Reg. No.

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

III SEMESTER B.TECH (AUTOMOBILE ENGINEERING)
END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: MATERIALS SCIENCE AND METALLURGY [AAE2153]
REVISED CREDIT SYSTEM

Time: 3 Hours   MAX. MARKS: 50

> **Instructions to Candidates:**
> ❖ Answer **ALL** the questions.
> ❖ Missing data may be suitable assumed.

1A. What is atomic packing factor? **(01)**

1B. Show that the atomic packing factor for the FCC crystal structure is 0.74.? **(04)**

1C. Copper has an atomic radius of 0.128 nm, an FCC crystal structure, and an atomic weight of 63.5 g/mol. Compute its theoretical density. Avogadro's number= 6.022×10^{23} atoms/mol) **(05)**

2A. Briefly explain X-ray diffraction and Bragg's law. **(03)**

2B. For BCC iron, compute (a) the interplanar spacing, and (b) the diffraction angle for the (220) set of planes. The lattice parameter for Fe is 0.2866 nm. Also, assume that monochromatic radiation having a wavelength of 0.1790 nm is used, and the order of reflection is 1. **(05)**

2C. Differentiate between (i) isotropic and anisotropic materials and (ii) amorphous and crystalline materials **(02)**

3A. Write the differences between interstitial and substitutional solid solutions. **(02)**

3B. What are the conditions for proper solubility of solute atoms in a solvent? **(04)**

3C. What is Fick's law of Diffusion? What is the influence of temperature and size of atoms on the rate of diffusion? **(04)**

4A. A hypothetical alloy that initially has a uniform carbon concentration of 0.25 wt% and is to be treated at 950^0 C (1750 F). If the concentration of carbon at the surface is suddenly brought to and maintained at 1.20 wt%, how long will it take to achieve a carbon content of 0.80 wt% at a position 0.5 mm below the surface? The diffusion coefficient for carbon in iron at this temperature is 1.6×10^{-11} m^2/s; assume that the steel piece is semi-infinite. The required data is given in table1. **(05)**

4B. Differentiate between AX, AmXp and AmBnXp-Type Crystal Structures with respect to ceramics. **(03)**

4C. What is a binary phase diagram? What is an invariant point with respect to phase diagram of water? **(02)**

5A. Differentiate between pro-eutectoid and hypo-eutectoid iron alloys. **(02)**

5B. Explain the development of microstructure of a binary isomorphous system referring to **(05)**
the diagram given below.
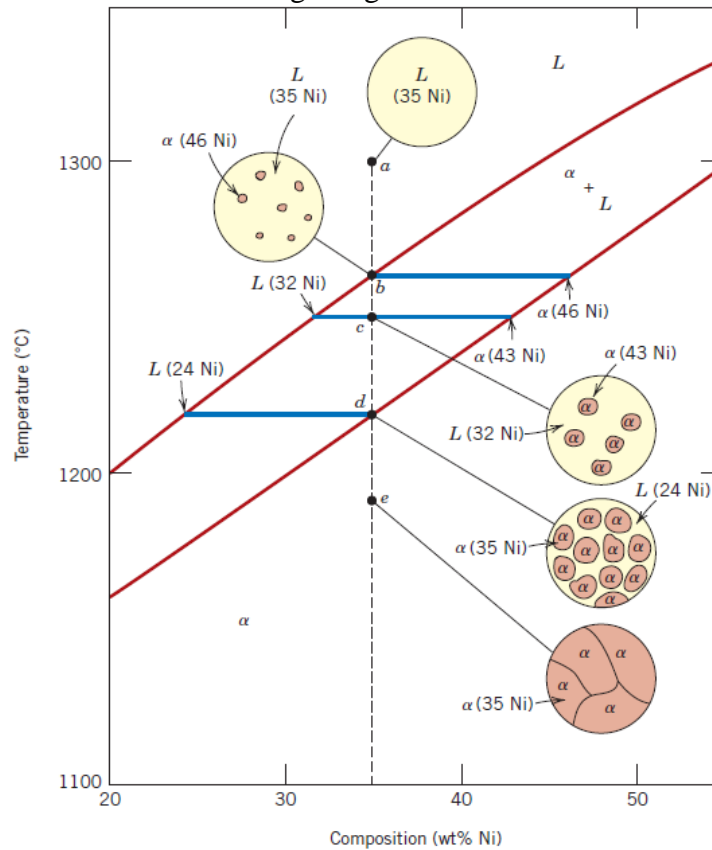
5C. Briefly explain Jominy end quench test. **(03)**

Table1: Tabulation of Error Function Values

z	erf(z)	z	erf(z)	z	erf(z)
0	0	0.55	0.5633	1.3	0.9340
0.025	0.0282	0.60	0.6039	1.4	0.9523
0.05	0.0564	0.65	0.6420	1.5	0.9661
0.10	0.1125	0.70	0.6778	1.6	0.9763
0.15	0.1680	0.75	0.7112	1.7	0.9838
0.20	0.2227	0.80	0.7421	1.8	0.9891
0.25	0.2763	0.85	0.7707	1.9	0.9928
0.30	0.3286	0.90	0.7970	2.0	0.9953
0.35	0.3794	0.95	0.8209	2.2	0.9981
0.40	0.4284	1.0	0.8427	2.4	0.9993
0.45	0.4755	1.1	0.8802	2.6	0.9998
0.50	0.5205	1.2	0.9103	2.8	0.9999

Solution to second law of Diffusion is given by $\dfrac{C_x - C_o}{C_s - C_o} = 1 - erf\left(\dfrac{x}{s\sqrt{Dt}}\right)$