

Total No. of printed pages = 4

ME 181404

Roll No. of candidate

07/07/23

--	--	--	--	--	--	--	--	--	--	--

BINA CHOWDHURY CENTRAL LIBRARY
(GIMT & GIPS)
Azara, Hatkhowapara
Guwahati - 781017

2023

B.Tech. 4th Semester End-Term Examination

MATERIAL SCIENCE

New Regulation (w.e.f. 2017-18) & New Syllabus (w.e.f. 2018-19)

Full Marks – 70

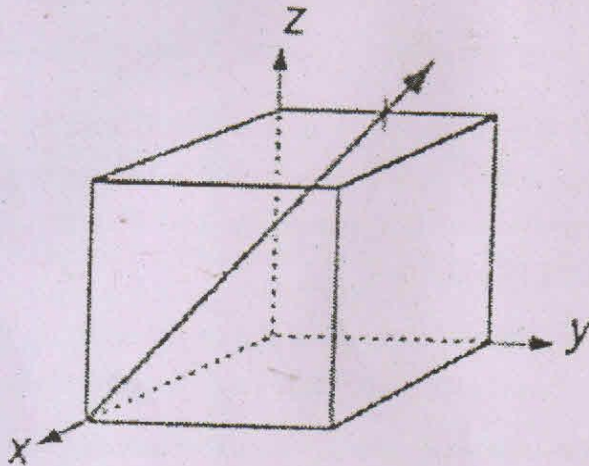
Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer Question No. 1 and any *four* from the rest.

1. Multiple choice questions :

- (a) A Crystallographic plane makes intercepts of 2\AA , 3\AA , and 1\AA respectively on x , y and z axes of a cubic crystal. The Miller indices of the plane is (2)
- (i) (231) (ii) (326)
(iii) (623) (iv) (631)
- (b) Miller indices of the direction shown in the figure below is represented by (1)



(i) $[\bar{2}12]$

(ii) $[\bar{1}21]$

(iii) [121]

(iv) [212]

[Turn over

(c) In a tensile test on a metal, true strain = 0.08 at a stress = 265 MPa. When the true stress = 325 MPa, the true strain = 0.27. The strain-hardening exponent in the flow curve equation for the metal will be equal to (2)

(i) 0.1454

(ii) 0.1545

(iii) 0.1578

(iv) 0.1678

(d) In a binary phase diagram involving a eutectic reaction, the degrees of freedom (F) at the point of eutectic reaction would be equal to (1)

(i) 0

(ii) 1

(iii) 2

(iv) 3

BINA CHOWDHURY CENTRAL LIBRARY
(GIMT & GIPS)
Azara, Hatkhowapara
Guwahati - 781017

(e) Fe-C alloys containing carbon content in between 2.14 wt% C to 4.3 wt.% C are called (1)

(i) Hypo-eutectoid steels

(ii) Hyper-eutectoid steels

(iii) Hypo-eutectic steels

(iv) Hyper-eutectic steels

(f) If the lattice parameter of Ag (*fcc* structure) is 0.409 nm, find the minimum distance that a dislocation can move during plastic deformation is (2)

(i) 0.204 nm

(ii) 0.235 nm

(iii) 0.289 nm

(iv) 0.303 nm

(g) Fe-C alloy of eutectoid composition when cooled slowly below lower critical temperature results in the formation of a mixture consists of (1)

(i) Ferrite and austenite

(ii) Ferrite and cementite

(iii) Austenite and cementite

(iv) None of the above

2. Two elements P and Q have melting points 250°C and 400°C, respectively. Both the elements are completely soluble in the liquid state but insoluble in the solid state. A eutectic reaction takes place at 150°C when liquid of composition 40 wt.% P and 60 wt.% Q solidifies. (15)

(a) Draw the binary phase diagram of P and Q based on the above information. Join the known points with straight lines and label all the phase fields.

(b) Identify with sketches the changes in the microstructure that occur during solidification of liquid metal of overall composition 80 wt.% Q.

(c) Determine the relative amount of phases just above and below 150°C for a liquid containing overall 80 wt.% of Q.

3. A tensile test was carried out on a cylindrical specimen made of an aluminium alloy having a diameter of 12.8 mm and a gauge length of 50.8 mm. Using the load-elongation characteristics shown in the following table: (15)

- Draw the engineering stress versus engineering strain curve (use graph paper).
- Determine the yield stress.
- Determine the modulus of elasticity.
- Determine the tensile strength of this alloy.
- Determine the ductility.

BINA CHOWDHURY CENTRAL LIBRARY
(GIMT & GIPS)
Azara, Hatkhowapara
Guwahati - 781017

Load (N)	Gauge Length (mm)
0	50.5
7330	50.851
15100	50.902
23100	50.952
30400	51.003
34400	51.054
38400	51.308
41300	51.816
44800	52.832
46200	53.848
47300	54.864
47500	55.880
46100	56.896
44800	57.658
42600	58.42
36400	59.182

4. Identify the microstructures after the following heat treatments for the steel specimens of 0.6 wt% C: (15)

- Heated to a temperature above A_1 line (upper critical temperature) by 50 °C for sufficient time and then water quenched.
- Heated to a temperature below A_1 line by 30°C for sufficient time and then water quenched
- Heated to a temperature below A_1 line by 30°C then cooled slowly to the room temperature.

Which one of the three steel specimens will exhibit highest hardness value? Answer with proper justification.

5. An XRD pattern from an elemental metal was obtained using $CuK\alpha$ radiation [wavelength (λ) = 0.1542 nm]. The 2θ values (in degree) for the diffraction pattern are mentioned below. Determine the crystal structure and the lattice parameter of the metal. (15)

38.46, 55.54, 69.58, 82.46, 94.94, 107.64, 121.36

6. (a) For a cubic crystal with lattice parameter a , determine whether the following dislocation reactions are vectorially correct and energetically favourable? (5)

(i) $\frac{a}{2} [\bar{1}\bar{1}\bar{1}] + \frac{a}{2} [111] \rightarrow a[100]$

BINA CHOWDHURY CENTRAL LIBRARY
(GIMT & GIPS)
Azara, Hatkhwapara
Guwahati - 781017

(ii) $\frac{a}{2} [110] + \frac{a}{2} [110] \rightarrow a[110]$

- (b) An *fcc* metal is deformed under tension. The tensile axis lies along $[2\bar{3}1]$. Determine the Schmid's factor for the following slip systems. Which one of two slip systems would be the probable primary slip system during deformation? (10)

(i) $[0\bar{1}1] (\bar{1}\bar{1}\bar{1})$

(ii) $[110] (\bar{1}\bar{1}\bar{1})$

7. (a) How are the stainless steels classified? Explain them very briefly.

Or

- (b) With aluminium rich end of Al-Cu binary phase diagram, explain the characteristics of Al-Cu alloys containing up to 5.65 wt.% Cu (2xxx series).

(15)