

**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**

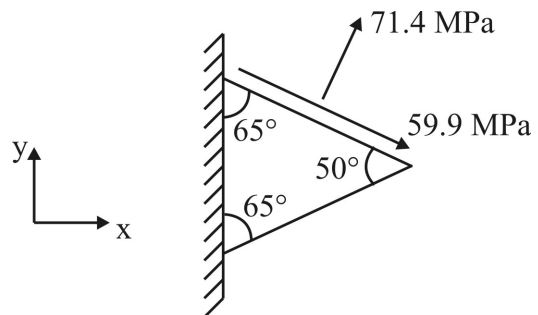
For Marker's  
Use Only

LAST NAME (printed): _____	1. _____
FIRST NAME (printed): _____	2. _____
STUDENT NUMBER: _____	3. _____
EXAMINATION ROOM: _____	4. _____
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**INSTRUCTIONS**

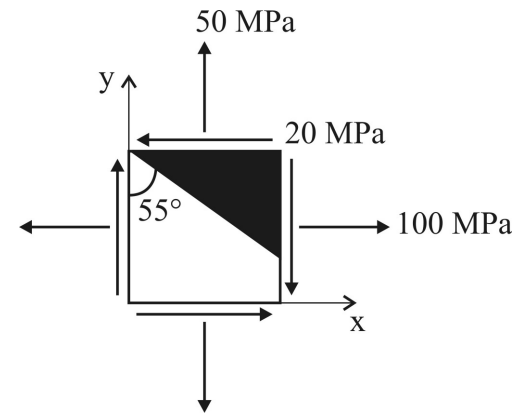
1. The examination consists of 4 questions.  
Answer all FOUR questions. The exam is out of a total of 40 marks.  
The number of marks for each question is given in brackets.  
**PRINT YOUR NAME AT THE TOP OF EACH PAGE.**
2. This is a closed book exam.  
Calculators are permitted.  
A list of formulas 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  $\sigma_x$ ,  $\sigma_y$ , and  $\sigma_z$ .



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

- 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.
- Using your sketch of Mohr's circle, determine the in-plane principal stresses and directions. Show your answer on a properly oriented element.
- Determine  $\tau_{\max}$  for the state of stress in a 3-D sense. Do NOT show  $\tau_{\max}$  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  $\tau_{xy}$  term and the  $\tau_{yx}$  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  $\tau_{\max}$  from the  $3 \times 3$  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  $\sigma_1$ ,  $\sigma_2$ , and  $\sigma_3$  at the point.