UNIVERSITY OF BRITISH COLUMBIA
DEPARTMENT OF MECHANICAL ENGINEERING

QUIZ 3. Thursday October 20, 2016

MECH 221

READ THESE INSTRUCTIONS CAREFULLY BEFORE BEGINNING THE QUIZ. GOOD LUCK!

Duration: Target = 1 hour 30 minutes. Maximum = 1 hour 50 minutes.

Materials admitted: Pencil, eraser, straightedge, Mech2 calculator, Mech2 formula book, one 3x5 inch index card.

There are five short-answer questions and two long-answer questions. ***All questions must be answered.***

Provide **all** work and solutions **on these test pages**. Scrap paper is available for your use, but **will not be collected or marked**. An additional mark of up to 5% of the exam value is available for orderly presentation of work

Illegible work, or answers that do not include supporting calculations and explanations will NOT be marked.

BE SURE TO WRITE YOUR NAME ON THE TOP OF ALL EXAM PAGES

NAME:_____Section_____

SIGNATURE:_____

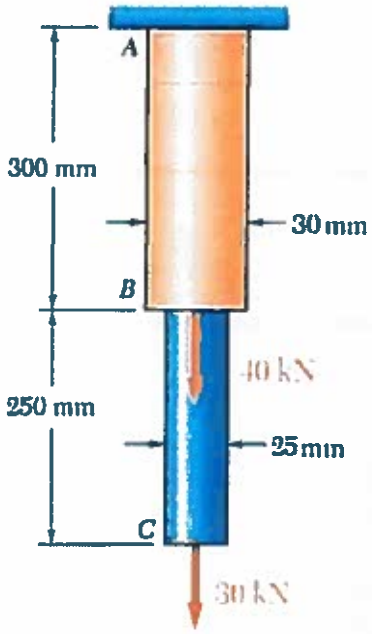
STUDENT NUMBER:_____

Question	Mark Received	Maximum Mark
SA 1		6
SA 2		6
SA 3		6
SA 4		5
SA 5		9
LA 1		22
LA 2		21
Presentation		
TOTAL		

Name:_____ Section:_____

Part I.

SA 1. A stepped rod has a solid circular cross-section, with the lengths and diameters shown in the diagram. It supports the two axial loads shown. The top part is made of brass and the lower part of steel. Calculate the downward motion at the joint B. *(Hint: Your formula sheet contains some needed information.)*



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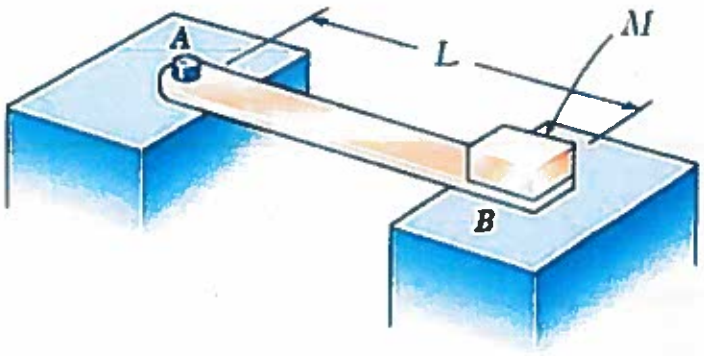
SA 2. A metal strip of length L rests between two rough blocks. It is pinned at A and supports a mass M at B. Derive a formula for the maximum temperature change that can occur after the setup has been assembled before slippage at end B occurs. Identify and define the symbols you use for the various quantities needed.



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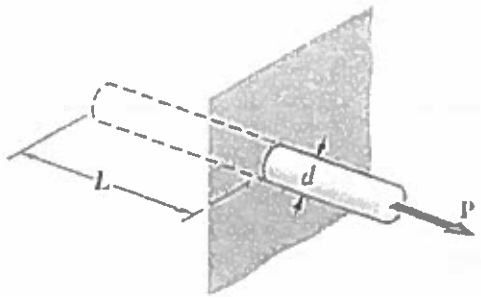
SA 3. A wire of diameter d is glued to a depth L in a solid block. There is no glue on the flat circular surface at the left end of the wire. The breaking stress of the glue is 10% of the breaking stress of the wire. Determine the minimum depth L that is needed to ensure that the wire breaks before it can be pulled out by an axial force P.



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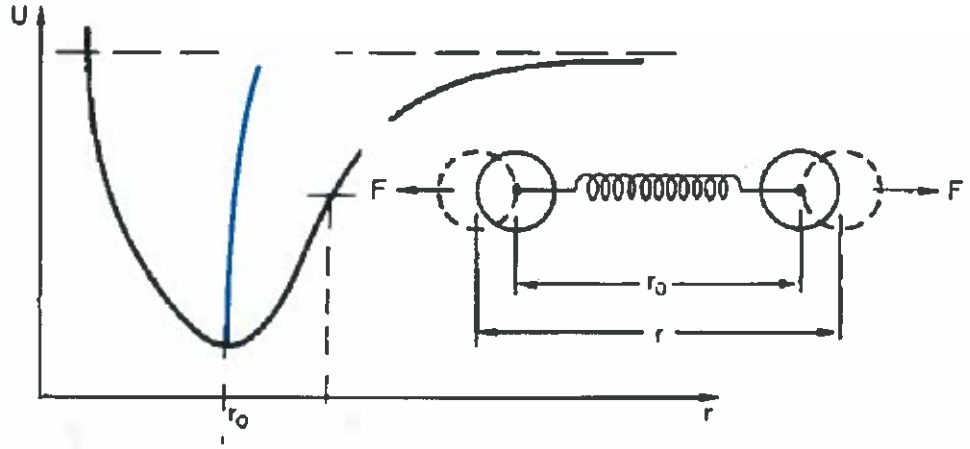
SA 4. An aluminum bar of length = 1 m is used in a window frame. It expands by 2.2 mm when the temperature is raised from 20 to 120°C. Explain from an atomic bonding point of view why materials expand when heated (use of sketch(s) is recommended). If the aluminum was replaced by stainless steel, how would you qualitatively expect the expansion to change (Given the melting points for aluminum and stainless steel are 660 °C and 1400 °C). Calculate the coefficient of thermal expansion for aluminum.



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SA 5. Three fundamental material properties that we have studied are stiffness, strength and toughness. Define what each of properties is and how it is related to design. Describe one method to measure each of these properties.

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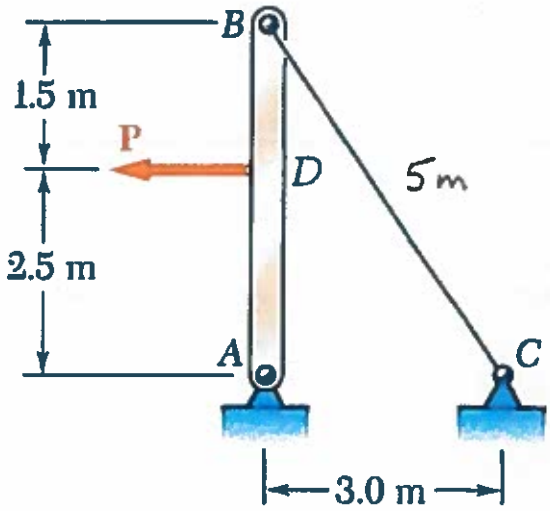
Part II.

LA 1. A rigid bar is pinned at its lower end A and secured by a 8mm diameter steel wire at its upper end B. A load P = 12kN is applied part way along the bar at D. You are asked to determine the resulting sideways motion of point D.



(a) Describe in words your visualization of what happens when the load is applied to the bar. Draw a sketch showing the expected deformations.

(b) What physical principles need to be considered to answer this question ?

(c) Describe in detail your planned solution procedure.

(d) Implement your planned procedure to determine the sideways motion of the force at D.

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Name:_____ Section:_____

LA 2. A cylindrical specimen of a tungsten having an elastic modulus of 400 GPa and an original diameter of 6.3 mm experiences only elastic deformation when a tensile load of 20 kN is applied. Compute the maximum length of the specimen before deformation if the maximum allowable elongation is 100 μm. Note: please show all units in your calculation.

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b) Tensile tests samples were prepared from the tungsten bar. It was requested that the yield stress, ultimate tensile and %elongation to failure be reported. Due to an error in the machine shop, the gauge length of the sample was made to be 25 mm rather than the 50 mm required by ASTM standard E8M.

i) How would the machining error affect the measurement of these 3 material properties?

(3)

ii) It was observed from optical measurements that the change in length up of the sample up to the necking point was 5 mm and the change in length of the sample after necking was 2.5 mm for the sample with a gauge length of 25 mm.
   a. Calculate the % elongation.
   b. Estimate the % elongation if the standard sample with a gauge length of 50 mm had been used.

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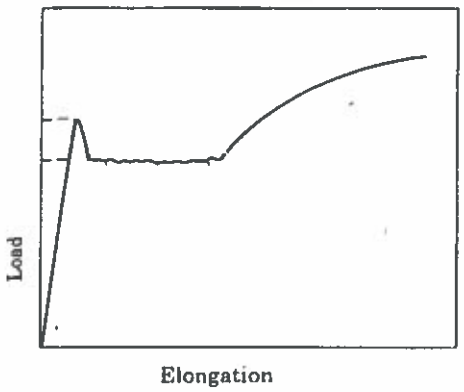
c) The load-elongation curve for the test of tungsten was observed to have the following characterisitics:



a) What does this suggests in terms of the yield behavior of tungsten. Using diagrams, sketch how you would expect the yielding of the sample to occur.

(4)