B.E. MECHANICAL ENGINEERING SECOND YEAR FIRST SEMESTER EXAMINATION- 2019

Subject: **MATERIAL SCIENCE AND ENGINEERING**

Time : Three hours **Full Marks: 100**

Different parts of the same question should be answered together.

CO1 [15]

*Answer **all** questions in this block*

[1a] Briefly discuss about Ferrous Materials. [6]

[1b] Explain the mechanical propertries (any three): [9]
(i) Toughness (ii) Fatigue (iii) Creep (iv) Modulus of resilience

CO2 [20]

*Answer any **one (1) from (2a) and (2b) in this block:***

[2a] (i) How will you determine Miller Indices for HCP crystal structure? Explain with examples. [6+4]
(ii)Draw the following crystallographic planes and directions:
$(2\bar{1}0)$, (102) , $(12\bar{1})$, [122] , $[32\bar{1}]$ [10]

[2b] (i) How will you measure activation energy for diffusion in solids? [5]
(ii) For a BCC crystal structure, determine the followings:
(a) Atomic packing factor (b) Linear density in terms of atomic radius (r) along the direction [111]
(c) Planner density in terms of atomic radius (r) along the plane (111). [15]

CO3 [40]

*Answer any **two (2) from (3a) , (3b) and (3c) in this block:***

[3a] (i) State Fick's laws of diffusion. Explain any one type of diffusion mechanism. [4+4]
(ii) At 900 °C , what is the time required to carburize a steel with initial composition of 0.2% carbon to 1% carbon at a depth of 0.2 mm ? Assume a constant surface concentration of 1.4% carbon due to carburizing atmosphere. [12]

Given: $D_o = 0.7\times10^{-4}\ \frac{m^2}{s}$; $Q = 157\ \frac{KJ}{mol}$; $R = 8.314\ \frac{J}{mol\,K}$

Z	0.25	0.30	0.35	0.40
erf(Z)	0.2763	0.3268	0.3794	0.4284

[3b] (i)Derive the expression for composite elastic modulus under iso-strain condition for a fibre reinforced composite material. Also mention the assumptions made to derive the expression. [6+4]
(ii) For a fibre reinforced composite material, the modulus ratio is 26 and the fibre takes 35% of the cross sectional area. What percentage of the longitudinal load is taken by the fibre ? [5]
(iii)Explain the stress-strain behaviour of a fibre reinforced composite under longitudinal loading. [5]

[3c](i) Explain the 'Energy Band Structure' in solids. Differentiate among conductors, semiconductors and insulators in the light of energy band structure. [4+6]
(ii) Explain the terms 'ferroelectricilty' and 'piezoelectricity'. [6]
(iii) A piezoelectric material has elastic modulus 90 GPa. Calculate the stress required to change its

	polarization from 650 $\frac{C}{m^2}$ to 665 $\frac{C}{m^2}$.	[4]
CO4 [20]	***Answer any one(1) from (4a) and (4b) in this block:***	
	[4a] Draw the Fe-Fe_3C equilibrium phase diagram according to scale and label it. What do you mean by 'Eutectic', 'Eutectoid' and 'Peritectic' reactions?	[14+6]
	[4b] Draw and explain the Time Temperature and Transformation (TTT) diagram and explain the important features of this diagram?	[20]
CO5 [5]	***Answer any one from (5a) and (5b) from this block:***	
	[5a] Write short notes on: i) Annealing ii) Normalizing.	[5]
	[5b] Explain various corrosion prevention techniques with brief explanation.	[5]

CO1: Identify materials for different engineering applications. (K2)
CO2: Interpret various structures and properties of materials, material characterization techniques. (K2)
CO3: Solve numerical problems related to materials, properties and processes. (K3)
CO4: Analyze structures of materials to investigate the structure–property correlation for various engineering applications.(K4)
CO5: Identify mechanisms of material degradation and techniques for prevention of degradation. (K2)