(3 Hours) **Total Marks : 80**

N.B:
1. Attempt any **FOUR** questions.
2. Assume suitable data wherever necessary.
3. Figures to the right indicate full marks.

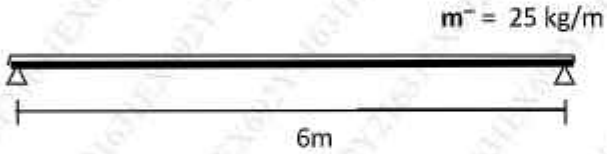
1(a) A heavy table is supported by flat steel legs; its natural time period in lateral direction is o.5 seconds when a 800 N plate is clamped on its surface, the natural period is lengthened to 0.8 seconds. What are the weight and the effective lateral stiffness of the table. 5

(b) What is transmissibility of a system? Briefly explain how vibration isolation can be achieved. 5

(c) What is response spectrum? Briefly explain the procedure to construct response spectrum for a given ground motion. 5

(d) Derive the expression for equivalent spring stiffness when connected in parallel and in series. 5

2 (a) For the beam shown in figure, calculate the fundamental frequency using Rayleigh's method. 10
$E=2x10^5$Mpa , $I = 9x10^7 mm^4$

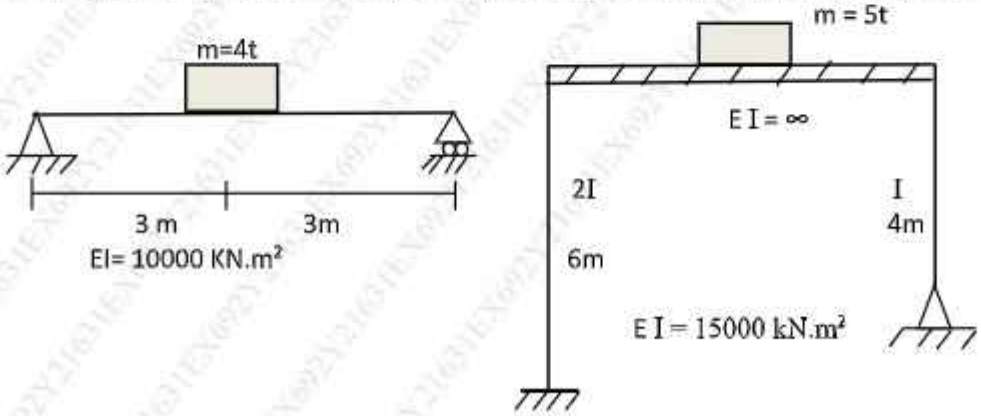


(b) 10
Derive the expression for steady state response of damped SDOF system subjected to harmonic force defined by $P_{(t)} = P_0 \sin\omega t$.

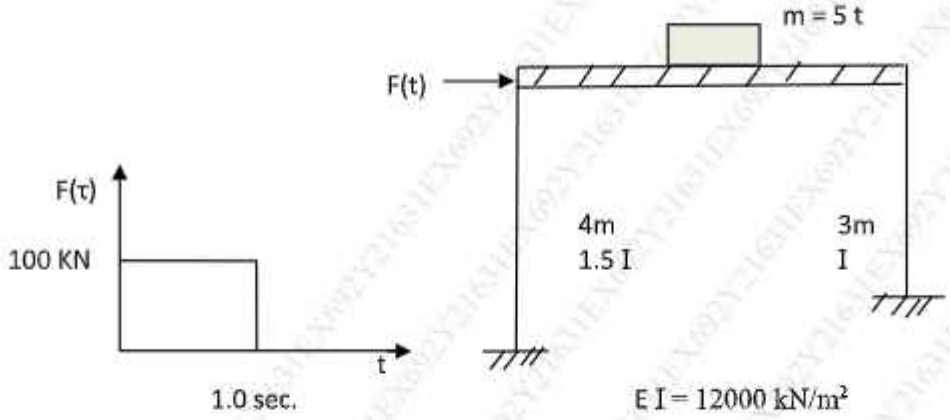
3(a) State and prove orthogonality principle. 5

(b) A three storey single bay frame has storey height of 4m each. All columns are 300mm wide x600mm deep and beams are very stiff. The mass on each floor is 25t .E=20000Mpa. Calculate natural frequencies and mode shapes. 15

4(a) For the structural systems shown in the figure, compute the natural frequency of vibration. 6



(b) The frame shown in the figure is subjected to a horizontal pulse type load .Determine the horizontal displacement at girder level at t = 0.5 sec.,t = 1.0 sec. & t = 2 sec 10



(c) What are the ductility provisions in the RCC buildings as per IS: 13920. 4

5(a) A three storey frame with the free vibration characteristics are given below is subjected to a suddenly applied constant load of 50 KN at 2nd floor level only. Determine maximum displacement of each storey by ABS and SRSS method 16

Storey Level	Storey Height (m)	Mass No.	Mass (t)	Mode shapes		
				T= 0.3 sec	T= 0.13 sec	T= 0.1 sec
				Mode 1 (Φ1)	Mode 2 (Φ2)	Mode 3 (Φ3)
First	3	1	25	0.404	-0.676	2.959
Second	3	2	25	0.716	-0.526	-2.578
Roof	3	3	25	1.0	1.0	1.0

(b) What is an earthquake? Explain how the earthquakes are classified based on their causes. 04

6 (a) Explain the concept involved in carrying out modal analysis of structure subjected to dynamic loads in MDOF system. 08

(b) A machine of 1000 kg mass supported on springs of total stiffness 1200 kN/m and has an unbalanced rotating element which results in a disturbing force of 400 N at a speed of 1200 rpm. calculate following for 5% and 10% damping 12

i. Amplitude of motion.
ii. Transmissibility and
iii. Force transmitted to foundation

****

Duration: 3hrs **[Max Marks:80]**

Instructions:

(1) Question No.1 is Compulsory.
(2) Attempt any three questions out of the remaining five.
(3) All questions carry equal marks.
(4) Assume suitable data, if required and state it clearly.

1 Attempt any **FOUR:**

Briefly explain the following:

a St. Venant's principle and its significance. 05M
b Airy's stress functions. 05M
c Stress invariants. 05M
d Compatibility equations. 05M
e Lateral Torsional buckling of beams. 05M
f Differential Equations of Equilibrium for a 2-D problem in Cartesian Coordinate System. 05M

2 a The stress tensor at a point is given by the following array; 12M

$$\sigma_{(xyz)} = \begin{bmatrix} 20 & 40 & 0 \\ 40 & 0 & 60 \\ 0 & 60 & 30 \end{bmatrix} \text{MPa}$$

Calculate
(i) deviator and spherical stress tensors
(ii) Principal stresses
(iii) normal and shearing stresses on a plane inclined at 30^0 with the x-axis.

b Show that for an isotropic material, the independent elastic constants are λ and G. 08M

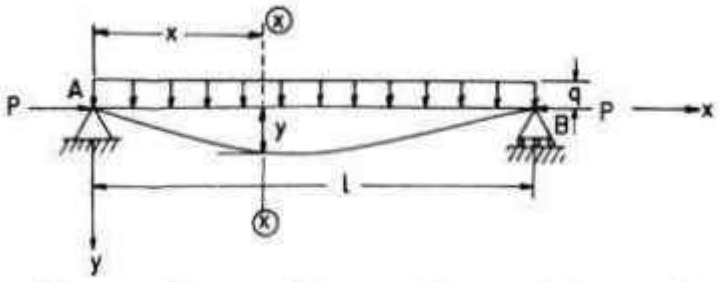
3 a Derive the equation of deflection of a cantilever prismatic beam having length L rectangular cross section, carrying a concentrated load P at the free end. 12M

b The components of the strain tensor at a point in a body are given by ε_x=0.005, ε_y= 0.004, ε_z = -0.002, γ_{xy} = 0.001, γ_{yz} = 0.0005, γ_{zx} = 0.002. If the modulus of elasticity $E = 2 \times 10^5$ N/mm² and the Poisson's ratio is 0.25, determine the Lame's constant. Also determine the components of the stress tensor. 08M

4 a Derive Euler's expression for buckling load for a column of length L and both ends fixed. Consider EI to be constant throughout the length of Column. 12M

b Derive the differential equation of equilibrium for 2D elements in polar coordinates. 08M

5 a What are beam columns? A beam column is subjected to a uniformly distributed load of q per m, in addition to an axial compressive force P. The beam is simply supported at the ends and having a span L and uniform flexural rigidity EI. Derive the equation of deflection for this beam column. 15M



b Explain the use of energy methods for the solution of buckling problems. 05M

6 a Derive the equation for torsion of prismatic bars of elliptical cross section. 12M

b Show that the biharmonic equation for a plane strain problem, in the absence of body forces, is $\nabla^4(\phi) = 0$. 08M