Mid-West University

Examinations Management Office

End Semester Examinations-2080

Master level/Structural Engineering /1st Semester — Full Marks: 60

Time: 3 hours — Pass Marks: 30

Subject: Advanced Mechanics of Solid (STR513/MSTR503)

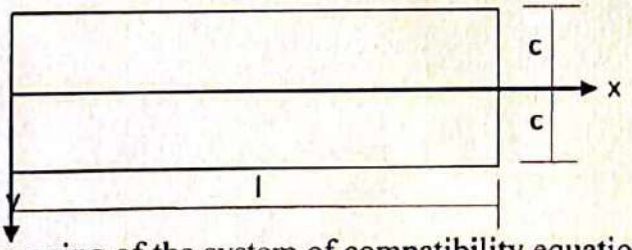
- *Candidates are required to answer the questions in their own words as far as possible.*
- *Assume suitable values, with stipulation, if necessary.*
- *Figures in margin indicate full marks.*
- *Attempt any Five questions*

1. a) Using Kronecker delta function find out the multiplication of 2nd order tensor and a vector. [4]

   b) At a point inside a solid body the principle stresses determined are: $\sigma_1 = 50$ N/cm^2 , $\sigma_2 = -50$ N/cm^2 and $\sigma_3 = 75$ N/cm^2. Calculate the normal stress and the shear stress on the plane equally inclined to the principal axes for this stressed condition. [8]

2. a) Explain the concept of strain tensor and write the expression for strain tensor. Give the strain tensor in matrix form when the axes of coordinates are principal ones. [4]

   b) Determine the necessary relationship among the coefficients of the 4th degree homogeneous algebraic polynomial to be suitable for Airy's stress function in a plane problem in Cartesian coordinates. Give stress conditions at the edges of the plate shown when all the other coefficients except fourth one (that of xy^3) of the polynomial are zeros. [8]

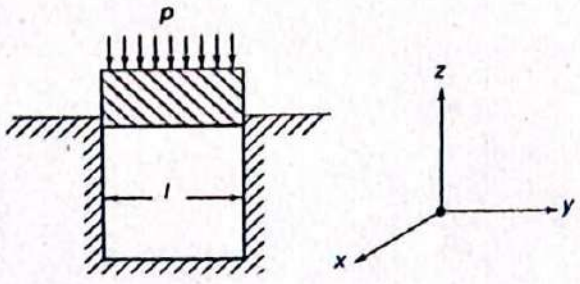


3. a) Give the physical meaning of the system of compatibility equations and derive them in Cartesian coordinates. Give its particular form when it is for plane problems. [4]

   b) The displacement component functions for a strained body are given as: $u_x = x^2 + y$, $u_y = 3 + z$, $u_z = x^2 + 2y$, calculate the principal strains at the point (3,1,-2) and the direction of the minimum principal strain. [8]

4. a) Derive elastic constitutive relationship in Lame's form. Discuss the necessity of only two physical constants in these relationships. [4]

   b) A rubber cube is inserted in a cavity of the same form and size in a steel block and the top of the cube is pressed by a steel block with a pressure of p pascals. Considering the steel to be absolutely hard and assuming that there is no friction between steel and rubber, find (i) the pressure of rubber against the box walls, and (ii) the extremum shear stresses in rubber. Assume value of poison's ratio is 0.4. [8]



5. a) Define biharmonic function and explain it through Laplace operator in Cartesian coordinates. [4]

b) The Constants of Lame for Steel are given to be as follows: [8]
$\lambda = 1.1398 * 10^5$ MPa and $\mu = 0.8 * 10^5$ MPa. Calculate the stress matrix at a point where strain matrix is as follows:

$$\begin{pmatrix} 0.001 & 0 & -0.002 \\ 0 & -0.003 & 0.0003 \\ -0.002 & 0.0003 & 0 \end{pmatrix}$$

THE END

ME - Adv. mech of solids