UNIVERSITY OF SASKATCHEWAN
COLLEGE OF ENGINEERING

MECHANICAL ENGINEERING (M.E.) 214

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

TIME: 1 hour 20 minutes **November 2004**

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) On an oblique representation of a cubic unit cell, sketch [101] and [012] What are the indices of the plane containing these?

(b) It is possible to cool aluminum very quickly so that the number of vacancies present in equilibrium at high temperature is "frozen in". If the equilibrium fraction of lattice sites that are vacant at 600 ^{o}C is 10^{-5}, and the equilibrium fraction vacant at room temperature is $3x10^{-15}$, calculate the percentage change in density of the quenched aluminium resulting from the excess vacancies.

Question 2

(a) Calculate the diffusion coefficient (D) for the diffusion of

(i) Fe in α-Fe (ferrite) at 600 ^{o}C and

(ii) C in α -Fe (ferrite) at 600 ^{o}C.

Briefly explain the difference between the values.

(b) During carburising, carbon is diffused into austenite (f.c.c. Fe) from an environment of constant carbon concentration.

If the required depth of carburisation is achieved at 900 ^{o}C in 10 hours, what time would be required at 950 ^{o}C?

Question 3

(a) The non-destructive testing department assures you that they can detect any through thickness cracks greater that 7 mm in a 2024 -T3 component. The dimensions of the component are 900 mm long 200 mm wide and 5 mm thick. In service a tensile load is applied parallel to the long axis.

Determine what you believe to be the maximum load that should be applied to the component, giving reasons for your decision.

(b) High-temperature creep tests were performed on a nickel alloy and the results were to be used to predict long-term low-temperature performance. The steady state creep rate at 800 ^{o}C was found to be 0.8 % per hour and the steady state creep rate at 750 ^{o}C was found to be 0.04 % per hour. The stress applied was constant and was the same for each test.

What is the activation energy for creep in this alloy?

Question 4

(a) What phases are present, what are the compositions of those phases and what would be the amounts in 100 kg of alloy for:
(i) Mg 50 wt% Pb slowly cooled from 700 ^{o}C to just above the eutectic temperature,
(ii) Mg 50 wt% Pb slowly cooled from 700 ^{o}C to just below the eutectic temperature.

(b) Mg 50 wt% Pb is slowly cooled from 700 ^{o}C to just below the eutectic temperature. What is the ratio of the amount of proeutectic α to eutectic α.