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16/6/14

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(An Autonomous Institution Affiliated to University of Mumbai)

Subject : Advanced Solid Mechanics

CLASS: ME (STRUCT) SEM I (KT-exam) Total Marks : 100

Date: /06/2014 Duration : 4 Hour

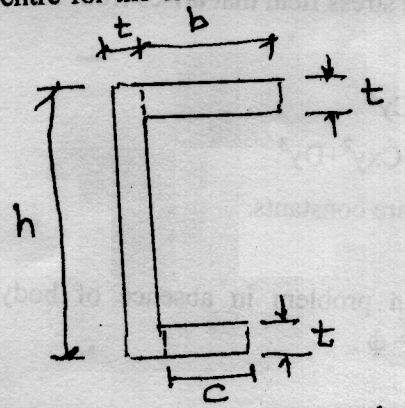
MASTER

- Figures to the right indicate full marks.
- Assume suitable data if necessary and state the same clearly.
- Solve any **Five** questions.

Q.1 (a) Explain compatibility with respect to stress distribution and write six compatibility equations . (10)

(b) For plain stress problem , derive relationship between stress and strain (10)

Q. 2 Determine the shear centre for the cross section shown , the dimensions are from wall centers. (20)



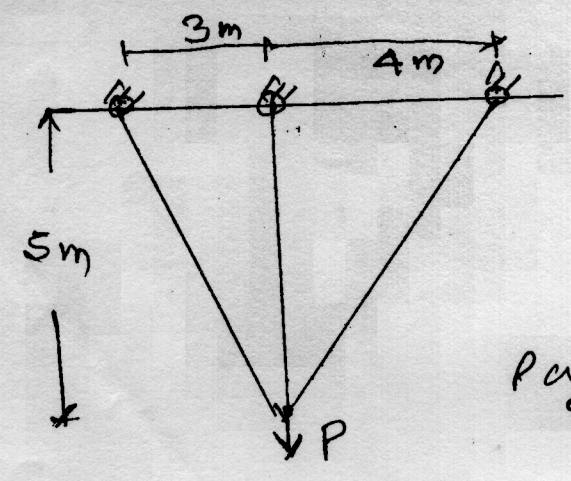
Q. 3 The State of stress at a point in a body relative to the xyz co-ordinate system is given by (20)

$$\begin{bmatrix} 10 & -5 & 12 \\ -5 & 7 & 2 \\ 12 & 2 & 8 \end{bmatrix}$$

Determine the principal stresses and the directional co-sines associated with the directions of each Principal stress.. Determine also the maximum shear stress at the point.

Q. 4 (a) Explain the use of complimentary energy theorem (04)

(b) Calculate forces in cables shown using complimentary energy theorem if effective area of each cable is 125 mm2, P = 8 KN, length of AB= 500 mm and BC = 750 mm E= 2x 10^5 N/mm^2 (16)



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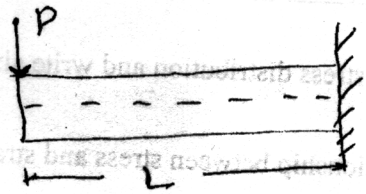
Q. 5 (a) The elliptical cross section is transmitting a torsional moment T , Determine the stress function, the shear stress equations, the maximum shear stress and its location and angle of twist per unit length . (14)

(b) For the elliptical cross section determine maximum shear stress and angle of twist per unit length for following data (06)
a = 15 mm, b= 30 mm T= 500 N=m, E = 200 GPa, and υ= 0.3.

Q. 6 The cantilever beam shown has a point load P applied at the free end. Using (20)
σ_x = -Mz * y/ Iz, , σ_y= 0, τ_{xy} =0, determine the displacement fields u(x,y) and v (x,y)



Q.7 (a) Determine and explain the stress field that arises from following stress functions. (10)

$\Phi = Cy^2$

$\Phi = Ax^2+Bxy+Cy^2$

$\Phi = Ax^3+Bx^2y+Cxy^2+Dy^3$

Where A. B, C, D are constants.

(b) Show that a plain strain problem in absence of body forces has to satisfy the differential equation $\nabla^4 = \phi$. (10)

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July 2014

Total Marks : 100 | Duration : 4 Hours

CLASS/SEM : ME Civil with Structural Engineering Subjects SEM I | SUBJECT : STRUCTURAL DYNAMICS

MASTER

- Attempt any FIVE questions out of SEVEN questions.
- Answers to all sub questions should be grouped together.
- Figures to the right indicate full marks.
- Assume suitable data if necessary and state the same clearly.

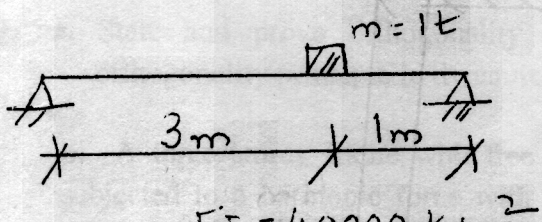
Q.1 **a.** Answer the following:

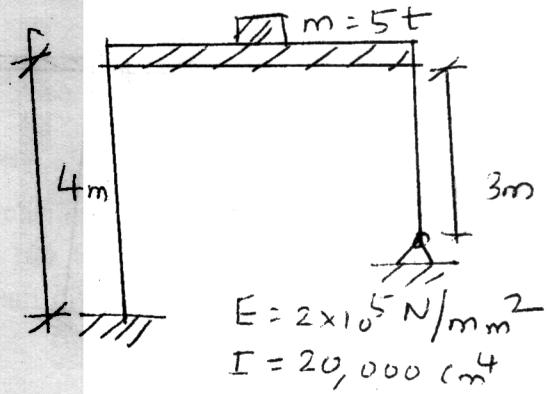
(i) Define Dynamic load. Distinguish between Prescribed and Random dynamic loads — 2

(ii) State the different methods for writing equation of motion — 2

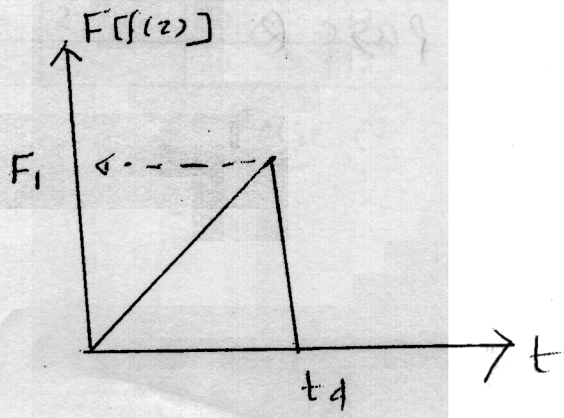
(iii) Define damping. State the different types of damping and effects of damping — 3

b. For the structural systems shown in figure compute the natural frequency of vibration — 6





d. For the pulse type load shown in figure, derive the expression for DLF using Duhamel's Integration. — 7



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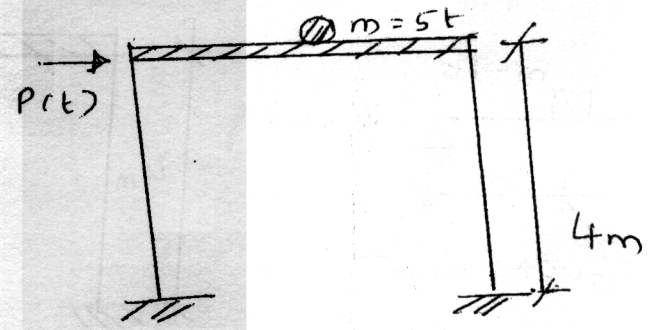
Q.2 a. A one storey building is idealized as a rigid girder supported by weightless columns. In order to evaluate the dynamic properties of this structure a free vibration test is made in which the rigid girder is displaced laterally by a hydraulic jack & then suddenly released. During the jacking operation, it is observed that a force of 5000 N is required to displace the girder by 6mm. After the instantaneous release of this initial displacement, the maximum displacement of first return swing is 4 mm & the period of this displacement cycle is 1.2 sec. The following results are required 7

- Lateral stiffness of the frame
- Effective mass of the frame
- Logarithmic decrement
- Damping ratio
- Damping coefficient
- Damped frequency
- Amplitude after six cycles of vibrations

b. A rigid steel frame shown in figure, support a rotating machine which exerts a horizontal force at girder level. The amplitude of force is 4000N and its frequency is 1.4 times the natural frequency of the structure. Assuming the force to be harmonic and damping ratio as 2%, determine the maximum displacement at girder level and maximum stress developed in columns if the depth of column = 500 mm 8



c. A heavy table is supported by flat steel legs, its natural time period in lateral direction is 0.6 sec. when an 1000N plate is clamped on its surface, the natural period is lengthened to 0.8 sec. what is the weight and effective lateral stiffness of the table. 5

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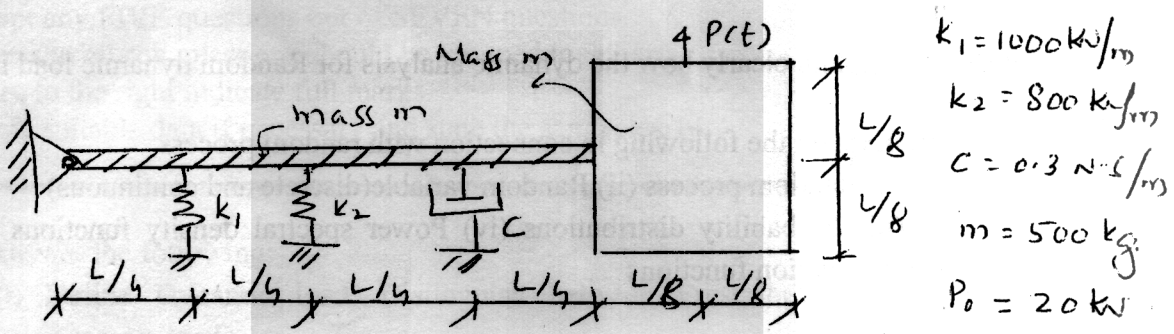
Q.3 For the rigid body system shown in figure: 20 17/6/14

(a) Formulate the equation of motion
(b) Determine the natural frequency and damping ratio
(c) Determine the displacement response u(x, t) due to p(t)= P_0, a suddenly applied constant load
(d) Evaluate the maximum response u(x)



Q.4 A three storey single bay frame has storey height of **4 m.** each. All columns are **300 mm** wide **X 600 mm** deep& beams are very stiff. The mass on each and floor is **30 t.** **E = 20000 Mpa**. Calculate natural frequencies & mode shapes. 20

Q.5 **a.** State and prove orthogonality principle. Also state the significance of orthogonality principle in dynamic analysis 5

b. A three storey frame with free vibration characteristics as given below is subjected to a harmonic force with amplitude **100 KN** and at frequency of 10 rad/sec.at the 3rd floor level. Calculate maximum displacements of each storey. Take damping ratio =5% 15

Storey No.	Storey ht. (m)	Mass No.	Mass (t)	ω rad/sec	Mode shapes		
					Φ_{i1}	Φ_{i2}	Φ_{i3}
1	3	1	30	4.92	0.336	0.759	1.0
2	3	2	30	13.45	-2.46	-0.804	1.0
3	3	3	30	18.7	1.58	-1.157	2.58

M.E(C) with Str. Engg Sem IE
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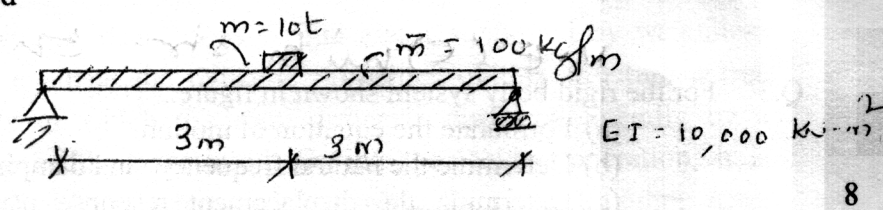
Q.6 **a.** For the beam shown in figure calculate the fundamental frequency using Rayliegh's Method 12



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. 8

Q.7 **a.** Explain clearly how the dynamic analysis for Random dynamic load is done 5

b. Explain the following in connection with random process 5
(i) Random process (ii) Random variable(discrete and continuous)
(iii) Probability distributions (iv) Power spectral density functions (v) Auto correlation functions

c. A simply supported beam of 8m span, 300 mm wide 600 mm deep carries a suddenly applied force of 100 KN at mid span. Calculate the maximum displacement and bending moment responses at mid span and shear force at left support. E= 2×10^4 Mpa. and density of material = 2500 kg/m^3. Take contribution from the four lowest contributing modes 10

Please Turn