UNIVERSITY OF RUHUNA

Faculty of Engineering

Mid-Semester 6 Examination in Engineering: November 2014

Module Number: ME 6316 **Module Name: Strength of Materials**

[Two Hours]

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

Q1. a) A steel bar having square cross section with one side dimension of 2 cm is subjected to an axial compressive load of 40 kN. Determine the normal and shear stresses acting on a plane inclined at 30° to the line of action of the axial loads using analytical methods.

[2.0 Marks]

b) A plane element removed from a thin-walled cylindrical shell loaded in torsion is subjected to the shearing stresses shown in Figure Q1. Determine the principal stresses existing in this element and the directions of the planes on which they occur. [3.0 Marks]

Q2. A plane element is subjected to the stresses as shown in Figure Q2. Using Mohr's circle, determine

a) The principal stresses and their directions [2.5 Marks]

b) The maximum shearing stresses and the directions of the planes on which they occur. [2.5 Marks]

Q3. a) Explain the following terms;

I. Proof stress

II. Ductile to Brittle Transition Temperature (DBTT)

III. Intergranular fracture [2.0 Marks]

b) A cylindrical Aluminum specimen having a diameter of 12.8 mm and a gauge length of 50.800 mm is pulled in tension. Use the load-elongation characteristics shown in the Table Q3 to obtain the followings:

I. A plot of the stress-strain relationship. Label the axes and show units. (Use the graph sheet provided) [1.0 Marks]

II. Determine **modulus of elasticity** and **tensile strength.** [1.0 Marks]

III. Determine the yield strength at a 0.2% of total strain. [0.5 Marks]

IV. What is the approximate ductility, in percentage of elongation?

[0.5 Marks]

Q4. a) Using suitable sketches, define the term "Stress concentration factor (K_t)".

[1.0 Marks]

b) A machine component is fabricated from medium carbon steel that has a plane strain fracture toughness of 32MPa $m^{1/2}$. It has been determined that fracture results at a stress of 250 MPa when the maximum (or critical) internal crack length is 2.0 mm. For the same component, will fracture occur at a stress of 315 MPa when the maximum internal crack length is 0.8 mm? Justify your answer.

[2.0 Marks]

c) An aluminum alloy plate has a plane strain fracture toughness of 40 MPa.$m^{1/2}$. If, during service use, the plate is exposed to a tensile stress of 180 MPa; determine the minimum length of the surface crack that will lead to fracture. Assume Y= 0.9, which depends on crack and size of the specimen.

[2.0 Marks]

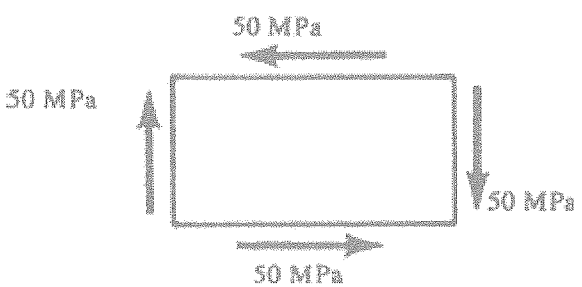

Figure Q1

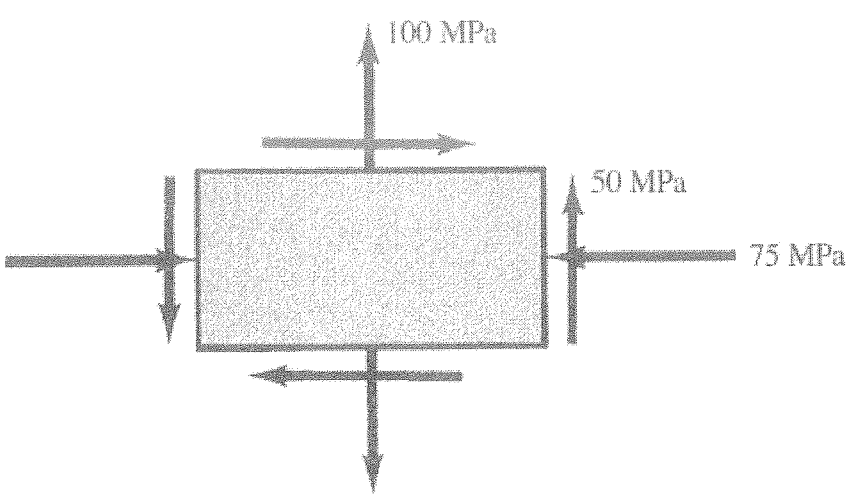

Figure Q2

Table Q3: Load-elongation characteristics

Load (N)	Length (mm)
0	50.800
7330	50.851
15100	50.902
23100	50.952
30400	51.003
34400	51.054
38400	51.308
41300	51.816
44800	52.832
46200	53.848
47300	54.864
47500	55.880
46100	56.896
44800	57.658
42600	58.420
36400	59.182