Quadrant II - Notes

Programme: Bachelor of Science (T.Y.B.Sc.)
Subject: Physics

Paper Code: PYC110

Paper Title: Electromagnetic Theory II & Theory of Relativity

Unit: 2- Magnetic Field in material media

Module Name: Magnetic susceptibility and permeability
Module No: 10

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Notes

Magnetic Susceptibility and Permeability.

If the magnetic material is isotropic and linear there exists a linear relationship between $\vec{M}$ and $\vec{H}$

$$\vec{M} = \chi_M \vec{H}$$

Dimensionless quantity χ_M is called the magnetic susceptibility

For paramagnetic materials χ_M is positive **(Magnetic induction is strengthened by the presence of the material)**

For diamagnetic materials χ_M is negative **(Magnetic induction is weakened by the presence of the material)**

$$|\boldsymbol{\chi_m}| \ll \mathbf{1}\ \boldsymbol{(for\ paramagnetic,\ diamagnetic\ materials)}$$

The linear relationship between $\vec{M}$ and $\vec{H}$ implies also a linear relationship between $\vec{B}$ and $\vec{H}$

$$\vec{B} = \mu \vec{H}$$

Where $\mu\ is$ the permeability of the medium

$$\overrightarrow{\boldsymbol{H}} = \frac{\mathbf{1}}{\boldsymbol{\mu_0}}\overrightarrow{\boldsymbol{B}} - \overrightarrow{\boldsymbol{M}}$$

Substituting

$$\vec{B} = \mu\vec{H} \text{ and } \vec{M} = \chi_M\vec{H}$$

$$\boldsymbol{\vec{H}} = \frac{\mu}{\boldsymbol{\mu_0}}\vec{H} - \chi_M\vec{H}$$

$$\boldsymbol{\mu = \mu_o(1 + \chi_m)}$$

$$K_m = \frac{\mu}{\boldsymbol{\mu_0}} = \mathbf{1} + \boldsymbol{\chi_m}$$

- Where K_m is known as relative permeability
- Which is dimensionless quantity
- For paramagnetic and diamagnetic materials K_m is close unity

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