BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: BTECH **SEMESTER : III**
BRANCH: MECH/PIE **SESSION : MO/2025**

SUBJECT: PE24201 INTRODUCTION TO MATERIALS ENGINEERING

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:

1. **The question paper contains 5 questions, each of 10 marks totalling 50 marks.**
2. **Attempt all questions (no alternatives).**
3. **Frame your answers strictly according to the marks allotted.**
4. **The missing data, if any, may be assumed and stated suitably.**
5. **Make sure that you have the correct question paper.**
6. **Tables/Data handbook/Graph paper, if needed, will be supplied to the candidates in the examination hall.**
7. **All rough work must be done on the last page of the answer script.**
8. **Any unfair means adopted by the student will invite summary disqualification.**

				CO	BL
Q.1(a)	I.	Differentiate between crystalline and amorphous solids.	[2]	CO1	BL2
	II.	Determine the relationship between lattice parameters and atomic size for a body centered cubic unit cell with the help of a neat diagram.	[2]	CO1	BL3
	III.	Classify micro-defects in crystalline solids in terms of dimensions.	[1]	CO1	BL2
Q.1(b)	I.	What is the definitive way to determine the crystal structure of a solid?	[2]	CO1	BL1
	II.	'Polishing before examination by optical microscopy is done by introducing scratches' – explain the principle of polishing briefly.	[1]	CO1	BL5
	III.	Why is etching after polishing required to reveal phases and boundaries under an optical microscope?	[1]	CO1	BL1
	IV.	Why do you need a transmission electron microscope to reveal dislocations?	[1]		
Q.2(a)	I.	Name and state all the invariant transformations in the Fe-Fe_3C system, including pure components.	[3]	CO2	BL2
	II.	'A lower melting temperature of an engineering solid is preferable for casting' – Justify the logic with a suitable argument. In this regard, state the invariant reaction that is most relevant for casting.	[2]	CO2	BL4
Q.2(b)	I.	For a Fe–0.30 wt% C alloy at a temperature just below the eutectoid, calculate the following: A. The fractions of total ferrite and cementite phases B. The fractions of the proeutectoid ferrite and pearlite	[2]	CO2	BL3
	II.	Why is the solidification of a pure/elemental solid an invariant change, but that of an alloy only shows an inflexion, but no arrest?	[1]	CO2	BL2
	III.	Briefly state Hume-Rothery's rules of alloying.	[1]	CO2	BL1
	IV.	Explain the meaning of the statement – 'Ease or difficulty of dislocation gliding is equivalent to ductility or strengthening for metallic solids'	[1]	CO2	BL4
Q.3(a)	I.	'Time taken to start or finish eutectoid change in steel is high both at higher and lower temperature ranges of the TTT diagram – why?	[2]	CO3	BL5
	II.	What does ideal critical diameter convey about hardenability of steel?	[1]	CO3	BL2
	III.	Draw relevant schematic diagrams with labelling to indicate the (a) tensile toughness of a mild steel bar, (b) endurance limit of a steel shaft, (c) Burgers vector of a positive edge dislocation, and (d) critical cooling rate of plain carbon eutectoid steel.	[2]	CO3	M3

PTO

Q.3(b)	I.	Draw a schematic temperature-time diagram to show the three stages of quenching a hot component in a water bath.	[1]	CO3	BL2
	II.	Name the four 'keywords' for the four most common heat treatments of steel.	[2]	CO3	BL1
	III.	Explain the stages of annealing of a cold-worked alloy using a neat diagram. Superimpose the change in the mechanical properties (hardness, ductility), dislocation density, and average grain size during these stages of annealing.	[2]	CO3	BL2
Q.4(a)	I.	Differentiate between the microstructures of gray (GCI) and white cast iron (WCI). Offer one reason each why GCI and WCI are more suitable for engine block and brake shoe applications, respectively.	[2]	CO4	BL3
	II.	Explain briefly why viscoelasticity is common in thermoplastic, not thermosetting polymers.	[1]	CO4	BL1
	III.	'Melting and casting of ceramics are not feasible' – Justify the statement.	[2]	CO4	BL5
Q.4(b)	I.	Name four major strengthening mechanisms of non-ferrous metallic alloys.	[2]	CO4	BL1
	II.	'Polymeric solids are usually non-crystalline' – Explain with proper reasoning. State a strategy by which polymers can be partially crystallized.	[2]	CO4	BL3
	III.	'While normal glass utensils are shattered in a microwave, a glass ceramic vessel is easily microwavable' – name the heat treatment technique to make glass ceramic and how it works.	[1]	CO4	BL4
Q.5(a)	I.	Superimpose the stress (Y) versus strain (X) curves of metals/alloys, polymers and ceramics on the same X-Y plot and explain their behaviors.	[2]	CO5	BL3
	II.	Name the techniques to assess the hardness of (a) a porous solid, and (b) a rock mass with irregular contour?	[1]	CO5	BL1
	III.	How does nanoindentation hardness differ from Rockwell or Brinell hardness? How can one measure the elastic modulus from a nanoindentation test?	[2]	CO5	BL3
Q.5(b)	I.	What is corrosion? State any two methods suitable for the prevention of galvanic corrosion.	[2]	CO5	BL1
	II.	Define thermal conductivity. Why are the thermal and electrical conductivities of metals always higher than those of polymers and ceramics?	[1]	CO5	BL3
	III.	Draw a typical magnetic hysteresis plot of a magnetic material, mark the two axes, and show the coercivity and retentivity values on it.	[2]	CO5	BL1

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