Mod.-2

T/K/TY

Reg. No: 24BMF0232

VIT
Vellore Institute of Technology

Final Assessment Test – November 2025

Course: BMEE209L - Materials Science and Engineering
Class NBR(s): 2143 / 2144 / 2900 / 2909 / 2916 / 7377 Slot: B2+TB2
Time: Three Hours Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

COs	CO Statements
CO1	Compare different structures based on the atomic arrangement.
CO2	Examine various phases of metals and alloys using phase diagrams.
CO3	Assess the mechanical behaviour of materials according to the standards.
CO4	Recommend suitable heat treatment and surface hardening processes.
CO5	Propose the suitable material based on the structure-property relationships

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions
(10 X 10 = 100 Marks)

1. a) Compare and contrast all the components of materials tetrahedron in multiscale links among processing, structure, properties and performance for rapid decision making in industry. [7] CO1 BL4

   b) Analyse the classifications schemes for advanced materials. [3]

2. a) Name point defects that are limited to ionic crystals only and explain them briefly. [3] CO2 BL3

   b) Describe Schmid law? Establish the relation between critical resolved shear stress and slip systems for a single crystal. [7]

3. a) Calculate the size of the critical radius and the number of atoms in the critical nucleus when solid copper forms by homogeneous nucleation. [7] CO2 BL3

   Comment on the size of the nucleus and assumptions we made while deriving the equation for the radius of the nucleus. The undercooling temperature for homogeneous nucleation is 236°C, The melting temperature of Cu is 1085°C, heat of fusion 1628 J/cm^3, solid-liquid interfacial energy 177×10^{-7} J/cm^2, and lattice parameter for Cu is 0.3615 nm.

   b) Explain the Fick's first law of diffusion with the help of an appropriate diagram. [3]

4. Draw and interpret the significance of the following compositions, temperatures and phases given below concerning Fe-Fe_3C phase diagram CO2 BL4

Temperature (^{o} C)	1538, 1493, 1394, 910, 723
Composition (wt %)	0.02, 0.08, 0.8, 2, 4.3, 6.67
Phase	α Ferrite, Austenite, δ Ferrite, Pearlite, Cementite

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5.	Justify the statement that a material exhibiting high yield strength in a tensile test might still have low resistance to failure in an impact test, especially at low temperatures. Also, evaluate the material's fracture mode under dynamic v/s static loading based on the above statement.	CO3	BL4
6.	Two structural alloys, Material A and Material B, are tested for fatigue strength. Material A's S-N curve becomes nearly horizontal at 10^7 cycles, while Material B's curve continues to drop indefinitely. Interpret this difference and discuss its implications for designing a long-life (10^8 cycles) connecting rod for an internal combustion engine made from Material B.	CO3	BL4
7.	Assume two special bulk heat treatment procedures austempering and ausforming are used on an as-received medium carbon steel sample. Differentiate the heat treatment cycle and the cooling path for both these methods based on the final post-heat treatment microstructure. Also, analyze the differences between carbonitriding and cyaniding based on the process involved and the final microstructural changes.	CO4	BL4
8.	Describe the hardenability of a steel. Discuss how this property is measured with the help of a schematic. Also, explain how the alloying elements affect the hardenability of the steel.	CO5	BL3
9.a)	Compare any major five types of steels available based on the mechanical properties and microstructural features.	CO5	BL3
	OR		
9.b)	Compare the key mechanical, thermal, and corrosion properties of magnesium, aluminium, titanium, nickel, and copper alloys, highlighting their major application areas.	CO5	BL3
10.a)	A mechanical engineering firm is designing a new high-speed cutting insert to machine hardened steel alloys, requiring the tool material to maintain its strength and sharpness at extremely high operating temperatures (up to 1000°C). Name two distinct types of Non-Oxide Advanced Ceramics suitable for this application. For the ceramic class you identify, explain the major drawback that an engineer must overcome in the manufacturing or usage phase.	CO5	BL3
	OR		
10.b)	Differentiate composite materials based on the type of reinforcements used and the type of matrix materials used. Also, compare the composite materials formed from different matrix materials based on their mechanical properties.	CO5	BL3

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