. No		MARKS
1A	Asses the natural frequency and earthquake response of a generalized SDOF system of uniform cantilever beam of height 40 m subjected to base displacement of Vg (t). The properties of the system are m = 30000 kg/m, EI = 95.44×10^9 N-m^2, ζ = 5%. Take Spv = 16 cm/sec. Evaluate the maximum displacement, maximum base shear and moment $\psi(x) = \frac{3x^2L - x^3}{2L^3}$	5
1B	Formulate the expression for displacement, elastic force vector, base shear and overturning moment of a Generalized SDOF system subjected to earthquake ground motion.	5
2	The mass of a 3 storey shear building together with its undamped vibration mode shape and frequencies are shown below. Using acceleration response spectrum values for ζ = 5% and for hard soil (refer IS -1893 – 2016) evaluate the response (displacement, elastic force vector, base shear and overturning moment) when subjected to earthquake ground acceleration of 0.3 g. Height of each storey is 3.5 m. (Fig. Q2) $\omega = \begin{Bmatrix} 15 \\ 25 \\ 35 \end{Bmatrix}$ rad/sec $\Phi = \begin{pmatrix} 1 & 1 & 1 \\ 0.9 & -0.5 & -1.3 \\ 0.7 & -0.7 & 1.1 \end{pmatrix}$ $m = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 3 \end{pmatrix}$ 10^3 kg	10
3	A fixed ended RCC beam of rectangular section has to carry a distributed live load of 26 kN/m in addition to its own weight and a dead load of 28 kN/m. The maximum bending moment and shear force due to the earthquake are 80 kN-m and 40 kN respectively. Center to center distance between supports is 5.6 m. Design the beam using M-25 grade	10

	concrete and Fe 415 steel.	
4	A one storey residential building with plan shown in Fig. Q4 is to be constructed in Kota on medium soil. Each wall is 230 mm thick and is constructed of brick masonry. The relative stiffness of these walls are KA = 1.5, KB = 0.9, KC = 0.75 and KD = 0.4. The roof consists of a 150 mm thick RC slab. The walls are 5 m height except wall C which is 6 m high. Evaluate design earthquake force for each of the walls. Take I = 1 and R = 1.5.	**10**
5	An elevated water tank has a capacity of 400 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 Mandi and founded on medium type of soil. The footing consists of an angular circular raft. The weight of the empty tank is 2200 kN. The weight of the staging is 1200 kN. The weight of water in the tank when it is full is 4000 kN. Evaluate earthquake forces on this water tank. Take Ec = 2×10^7 kN/m^2, Es = 2.1×10^8 kN/m^2, I = 1.5 and R = 3. (Fig. Q5).	**3**

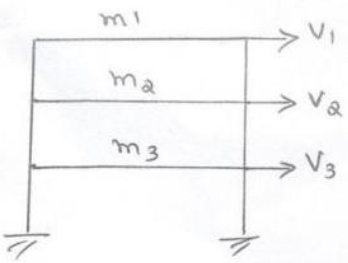

Fig. Q2

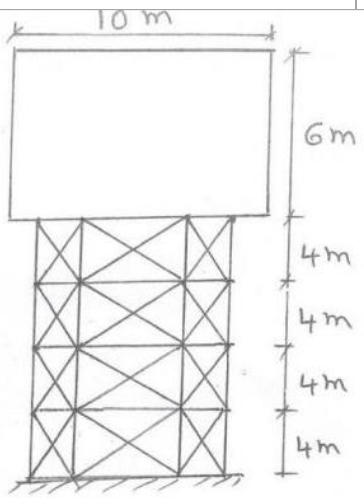

Fig Q5

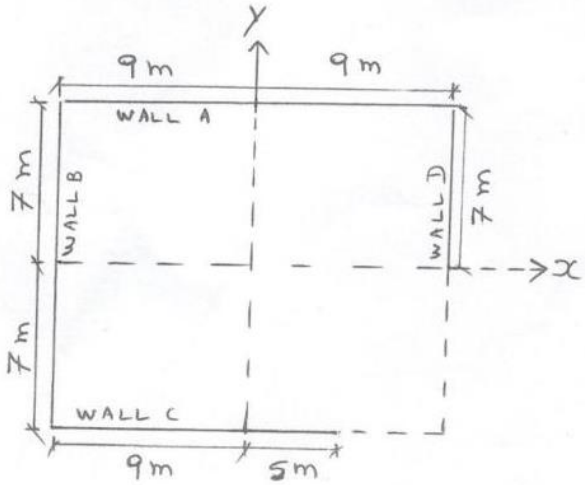

Fig Q4