NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

APPLIED PHYSICSDEPARTMENT

SPH 1209 ENGINEERING MATERIALS
SUPLEMENTARY EXAMINATION

BSCHONOURS PART I: MAY 2013 *DURATION: 3 HOURS*

ANSWER ALL PARTS OF QUESTION 1 IN SECTION A AND ANY THREE QUESTIONS FROM SECTION B. SECTION A CARRIES 40 MARKS AND SECTION B CARRIES 60 MARKS.

SECTION A

1 (a) Which properties of a material would you consider, if you require them:

(i) to be capable of being bent into a fixed shape [1]

(ii) to act as an electrical insulator. [1]

(iii) to be capable of being used as lining for a tank storing acid [1]

(iv) to be capable of not fracturing when small cracks are present. [1]

(b) An alloy contains 85 wt % copper and 15 wt% tin. Calculate the atomic percent of each element. [5]

(c) Define the following terms.

(i) Hardenability [2]
(ii) Anealling [2]
(iii) Hardness [2]

(d) In a Brunel hardness test, a 10 mm diameter ball with a 3 000 kg load resulted in an indentation with a diameter of 4.10 mm. Determine the hardness of the material. [4]

(e) The atomic radius of iron is 0.1238 nm. Iron crystallizes as BCC.

(i) Calculate the lattice parameter **a**, of the unit cell. [4]

(ii) How many atoms are contained within the BCC unit cell? [2]

(f) (i) Give two common properties of ceramics. [2]
(ii) Choose one property in (i) above and suggest one use of ceramics based on the property. [3]

(g) Why is ductile fracture preferred in most applications? [5]

(h) Why are metals with a body centred cubic closing packing structure more ductile compared to materials like aluminum with a hexagonal close packing structure? [5]

SECTION B

2 (a) (i) Calculate **n,** the number of atoms per cm^3 for diamond given that the density of diamond is 3.5 g/ cm^3. [4]

(ii) Calculate the mean distance between atoms **L,** for a material with 6 $x10^{23}$atoms/ cm^3. [4]

(b) (i) What are polymers? [3]

(ii) Define thermopolymers. [2]

(c) The formula for vinyl acetate is $CH_2CHCO_2CH_3$

It forms a polymer by addition polymerisation with an average molecular mass of 4.5×10^4.

(i) What is meant by addition polymerisation? [2]

(ii) Find the degree of polymerisation. [5]

3 (a**)** Define the following

(i) Face centred cubic unit cell [2]

(ii) Body centred cubic unit cell [2]

(b) The atomic weight of copper is 63.54 and the atomic radius is 0.1276 nm.

Copper crystallises as FCC. Calculate the density of copper. [7]

(c) Why are polycrystalline metals stronger than single crystal ones? [5]

(d) Describe the bonding in the metals in relation to a common property of metals. [4]

4 (a) (i) The Al-Cu system is an alloy commonly used in the air craft industry. What are its advantages over other materials? [6]

(ii) Name another material that is being used as a substitute for the alloy in this industry. [2]

(b) (i) Define a solid solution. [2]

(ii) Give two properties of a solid solution. [4]

(c) Why are most alloys generally stronger when compared to their separate constituent elements? [6]

5 (a) Define the term *fatigue.* [2]

(b) Distinguish between fatigue and creep in materials. [4]

(c) Outline the three stages of fatigue development materials. [12]

(d) Suggest two methods of minimising the effects of fatigue in materials [2]

6 (a) Give an example of a non destructive technique with its application. [4]

(b) A tensile test on plastics material gave the results shown in table 1 below during the initial states of the test.

Table 1 Test results on a plastic specimen.

Force (N)	**Extension (mm)**
0	0
100	0.03
150	0.05
200	0.09
250	0.14
300	0.20
400	0.37
500	0.61

The test piece had a cross sectional area of 50 mm^2 and a gauge length of 50 mm.

(i) Plot the force /extension graph for the material over the range of the readings given. [6]

(ii) Determine the tangent modulus at strain rate 0.2% [5]

(iii) Determine the secant modulus at strain rate 0.5% [5]

END OF EXAM