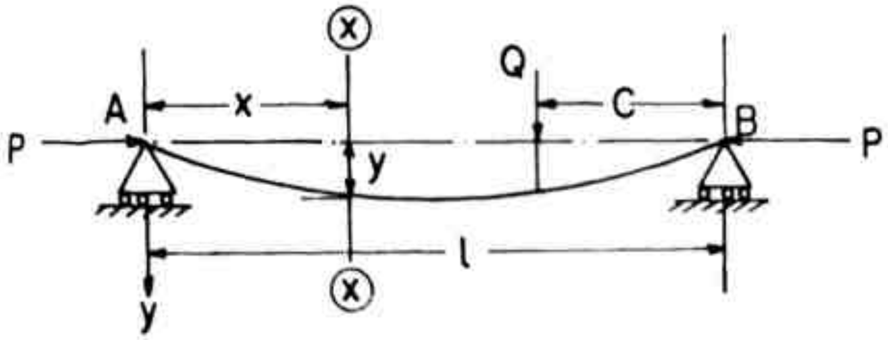
Duration: 3hrs **[Max Marks: 80]**

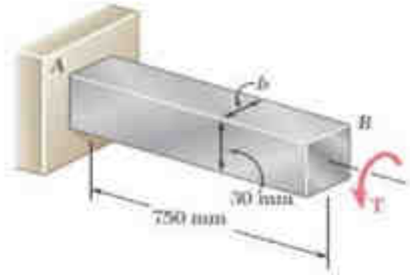
Instructions:

(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.
(5) Figures to the right indicate marks.

1		Attempt any **FOUR:**	
	a	Explain the components of stresses.	**05**
	b	Write assumptions on Theory of Elasticity	**05**
	c	Explain in brief Saint Venant's principal along with its importance.	**05**
	d	Determine Lame's constant μ and λ. Assume E=100 MPa and G = 84GPa.	**05**
	e	Explain the Stress Tensor and Strain Tensor.	**05**
	f	Wite applications of Theory of Elasticity.	**05**
2	**a**	Derive Euler's expression for buckling load for a column of length L, with both ends fixed.	**12**
	b	Show that for an isotropic material, the independent elastic constants are λ and G.	**08**
3	**a**	Explain Pure torsion of thin-walled bars of open cross section	**10**
	b	Explain Pure bending of Prismatic bars	**10**
4	**a**	A prismatic beam column of length L and flexural rigidity El carries an axial compressive force P and a transverse concentrated load Q at a distance C from end support. Find the expression for the deflection, if both end of the beam is on a roller.	**12**



b A bar of rectangular cross-section measuring 25 mm x 30 mm is subjected to a twisting moment of 40 kN.m. Determine the maximum shear stresses and the angle of twist, if G = 100 GPa and length of bar is 750mm. **08**



5 **a** The components of the strain tensor at a point in a body are given by εx = 0.005, εy = 0.004, εz = -0.002, γxy = 0.001, γyz = 0.0005, γzx = 0.002. If themodulus of elasticity E = 2 x 10^5 N/mm^2 and the Poisson's ratio is 0.25, determine the Lame's constant. Also determine the components of the stress tensor. **10**

b The stress tensor is given. find the strain tensor E=2x10^5 N/mm^2, Poisson's Ratio= 0.3 **10**

$$\begin{bmatrix} 20 & 40 & 30 \\ 40 & 45 & -25 \\ 30 & -25 & 40 \end{bmatrix}$$

6 **a** Explain Membrane analogy **05**

b Buckling of Continuous beams **05**

c Show that the biharmonic equation for a plane strain problem, in the absence of body forces, is $\nabla^4(\varphi) = 0$. **10**

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N.B **(3 Hours)** **Maximum Marks: 80**

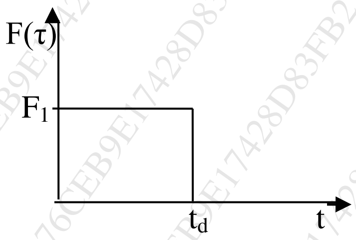
1) Attempt any **FOUR** questions.
2) Assume suitable data wherever necessary and mention the same.
3) Figure to the right indicate full marks.

1(a) What is damping? Explain the various the various types of damping. What are the effects of damping on the structure? **5**

(b) State and prove orthogonality principle. **5**

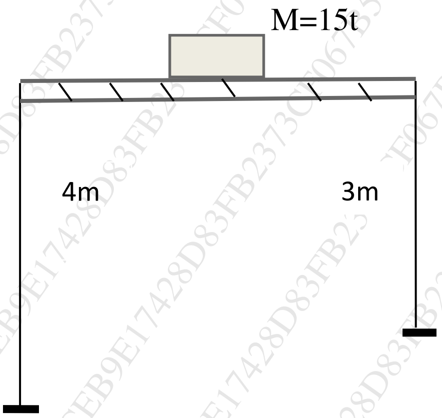
(c) Explain the terms, magnitude and intensity of earthquake. How it is measured? **5**

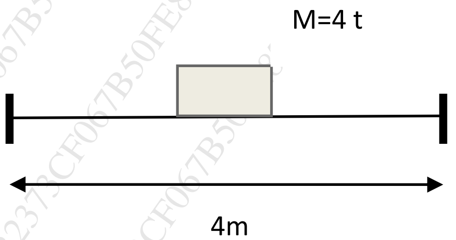
(d) For the pulse type load shown in the figure, derive the expression for DLF. **5**



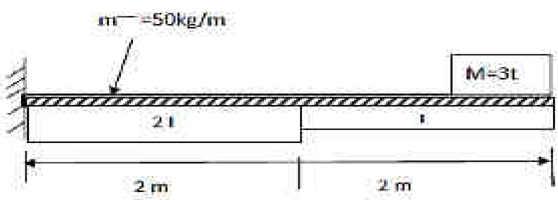
2(a) A heavy table is supported by flat steel legs; its natural time period in lateral direction is o.4 seconds. When a 550 N plate is clamped on its surface, the natural period is lengthened to 0.6 seconds. What are the weight and the effective lateral stiffness of the table? **4**

(b) For the structural systems shown in the figure, compute the natural frequency of vibration. EI= 16000KN.m^2 **6**





(c) For the beam shown in figure, calculate the fundamental frequency using Rayleigh's method. E=2x10^5Mpa I = 9x$10^7$$mm^4$ Mass of the beam is 50Kg/m. **10**



3(a) A three storey frame with free vibration characteristics are given below. It is subjected to a suddenly applied constant force of 60 kN at 3rd floor level and 30KN at 2nd floor level. Calculate the maximum displacements at each storey by SRSS and ABS method. **15**

Storey Level	Storey Height (m)	Mass No.	Mass (t)	Mode shapes		
				T= 0.372 sec	T= 0.112 sec	T= 0.067 sec
				Mode 1	Mode 2	Mode 3
First	3	1	30	0.32	1.0	-0.967
Second	3	2	30	0.697	0.749	1.0
Roof	3	3	30	1.0	-0.567	-0.258

(b) State the different methods of seismic analysis as per IS 1893-2016.Also state under what conditions these methods are used. **5**

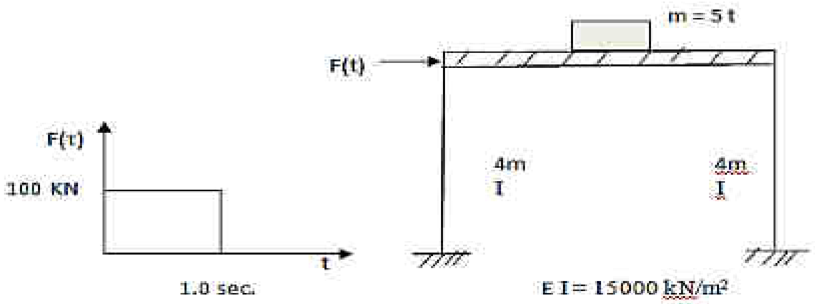
4(a) A three storey single bay frame has storey height of 4m each. All columns are 250 mm x 600 mm and beams are very stiff. The mass on the first and the second floor is 30 t & on the third floor is 20 t. Calculate natural frequencies and mode shapes of the frame. Also calculate normal mode shape coefficients and verify its orthogonality. $E = 2x10^5$ Mpa. **15**

(b) What is an earthquake? Explain how the earthquakes are classified based on their causes. **5**

5(a) Explain the concept involved in carrying out modal analysis of structure subjected to dynamic loads in MDOF system. **10**

(b) Starting from first principle ,derive the expression for frequency of vibration of a simply supported beam of span L, flexural rigidity EI and uniform mass 'm' kg/m. **10**

6(a) The frame shown in the figure is subjected to a horizontal pulse type constant load .Determine the horizontal displacement at girder level at t = 0.5 sec.,t = 1.0 sec. & t = 2.0 sec **10**



(b) A machine of 1400 kg mass supported on springs of total stiffness 1200 kN/m and has an unbalanced rotating element which results in a disturbing force of 500 N at a speed of 1800 rpm. Assuming 15% damping, calculate **10**

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

TIME:3hrs **MARKS:80**

N.B: (1) Question **No. 1** is compulsory.
(2) Attempt any **three** questions out of remaining five questions.
(3) Assume suitable data wherever required and state it clearly.
(4) Illustrate your answers with neat component sketches wherever required.
(5) IS 1343:1980, IS 3370 and relevant codes require for design are permitted.

1. Design a post tensioned roof girder as a class I structure using following data **32**
Effective span = 40 m
Live load = 9 kN/m
Dead load (excluding self-weight) = 2 kN/m
Load Factors (For dead load = 1.4, for live load 1.6) Cube strength of concrete, fcu = 50 N/mm^2
Cube strength at transfer fci = 35 N/mm^2
Tensile strength of concrete ft = 1.7 N/mm^2
Modulus of elasticity of concrete Es = 34 kN/mm^2, Loss ratio = 0.85
8 mm diameter high tensile wires having a characteristic tensile strength fpu = 1200 N/mm^2 are available for use.
The modulus of elasticity of high tensile wires is 200 kN/mm^2.

OR

Design a post tensioned pre-stressed concrete slab bridge deck for a national highway crossing to suit the following data

- a Clear span = 10.5m
- b Live load = IRC class AA traced vehicle
- c width of bearing = 400 mm
- d Clear width of roadway = 7.5m
- e footpath 1m on either side
- f kerbs = 600 mm wide
- g thickness of wearing coat = 80mm
- h type of structure = class 1 type

Materials M -40 grade concrete and 6mm diameter high tensile wires with an ultimate tensile strength of 1200 N/mm^2 housed in cables with 12 wires and anchored by freyssinet anchorages of 150 mm diameter. For supplementary reinforcement, adopt Fe 415 grade HYSD bars. Compressive stress at transfer, fci =35 N/mm^2, loss ratio =0.8. The permissible compressive stresses in concrete at transfer and working loads are fct = 15 N/mm^2, fcw = 12 N/mm^2, ftt = ftw = 0

2. **a)** Explain stages of prestressing **4**

b) A reinforced concrete dome of 30 m base diameter and a rise of 3.75 m is to be designed for a pre-stressed concrete cylindrical tank. The shell dome to be provided with a pre-stressed concrete ring beam. Design the dome and the ring beam for a superimposed load of 1.5 kN/m^2. The 5 mm diameter high tensile wires initially stressed to 1000N/mm^2 are available for pre-stressing the ring beam. The loss ratio is 0.80 and permissible compressive stress in concrete at transfer is 14 N/mm^2. Assume radius of the shell dome = 32 m, thickness of shell = 75 mm, semi central angle α = 28º 4'. **12**

3. a) A prestressed beam with rectangular cross section with a width of 120mm and depth of 300mm is continuous over two spans AB = BC = 8m. The cable with zero eccentricity at the ends and an eccentricity of 50mm towards the top fibers of the beam over the central support, carries an effective force of 500kN. **12**

(i) Calculate the secondary moments developed at B.

(ii) If the beam supports the concentrated load of 20kN each at mid points of the span, evaluate the resultant stresses at the central support section B.

Also locate the position of pressure line at the section.

b) What is concordant cable profile? Explain its advantages **4**

4. a) Explain methods of prestressing of shell structure **6**

b) A composite beam of rectangular section is made up of a pre-tensioned inverted T-beam having a slab thickness and width of 150 and 1050mm respectively The rib size is 150mm by 800 mm The cast in situ has thickness and width of 1000mm with the modulus of elasticity of 30 kN/mm^2 If the differential shrinkage is 100×10^{-6} units, estimate the shrinkage stresses developed in the precast and cast in situ units. **10**

5. a) Explain the concept of load balancing. **4**

b) Design a non cylinder prestressed concrete pipe of 600 mm internal diameter to withstand a working hydrostatic pressure of 1.05 N/mm^2, using a 2.5 mm high tensile wire stressed 1000 N/mm^2 at transfer. Permissible maximum and minimum stresses in concrete at transfer and service loads are 14 and 0.7 N/mm2. The loss ratio is 0.8. Calculate also the test pressure required to produce a tensile stress of 0.7 N/mm^2 in concrete when applied immediately after tensioning and also the winding stress in steel if ES = 35 kN/mm^2 **12**

6. a) Explain different cross section of folded plate. **4**

b) Design a post-tensioned pre-stressed concrete two-way slab, 6m × 9 m with discontinuous edges, to support an imposed load of 3 kN/m^2. Cables of four wires of 5 mm diameter carrying an effective force of 120 kN are available for use. Design the spacing of cables in the two directions and check for the safety of the slab against collapse and excessive deflection at service loads. Assume (B. M coefficients for short span = 0.089, = 0.056 for long span), f_{ck} = 40 N/mm^2, f_p = 1500 N/mm^2 and E_c = 38 kN/mm^2 **12**

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