THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
DIPLOMA IN TECHNOLOGY – LEVEL 06
FINAL EXAMINATION 2009/2010
MEX 6330 – MECHANICS OF MATERIALS
DATE : 01ST APRIL 2010
TIME : 1400 HRS - 1700 HRS
DURATION : 03 HOURS

ANSWER ANY FIVE (05) QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS.

QUESTION 01:

The stress function $\phi = Axy + Bxy^3$ can be used to get a solution for the plane stress problem indicated in Fig.Q1.

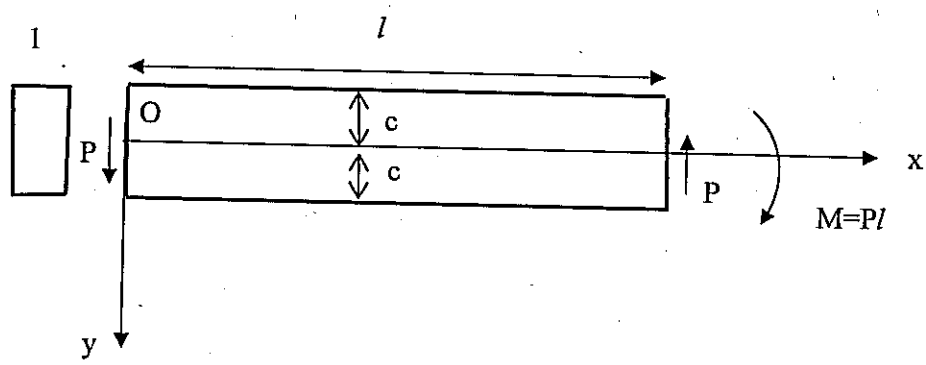


Fig.Q1

(a) Determine the constants so that the sides $y = \pm c$ are free from traction and the force P on the end $x = 0$ is acting downwards.

(12 Marks)

(b) Verify from the stress distribution that the bending moment M on a section where x = constant, has the value Px.

(08 Marks)

QUESTION 02:

(a) What is meant by an isotropic material? *(03 Marks)*

(b) State the generalized Hook's Law for an isotropic body using index notation and with appropriate description of the terms used in your definition

(07 Marks)

(c) For the element subjected to a two dimensional stress system as shown in Fig.Q2, verify that the Young's Modulus (E) and the Poisson's ratio (v) are given by

$$E = \frac{\mu(3\lambda + 2\mu)}{(\lambda + \mu)} \quad \text{and} \quad \upsilon = \frac{\lambda}{2(\lambda + \mu)}$$ *(10 Marks)*

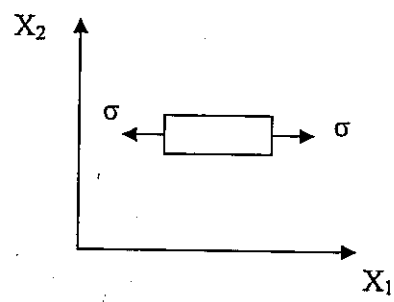


Fig.Q2

QUESTION 03:

(a) Write down the properties of stress tensor *(05 Marks)*

(b) A state of stress is given by

$$\sigma_{ij} = \begin{bmatrix} -110 & 45 & 25 \\ 45 & 130 & -60 \\ 25 & -60 & 60 \end{bmatrix}$$

(i) Find the invariants I_1, I_2 and I_3.
(ii) Write the equation to find the principal stresses using these invariants

(15 Marks)

QUESTION 04:

(a)

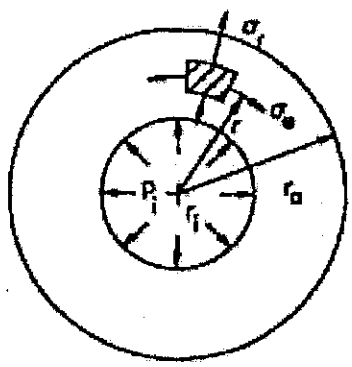


Fig.4(a)

A thin circular angular disk is subjected to a uniform pressure at its inner radius. At any radius r_0 Fig.4 (a), the radial stress is given by $\sigma_r = A + B/r^2$, where A and B are constants. Find an expression for σ_θ.

(05 Marks)

(b) A hollow circular cylinder with inner and outer radii r_i and r_o respectively, undergoes a radial displacement $u = Ar + B/r$ and v = w = 0.

(Where '**v**' is the tangential displacement and '**w**' is the displacement in the direction of cylinder axis.)

Determine the corresponding strains and stresses and the constants A and B. Check if the stresses satisfy the equilibrium equations. Neglect body forces and assume elastic deformations.

(15 Marks)

QUESTION 05:

An air craft panel has a central crack of length 2.5 mm for which $K_I = \sigma\sqrt{\pi a}$, where a = half the crack length. Failure by plain strain will occur when the crack grows to a length of 4.04 mm. Determine the number of fatigue load cycles that the panel will withstand before plain strain fracture occurs if each load cycle produces a stress cycle of 0 to 700 MNm^{-2}.

The panel material obeys the following crack propagation relationship:

$$da/dN = 1.1 \times 10^{-39}(\Delta K)^4$$

where da/dN and ΔK have the units m/cycle and $MNm^{-3/2}$ respectively.

(20 Marks)

QUESTION 06:

For the given stress function

$$\phi = \frac{-p}{2\pi}\left[\left(x^2+y^2\right)\tan^{-1}\frac{y}{x} - xy\right]$$

(a) Derive the stress distribution to show that

$$\sigma_x = \frac{-p}{\pi}\left[\tan^{-1}\frac{y}{x} + \frac{xy}{x^2+y^2}\right];$$

$$\tau_{xy} = \frac{-p}{\pi}\left[\frac{y^2}{x^2+y^2}\right];$$

$$\sigma_y = \frac{-p}{\pi}\left[\tan^{-1}\frac{y}{x} - \frac{xy}{x^2+y^2}\right]$$

(12 Marks)

(b) Following stress tensors represent two stress fields. Check whether these stress fields are within an elastic structural member.

(i) $\begin{bmatrix} c_1x+c_2y & c_5x-c_1y \\ c_5x-c_1y & c_3x+c_4 \end{bmatrix}$ (ii) $\begin{bmatrix} -\frac{3}{2}x^2y^2 & xy^3 \\ xy^3 & -\frac{1}{4}y^4 \end{bmatrix}$

Where c_1, c_2, c_3, c_4 and c_5 are constants and assume that the body forces are negligible.

(08 Marks)

QUESTION 07:

(a) Explain briefly the following terms using appropriate diagrams.

(i) Birefringence
(ii) Polarisation
(iii) Isocromatics
(iv) Isoclinics

(12 Marks)

(b) Discuss the photoelastic method and the elastic strain gauge technique of stress analysis considering the suitability of each method for a particular application.

(04 Marks)

(c) Illustrate the reflective coating techniques.

(04 Marks)

QUESTION 08:

(a) State five methods generally used in experimental stress analysis. Briefly explain two of them.

(09 Marks)

(b) What is the " Gauge factor" of electrical resistance strain gauge? Describe an experiment you would conduct to determine the gauge factor of such a gauge.

(04 Marks)

(c) What are the important advantages and disadvantages of using electrical resistance strain gauges over the other methods of experimental stress analysis?

(07 Marks)

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