UNIVERSITY OF SASKATCHEWAN
ME 313.3 – MECHANICS OF MATERIALS I
MIDTERM EXAM – OCTOBER 19, 2006

Professor A. Dolovich

A CLOSED BOOK EXAMINATION
TIME: 2 HOURS

For Marker's Use Only

LAST NAME (printed): _____ 1. _____

FIRST NAME (printed): _____ 2. _____

STUDENT NUMBER: _____ 3. _____

EXAMINATION ROOM: _____ 4. _____

SIGNATURE: _____ Total: _____

INSTRUCTIONS

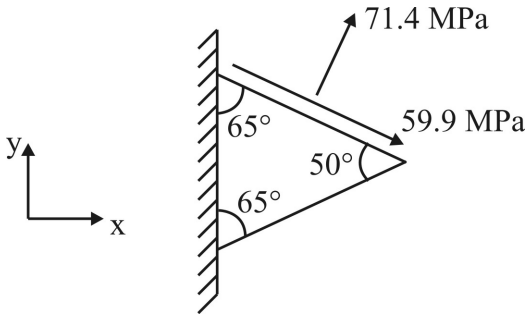
1. The examination consists of 4 questions.
   Answer all FOUR questions. The exam is out of a total of 40 marks.
   The number of marks for each question is given in brackets.
   PRINT YOUR NAME AT THE TOP OF EACH PAGE.

2. This is a closed book exam.
   Calculators are permitted.
   A list of formulas will be provided separately.

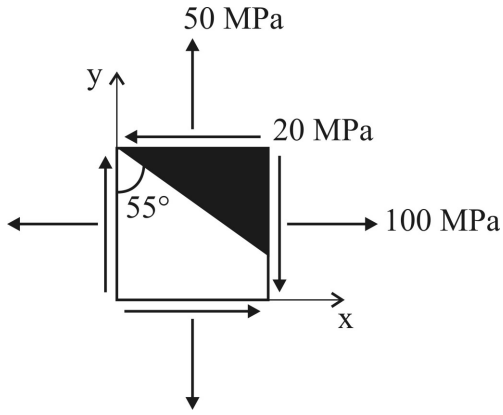
3. SHOW YOUR WORK CLEARLY.
   Give final answers to 3 significant figures.

4. Your answers are to be given in the space below the question.
   The back of each page may be used as a continuation sheet if required.

(10) 1. A triangular plate is subjected to a normal stress of 71.4 MPa and a shearing stress of 59.9 MPa on a surface, as shown, and is in a uniform state of plane stress. Using the transformation law, determine σ_x, σ_y, and σ_z.



(10) 2. A point in a loaded body is in a state of plane stress, as shown.



(a) Draw a properly labeled sketch of Mohr's circle and use the circle to determine the normal and shearing stress components on the inclined face. Show your answer on a sketch of the shaded triangular element showing the stress components on all faces of the triangle.

(b) Using your sketch of Mohr's circle, determine the in-plane principal stresses and directions. Show your answer on a properly oriented element.

(c) Determine τ_{max} for the state of stress in a 3-D sense. Do NOT show τ_{max} on an element. (Just give the value.)

Question 3 – Do Parts (a) to (e)

(3) (a) In words, describe what a Mohr's circle for stress represents physically.

(2) (b) For what element orientation will the normal stresses on all four faces of a 2-D element be the same?

(2) (c) Why, in general, do we need to write both the τ_{xy} term and the τ_{yx} term in the cosine transformation law even though $\tau_{xy} = \tau_{yx}$?

(3) (d) For a 3-D state of stress, how would you determine τ_{max} from the 3×3 stress matrix?

(2) (e) How many components are there in a third-order, 2-D tensor? (Assume that the tensor does not exhibit any symmetry, and that all the components are independent.) Place a box around your answer.

(8) 4. For a point in a loaded body, it is known that one of the principal stresses is 20 MPa. It is also known that for some Cartesian x-y-z coordinate system at that point,

$$\sigma_x + \sigma_y + \sigma_z = 50 \text{ MPa},$$

and

$$\sigma_x\sigma_y + \sigma_y\sigma_z + \sigma_z\sigma_x - (\tau_{xy})^2 - (\tau_{yz})^2 - (\tau_{zx})^2 = 400 \text{ MPa}^2 .$$

Determine the principal stresses σ_1, σ_2, and σ_3 at the point.