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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

First Semester, M. Tech - Civil Engineering (MCAD)

Semester End Examination; Jan/Feb. - 2016

Continuum Mechanics-Classical and EF Approach

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each **unit**.*

ii) If any missing data, Assume suitably.

UNIT - I

1 a. Distinguish between plane stress and plane strain idealizations. 4

b. Derive the expressions for equilibrium of a three dimensional problem in Cartesian coordinate system. 8

c. In a stress field, displacement components are as follows :

$u = x^3 + 2y^2 + 3z - 5$; $v = x^2 + 3y^3 + 4z - 7$

$w = x - 4y^2 + 2z^3 + 3$; 8

Find whether the compatibility conditions are satisfied.

2 a. Define generalized Hook's Law. Obtain the expressions for stress strain relationships in a three dimensional problem in Cartesian coordinate system. 10

b. In the absence of body forces, the state of stress at a point is given as follows :

$\sigma_x = x + y$; $\sigma_y = x - 2y$; $\sigma_z = y$; $\tau_{xy} = \alpha = f(x, y)$; $\tau_{zy}; \tau_{zx} = 0$. 10

Find α such that the system is in equilibrium.

UNIT - II

3 a. Define St Venant's Principle. Explain its significance in solution to engineering problems. 5

b. Check whether $\phi = Ax^2$ is a valid stress function. Mention the type of engineering problem solved by it. 5

c. A cantilever beam of uniform rectangular section is subjected to a point load P at its free end. The stress distribution to the problem is defined by $\sigma_x = A_{xy}$; $\sigma_y = 0$; $\tau_{xy} = B + Cy^2$; Determine the constants A, B and C. Also determine the strain components and find whether they are compatible. 10

4 a. What are Airy's stress functions? Mention their importance in solution to engineering problems. 5

b. Check whether $\phi = By^3$ is a valid stress function. Mention the type of engineering problem solved by it. 5

c. A simply supported beam of rectangular cross section is loaded with a point load at its mid span. Assuming a suitable stress function, obtain the expressions for stress components and strain components for the beam. 10

UNIT - III

5 a. What are compatibility equations? Explain their significance. 4

b. Derive the expressions for equations of equilibrium of a two dimensional system in polar coordinates. 8

c.	Assuming a suitable stress function, obtain the expressions for stress components of a beam of rectangular cross section subjected to pure bending.	8
6 a.	Obtain strain - displacement relations for a two dimensional system in polar coordinates.	10
b.	Obtain the expressions for stress components of a thick cylinder subjected to internal and external fluid pressure assuming a suitable stress function. Obtain the variations in radial and tangential stresses across the thickness of cylinder when the external pressure is absent.	10

UNIT - IV

7 a.	What are stress invariants? Write down the expressions for stress invariants.	4
b.	Given stress at a point as follows : $[\sigma]=\begin{bmatrix}10 & 4 & 8\\ 4 & 20 & -6\\ 8 & -6 & -30\end{bmatrix}\ MPa$ Find principal stresses, maximum shear stresses, octahedral stresses with respect to principal stresses and plane of intermediate principal stress.	16
8 a.	What are hydrostatic and deviatoric stresses? Explain their significance.	4
b.	Given strain at a point as follows E_x = - 0.004, E_y = 0.002, E_z = 0.006, γ_{xy} = - 0.002, γ_{yz} = 0.003, and γ_{zx} = 0.004, find principal strains, maximum shear strains, octahedral strains with respect to principal planes and plane of minor principal strain.	16

UNIT - V

9 a.	Write the shape functions for a CST element. Sketch neatly the variations of shape function N_2.	4
b.	For the CST element shown in Fig. 9 b, find the strain displacement matrix, element strains and element stresses. The nodal coordinates are in mm. The nodal displacement are {q} = [0.001, 0.003, - 0.002, - 0.004, 0.002, 0.005]^T mm. Assume plane stress condition. Take; E = 200GPa and μ = 0.3.	8

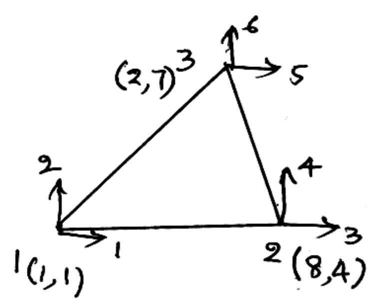

Fig 9b

c.	Derive the Jacobian matrix of a four noded quadrilateral element.	8
10a.	Derive the shape functions of one corner node and one mid side node of a six noded triangular element.	6
b.	Show that the convergence requirements of an isoparametric element can be satisfied if $\sum N_i = 1$.	8
c.	Evaluate the following integral by Gauss Quadrature using three point approximation, $I = \int_{-1}^{1} \cos\left(\frac{\pi x}{2}\right) dx$	6

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