

CARLETON UNIVERSITY

<p style="text-align: center;">MIDTERM EXAMINATION February 2014</p>

Duration: 1h 20 min.

No. of Students: 127

Department Name & Course Number: **Mechanical & Aerospace Engineering MECH 3700 A**

Instructor(s): **A. Speirs**

<p>AUTHORIZED MEMORANDA</p>

<p>1 sheet 8 1/2 x 11, both sides; any non-transmitting, non-receiving calculator</p>

Student **MUST** count the number of pages in this examination question paper **before** beginning to write and report any discrepancy immediately to a proctor. This question paper has 2 pages.

ATTEMPT ALL QUESTIONS. THE VALUE OF EACH QUESTION IS GIVEN IN THE MARGIN

Question 1.

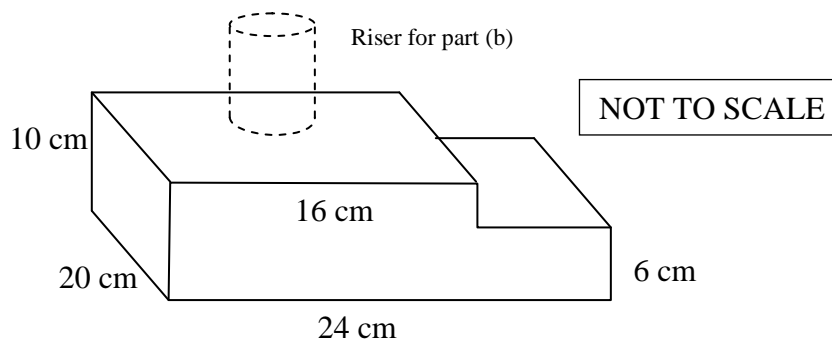
- [10] a) Explain, with the aid of a generic phase diagram the phenomenon of constitutional undercooling.
- [5] b) Many parts may be manufactured by bending sheet metal. Is a high or low strain hardening exponent desirable for the workpiece? Explain.
- [5] c) List the main ingredients used to make pig iron in steelmaking, and briefly describe the purpose of each

Question 2.

The part shown below is to be sand cast from molten aluminum at the melting temperature. Assume the mould can be treated as semi-infinite and the ambient temperature (T_0) is 30°C. Properties of aluminum: Specific heat (solid) 0.9 J/g°C; specific heat (liquid) 1.05 J/g°C; density 2.7 g/cm³; thermal conductivity 202 W/m°C;

melting point 660°C ; latent heat of solidification 396 J/g . Properties of sand: specific heat $1.16\text{ J/g}^{\circ}\text{C}$; density 1.5 g/cm^3 ; thermal conductivity $0.6\text{ W/m}^{\circ}\text{C}$

- [10] a) Calculate the die constant used for Chvorinov's Rule and estimate the cooling time.
- [10] b) A cylindrical riser is included to prevent pipe formation as shown. If proper function of the riser requires a solidification time 25% longer than the casting, what is the required diameter of the riser if the riser is 20 cm tall? State any assumptions you make.



Question 3

A cylindrical test specimen is loaded in tension, giving the following engineering stress and strain values during the test:

σ (MPa)	e
90	0.10
120	0.32

- [10] a) Assuming the material obeys the Hollomon equation, calculate the strength constant (K), strain hardening exponent (n) and ultimate tensile strength.
- [10] b) If the initial diameter of the test piece was 10 mm, what was the maximum load during the test?
- [Bonus 5] c) If you cold rolled this material by applying a reduction in area of 40%, what would the new yield strength be?