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	:	**MEX6230 Mechanics of Materials**
Academic Year	:	2016/17
Date	:	19th November 2017
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.
3. Answer any 5 questions. All questions carry equal marks.

Q1 a) Explain the term "Index Notation" of a Cartesian coordinate axis system (X_1, X_2, X_3).

[3 Marks]

b) Write down the properties of a stress tensor.

[5 Marks]

c) Write short notes on the following terms.
   i) Transformation law for stress at a point
   ii) Forces acting in a continuum

[6 Marks]

d) The state of stress at a point in a machine part is given by,

$$\sigma_{ij} = \begin{bmatrix} -110 & 35 & 30 \\ 35 & 180 & -90 \\ 30 & -90 & 50 \end{bmatrix} MPa$$

Find the values of three invariants I_1, I_2, and I_3.

[6 Marks]

Q2 Describe the following terms using appropriate figures.

i. Transformation law for strain
ii. Strain-Displacement relationship
iii. Physical interpretation of strain tensor
iv. Properties of the strain tensor

[20 Marks]

Q3 a) Describe 'Plane Stress' and 'Plane Strain' relationships of a thin plate using appropriate equations.

[6 Marks]

b) State the Airy's stress function for a two dimensional state of stress.

[4 Marks]

c) A large thin plate is subjected to uniform tensile stress σ_0 at its ends as shown in *Figure Q3*. Determine the field of stress existing within the plate in the terms of σ_0 and θ.

Stress function $\emptyset = \sigma_0 y^2/2$

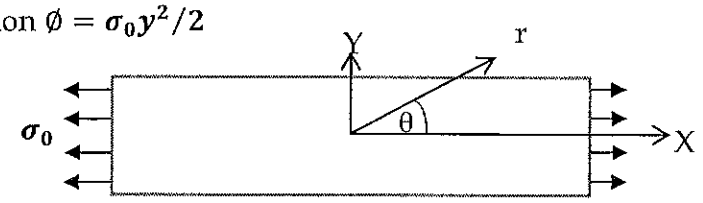


Figure Q3

[10 Marks]

Q4 a) State all types of strain gauges and briefly describe the features of two of them.

[8 Marks]

b) The state of strain at a point on a bracket is measured using the strain rosette shown in ***Figure Q4***. The readings from the respective strain gauges A, B and C are 50 x 10^{-6}, 125 x 10^{-6} and 250 x 10^{-6} respectively. Determine the plain principle strains of the gauge.

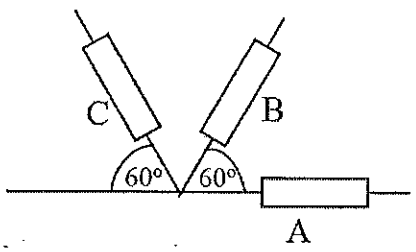


Figure Q4

Note: You may use following equations with usual notations.

Strain gauge rosette equation,

$$\varepsilon = \varepsilon_x \cos^2\theta + \varepsilon_y \sin^2\theta + \gamma_{xy} \sin\theta \cos\theta$$

Principle strains,

$$\varepsilon = \left[\frac{\varepsilon_x + \varepsilon_y}{2}\right] \pm \sqrt{\left[\frac{\varepsilon_x - \varepsilon_y}{2}\right]^2 + \left(\frac{\gamma_{xy}}{2}\right)^2}$$

[12 Marks]

Q5 a) Explain the term 'Polarization'

[4 Marks]

b) Describe the arrangement of 'Plane Polariscope' and 'Circular Polariscope'

[6 Marks]

c) Briefly describe the differences between 'Isoclinics' and 'Isocromtics'

[6 Marks]

d) What are the important properties of the material used for the Polariscope model?

[4 Marks]

Q6 a) Explain yield criteria for a ductile material.

[5 Marks]

b) When the loads on a hub of a fly wheel reach their working values, the non-zero stress components at the critical point in the hub where yield is initiated are σ_{xx} = 100 MPa, σ_{yy} = -14 MPa and σ_{xy} = 50 MPa. The load-stress relations are linear, so that the factor of safety can be applied either to loads or stress components. The fly wheel material has a yield stress (Y) of 300 MPa.

i. Assuming the material is 'Tresca material', determine the factor of safety against yield.

ii. Assuming the material is 'Von-Misses material', determine the factor of safety against yield.

iii. Determine which criterion, Tresca or Von-Misses, is more conservative

Note: You may use following equation with usual notations to obtain principle stresses.

$$\sigma_p^3 - I_1\sigma_p^2 + I_2\sigma_p - I_3 = 0$$

σ_p – Principle Stress

[15 Marks]

Q7 a) Explain the causes for fatigue failure and methods to improve the fatigue strength of a material.

[6 Marks]

b) Briefly explain following terms in relation to fatigue behavior using the S/N curve for fatigue life.

i) Stress Amplitude
ii) Mean Stress
iii) Fatigue Limit
iv) Endurance Limit

[8 Marks]

c) State and explain the factors which influence the creep of a material.

[6 Marks]

Q8 a) Explain the three opening modes of crack propagation of a stressed body.

[6 Marks]

b) Explain three microscopic fracture mechanisms.

[6 Marks]

c) The fracture toughness (K_{IC}) of Titanium alloy is 44 $MPam^{0.5}$. A penny shape crack of diameter 1.6 cm is presented in plate subjected to uni-axial tension as shown in *Figure Q8*. Calculate the maximum stress that can be imposed without fracture.
Yield stress = 900 MPa
Plate Thickness = 5 cm

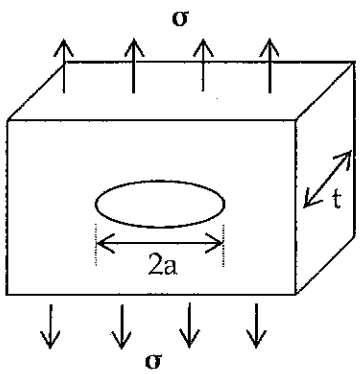


Figure Q8

[8 Marks]

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