The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Diploma in Technology/Bachelor of Technology (Engineering)
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX6330 Mechanics of Materials**
Academic Year	:	2012/13
Date	:	22nd August 2013
Time	:	0930hrs – 1230hrs
Duration	:	3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of 8 questions. All questions carry equal marks.
3. Answer any 5 questions only.

Question 01:

Describe any TWO of the following

(a) Failure of ductile and brittle materials *(10marks)*

(b) Experimental determination of plane strain Fracture Toughness (K_{IC}) and the practical difficulties encounted in such determination. *(10marks)*

(c) Application of Fracture Mechanics in engineering design. *(10marks)*

Question 02:

(a) List the main components of a plane polariscope and describe the functions of each of them. *(05marks)*

(b) What is the difference between a plane polariscope and a circular polariscope? *(05marks)*

(c) Briefly describe the two basic arrangements in circular polariscopes. *(05marks)*

(d) Describe how you would use a polariscope to determine the principal stresses and the principal directions at different points in a given specimen. *(05marks)*

Question 03:

(a) What is the basic principle behind strain gauges? *(02marks)*

(b) List out the required properties of a strain gauge. *(03marks)*

(c) What are the uses of strain gauges? *(03marks)*

(d) In order to determine the state of strains a rectangular rosette of strain gauges is arranged on the surface of a material under stress, as shown in Fig. Q3.

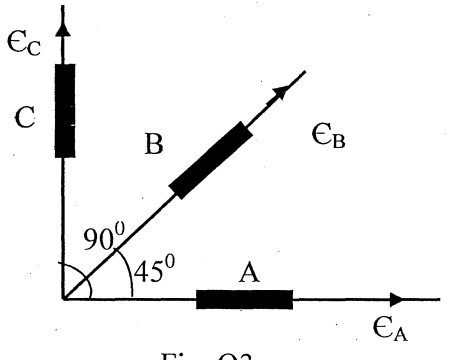


Fig. Q3

The gauges recorded the following readings of strain.

Gauge A: $450X10^{-6}$ Gauge B: $200X10^{-6}$ Gauge C: $-200X10^{-6}$

Determine the magnitudes of the principal strains and the directions of the principal strain axes.

(12marks)

Question 04:

(a) What is meant by the term "index notation"? *(03marks)*

(b) List out the properties of the stress tensor. *(03marks)*

(c) The known stress components at a point in a body, relative to the (x,y,z) axes, are $\sigma_{xx} = 20MPa$, $\sigma_{yy} = 10MPa$, $\sigma_{xy} = 30MPa$, $\sigma_{xz} = -10MPa$, $\sigma_{yz} = 80MPa$. Also the second stress invariant is $I_2 = -7800(MPa)^2$.

(i) Determine the stress component σ_{zz}. Thus determine the stress invariants I_1 and I_3 and the three principal stresses.

(ii) Show that I_1, I_2 and I_3 are the same relative to (x,y,z) and relative to principal axes (1,2,3)

(14marks)

Question 05:

Airy stress function $\emptyset = \frac{My^3}{6I}$ represents the 2 –D plane stress beam problem illustrated in Fig.Q5. Show that the boundary loading conditions are satisfied.

Given that at the origin (O) both x, y displacements as well as the gradient of the neutral axis are zero and on the y-z plane the x displacement is zero, find expressions for u, v as functions of x, y. Show that the deflected form of the neutral axis (y = 0) is given by $v = -\frac{Mx^2}{2EI}$

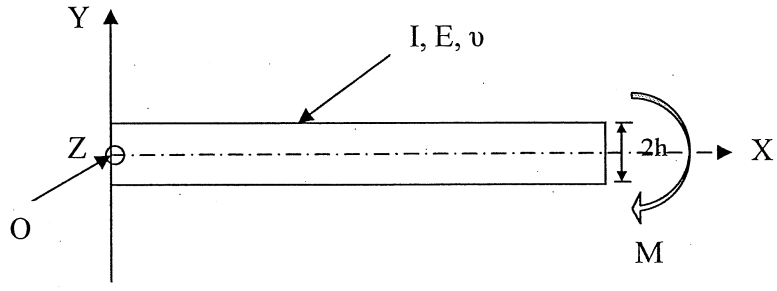


Fig.Q5

(20marks)

Question 06:

Determine the intensities of principal stresses in a flat steel disk of uniform thickness having a diameter of 1m and rotating at a speed of 2400 r.p.m.
What will be the stresses if the disk has a central hole of 0.2m diameter?

Take Poisson's ratio = 1/3 and the density of the material ρ = 7850 kg/m^3.

Note: The intensities of radial and circumferential (or hoop) stresses are given by:

$$\sigma_r = \frac{C_1}{2} + \frac{C_2}{r^2} - \left[\frac{3+\frac{1}{m}}{8}\right]\rho\omega^2 r^2$$

$$\sigma_h = \frac{C_1}{2} - \frac{C_2}{r^2} - \left[\frac{1+\frac{3}{m}}{8}\right]\rho\omega^2 r^2$$

(20marks)

Question 07:

(a) State the following stress theories
(i) Tresca stress Criterion
(ii) Von-Mises stress Criterion

(08marks)

(b) A machine component consisting of a steel tube is used to transmit torque from its prime mover. The tube has a thickness of 4mm with a mean diameter of 90mm. The elastic limit of steel in tension is 225 MN/m and the Poisson's ratio (υ) is 0.3. Assuming a safety factor of 2.5, calculate the torque that can be transmitted by the tube when the criterion for failure is taken as;

(i) maximum shear stress (Tresca criterion)
(ii) maximum strain energy
(iii) maximum shear strain energy (Von-Mises)

(12marks)

Question 08:

(a) Lame's equations are given by

$\sigma_r = \frac{b}{r^2} - a$ and $\sigma_h = \frac{b}{r^2} + a$

State the assumptions made in the development of Lame's theory

(06marks)

(b) A thick walled closed-end cylinder made of an Aluminium alloy has an inside diameter of 200mm and an outside diameter of 800mm. The cylinder is subjected to an internal fluid pressure of 150MPa. Determine the principal stresses and the maximum shear stress at a point on the inside surface of the cylinder. Also determine the increase in inside diameter due to fluid pressure.

$E_{Al\ alloy} = 72$ GPa, $\upsilon = 0.33$

(14marks)

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