BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION SP/2025)

CLASS: B.TECH. **SEMESTER: VI**
BRANCH: PIE/MECH **SESSION: SP/2025**

SUBJECT: PE324 SURFACE ENGINEERING AND LASER ADDITIVE MANUFACTURING
TIME: 2 Hours **FULL MARKS: 100**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 20 marks and total 100 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates**

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Q.1(a)	Draw a schematic stress-strain diagram of a ductile metal and a sintered ceramic solid to mark the following on them: (i) yield point, (ii) ultimate tensile strength, (iii) fracture or breaking stress, (iv) resilience, (v) toughness.	[2X5=10]	1	2
Q.1(b)	Make only a very brief remark or statement to define the similarities and dissimilarities between the following pairs: i. Hardness and compressive strength ii. Crystal system and crystal lattice iii. Hydrophobicity and hydrophilicity iv. Dislocation and grain boundary v. Grinding and polishing	[2X5=10]	1	3

Q.2(a) [1X10=10] 3 1

Select appropriate items from Column A and Column B to form a relevant pair in terms of process, property and/or product:

Column A	Column B
a) Gas nitriding	i) Residual tensile stress
b) Surface melting	ii) Primer coating before painting
c) Carburizing	iii) Cementite
d) Anodizing	iv) Steel with at least 0.4 wt.% C
e) Austenite	v) Thin, adherent film of Cr_2O_3
f) Electropolishing	vi) Highest solubility of carbon
g) Induction hardening	vii) Dispersion hardening
h) Corrosion of stainless steel	viii) Selective dissolution from anodic surface
i) Conversion coating	ix) Oxidation of the anode metal
j) Hardest phase in steel	x) Barium carbonate

Q.2(b) Name the most obvious/common mode of failure (or combination) for the following engineering members/components/machines: [1X10=10] 4 2

i. Axle rod of an automobile to transfer power
ii. Turbine rotor blades and vanes of an aircraft engine
iii. Electrical contacts and switch gears
iv. Rubber tyres for motorcycles
v. Saw blade for metal cutting
vi. Drill head for drilling holes in concrete or metals
vii. Pipeline for transporting crude oil
viii. Steam boiler for thermal power units
ix. Excavator shovels
x. Chains used in pulley

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Q.3(a)	Examine and correct the following statements by revising only the underlined word/phrase, wherever applicable: i. Residual compressive stress in ultrasonic peening is due to **martensite** ii. Rust on corroded steel is **iron-sulphide** iii. An example of an interstitial solute in steel is **nickel** iv. The most common threat to aero-turbine blades is **wear** v. Glass-ceramic used in microwave cooking bowls is toughened due to partial **vitrification** vi. The most important property of a bulletproof armor plate is **hardness** vii. The most common method of toughening and strengthening elastomeric rubber is **carburizing** viii. Bonding of ceramic solids is predominantly **metallic** ix. Rapid water quenching following flame hardening is essential to avoid the formation of **martensite** x. The instrument used to measure surface roughness is called a **tensometer**	[1X10=10]	1,2	2
Q.3(b)	Answer the following questions just in one word or a phrase: i. The hardest solid solution in steel: ii. The hardest naturally occurring solid in nature: iii. A method to deposit nickel on steel at room temperature from an aqueous bath: iv. The rule applied for determining relative amounts of phases at a given T from a phase diagram is called: v. The most important property considered for designing a tank for storing liquid nitrogen is: vi. The most effective and essential alloying element in stainless steel is: vii. The invariant change in which a binary alloy produces a solid solution by a reaction between a solid and a liquid phase on cooling is called: viii. Degree of freedom for eutectic solidification of a quaternary alloy is: ix. Number of atoms per a body-centred orthorhombic pure metal unit cell is: x. Bainite in plain carbon steel can only be produced by an isothermal heat treatment called:	[1X10=10]	1	1
Q.4(a)	(i) What is the origin of surface energy or tension in an engineering solid? (ii) NaCl is a crystalline solid with FCC lattice, yet it has practically no ductility – why? (iii) Name a possible way a pure metal can be strengthened without changing its composition. (iv) Why is aluminium thermally and electrically conducting but alumina is not? (v) What does the endurance limit of a rotating shaft mean?	[2X5=10]	1	3

Q.4(b)	(i) What is aqueous corrosion and why do metals easily corrode but oxides do not? (ii) Name the components that make up a typical Galvanic Cell and state which of them undergo dissolution. (iii) How does abrasive wear differ from adhesive wear? (iv) Name any two instruments used for monitoring or assessing wear damage. (v) What is creep? Why creep is an important design criterion for superheater tubes in a thermal power plant?	[2X5=10]	1,2	3
Q.5(a)	Draw the following schematically (any FOUR): i. A binary isomorphous phase diagram ii. A Frenkel defect iii. Pearlite microstructure in steel iv. Octahedral void in an FCC unit cell v. A CCT diagram of a eutectoid plain C steel vi. A TTT diagram of a eutectoid plain C steel vii. Heat treatment (thermal cycle) for normalising of a hyper-eutectoid steel viii. A part of a phase diagram showing the peritectic phase transformation	[2.5X4=10]	1	3
Q.5(b)	(i) What is precipitation hardening? What are the conditions for precipitation hardening? (ii) What is carburizing of 0.2 wt.% C steel done above AC3 in single phase austenite region? (iii) What is diffusion? What does it depend upon? (iv) What is diffusion coating? What is the difference between diffusion coating from nitriding?	[2.5X4=10]	3	2

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