MODULE - IV

MAGNETIC MATERIALS & SUPERCONDUCTIVITY

Numerical Problems

6 Calculate magnetization and magnetic flux density if magnetic field intensity 250amp/m and relative permeability is 15.

Given Data:

$\mathbf{H = 250\ A/m}$

$\boldsymbol{\mu_r = 15}$

$\boldsymbol{\mu_0 = 4\pi \times 10^{-7}}$ **H/m**

$\boldsymbol{\chi = \mu_r - 1 = 15 - 1 = 14}$

Magnetic Flux Density $\boldsymbol{B = \mu H = \mu_r \mu_0 H = 15 \times 4\pi \times 10^{-7} \times 250}$

$\mathbf{= 47.12 \times 10^{-4}\ T}$

Magnetization $\mathbf{M = \boldsymbol{\chi . H} = 14 \times 250 = 3500\ A/m}$

Numerical Problems

7. Find relative permeability, if H=220amp/m and M=3300 amp/m

Given:

H=220amp

M=3300 amp/m

We have $\chi = \frac{M}{H}$ = 3300/220 = 15

$\mu_r = 1 + \chi$= 1+15=16

Numerical Problems

8. The magnetic susceptibility of aluminium is 2.3 x 10^{-5} . Find its permeability and relative permeability.

Given:

$$\chi = 2.3 \times 10^{-5}$$

$$\mu_r = 1 + \chi = 1 + 2.3 \times 10^{-5} = 1.000023$$

$$\mu = \mu_0 \times \mu_r = 4\pi \times 10^{-7} \times 1.000023 = 12.566 \times 10^{-7} \text{ H/m}$$

Numerical Problems

9 If a magnetic field of strength 300 amp/meter produces a magnetization of 4200 A/m in a ferromagnetic material, find the relative permeability of the material

Given:

H = 330 A/m

M= 4200 A/m

We have $\chi = \frac{M}{H}$ **= 4200/300 = 14**

$\mu_r = 1 + \chi$**= 1+12=15**

Numerical Problems

10. A paramagnetic material has a magnetic field intensity of 10^4 A/m. If the susceptibility of the material at room temperature is 3.7×10^{-3} , calculate the magnetization and magnetic flux density in the material.

Given:

$$H = 10^4 \text{ A/m}$$

$$\chi = 3.7\times10^{-3}$$

$$M = \chi . H = 3.7\times10^{-3}\times10^{4} = 37 \text{ A/m}$$

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$$B = \mu_0 \times (1+\chi)H = 4\pi\times10^{-7}(1.0037)10^{4} = 0.0126 \text{ wb/m}^2$$

Numerical Problems

1. The transition temperature for Pb is 7.2 K. However, at 5 K it loses the superconducting property if subjected to magnetic field of 3.3×10^4 A/m. Find the maximum value of H which will allow the metal to retain its superconductivity at 0 K.

Given:

Transition Temperature $T_C = 7.2$ K

$H_c(T) = 3.3 \times 10^4$ A/m

Temperature T = 5 K

$$H_C(0) = \frac{H_C(T)}{1 - T^2/{T_C}^2} = \frac{\mathbf{3.3 \times 10^4}}{\mathbf{1 - (\frac{25}{51.84})}} = \mathbf{6.37 \times 10^4\ A/m}$$

Numerical Problems

2. The critical field of niobium is 1×10^5 A/m at 8 K and 2×10^5 A/m at 0 K. Calculate the transition temperature of the element.

Given:

$H_c(T) = 1 \times 10^5$ A/m
Temperature T = 8 K
$H_c(0) = 2 \times 10^5$ A/m
Transition Temperature T_C = ? K

$$\boldsymbol{T_C = \frac{T}{\left[1 - \frac{H_C(T)}{H_C(0)}\right]^{1/2}} = \frac{8}{\left[1 - \frac{1 \times 10^5}{2 \times 10^5}\right]^{1/2}} = 11.3^0\mathrm{K}}$$

Numerical Problems

3. The critical magnetic field at 5 K is 2×10^3 A/m in a superconductor ring of radius 0.02 m. Find the value of critical current

Given:

$H_c(T_C) = 2 \times 10^3$ A/m

Temperature T = 5 K

R = 0.02 m

$I_C = 2\pi r\, H_C = 2 \times 3.143 \times 0.02 \times 2 \times 10^3 = 251.4$ A

4. A superconducting tin has critical temperature of 3.7k at zero magnetic field and critical field of 0.0306 T at 0 k. Find critical field at 2 k. Find critical current also if r =1 m.

Given:

Critical Temperature T_C = 3.7 K

Critical Field at 0 K = 0.0306 **A/m**

r = 1m

We have $H_C = H_0 \left[1 - \frac{T^2}{{T_C}^2}\right]$

$= \mathbf{0.0306} \left[1 - \frac{2^2}{3.7^2}\right]$

= 0.02166 A/m

Critical Current = $I_C = 2\pi r\, H_C$

= 2 × 3.143 × 1 × 0.02166 = 0.136 A

Numerical Problems

5. Calculate the critical current for a wire of lead having a diameter of 1 mm at 4.2 K. The critical temperature for lead is 7.18 K and $H_C(0) = 6.5 \times 10^4$ A/m

Given:

Critical Temperature T_C = 7.18 K

Critical Field at 0 K = 6.5×10^4

d = 1mm **r = 0.5 mm**

We have $H_C = H_0\left[1 - \frac{T^2}{{T_C}^2}\right]$

$= 6.5 \times 10^4\left[1 - \frac{4.2^2}{7.18^2}\right]$

$= 42.758 \times 10^3$ A/m

Critical Current = $I_C = 2\pi r\, H_C$

$= 2 \times 3.143 \times 1 \times 10^{-3} \times 6.5 \times 10^4 = 134.26$ A

0.5


Thank you!