VIT
Vellore Institute of Technology

SCHOOL OF MECHANICAL ENGINEERING

Continuous Assessment Test – I - Fall Semester 2019-2020

Programme Name & Branch: B.TECH. (BEM/BMA/BME/BPI)

Course Name & Code: Materials Engineering & Technology (MEE1005)

Class Number: *VL2019201001078; VL2019201005071; VL2019201001567; VL2019201001633; VL2019201001401; VL2019201001835; VL2019201000897* Slot: B1

Exam Duration: 90 mins Maximum Marks: 50

(Answer all the questions)

1. A material is suspected to have magnesium cations (Mg^{2+}) at locations (½, 0, 0), (0, ½, 0), (0, 0, ½), (½, ½, ½) and oxygen anions (O^{2-}) at all (0,0,0), (½, ½, 0), (½, 0, ½), (0, ½, ½) positions.

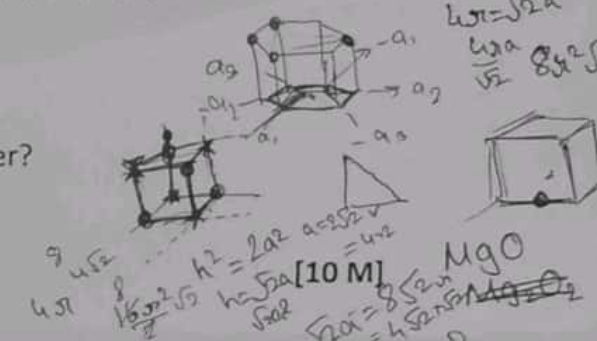
(i) Draw and label the contents of a unit cell of this material.

(ii) What is the chemical formula?

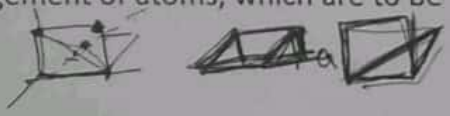
(iii) Is it likely that the material is an alloy? a ceramic? a polymer?

(iv) Do you expect this material to be isotropic?

(v) Do you expect this material to be ductile? [10 M]



2. (i) Draw (110) plane in alpha-Fe (BCC) to show the arrangement of atoms, which are to be represented as hard spheres.



(ii) On the sketch you have drawn in answer to part (i), draw and find out the directions along which slip occurs and name the family of directions to which they belong.

(iii) Calculate the planar density in the (110) plane of alpha-Fe. Express your answer in units of atoms cm^{-2}. Assume that the lattice parameter of alpha-Fe = 0.316 nm. [10 M]

3. Identify 3 types of crystal defects in solids (one point, one line, and one surface) and suggest for each of these one material property that is adversely affected by its presence and one that is improved. Also state what to look for in a crystal that possesses each of these defects.

[10 M]

$\sigma \sin\chi$ $\sigma = F/A$

4. (a) Derive the relationship between the applied tensile stress and the shear stress acting on the slip plane in the slip direction during the plastic deformation of single crystal material.

(b) Consider a silver single crystal oriented such that the normal to the slip plane and the slip direction are at angles of 60° and 35°, respectively, with the tensile axis. If the critical resolved shear stress is 6.2 MPa, will an applied stress of 12 MPa cause the single crystal to yield? If not, what stress will be necessary?

[5 M + 5 M]

5. For the solidification of pure gold (FCC), calculate the critical radius (r*), if nucleation is homogeneous. Values for the melting point, enthalpy, surface free energy and degree of super-cooling are 1064°C, -1.16×10^9 J/m^3, 0.132 J/m^2, and 230°C respectively.

Also, calculate the number of atoms found in a nucleus of critical size. Assume that the lattice parameter of solid gold is 0.413 nm.

[10 M]