ADVANCED STRUCTURAL ANALYSIS
(CIVL 4141)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Flexibility method is a matrix of
(a) force method (b) displacement method
(c) energy method (d) numerical method.

(ii) The direction cosines of an octahedral plane to the three axes of reference are
(a) $\pm 1/\sqrt{2}, \pm 1/\sqrt{2}, \pm 1/\sqrt{2}$ (b) $\pm 1/\sqrt{3}, \pm 1/\sqrt{3}, \pm 1/\sqrt{3}$
(c) $\pm\sqrt{3}/2, \pm\sqrt{3}/2, \pm 1/\sqrt{2}$ (d) $\pm 1/\sqrt{2}, \pm 1/\sqrt{3}, \pm\sqrt{3}/2$

(iii) Stress invariant I_2 is given as
(a) $\sigma_x\sigma_y + \sigma_y\sigma_z + \sigma_z\sigma_x$
(b) $\sigma_x + \sigma_y + \sigma_z$
(c) $\tau^2_{xy} + \tau^2_{yz} + \tau^2_{zx}$
(d) $\sigma_x\sigma_y + \sigma_y\sigma_z + \sigma_z\sigma_x - \tau^2_{xy} - \tau^2_{yz} - \tau^2_{zx}$

(iv) Synclastic shell is a
(a) singly curved shell (b) developable shell
(c) shell in translation (d) doubly curved shell.

(v) The Navier's solution of bending of simply supported plate is based on
(a) double trigonometric series (b) single trigonometric series
(c) single Fourier series (d) double Fourier series.

(vi) The fourth order differential equation of isotropic plate subjected to external load of intensity q is
(a) $\frac{\partial^4\omega}{\partial x^4} + 2\frac{\partial^4\omega}{\partial x^2\partial y^2} + \frac{\partial^4\omega}{\partial y^4} = q/D$ (b) $\frac{\partial^4\omega}{\partial x^4} + 2\frac{\partial^4\omega}{\partial x^2\partial y^2} = q$
(c) $\frac{\partial^4\omega}{\partial x^4} + \frac{\partial^4\omega}{\partial y^4} = q$ (d) $2\frac{\partial^4\omega}{\partial x^2\partial y^2} + \frac{\partial^4\omega}{\partial y^4} = q$

(vii) The thickness to width ratio in case of thin plate shall be less than
(a) 0.1 (b) 0.2 (c) 0.01 (d) 0.02.

(viii) The finite difference representation of the first derivative is given by
(a) $\frac{1}{2h}(w_{i+1} - w_{i-1})$ (b) $\frac{1}{2h}(w_{i-1} - w_{i+1})$
(c) $\frac{1}{h}(w_{i+1} - w_{i-1})$ (d) $\frac{1}{h}(w_{i+1} + w_{i-1})$.

(ix) Size of the stiffness matrix for a structure having 3 DOF is
(a) 6 × 6 (b) 3 × 3 (c) 9 × 9 (d) 2 × 2.

(x) The elements stiffness matrix of a two noded bar element is
(a) $\frac{AE}{L}\begin{bmatrix}1 & 1\\ 1 & 1\end{bmatrix}$ (b) $\frac{AE}{L}\begin{bmatrix}1 & -1\\ -1 & 1\end{bmatrix}$
(c) $\frac{AE}{L}\begin{bmatrix}-1 & 1\\ 1 & -1\end{bmatrix}$ (d) $\frac{AE}{L}\begin{bmatrix}-1 & -1\\ 1 & 1\end{bmatrix}$.

Group – B

2. Determine the structure stiffness matrix, the force in each member and deflection of joint A for the two member truss shown in figure 1. AE is constant.

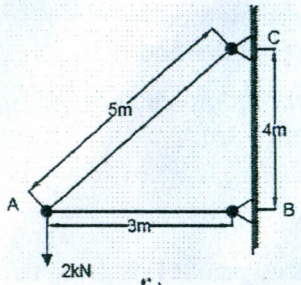

figure 1

12

3. Derive the member stiffness matrix of a 2-noded beam and frame element.
12

Group – C

4. Explain the three different schemes of finite difference method.
12

5. Compute deflections at quarter points and centre of a simply supported beam for the loading shown in figure 2 by using finite difference method.

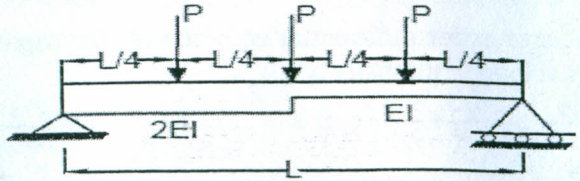

figure 2

12

Group – D

6. Describe the Navier solution for simply supported rectangular plate.
12

7. (a) State the assumption of classical plate theory.
(b) Write brief note on Navier's and Levis' solution for plate buckling problem.
5 + 7 = 12

Group – E

8. The state of stress at a point is given by the following array of terms:

$$\begin{bmatrix}10 & 6 & 3.5\\ 6 & 4 & 2\\ 3.5 & 2 & 4.5\end{bmatrix} MPa.$$

Determine the principal stress and principal directions.
12

9. Write short note on the following: (4 × 3) = 12
(i) Plane stress and plain strain problem
(ii) Spherical and deviator stress tensor
(iii) Stress invariants
(iv) Octahedral stress.