THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
BACHELOR OF TECHNOLOGY – LEVEL 06
FINAL EXAMINATION 2011/2012
MEX 6330 – MECHANICS OF MATERIALS
DATE : 22nd MARCH 2012
TIME : 1400HRS - 1700 HRS
DURATION : 03 HOURS

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

Question No.01

a) State the Airy's stress function for a 2-D state of stress

b) A large thin plate is subjected to uniform tensile stress σ_0 at its ends as shown in Fig.Q1. Determine the field of stress existing within the plate in polar coordinates.
Stress function $\phi = \sigma_0 y^2/2$

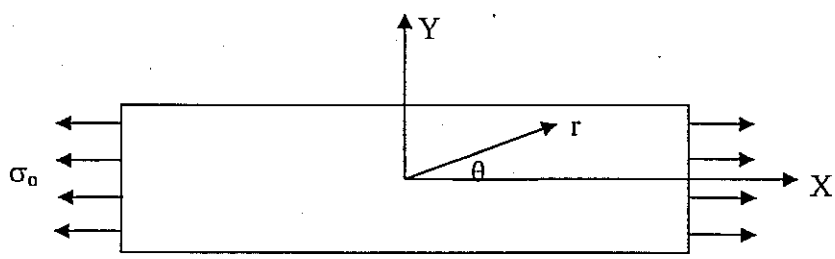


Fig.Q1

Question No.02

a) Explain the causes for fatigue failure and the methods to improve the fatigue strength of a material.

b) Large grain bins are fabricated with thin sheet metals of low alloy steel. For a steel of ultimate stress σ_u=1300MPa, the stress intensity factor (K_C) is measured in a thin sheet to be 69 MPa$\sqrt{m}$. The design code specifies a safety factor of 2.2. A thin sheet metal is tested in the laboratory and for a thin sheet in plane stress, σ_C at fracture is found to be given by $\sigma_c = \frac{K_C}{\sqrt{\pi a}}$. Determine the maximum allowable crack length of a central crack in the sheet of steel.

Question No.03

a). Explain why electrical resistance strain gauges are very popular for measurement of strain.

b). Two strain gauges A and B are mounted on a surface at $\pm 45^0$ with respect to the X- axis as shown in Fig.Q3(a). They are connected to a Wheatstone bridge as indicated in Fig.Q3(b). Show that the output from the bridge can be used to measure the shear strain(γ_{xy}) if R_1 and R_2 represent A and B respectively.

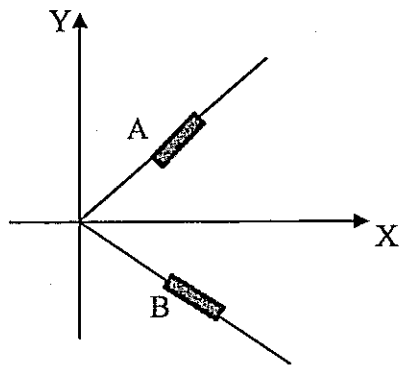


Fig. Q3(a)

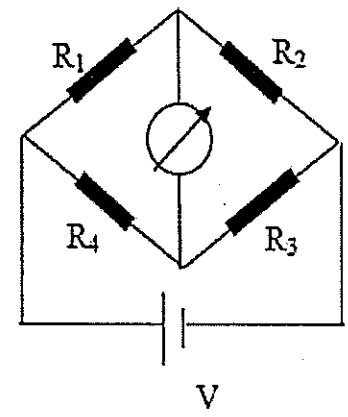


Fig.Q3 (b)

Question No.04

a) Generalized Hook's Law for an isotropic body can be written in the usual notation as

$$\sigma_{ij} = \lambda \varepsilon_{kk} \delta_{ij} + 2\mu \varepsilon_{ij}$$

Where $\delta_{ij} = 1$ for $i = j$, $\delta_{ij} = 0$ for $i \neq j$ and λ *and* μ are constants that depend upon the material properties. Obtain the following relationships for the elastic constants E, υ and G.

(i) $\upsilon = \dfrac{\lambda}{2(\lambda+\mu)}$ and $\mu = \dfrac{E}{2(1+\upsilon)}$ (you may consider the case of simple tension)

(ii) $G = \mu$ (you may consider the case of pure shear)

b) Find the Lame's constants if the value of modulus of elasticity (E) and modulus of rigidity (G) for an alloy are 200Gpa and 80GPa. Hence or otherwise determine the component of shear strain τ_{ij}, if

$$\varepsilon_{ij} = \begin{bmatrix} 0.001 & 0 & -0.002 \\ 0 & -0.003 & 0.0005 \\ -0.002 & 0.0005 & 0 \end{bmatrix}$$

Question No.05

(a) List main components of the plane polariscope and describe PPD field arrangement.

(b) Describe the difference between isoclinics and isocromatics

(c) How do you identify isoclinics and isocromatics separately using a plane polariscope?

(d) What are the possible arrangements for a circular polariscope to produce either a light field or a dark field?

Question No.06

a) Describe the common theories of elastic failure and illustrate them with the aid of graphical representations.

b)

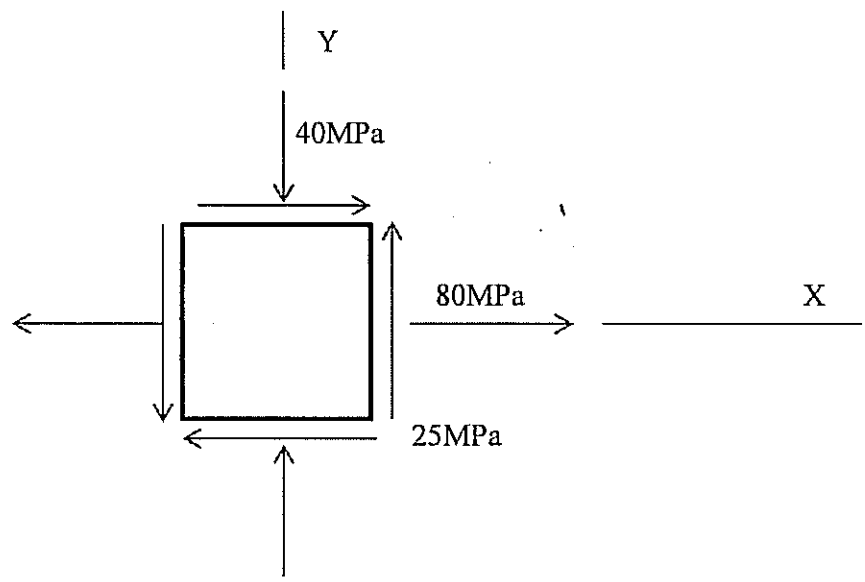


Fig. Q6

The state of plane stress shown in Fig.Q6, occurs at a critical point of a steel machine component. As a result of several tensile tests, it has been found that the tensile yield strength is 250MPa for the grade of steel used. Determine the factor of safety with respect to yield, using

(i) The maximum shear stress theory
(ii) The maximum distortion energy theory

Question No.07

a) State the St.Venent's Principle.

b) Briefly explain the following,

(i) Engineering Stress
(ii) Engineering Strain
(iii) True Stress
(iv) True Strain

Question No.08

a) In a stressed body a crack can propagate in combination of three different opening modes. Explain them with appropriate sketches.

b) A cylindrical component, which has a diameter of 1.5 m and a wall thickness of 100 mm is subjected to an internal pressure of 15 MN/mm^2. If the cylinder is made of a material, where the fracture toughness (K_{IC}) is 138 $MN/mm^{3/2}$, find the number of pressurization cycles the cylinder can withstand, if nondestructive tests reveal that no flaw above 10 mm exists within the cylinder.

Assumptions:
Treat the cylindrical component as a thin cylinder.
The flaw is sharp and perpendicular to the direction of hoop stress.

Crack growth is given by $da/dN = C(\Delta k)^m$ where $C = 3x10^{-12}$, $m = 3.8$

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