B. E. 7TH SEMESTER (CE) FINAL EXAMINATION 2011-12

STRUCTURAL ANALYSIS -III (CE-701)

Full Marks-70 Time - 3 hrs

ANSWER ANY **THREE** QUESTIONS FROM EACH HALF

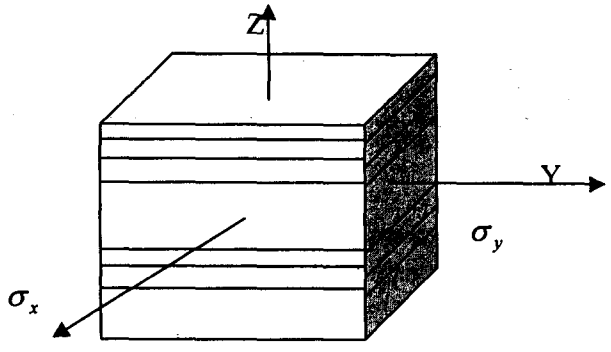
All questions are of equal value.
Two marks are reserved for neatness in each half.
Symbols and abbreviations have usual meanings.

FIRST HALF

1. a) Explain plane stress and plain strain conditions with examples.
b) For the following plane strain distribution, verify whether the compatibility condition is satisfied.

$$\varepsilon_x = 3x^2y \qquad \varepsilon_y = 4y^2x + 10^{-2} \qquad \gamma_{xy} = 2xy + 2x^3\,\sigma_y$$

2.a) A thin rubber sheet is enclosed between two fixed hard steel plates. Friction between rubber and steel faces is negligible. If rubber sheet is subjected to the stresses σ_x and σ_y, determine ε_x, ε_y and ε_z.



b) Given strain matrix is $\varepsilon_{ij} = \begin{bmatrix} 0.001 & 0 & -0.002 \\ 0 & -0.003 & 0.0003 \\ -0.002 & 0.0003 & 0 \end{bmatrix}$

Calculate the stress matrix for $E = 207 \times 10^6$ KPa and $G = 80 \times 10^6$ KPa

3. a) Distinguish between principal stress and octahedral normal stress.
b) Determine normal and shear stresses on octahedral plane for the following state of stress: $\sigma_x = 9$, $\sigma_y = 3$, $\sigma_z = 6$, $\tau_{xy} = 3$, $\tau_{yz} = 5$ and $\tau_{zx} = 5$. Resolve the given state of stress into hydrostatic and pure shear conditions. Also calculate octahedral normal and shear stresses for hydrostatic and pure shear conditions separately.

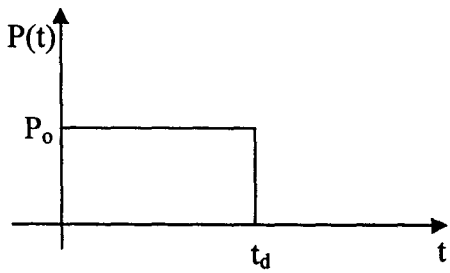
4.a)Establish the differential equilibrium equations for a two dimensional element under nonuniform stress condition.
b) Determine principal stresses using stress invariants for the following state of stress: $\sigma_x = 8$, $\sigma_y = 2$, $\sigma_z = 5$, $\tau_{xy} = 4$, $\tau_{yz} = 6$ and $\tau_{zx} = 6$.

5. Write short notes on the following: (any two)
a) Lame's coefficients
b) Kirchoff's plate theory
c) Strain invariants

SECOND HALF

6. Derive Duhamel's integral for obtaining the displacement response of an undamped SDOF system, initially at rest, subjected to an arbitrary loading P(t). Explain why it is applicable only to linear systems. Using Duhamel's integral, obtain the displacement response of an undamped SDOF system, initially at rest, subjected to a rectangular force as shown below, for (i) $t \leq t_d$ and for (ii) $t > t_d$.

(11)



7. a) Explain, with appropriate sketches, the basic principles underlying the design of instruments to measure (i) the acceleration, and (ii) the displacement, of a vibrating support.

b) An instrument has a natural frequency of 40 Hz and its damping ratio is 70%. For the measurement of which support motion parameter would you use it and for what range of input frequencies would it be applicable? How would you increase its range of applicability?

(7+4 = 11)

8. For the case of SDOF systems subjected to harmonic loading, sketch the plot of dynamic magnification factor (D) vs ratio of applied frequency to system frequency (r) for different values of damping (ζ). Give your observations for the three cases of (i) $r << 1$ (ii) $r \cong 1$ and (iii) $r >> 1$.

(11)

9. (a)Explain the significance of $r = \sqrt{2}$ in transmissibility of harmonic excitation.

(b) A sensitive instrument weighing 5 kg is subjected to a support acceleration of 0.15g at a frequency of 5 Hz. To minimize the acceleration transmitted to the instrument, it is mounted on a rubber pad of stiffness 1500 N/m and damping such that the damping ratio for the system is 8%. What is the acceleration transmitted to the instrument? If the instrument can tolerate only an acceleration of 0.01g, determine how this can be achieved assuming the same rubber pad is to be used.

(4+7 = 11)

10. a) Define Response Spectrum. A structure modelled as a SDOF system has a mass of 250 kg, time period of 0.5 sec and damping ratio 2%, for which the design pseudo acceleration response quantity is obtained as 0.3g. Calculate the base shear of the system.

b) Describe the Half-Power (Bandwidth) method for the evaluation of the damping ratio of a SDOF system. Derive the expression for the same.

(5+6 = 11)