Module 3: Magnetism and Capacitors

30 Important Questions and Answers

1. Magnetism

Q1. What is magnetism? State the properties of a magnet.

Ans: Magnetism is the property of a material by which it attracts iron, steel, nickel and cobalt. A magnet has two poles (N and S), a freely suspended magnet points north-south, like poles repel and unlike poles attract.

Q2. What are lines of magnetic force? State their properties.

Ans: They are imaginary lines showing the direction of a magnetic field. They leave the N pole and enter the S pole outside the magnet, form closed loops, never cross each other, and are closer together where the field is stronger.

Q3. What is the difference between a permanent magnet and a temporary magnet?

Ans: A permanent magnet retains its magnetism for a long time (steel, alnico). A temporary magnet is magnetic only while the magnetising force acts (soft iron in an electromagnet).

2. Classification of Magnetic Materials

Q4. How are materials classified on the basis of their magnetic properties?

Ans: Into three groups: diamagnetic, paramagnetic and ferromagnetic materials.

Q5. What are diamagnetic materials? Give examples.

Ans: Materials that are weakly repelled by a magnet, with relative permeability slightly less than 1. Examples: bismuth, copper, zinc, silver, gold and water.

Q6. What are paramagnetic materials? Give examples.

Ans: Materials that are weakly attracted by a magnet, with relative permeability slightly greater than 1. Examples: aluminium, platinum, manganese, tin and oxygen.

Q7. What are ferromagnetic materials? What is the Curie temperature?

Ans: Materials strongly attracted by a magnet, with very high permeability. Examples: iron, nickel, cobalt and their alloys. Above the Curie temperature a ferromagnetic material loses its ferromagnetism and behaves as paramagnetic.

3. Electromagnetism

Q8. What is electromagnetism?

Ans: The production of a magnetic field around a conductor carrying current (Oersted's discovery). The field exists only while current flows.

Q9. How is the direction of the magnetic field around a current-carrying conductor found?

Ans: By the right-hand thumb rule or the corkscrew rule: if the thumb points along the current, the curled fingers show the direction of the magnetic field.

Q10. What is a solenoid? On what factors does the strength of its field depend?

Ans: A solenoid is a long coil of wire that behaves like a bar magnet when current flows. Its strength depends on the number of turns, the current, and the core material (a soft iron core greatly increases it).

4. Fleming's Left-Hand and Right-Hand Rules

Q11. State Fleming's left-hand rule.

Ans: Stretch the thumb, forefinger and middle finger of the left hand mutually perpendicular. If the forefinger shows the direction of the field and the middle finger the current, the thumb shows the direction of force (motion) on the conductor.

Q12. State Fleming's right-hand rule.

Ans: Stretch the thumb, forefinger and middle finger of the right hand mutually perpendicular. If the forefinger shows the direction of the field and the thumb the direction of motion of the conductor, the middle finger shows the direction of the induced EMF (current).

Q13. Where is each of Fleming's rules used?

Ans: The left-hand rule is used for motors (electrical to mechanical energy). The right-hand rule is used for generators (mechanical to electrical energy).

Q14. What is the force on a current-carrying conductor in a magnetic field?

Ans: F = B x I x l x sin(theta) newtons, where B is flux density, I the current, l the length in the field and theta the angle between conductor and field. It is maximum when the conductor is at right angles to the field.

5. MMF, Flux Density and Reluctance

Q15. What is magnetomotive force (MMF)? State its unit.

Ans: The force that produces magnetic flux in a magnetic circuit. MMF = N x I, unit: ampere-turn (AT).

Q16. What is magnetic flux? State its unit.

Ans: The total number of magnetic lines of force in a magnetic field. Symbol: phi. Unit: weber (Wb).

Q17. What is flux density? State its unit and formula.

Ans: The flux per unit area at right angles to the field. B = phi / A. Unit: tesla (T) or Wb/m^2.

Q18. What is reluctance? State its unit and formula.

Ans: The opposition offered by a magnetic circuit to the setting up of flux. S = l / (mu x A). Unit: ampere-turn per weber (AT/Wb). Also, flux = MMF / reluctance, which is Ohm's law of the magnetic circuit.

Q19. A flux of 0.002 Wb passes through a core of cross-section 0.01 m^2. Find the flux density.

Ans: B = phi / A = 0.002 / 0.01 = 0.2 T.

6. Faraday's Laws and Lenz's Law

Q20. What is electromagnetic induction?

Ans: The production of an EMF in a conductor or coil when the magnetic flux linked with it changes.

Q21. State Faraday's laws of electromagnetic induction.

Ans: First law: whenever the flux linked with a coil changes, an EMF is induced in it. Second law: the magnitude of the induced EMF equals the rate of change of flux linkages, e = N x (change in phi / change in time).

Q22. State Lenz's law.

Ans: The direction of the induced EMF is such that the current it produces opposes the cause that produced it. This is why a negative sign appears in e = -N (d phi / dt).

Q23. What is the difference between dynamically and statically induced EMF?

Ans: Dynamically induced: the conductor moves in a steady field (generator). Statically induced: the conductor is stationary and the flux changes (transformer, self and mutual induction).

Q24. A coil of 100 turns has its flux changed from 0 to 0.05 Wb in 0.5 s. Find the induced EMF.

Ans: e = N x (change in phi) / t = 100 x 0.05 / 0.5 = 10 V.

7. Capacitor: Types and Functions

Q25. What is a capacitor?

Ans: A device made of two conducting plates separated by an insulating material (dielectric). It stores electrical energy in the form of an electric field.

Q26. What is capacitance? State its unit.

Ans: The ability of a capacitor to store charge. C = Q / V. Unit: farad (F). Practical units: microfarad and picofarad.

Q27. On what factors does the capacitance of a capacitor depend?

Ans: Capacitance increases with larger plate area and with higher dielectric constant, and decreases as the distance between plates increases: C = (epsilon0 x epsilon_r x A) / d.

Q28. Name the different types of capacitors.

Ans: Fixed: paper, mica, ceramic, plastic film and electrolytic (polarised; connect with correct polarity). Variable: gang (tuning) capacitor and trimmer capacitor.

Q29. State the functions of capacitors.

Ans: Storing charge and energy, smoothing and filtering in power supplies, blocking DC while passing AC, coupling between stages, tuning circuits, power factor improvement, starting single-phase motors and suppressing sparks.

Q30. Find the equivalent capacitance of 4 microfarad and 6 microfarad capacitors in series and in parallel.

Ans: Series: (4 x 6) / (4 + 6) = 2.4 microfarad. Parallel: 4 + 6 = 10 microfarad.