**DEPARTMENT OF METALLURGY AND MATERIALS ENGINEERING**

**MT: 202 Electrical and Electronic Materials**

**Tutorial 2**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1. | a | Treating electron as a particle and applying classical mechanics, derive Ohm’s law using Drude’s Model of classical theory. | | | |
|  | b | State the assumptions and limitations of this model. | | | |
| 2. | a | Explain with neat sketches the microscopic processes that cause the scattering of electrons in metals. | | | |
|  | b | How does the scattering affect the electrical conductivity ,**σ** that is equal to **enµd** ? | | | |
| 3. |  | Calculate and compare the drift mobility of free electrons in case of Ag and Cu at room temperature (200 C). Given: | | | |
|  |  | Element | **Atomic Mass** | **Conductivity** | **Density** |
|  |  | Ag  Cu | 107.8 g/mol  63.5 g/ mol | 6.3 x 105 Ω-1cm-1  5.9 x 105 Ω-1cm-1 | 10.49 g/cm3  8.96 g/cm3 |
|  |  | *Hint: Use formula . Using atomic mass and density, calculate number of atoms per unit volume. Knowing the valency of Ag and Cu as one, n will be same as atoms/volume. For copper valency can also be two. Check in the book if any information is available.* | | | |
| 4. | a | What is lattice – scattering- limited conductivity?  For pure metal derive an expression, σT =AT | | | |
|  | b | Calculate the % change in the electrical resistance of a pure metal wire between winter (50C) and summer (400C). Neglect the changes in the dimensions of the wire. | | | |
|  | c | How will the out-door cable power losses be affected? | | | |
|  | d | Connecting cable for your experimental set-up when given Ag, Cu and Al wires, which one would you prefer? Justify your answer. | | | |
| 5. | a | What is the significance of **Mathiessen’s**  rule used for finding ρ of metals and alloys? | | | |
|  | b | Explain the typical resistivity, ρ verses temperature (absolute) behavior for the given copper alloys containing various amounts of nickel, pure copper sample that is annealed and two samples that are cold- worked (deformed) to give same amount of plastic deformations. | | | |
| 6. | a | What is the composition of nichrome? | | | |
|  | b | Why nichrome is widely used as a heater wire in house hold and industrial furnaces? | | | |
|  | c | What is Nordheim’s rule? State the limitations of this rule. | | | |
|  | d | What is the significance of Nordheim’s coefficient? Why it is modified to taken into account of solid solutions with higher concentrations? | | | |
|  | e | For low voltage dc electrical appliances, the alloy Au-15 wt. %Cu is used. Calculate the resistivity of the alloy. Given : Nordheim’s coefficient ,C when Cu is dissolved in Au to form solid solution is, 450 nΩm. | | | |
| 7. | a | Show with neat sketches, the effective resistivity of composite materials, i) along a direction perpendicular to the layer, ii) along a direction parallel to the plane of the layer and iii) material with dispersed phase in a continuous matrix. | | | |
|  | b. | For a binary alloy system with partial solid solubilities (i.e. having two terminal solid solutions) estimate the nature of resistivity behavior with concentration. Show with neat sketch taking an example. | | | |
| 8. | a | What is Hall effect? Give an example of a material used for a particular application. | | | |
|  | b | Explain how the conduction occur in ionic crystals and glasses in an applied electric field. | | | |
|  | c | Compare the electrical conductivity with the thermal conductivity of metal. | | | |
|  |  |  | | | |