UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 3 Examination in Engineering: August / September 2018

Module Number: ME3304 **Module Name: Strength of Materials**

[Three Hours]

[Answer **all questions**, each question carries **twelve** marks]

(State the assumptions where necessary and do the calculations stating the units)

Q1. a) Explain the step by step process of fatigue crack growth.

[3.0 Marks]

b) What are the roles of the following kinds of stress in fatigue failure?

i) Compressive stress

ii) Tensile stress

ii) Shear stress

[3.0 Marks]

c) Describe all the steps involved with ductile failure.

[2.0 Marks]

d) Modulus of elasticity of steel is 2.3×10^{11} Pa. Calculate the theoretical fracture strength of steel.

[2.0 Marks]

e) Actual fracture strength of steel is 2.28×10^{8} Pa. Is there any difference between actual and theoretical fracture strength values of steel? If it is so, what are the reasons for that?

[2.0 Marks]

Q2. a) Briefly describe the Transgranular and Intergranular fracture in brittle materials.

[2.0 Marks]

b) Discuss three methods which are used to strengthen the metals.

[2.0 Marks]

c) Explain two methods of reducing stress concentrations.

[2.0 Marks]

d) What is meant by:

i) The stress intensity factor

ii) The critical stress intensity factor

[2.0 Marks]

e) A 4 mm thick tension panel 10 cm wide containing an edge crack of 1.5 mm yielded at a load of 150 kN. However, at a load of 120 kN, another panel of same material cracked into two pieces when the crack was 4 mm long. With this information, calculate the yield stress and fracture toughness of the material. (Hint, $K_I = 1.12\,\sigma\sqrt{\pi \cdot a}$)

[4.0 Marks]

Q3. a) Differentiate Primary creep, Secondary creep and Tertiary creep of materials.

[3.0 Marks]

b) What are the places which we can see creep failures?

[2.0 Marks]

c) What are the necessities of performing creep tests?

[3.0 Marks]

d) Suggest and explain a method to perform a creep test for a particular material (Metallic).

[4.0 Marks]

Q4. a) Define the following terms.

i) Elastic limit
ii) Factor of safety
iii) Poisson's ratio
iv) Generalized Hook's law

[4.0 Marks]

b) Establish a relationship between the modulus of elasticity and the bulk modulus (considering volumetric strain).

[3.0 Marks]

c) Sketch and explain typical stress-strain curve for steel indicating all salient points and zones on it.

[3.0 Marks]

d) What is meant by normal stress and shear stress? What are the effects of normal and shear stresses on a body?

[2.0 Marks]

Q5. a) Define the principle planes and principle stresses.

[2.0 Marks]

b) Show that the sum of the normal stresses on any two planes of right angles in a general two dimensional stress system is constant.

[2.0 Marks]

c) Explain the procedure for constructing Mohr's circle for a stressed body.

[2.0 Marks]

d) At a certain point in a strained material the values of normal stresses across two planes at right angle to each other are 80 MPa and 32 MPa, and there is a shear stress of 32 MPa clock wise on the plane carrying 80 MPa stress across the plane as shown in Fig. Q5.

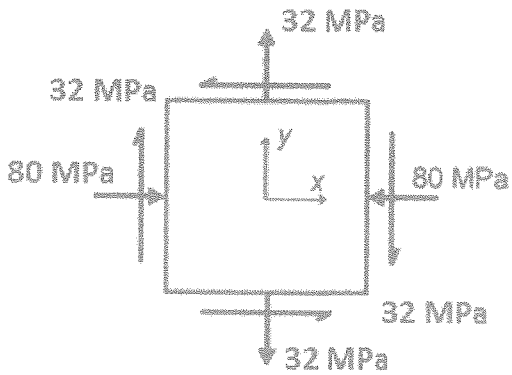

Figure Q5

i) Determine the maximum and minimum normal stress and locate their planes.

[2.0 Marks]

ii) Determine the maximum shear stress and specify its plane.

[2.0 Marks]

iii) What would be the effect on these results if owing to a change of compressive loadings to tensile while shear stresses and other normal stress remain unchanged?

[2.0 Marks]