**TUTORIAL EMG 2104 INTRODUCTION TO MATERIAL SCIENCE**

1. Define the following terms as they are applied in crystal structures
2. Unit cell
3. Crystal / space lattice
4. Primitive cell
5. Polymorphism
6. With the aid of well labeled sketches, determine the density of packing of the following unit cells;
7. Body centered cubic (BCC)
8. Face centered cubic (FCC)

1. With the aid of a well labeled diagram, describe the arrangement of atoms in a hexagonal close packed (HCP) structure
2. Draw the following direction vectors in cubic unit cell
3. [112]
4. [
5. Draw the [111] direction in an atomic site BCC unit cell and list the atom positions whose centers are intersected inside the cube by the direction vector
6. Determine the miller indices of the planes with the following x y z intercepts. **Sketch the planes**

|  |  |  |  |
| --- | --- | --- | --- |
| Axis | x y z | x y z | x y z |
| Intersection | 1 ∞ ∞ | 1 1 ∞ | 1 1 1 |
|  |  |  |  |
| Miller indices |  |  |  |

1. With the aid of well labelled sketches, describe the following primary bonds;
2. Covalent bond
3. Ionic bond
4. Metallic bond

1. **Explain** the difference between crystalline and amorphous solids. **State** *two* examples of each of these solids
2. State three secondary bonds
3. With the aid of well labeled sketches, explain how the following crystal defects occur.
4. Interstitial defect
5. Substitutional defect
6. Edge dislocation
7. Twin boundary
8. Stacking fault
9. Define *corrosion*
10. Explain briefly **seven** types of corrosion
11. State 5 methods that are used to prevent or control corrosion in metals
12. Explain **three** ways in which corrosion may be prevented (or minimized) **by selecting a suitable design and fabrication procedure** for a particular component.
13. What is a composite material?
14. **State** and **describe** briefly ***three*** types of composites. Give **two** examples of each of these types of composites.
15. Determine the volume ratio of aluminium and boron in aluminium-boron composite which can have the same Young’s modulus equal to that of iron. The Young’s modulus of aluminium, iron and boron are 71, 210 and 440 GPa respectively.
16. Sketch an iron-iron carbide phase diagram (with the composition of carbon by weight ranging from 0% to 6.7% and the temperature ranging from 400 to 1600◦ C) and show all the phases present.
17. State the difference between a phase and an alloy
18. Give a brief description of the following solid phases in iron-iron carbide phase diagram
19. α-ferrite
20. Austenite
21. Define the following terms
22. Eutectoid steel
23. Hypoeutectoid steel
24. Hypereutectoid steel

1. A tensile test was conducted on a mild steel bar. The following data was obtained from the test:­
   1. Diameter of the steel bar = 30 mm
   2. Gauge length of the bar = 200 mm
   3. Load at elastic limit = 250 kN
   4. Extension at a load of 180 kN = 0.21 mm
   5. Maximum load = 400 kN
   6. Total extension = 60 mm
   7. Diameter of the rod at the failure = 22.5 mm

Determine:

* + 1. The young’s modulus
    2. The stress at elastic limit
    3. The percentage elongation
    4. The percentage reduction in cross sectional area
    5. The ultimate tensile stress

1. Briefly explain four non-destructive testing methods used in engineering materials’ inspection
2. State 4 factors that affect impact resistance
3. State any 3 types of hardness test
4. With the aid of well labelled sketches, describe how a charpy test is carried out
5. Mechanical properties of materials are important in the engineering field, explain the following four mechanical properties of metals
6. Plasticity
7. Brittleness
8. Fatigue
9. Toughness
10. What is **vulcanization**? What effect does it have on rubber?
11. State the difference between addition polymerization and condensation polymerization
12. State the substances that are usually added to monomers and give the function of each.
13. Give **three** differences between thermoplastics and thermosetting plastics
14. Describe the *production*, *properties* and *uses* of the following thermoplastics
    * 1. Polyethylene (polythenes)
      2. Polystyrenes
15. List the powder metallurgy processes in the order in which they are carried out during the production of a powder metallurgy part.
16. What is pre-sintering? How is pre-sintering carried out?
17. State four objectives of normalising heat treatment process
18. Describe how a steel component can be normalised and give the effects of this processes on the component
19. State four objectives of full annealing
20. Describe the procedure of full annealing of a steel component
21. State THREE defects caused by improper heat treatment of materials
22. Explain the significance of surface hardening of steels in the industry. Give two examples of surface hardening methods.
23. What is a refractory material
24. State 6 properties of refractory materials