MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

III SEMESTER B. TECH. (AUTOMOBILE ENGINEERING)

END SEMESTER EXAMINATIONS, DECEMBER 2017

SUBJECT: MATERIALS SCIENCE AND METALLURGY (AAE 2153)

REVISED CREDIT SYSTEM
(28/12/2017)

Time: 3 Hours   MAX. MARKS: 50

Instructions to Candidates:

❖ Answer **ALL** the questions.
❖ Assume missing data suitably by clearly stating the assumption.
❖ Give sketches/graphs/examples wherever necessary.

1A	Write any two applications of (a) SEM (b) TEM in material science.	**(02)**
1B	Explain the allotropic behavior of Iron.	**(02)**
1C	The results of a x-ray diffraction experiment using x-rays with $\lambda = 0.7107$ Å (a radiation obtained from molybdenum (Mo) target) show that diffracted peaks occur at the following 2θ angles: 20.20°, 28.72°, 35.36°, 41.07°. Determine the crystal structure.	**(02)**
1D	The d_{220} inter planar spacing in an FCC metal is 0.083393 nm. Determine the lattice edge parameter (*a*) and atomic radius of the material.	**(02)**
1E	Determine the Miller-Bravais indices for Plane A and Plane B with reference to Figure 1.	**(02)**
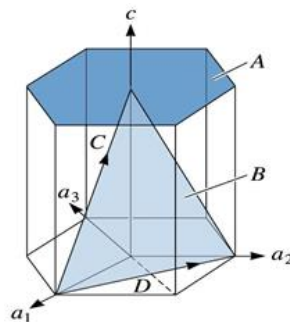
Figure 1

2A	Explain the mechanism by which strength of a material increases with alloying.	**(02)**
2B	What does Hall –Petch equation tell us?	**(02)**
2C	What is the significance of Frank-Read source in material science?	**(02)**
2D	Distinguish between edge dislocation and screw dislocation. What is the significance of Burger's vector?	**(04)**
3A	Draw the shape of the equilibrium phase diagram for an isomorphous alloy.	**(02)**
3B	Explain the changes in (a) hardness (b) ductility of a material during recovery and recrystallization of a material during annealing.	**(03)**

3C For a single crystal of BCC material subjected to a tensile stress of 72 MPa, the slip **(02)** occurs on a (110) plane and in a [111] direction. The angle between the normal to the slip plane and the applied stress direction is 40 º and the angle between the slip and stress directions is 62.36 º. Apply Schmid's law and find resolved shear stress.

3D State the Hume-Rothery rules for the formation of solid solution. **(03)**

4A Draw the cooling curve for (a) pure metal (b) an alloy. **(02)**

4B (a)Explain the eutectic reaction (b) eutectoid reaction (c) peritectic reaction during **(03)** alloying.
(b)Explain lever rule applied to phase diagram with an example of your choice? **(02)**

4.C Explain the information that are revealed by phase diagrams for a materials engineer. **(03)** What is the Gibb's phase rule that is applicable to metallurgical phase diagrams?

5A Draw time-temperature cooling paths of a 1090 steel on an isothermal **(03)** transformation diagram that will produce the following micro-structures. Start with steels in austenitic condition at time t=0 and 900°C.
(a) 100 % martensite .
(b) 50 % martensite and 50 % coarse pearlite.
(c) 100 % fine pearlite.
(d) 50 % martensite and 50 % upper bainite.
(e) 100 % upper bainite.
(f) 100 % lower bainite.

5B What is the advantage of nitriding over carburization? **(02)**

5C Differentiate between annealing and normalizing. **(02)**

5D What is hardness? What is hardenability of steel? **(02)**

5E Distinguish between (a) steel (b) cast iron in terms of carbon percentage. **(01)**

AAE 2153