# NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

## **APPLIED PHYSICSDEPARTMENT**

# SPH 1209 ENGINEERING MATERIALS SUPLEMENTARY EXAMINATION

BSCHONOURS PART I: MAY 2013

**DURATION: 3 HOURS** 

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

#### **SECTION A**

(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 al eleme	An alloy contains 85 wt % copper and 15 wt% tin. Calculate the atomic percent of element.		
(c)	Defin (i) (ii) (iii)	e the following terms. Hardenability Anealling Hardness	[2] [2] [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]		of the [4]	
(e)	The a (i)	tomic radius of iron is 0.1238 nm. Iron crystallizes as BCC. Calculate the lattice parameter <b>a</b> , of the unit cell.	[4]	
	(ii)	How many atoms are contained within the BCC unit cell?	[2]	
(f)	(i) (ii)	Give two common properties of ceramics. Choose one property in (i) above and suggest one use of ceramics based of property.	[2] on the [3]	
(g)	Why	is ductile fracture preferred in most applications?	[5]	

1

	(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]		e [5]	
2	(a)	(i)	<b>SECTION B</b> Calculate <b>n</b> , the number of atoms per cm <sup>3</sup> for diamond given that the de diamond is $3.5 \text{ g/ cm}^3$ .	nsity of [4]	
		(ii)	Calculate the mean distance between atoms <b>L</b> , for a material with $6 \times 10^2$ cm <sup>3</sup>	<sup>3</sup> atoms/	
	(b)	(i) (ii)	What are polymers? Define thermopolymers.	[4] [3] [2]	
	(c)	The f	Formula for vinyl acetate is $CH_2 CHCO_2 CH_3$		
		It for	ms a polymer by addition polymerisation with an average molecular mass of	of 4.5×	
		$10^{4}$ .			
		(i)	What is meant by addition polymerisation?	[2]	
		(ii)	Find the degree of polymerisation.	[5]	
3	(a)	Defin			
		(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.			
		Copp	per crystallises as FCC. Calculate the density of copper.	[7]	
	(c)	Why are polycrystalline metals stronger than single crystal ones?		[5]	
	(d)	Desci	ribe 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 i		The Al-Cu system is an alloy commonly used in the air craft industry. W	hat are	
			its advantages over other materials?	[6]	
		(ii)	Name another material that is being used as a substitute for the alloy in the	nis	
			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 co	nstituent	
		eleme	ents?	[6]	

5	(a)	Define the term <i>fatigue</i> .	[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