Ref. No. : Ex/CE/T/413/2019

Name of the Examinations: B.E. CIVIL ENGINEERING FOURTH YEAR FIRST SEMESTER - 2019

Subject : THEORY OF STRUCTURES IV

Time : Three Hours Full Marks: 100

Part I

Instructions : Use Separate Answer scripts for each part

1. a) Develop the relationship between the octahedral shear stress and the stress deviatoric and explain the significance of the same. (7)
   b) Develop the Biharmonic equation in terms of the Airy's Stress function for a plane strain problem with body force. (8)
   c) Develop the shape function for a 4-node Lagrangian element. (5)

2. Obtain the final assembled finite element stiffness matrix and the load vector for the problem described by the differential equation

$$-\frac{d^2u}{dx^2} - u + x^2 = 0 \; for \;\; 0 < x < 1$$

having a mixed boundary condition u(0) = 0 and $\frac{du}{dx} = 1 \; at \; x = 1$

Use a uniform mesh of three (3) elements based on Ritz procedure. (20)

Or

2. Based on the weighted residual method of (i) Galerkin (ii) Collocation principle, obtain the solution for the differential equation given in the previous problem with identical boundary terms. Tabulate the results for every 0.25 unit interval. (20)
3. a) Develop the stress equilibrium equation of a plane stress problem in polar coordinates. (5)
   b) A semi-infinite elastic continuum with a straight horizontal boundary as its surface is subjected to a line load of intensity 'P' per unit length acting on the boundary. Obtain the stress profile at a depth of 'h' below the surface and the displacement profile along the surface. Use Airy's Stress function to obtain the solution. (15)

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Theory structures –IV

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Part –II (40 Marks)

Answer Q1 and any one from Q2 & Q3
Assume reasonable values of any data if required
Notations have their usual meaning

Q 1 A spherical dome over a circular room is to be constructed. Diameter of the circular room is 20m and the central rise is 8 m. Thickness of the dome is 100 mm. Live load = 0.75 KN/m^2. The dome is also subjected to a concentrated load of 500 KN at the crown, Find the meridional stress and hoop stress at an interval of 20^0 from vertical axis. Deduce the expression for the above stresses. Sketch also the typical reinforcement generally provided in reinforced concrete dome. The dome is supported on a circular beam over the brickwork. **20**

Q2 A rectangular steel plate 3 X 2 m simply supported at the edges carrying a central concentrated load of 80 KN. Find the maximum deflection of the plate. Also calculate the moments at the centre of the plate. Derivation is needed assuming plate equation $\nabla^4 w = p/D$. Where p= uniformly distributed load .Take v =0.25. Thickness of the plate is 80 mm . **20**

Q3 Determine the stress distribution of N_ϕ at the center span of a simply supported symmetrical cylindrical shell of radius 13m , span 18 m and central angle 150^0 under dead load and live load intensity of 2 KN/m^2 (total). Assume $\partial N_x/\partial x + \partial N_{\phi x}/R\,\partial\phi + X = 0$, $\partial N_{x\phi}/\partial x + \partial N_\phi/R\,\partial\phi + Y = 0$ and $N_\phi/R + Z = 0$ where X, Y, Z = surface loading / unit area. Why the edge beam is needed along the free edges of the shell ? Find the maximum tension in the edge beam. **20**