UNIVERSITY OF SASKATCHEWAN
COLLEGE OF ENGINEERING

MECHANICAL ENGINEERING (M.E.) 214

ALL SECTIONS
MID-TERM EXAM
OPEN BOOK   **CALCULATORS ARE ALLOWED**

TIME: 2 HOURS   **October 2005**

Candidates are to answer all questions.
You are to show your solution in the space below the question.
The reverse side of the page may be used if required.
State all necessary assumptions.

NEATNESS and CLARITY will be considered in the marking of this examination

NAME: _____   Marks

               (First Name)   (Last Name)

                                                 1._____

Name of Lecturing Professor: _____   2._____

                                                   3._____

Student Number: _____   4._____

                                                 TOTAL._____

Examination Room: _____

There are 10 marks for each question.

Note: - make sure you have 4 problems in the exam
                 - the questions are of equal value

Question 1   **(a)** For the oblique representation of a cubic unit cell below, determine the indices of the plane ABC and of the direction from B to the centre of the line AC.
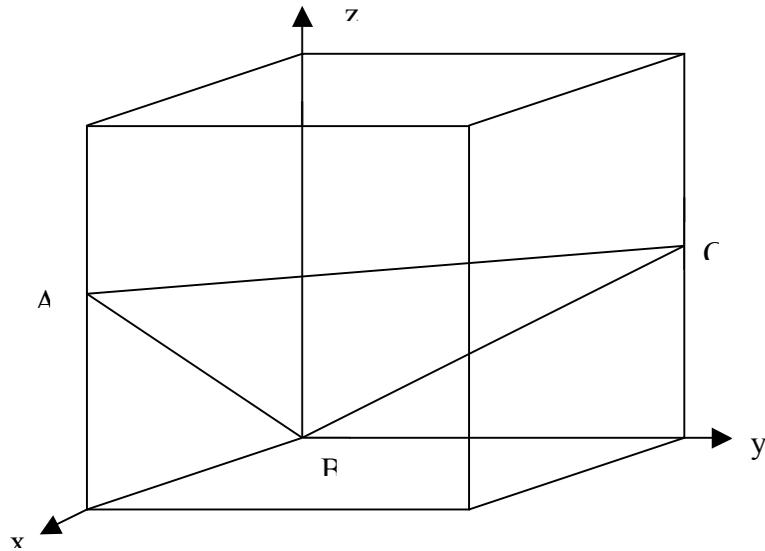
(b) What is the approximate grain size (diameter) for an alloy with an ASTM grain size number of 4 ?

Question 2

A heat-treatment shop is attempting to improve productivity by reducing the time for carburizing a steel component. The present treatment is to heat the steel component for 12 hours at 950 °C in a gas carburizing furnace. It is intended to reduce the carburizing time to 6 hours. Estimate the temperature required to produce the same case depth (thickness).

Question 3

(a) Given that a quality control inspection can ensure that a 200 mm wide plate of a 10 mm thick steel alloy 1 m long will have no flaws greater than 5 mm and that a tensile load is to be applied parallel to the long axis, determine what you believe to be the maximum stress that should be applied to the component, giving reasons for your decision State all assumptions.

(K_{1c} = 66 MPa m$^{1/2}$, σ_{ys} = 1000 MPa)

(b) It can be demonstrated that in a tensile test necking begins when $\dfrac{d\sigma}{d\varepsilon} = \sigma$ where σ is true stress and ε is true strain. Given that the true stress- true strain curve in the plastic region can be represented by $\sigma = K\varepsilon^{n}$, determine the value of the true strain at the onset of necking.

Question 4

(a) For a Cu-30% Ag alloy slowly cooled from the liquid to 778 ^{0}C:

      (i)   What is the mass fraction of the α phase?

      (ii)   What is the ratio of primary α to the total α phase?

(b) For an alloy of metal A and metal B held just above the peritectic temperature, Liquid (60% B) and α (20%B) exist with 60% of the mass being Liquid. After slowly cooling to below the peritectic temperature 20% of the mass is Liquid the remainder being the β phase.

    (a) What is the composition of the β phase?

    (b) If A has an atomic mass of 78 and B has an atomic mass of 26, what is the formula of the phase β?