Reg No.:_____ Name:_____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

B.Tech Degree S3 (R,S) / S3 (WP) (R,S) / S5 (PT) (R,S) Examination November 2024 (2019 Scheme)

**Course Code: MET205**

**Course Name: METALLURGY AND MATERIAL SCIENCE**

Max. Marks: 100 Duration: 3 Hours

**PART A**

***Answer all questions. Each question carries 3 marks*** Marks

| | | | |
|---|---|---|---|
| 1 | Sketch within a cubic unit cell the following planes (1 1 2), ($1\bar{1}$ 0) and (1 1 1). | (3) |
| 2 | How are yield strength and grain size of a crystal related? | (3) |
| 3 | What are "surface defects" in crystalline materials. | (3) |
| 4 | State and explain the Fick's first law of diffusion. | (3) |
| 5 | Draw Cu - Ni equilibrium phase diagram. What type of phase diagram is this? | (3) |
| 6 | Explain why case hardening of engineering components is important. Name any two types of case hardening. | (3) |
| 7 | How cold working increases the strength of a material? | (3) |
| 8 | What is the fundamental difference between steel and cast iron? | (3) |
| 9 | Creep is a temperature dependant phenomenon. Explain. | (3) |
| 10 | Give functions of matrix phase in composites. | (3) |

**PART B**

***Answer any one full question from each module. Each question carries 14 marks***

**Module 1**

| | | | |
|---|---|---|---|
| 11 | a) | Molybdenum has BCC structure and a density of 10.2 g/cm$^3$. Calculate its atomic radius. Atomic weight of Molybdenum is 95.94 g/mol and Avogadro's Number is 6.023 x $10^{23}$ atoms/mol. | (7) |
| | (b) | Estimate effective number of atoms, co-ordination number and atomic packing factor for an HCP unit cell. | (7) |
| 12 | (a) | Derive an expression for critical resolved shear stress (CRSS) and explain its importance. | (7) |
| | (b) | Explain under cooling and dendritic growth in crystal formation with neat diagrams. | (7) |

## Module 2

13 (a) Describe step by step procedure for metallographic specimen preparation? (10)

(b) Compare SEM with TEM. (4)

14 (a) Which of the following will have the largest interplanar spacing : $d_{200}$, $d_{220}$ or $d_{111}$ ? (for FCC crystal with $r=1.246A^0$). (6)

(b) A 3 mm thick palladium sheet with a cross sectional area of $0.2m^2$ is used as a steady state diffusional membrane for purifying hydrogen. If the hydrogen concentration on the high pressure (impure gas) side of the sheet is 1.5 $kg/m^3$, that on the low pressure side is $0.3kg/m^3$ and the diffusion coefficient for hydrogen in palladium is $1.0x10^{-8}$ $m^2/s$, determine the mass of hydrogen being purified per hour. (8)

## Module 3

15 (a) With the help of an Iron-Carbon phase diagram explain the eutectoid, eutectic and peritectic reaction of iron carbon alloy system. (10)

(b) State Hume-Rothery's rule for the formation of substitutional solid solution. (4)

16 (a) Distinguish between Austempering and Martempering with neat diagrams. (8)

(b) Explain Jominy end quench test for hardenability with neat diagrams. (6)

## Module 4

17 (a) Explain the following strengthening mechanism in metals: - (6)

i) Strengthening by grain size reduction.
ii) Solid solution strengthening.

(b) Explain the phenomena of recovery, recrystallisation and grain growth intimately associated with the annealing of a plastically deformed crystalline material with neat diagrams. (8)

18 (a) Distinguish between grey cast iron and spheroidal graphite cast iron with neat diagrams. (10)

(b) What is High Speed Steel? Give the composition of Tungsten based High Speed Steel. (4)

## Module 5

19 (a) What is fatigue? With the help of a neat sketch explain fatigue test. (8)

(b) What are the factors that affect creep? (6)

20 a) What are composites? Differentiate between Polymer Matrix Composites and Metal Matrix composites. (8)

(b) What is maraging steel? Write any two engineering applications. (6)

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