Name: MARKING SCHEME SHORT ANSWER Student #:_____

University of Toronto

Faculty of Applied Science and Engineering

APS112 and APS113 Engineering Strategies and Practice II

Quiz #1 February 14, 2014

This is a 50-minute closed-book quiz. No aids are permitted except for a translation-only dictionary. The quiz has a total of 18 questions. There are 14 multiple-choice questions and 4 written answer questions. There are a total of 30 marks with 14 marks for the multiple-choice questions and 16 marks for the written questions.

Your question paper, with your name and student number filled in **on each page**, must be returned with the multiple choice answer sheet slipped inside. Do not separate any pages.

Good Luck!

Written Answer Mark Breakdown

Question	Possible Marks	Marks
15	6	
16	2	
17	4	
18	4	
Total	16	

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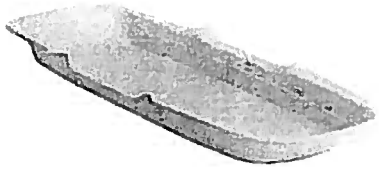
Written Answer (marks per question as indicated on question; 16 marks total)



Write answers into the spaces provided on the question paper.

Questions 15 – 17 refer to the following client statement: The client is a business person, starting up a new factory to make plastic snow toboggans (sleds) at the minimum possible cost. In the factory, 1.5 mm thick sheets of plastic have to be heated to 150°C so that they are soft, and then formed to the shape of the toboggan (see the figure). The client asks you to design a press to allow a single production worker to do this.

15.(6 MARKS) List two objectives, two constraints and two stakeholders that would be appropriate for this design.

OBJECTIVES: rapid cycle time, low capital cost, low operating cost, low maintenance, reliable, low power consumption, small footprint, etc. Essentially any x where "the design should be as x as possible. " where x can be measured.

2

CONSTRAINTS: operable by one person, meets all appropriate safety standards

2

Other clearly defined constraint based on a reasonable assumption may be acceptable.

STAKEHOLDERS: operator, factory owner, maintenance personnel, retailer, etc. Do not have to state

2

16. (2 MARKS) A worker in the factory is supposed to wear safety boots with steel toes while operating the press. One day, her supervisor notices that she is wearing running shoes that do not have steel toes.

Describe one obligation of the worker and one obligation of the supervisor in a case like this. Full sentences are not required.

Worker: wear all protective equipment (shoes), report safety issues. work in a safe manner

1 OR ½ OR ½

Supervisor: to ensure safety equipment is worn, ensure safety procedures followed, to advise workers of danger.

1 OR ½ ½

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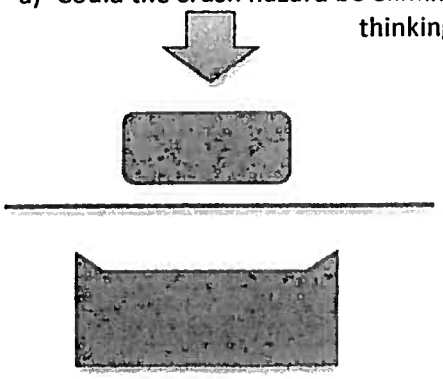
17.(4 MARKS) One way of forming plastic or metal sheets is to use matched steel dies that come together with the plastic in-between to form the final shape. Such presses could be very dangerous; for example, they could crush a worker's arm. You are to design a forming process that is as safe as possible.

a) Could the crush hazard be eliminated entirely? Show some evidence of structured creative thinking.



Press with Crush Hazard

To eliminate the crush hazard, apply the force to the sheet without a metal top press platen.

Q: What are the different ways that force could be applied to the soft plastic without direct contact:

A: Gravity (centriguge), Vacuum underneath, pressurized air or liquid bladder on top, hot sand or ball bearings, etc. None of these options present a crush hazard, although they might present other hazards such as burns.

b) If the crush hazard is not eliminated, how could you guard against the hazard to protect workers?

Any type of guarding with an interlock
Physical Guard,

Light Curtain or proximity sensor

Controls placed far from press, or two handed controls.

Any 2.

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18.(4 MARKS) Estimation Question:

How many metric tonnes (1 tonne = 1000kg) of salt does the City of Toronto use on its roads annually? Estimate this amount using reasonable assumptions based on your personal knowledge and the information provided here. Salt has a density of ~ 2 tonnes/m^3, and the city has an area of 630 km^2. You don't have to get the exact answer, obviously, but you do have to compute a number, and show an appropriate method of making this estimation. You may earn a bonus mark if you can suggest a way of being sure that your answer is reasonable, without using any additional information.

(1) for thought & estimate

Sequential estimates/assumptions are required to answer. Students should use whole numbers so they can do the math easily. It is hard to get the correct answer, which is ~!50,000 tonnes

A = 630 x 10^6 m^2
25% pavement
Salt is applied at a coverage (on the roads) of 1%
Salt applied 20 x per year
Salt grain is a cube 3 mm on a side.

(1) for listing any sequence of estimate i.e. knowing pro

(V of one grain is therefore ~9 mm^3 or 3 x 10^{-8} m^3/grain, Area = 1 x 10^{-5} m^2, but we don't need these. Just multiply coverage area x thickness of one grain.)

So V_{salt} = 600 x 10^6 m^2 x 0.01 x 0.25 x 20 x 0.003 m = 90,000 m^3 or 180,000 tonnes

1/2 (1) for calc

Bonus mark for cross checking with an alternative calculation: e.g. Use snowfall + snow left behind by the plows and compute the amount of salt needed to melt the snow using some basic physical chemistry. To earn the mark, you just have to suggest this method or some other feasible means of cross checking using a different set of assumptions.

(1) for any answer -

WRITE YOUR FINAL ANSWER (in Tonnes) HERE:

10,000 to 5,000,000 is ok.