The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Diploma in Technology/Bachelor of Technology (Engineering)
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX4233 Materials Engineering**
Academic Year	:	2012/13
Date	:	**3rd AUGUST 2013**
Time	:	**0930 HRS. – 1230 HRS.**
Duration	:	3 hours

ANSWER 5 PARTS FROM SECTION A & FIVE QUESTIONS FROM SECTION B.

SECTION A

Select any **Five** Parts

1 (a) Sketch the Body Centered Cubic (BCC) unit cell and derive a relationship between the atomic radius 'r' and unit cell parameter 'a'.
Hence find a value for the atomic radius of a Chromium atom in nanometers.
Chromium at 20^0 C is BCC and has a lattice constant of 0.2885 nm. ***4 marks***

(b) State the Hund's rule on pairing of electrons in an atom. ***4 marks***

(c) Calculate the linear atomic density in the [110] direction in the Copper crystal lattice in atoms per millimeter. Copper is FCC and has a lattice constant of 0.361 nm. ***4 marks***

(d) Within a cubic unit cell, sketch the following plane and direction.

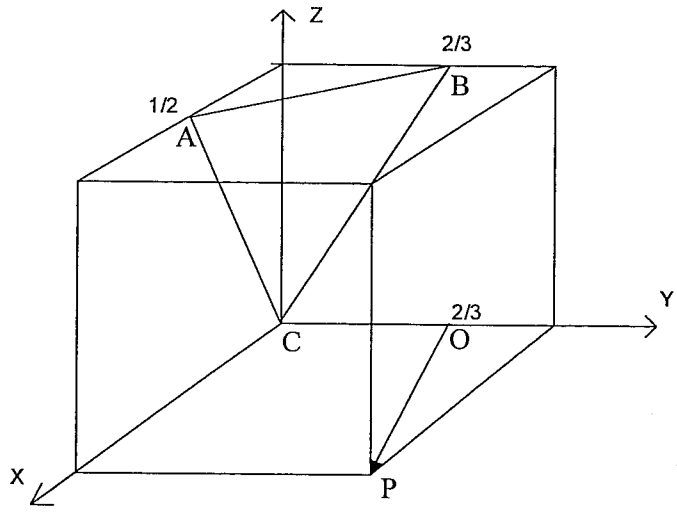
Plane : (202) Direction: $[1\bar{1}3]$ ***4 marks***

(e) Calculate a value for the density of FCC Platinum in grams per cubic centimeter from its lattice constant 'a' of 0.39239 nm and its atomic mass of 195.09 g/mol. ***4 marks***

(f) A 15 mm diameter round sample of a 1030 carbon steel is pulled to failure in a tensile testing machine. The diameter of the sample was 9 mm at the fracture surface. Calculate the percentage reduction in area of the sample. ***4 marks***

(g) Calculate the Atomic Packing Factor (APF) for the BCC unit cell, assuming the atoms to be hard spheres. *4 marks*

(h)



Identify, by Miller indices, the plane (ABC) and the direction (OP) given in the above figure.

4 marks

SECTION B

1 (a) State the four factors that affect solubility in the formation of substitutional solid solutions. *4 marks*

(b) A phase diagram of a binary alloy system A-B is shown in Fig.(1) given at the end of this paper.

(i) Label the phase(s) in areas 1-6 and name the reaction which occurs at point E.

(Remember to attach the phase diagram with the answer script) *4 marks*

(ii) Considering an alloy containing A-72wt% and B-28wt%, state the phase change when cooling from T_{ma} to T_0. *4 marks*

(iii)Calculate the amounts of liquid and solid present at temperature Tx for the above alloy. *4 marks*

2. (a) State the Fick's second law of Diffusion. *6 marks*

(b) For some applications, it is necessary to harden the surface of steel above that of its interior. One way of achieving this requirement is by carburizing. One such alloy initially has a uniform carbon concentration of 0.25 wt% and is to be treated at 950^0C. The concentration of carbon at the surface is suddenly brought to and maintained at1.20 wt%.

How long will it take to achieve a carbon content of 0.80 wt% at a position 0.5 mm below the surface? *10 marks*

The diffusion coefficient for carbon in iron at this temperature is $1.6x10^{-11}$ m^2/sec.
Error function values are as follows

Z	Erf(Z)
0.30	0.3286
0.35	0.3794
0.40	0.4284

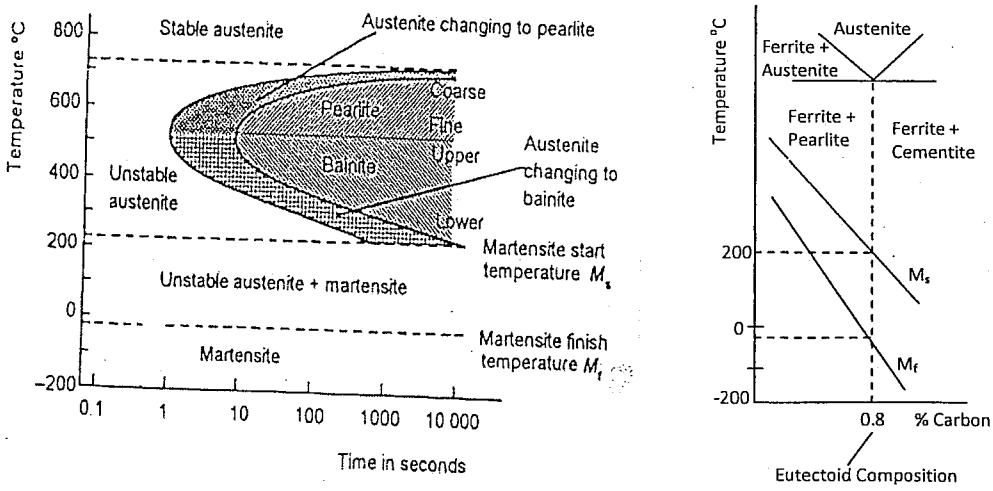
3. (a) What is secondary stage creep in metals and how is it affected by temperature? ***6 marks***

(b) Steady state creep data taken for stainless steel at a stress level of 70 MPa is given below.

E_{ss} (sec^{-1})	T(K)
$1x10^{5}$	977
$2.5x10^{-3}$	1089

If it is known that the value of the stress component 'n' for this steel is 8.0, compute the steady state creep rate at 1250^0 K and stress level of 50 MPa.
Activation energy Q = 140,000 J/mole and gas constant R = 8.31 J/mole. ***10 marks***

4. (a)



Shown above are the TTT diagram and phase diagram for a 0.8% plain carbon steel.
How long will it take the transformation of austenite to pearlite at 650°C for a 0.8% plain carbon steel. ***6 marks***

(b) What is the effect on the TTT diagram of carbon steel due to addition of Chromium to the alloy? ***4 marks***

(c) Describe the microstructure produced by the following heat treatments
(i) heated to 820°C and then water quenched to 25°C.
(ii) heated to 820°C, water quenched to 25°C, heated again to 350°C, held for 1 hour and air cooled to 25°C. ***6 marks***

5. (a) Describe the following three major polymer categories with the aid of diagrams showing their micro-structure.
(i) Thermoplastics
(ii) Thermosetting plastics
(iii) Elastomers ***6 marks***

(b) Molecular weight data for a polypropylene material are tabulated below. Compute,

(i) The number average molecular weight
(ii) The weight average molecular weight
(iii)The number average degree of polymerization

The atomic weights of C and H are respectively 12.01 & 1.01.

Molecular weight range (g/mole)	Xi	Wi
8000-16000	0.05	0.02
16000-24000	0.16	0.10
24000-32000	0.24	0.20
32000-40000	0.28	0.30
40000-48000	0.20	0.27
48000-56000	0.07	0.11

10 marks

6. (a) List and describe the types of common imperfections found in metal crystals. ***8 marks***

(b) The equilibrium vacancy concentrations of schottky defects in copper are $4x10^{-6}$ and $15x10^{-5}$ at temperatures of 1000^0 k and 1325^0 k respectively.
What is the energy of formation of these defects?
Boltzmann constant is $8.614x10^{-5}$ ev/k. ***8 marks***

7. (a) Define the term 'Corrosion" pertaining to materials. ***5 marks***

(b) Describe and differentiate crevice corrosion and stress corrosion cracking. ***6 marks***

(c) What are the methods used to prevent stress corrosion cracking? ***5 marks***

Discuss and analyze **three of** the following topics from an Engineering view point.

16 marks

(a) Types of primary bonds and Secondary bonds present in materials.

(b) Types of fibers and matrix materials used in composites.

(c) Mechanical properties of materials.

(d) Fatigue limit or the endurance limit.

(e) Strengthening mechanisms in materials

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Attach this Figure to the answer script

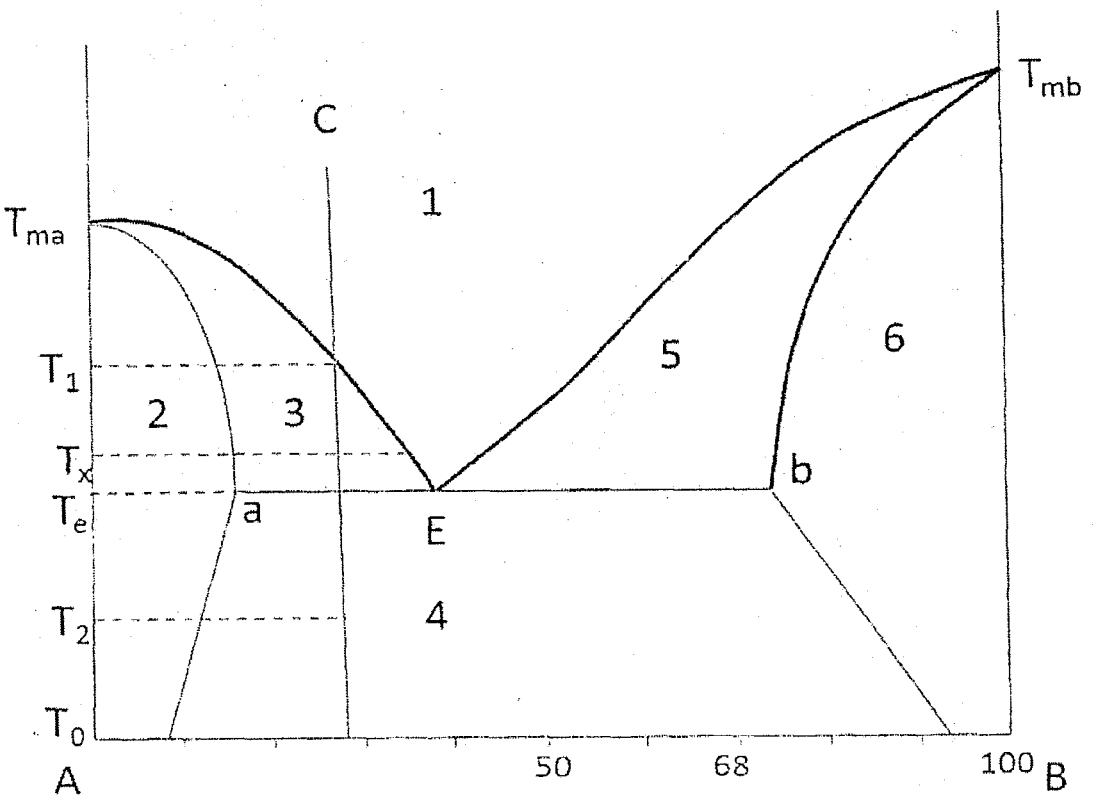


Fig. (1)