Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering

End Sem (Odd) Examination Dec-2017

AU3ES09 / FT3ES09 / ME3ES09

Engineering Materials

Programme: B.Tech. Branch/Specialisation: AU/FT/ME

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d.

Q.1 i. Atomic packing factor (APF) in the case of copper crystal is **1**

(a) 0.52 (b) 0.68 (c) 0.74 (d) 1.633

ii. Which of the following is not a point defect? **1**

(a) Interstitial atom (b) Substitutional atom

(c) Edge dislocation (d) None of these

iii. Consideration of creep is important in **1**

(a) Industrial belts (b) Blades of gas turbines

(c) Nuclear reactors (d) All of these

iv. Plastic deformation results from the following **1**

(a) Slip (b) Twinning

(c) Both (a) & (b) (d) None of these

v. As per Gibb's phase rule is given by (F = number of degree of freedom, C = number of components, P = number of phases) **1**

(a) F = C + P (b) F = C + P - 2

(c) F = C - P - 2 (d) F = C - P + 2

vi. Which one of the following has maximum hardness **1**

(a) Austenite (b) Pearlite (c) Marten-site(d) Sorbite

vii. 18/8 stainless steel contains **1**

(a) 18% Nickle, 8% Chromium

(b) 18% Chromium, 8% Nickle

(c) 18% Tungsten, 8% Nickle

(d) 18% Tungsten, 8% Chromium

P.T.O.

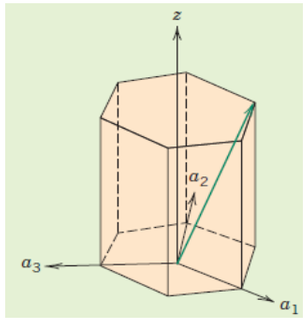
viii. The blade of a power saw is made up of **1**
(a) Boron steel (b) High speed steel
(c) Stainless steel (d) Malleable cast iron

ix. Bakelite is an example of **1**
(a) An elastomer (b) A fibre
(c) A thermoset (d) A thermoplast

x. Cubic boron nitride is used **1**
(a) As lining material in induction furnaces
(b) For making optical quality glass
(c) For heat treatment
(d) None of these

Q.2 i. What is the difference between atomic structure and crystal structure? **2**

ii. Determine the indices for the direction shown in the hexagonal unit cell of sketch below: **3**



iii. What do you mean by dislocation in crystal? Classify various types of dislocation and explain each of them with neat sketch. **5**

OR iv. Show that the ideal c/a ratio is 1.633 for HCP crystal structure. **5**

Q.3 i. Write down any four mechanical properties and define them. **2**

ii. What are different mechanisms of plastic deformation and explain one of them in brief with neat sketch. Also derive an expression of critical resolved shear stress and state how observed CRSS differ from estimated CRSS? **8**

OR iii. Classify strengthening mechanisms and explain any three of them in brief with neat sketch. **8**

Q.4 i. Define Phase, Isomorphous system with an example, lever rule with neat sketch. **3**

ii. Draw iron-iron carbide metastable diagram and explain the salient points on the curve. **7**

OR iii. Name various heat treatment processes for plain carbon steel and explain any three of them with their effects on mechanical properties of steel. **7**

Q.5 i. What do you mean by HSLA? Also write the applications of them. **4**

ii. Classify Mg-alloys and Titanium alloys along with applications. **6**

OR iii. Classify various types Cast Iron and explain them in brief along characteristics and applications. **6**

Q.6 Attempt any two:

i. What are composites? Also write engineering applications and explain one of the production techniques. **5**

ii. How metallic fibres are manufactured? (with neat sketch) **5**

iii. What is polymerisation? Classify various types polymerisation and explain them in brief. **5**

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Marking Scheme

Q.1	i)	(c) 0.74	**1**
	ii)	(c) Edge dislocation	**1**
	iii)	(d) All of these	**1**
	iv)	(c) Both (a) & (b)	**1**
	v)	(d) F = C - P + 2	**1**
	vi)	(c) Marten-site	**1**
	vii)	(b) 18% Chromium, 8% Nickle	**1**
	viii)	(b) High speed steel	**1**
	ix)	(c) A thermoset	**1**
	x)	(d) None of the above	**1**
Q.2	i.	Each difference consists 1 mark (1 mark * 2 = 2 marks)	**2**
	ii.	There are three co-ordinates of such crystal structure, determination of each carry 1 mark (1 mark * 3 = 3 marks)	**3**
	iii.	Definition - 1 mark Classification - 1 mark Explanation - 2 marks Diagram - 1 mark	**5**
OR	iv.	Diagram - 1 mark Identification of equilateral triangle and getting magnitude of one side in term of 'a' - 1 mark Identification of right angle triangle and applying Pythagoras theorem - 2 marks Getting relation between 'a' and 'c' – 1 mark	**5**
Q.3	i.	Each property and definition carry 0.5 mark (0.5 mark * 4 = 2 marks)	**2**
	ii.	Different mechanisms - 1 mark Explanation - 3 marks Diagram - 1 mark Derivation - 1 mark Diagram used for derivation – 1 mark Difference between observed CRSS differ from estimated CRSS - 1 mark	**8**
OR	iii.	Classification - 2 mark Explanation of each 1 mark (1 mark * 3 = 3 marks) Diagram of each 1 mark (1 mark * 3 = 3 marks)	**8**
Q.4	i.	Definition of each 1 mark (1 mark * 3 = 3 marks)	**3**
	ii.	Well labelled iron-iron carbide diagram - 4 marks Explanation of α-ferrite, δ-ferrite and cementite – 1.5 marks Explanation of Eutectoid, Eutectic and Peritectic reaction – 1.5 marks	**7**
OR	iii.	Name various heat treatment processes – 1 mark Explanation of each 1 mark (1 mark * 3 = 3 marks) Effect on properties of each process on steel (1 mark * 3 = 3 marks)	**7**
Q.5	i.	Definition 1 mark Each application 1 mark (1 mark * 3 = 3 marks)	**4**
	ii.	Classification of each 2 mark (2 mark * 2 = 4 marks) Application of each 1 mark (1 mark * 2 = 2 marks)	**6**
OR	iii.	Classification - 1 mark Explanation - 2 marks Characteristics – 1.5 marks Application - 1.5 marks	**6**
Q.6		Attempt any two:	
	i.	Definition - 1 mark Application – 1 mark Production technique - 2 marks Diagram - 1 marks	**5**
	ii.	Manufacturing process – 3 marks Diagram - 2 marks	**5**
	iii.	Definition - 1 mark Classification – 1 mark Explanation 3 marks	**5**

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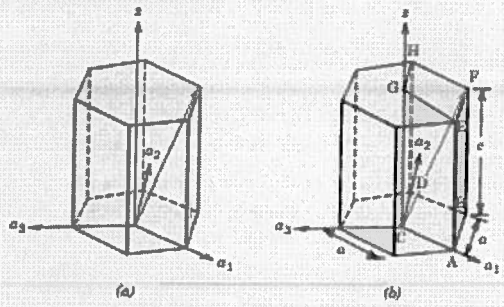
Q2 - (II)

Determination of Directional Indices for a Hexagonal Unit Cell

Determine the indices for the direction shown in the hexagonal unit cell of sketch (*a*) below.



Solution

In sketch (*b*), one of the three parallelepipeds comprising the hexagonal cell is delineated—its corners are labeled with letters A through H, with the origin of the a_1-a_2-a_3-z axes coordinate system located at the corner labeled C. We use this unit cell as a reference for specifying the directional indices. It now becomes necessary to determine projections of the direction vector on the a_1, a_2, and z axes. These respective projections are a (a_1 axis), a (a_2 axis) and c (z axis), which become 1, 1, and 1 in terms of the unit cell parameters. Thus,

$$u' = 1 \qquad v' = 1 \qquad w' = 1$$

Also, from Equations 3.6a, 3.6b, 3.6c, and 3.6d

$$u = \frac{1}{3}(2u' - v') = \frac{1}{3}[(2)(1) - 1] = \frac{1}{3}$$

$$v = \frac{1}{3}(2v' - u') = \frac{1}{3}[(2)(1) - 1] = \frac{1}{3}$$

$$t = -(u + v) = -\left(\frac{1}{3} + \frac{1}{3}\right) = -\frac{2}{3}$$

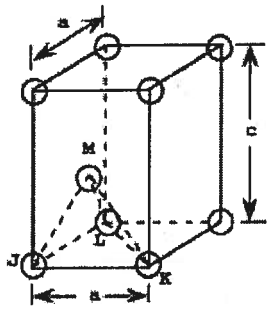
$$w = w' = 1$$

Multiplication of the above indices by 3 reduces them to the lowest set, which yields values for u, v, t, and w of 1, 1, −2 and 3, respectively. Hence, the direction shown in the figure is $[11\bar{2}3]$.

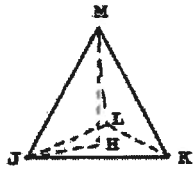
8.2 OR IV

1. For the HCP crystal structure, show that the ideal c/a ratio is 1.633.

We are asked to show that the ideal c/a ratio for HCP is 1.633. A sketch of one third of an HCP unit cell is shown below.



Consider the tetrahedron labeled as JKLM, which is reconstructed as



The atom at point M is midway between the top and bottom faces of the unit cell that is $\overline{MH} = c/2$. And, since atoms at points J, K, and M, all touch one another,

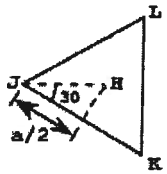
$$\overline{JM} = \overline{JK} = 2R = a$$

where R is the atomic radius. Furthermore, from triangle JHM,

$$(\overline{JM})^2 = (\overline{JH})^2 + (\overline{MH})^2, \text{ or}$$

$$a^2 = (\overline{JH})^2 + \left(\frac{c}{2}\right)^2$$

Now, we can determine the $\overline{JH}$ length by consideration of triangle JKL, which is an equilateral triangle,



$$\cos 30° = \frac{a/2}{JH} = \frac{\sqrt{3}}{2}, \text{ and}$$

$$JH = \frac{a}{\sqrt{3}}$$

Substituting this value for JH in the above expression yields

$$a^2 = \left(\frac{a}{\sqrt{3}}\right)^2 + \left(\frac{c}{2}\right)^2 = \frac{a^2}{3} + \frac{c^2}{4}$$

and, solving for c/a

$$\frac{c}{a} = \sqrt{\frac{8}{3}} = 1.633$$