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 2002**

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 On the cubic unit cell provided sketch (111) and (201). What are the indices of the line of intersection?

Question 2 The steady state creep rate of many alloys can be expressed by the formula

$$\text{steady state creep rate} = C_1 \sigma^n \exp(-Q/RT)$$

where C_1 and n are constants, Q is the activation energy and R is the gas constant.

If Q = 250 kJ/mol and n = 4, calculate what percentage increase in stress will be necessary to produce the same percentage increase in steady state creep rate as a 15 ^{o}C increase in temperature from 950 ^{o}C to 965 ^{o}C .

Question 3 A component made from a 0.1 wt % carbon steel is to be carburised. It is required that a carbon content of 0.8 wt % be achieved at a depth of 0.4 mm below the surface. The carburising furnace is at 1100 ^{o}C and is capable of maintaining a carbon content of 1.1 wt % at the surface of the steel. How long should the carburising treatment be?

Question 4 AB_2 is an intermetallic compound of fixed composition formed from two metallic elements A and B. AB_2 is stable up to its melting point of 500 ^oC. The phase diagram of A and B shows a eutectic between α (the solid solution of B in A) and AB_2 with eutectic composition of 15 wt % B and eutectic temperature of 250 ^oC. Another eutectic is formed between AB_2 and β (the solid solution of A in B) with eutectic composition of 60 wt % B and eutectic temperature of 350 ^oC. Pure A melts at 300 ^oC and has an atomic mass of 100 amu. Pure B melts at 650 ^oC and has an atomic mass of 60 amu. Complete the phase diagram below labelling the regions of the diagram (use straight lines for convenience). Sketch possible microstructures for an alloy containing 45 wt % B slowly cooled from the liquid to (a) 360 ^oC and (b) 340 ^oC.