Ref. No. : Ex/CE/T/413/2018

Name of the Examinations: B.E. CIVIL ENGINEERING FOURTH YEAR FIRST SEMESTER - 2018

Subject : THEORY OF STRUCTURES-IV Time : Three hours Full Marks : 100

Part I

Instructions : Use Separate Answer scripts for each Group / answer any two questions

Question 1

a) Write the properties of Lagrange Interpolation Function. (3)

b) Develop the Interpolation functions of a Cubic Lagrangian one dimensional finite element. (5)

c) The behaviour of a physical variable 'u(x)' within a physical domain 0<x<3 follows the differential equation as

$$-\frac{d}{dx}(2\frac{du}{dx}) + u - x^2 = 0 \text{ with u = 0 at x = 0 and } \frac{du}{dx} = 1 \text{ at x = 2.}$$

i) Develop the governing finite element (FE) equation for the problem after discretizing the domain into three (3) equally sized linear FE based on weak variational form.

ii) Show the assembled matrix equation for the entire domain citing proper assembling logic. (15 + 7)

Question 2

a) Obtain the equilibrium equation of a planar 2-D problem in polar coordinates. (5)

b) Develop the compatibility equation in polar coordinate in terms of Airy's Stress function. (5)

c) Obtain the expression for stresses in polar coordinates for a 2-D problem. (5)

d) A plate of length 'L' and width 'W' having a circular hole of diameter '2a' at its centre is subjected to a uniform tension applied at its two opposite ends. Find the stress distribution along the cross section through the hole if 2a<<L, B. (15)

Question 3

a) Develop the strain transformation relationship for shear strain. (7)

b) Define hydrostatic and deviatoric stress. (3)

c) Develop the relationship between octahedral shear stress and the deviatoric component of stress invariant. (5)

d) Obtain the relationship for Young's Modulus (E), Shear Modulus (G) and Poisson's ratio in terms of Lame's Parameters. (3 x 3)

e) Obtain the stress-strain elastic constitutive relationship for plane strain problem. (6)

B.E Civil Engineering Fourth Year First semester -2018

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Theory structures –IV

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Use separate answer script for each part

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 9 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 300 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 4 X 4 m simply supported at the edges carrying a central concentrated load of 30 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 70 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 20 m and central angle 160^0 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**