
🔹 **UNIT – IV : MAGNETIC & DIELECTRIC MATERIALS**

(Advanced Engineering Physics – R25)

---

1. Magnetic Materials (10 Marks)

Introduction

Magnetic materials are materials that respond to an external magnetic field. Their behavior depends on the alignment of magnetic dipoles present inside the material.

Classification of Magnetic Materials

1. Diamagnetic Materials

- Weakly repelled by magnetic field
- No permanent magnetic moment
- Examples: Copper, Bismuth, Silver

2. Paramagnetic Materials

- Weakly attracted by magnetic field
- Magnetic moments align partially
- Examples: Aluminium, Platinum

3. Ferromagnetic Materials

- Strongly attracted by magnetic field
- Permanent magnetic moments exist
- Examples: Iron, Cobalt, Nickel

Magnetic Susceptibility (χ)

It measures how much a material gets magnetized in an external magnetic field.

[
\chi = \frac{M}{H}
]

Where:
M = Magnetization
H = Magnetic field intensity

Conclusion

Magnetic materials are essential in transformers, motors, memory devices, and electric generators.

Keywords

Magnetization, susceptibility, diamagnetism, ferromagnetism

---

2. Hysteresis and Hysteresis Loop (10 Marks)

Introduction

Hysteresis refers to the lag between magnetization and applied magnetic field when a magnetic material is subjected to cyclic magnetization.

Hysteresis Loop

It is a closed curve obtained by plotting **magnetic flux density (B)** against **magnetizing field (H)**.

Important Terms

- **Retentivity:** Ability to retain magnetism
- **Coercivity:** Reverse field required to remove magnetism
- **Saturation:** Maximum magnetization

Diagram (Text Form)

```
   B
   |
   |      /----
   |     /
   |_____/_____ H
```

Applications

- Permanent magnets
- Transformers
- Magnetic recording

Conclusion

Hysteresis loss is important in designing magnetic devices efficiently.

Keywords

Hysteresis, coercivity, retentivity, magnetic loss

---

3. Dielectric Materials (10 Marks)

Introduction

Dielectric materials are electrical insulators that store electrical energy when placed in an electric field.

Polarization

When an electric field is applied, positive and negative charges shift slightly, producing polarization.

Types of Polarization

1. **Electronic polarization**
2. **Ionic polarization**
3. **Orientation polarization**
4. **Space charge polarization**

Dielectric Constant

[
\varepsilon_r = \frac{\varepsilon}{\varepsilon_0}
]

Applications

- Capacitors
- Insulating materials
- Energy storage devices

Conclusion

Dielectrics play a vital role in electronic and electrical systems.

Keywords

Polarization, dielectric constant, permittivity

---

4. Ferroelectric, Piezoelectric & Pyroelectric Materials (10 Marks)

Ferroelectric Materials

- Exhibit spontaneous polarization
- Polarization reverses with electric field
- Example: Barium Titanate

Piezoelectric Materials

- Generate electric charge under mechanical stress
- Used in sensors and transducers

Pyroelectric Materials

- Generate electric charge due to temperature change

Comparison Table

Property	Ferroelectric	Piezoelectric	Pyroelectric
Cause	Electric field	Mechanical stress	Temperature
Example	$BaTiO_3$	Quartz	Tourmaline

Conclusion

These materials are widely used in sensors, actuators, and electronic devices.

Keywords

Ferroelectricity, piezoelectricity, pyroelectricity

✅ **UNIT–IV FINAL CONCLUSION**

Magnetic and dielectric materials play a crucial role in modern electronics, communication systems, and industrial applications.
