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(NEP-2020)

(2nd Semester)

ELECTRONICS (MAJOR)

(Magnetism and Electromagnetism)

Full Marks : 75

Time : 3 hours

The figures in the margin indicate full marks for the questions

Use of Simple Calculator is allowed

(SECTION : A—OBJECTIVE)

(Marks : 10)

Tick (✓) the correct answer in the brackets provided :

1×10=10

1. When the relative permeability of a material is slightly greater than one, it is called

- (a) diamagnetic material ()
- (b) paramagnetic material ()
- (c) ferromagnetic material ()
- (d) electromagnet ()

2. The magnetic material used in permanent magnets is

- (a) iron ()
- (b) soft steel ()
- (c) nickel ()
- (d) hardened steel ()

3. Ampere's circuital law involves finding the
- (a) total voltage enclosed by a closed path ()
 - (b) total current enclosed by a closed path ()
 - (c) total flux in a magnetic circuit ()
 - (d) total charge enclosed by a closed surface ()
4. Which of the given properties cannot be calculated using the Biot-Savart equation?
- (a) Intensity of magnetic field ()
 - (b) Flux density ()
 - (c) Permeability ()
 - (d) Intensity of electric field ()
5. If the coefficient of coupling between two coils is increased, mutual inductance between the coils
- (a) is increased ()
 - (b) is decreased ()
 - (c) remains unchanged ()
 - (d) is insufficient ()
6. The direction of induced e.m.f. can be found with the help of
- (a) Fleming's right-hand rule ()
 - (b) Kirchhoff's voltage law ()
 - (c) Lenz's law ()
 - (d) Laplace's law ()
7. During the transient rise of current through an R - L circuit, which of the following has maximum initial value?
- (a) Circuit current ()
 - (b) Resistive drop ()
 - (c) Coil energy ()
 - (d) Coil voltage ()

8. The lagging of magnetic flux density behind the magnetizing force in a magnetic material subjected to cycles of magnetization is known as
- (a) magnetic hysteresis ()
 - (b) magnetic dipole ()
 - (c) magnetic field strength ()
 - (d) magnetic potential ()
9. The magnitude of induced e.m.f. in a conductor depends on the
- (a) amount of flux cut ()
 - (b) amount of flux linkages ()
 - (c) rate of change of flux linkages ()
 - (d) flux density of the magnetic field ()
10. The ratio of intensity of magnetization developed in the material to the applied magnetizing force is known as
- (a) magnetic dipole ()
 - (b) magnetic susceptibility ()
 - (c) magnetic potential ()
 - (d) magnetic flux ()

(SECTION : B—SHORT ANSWERS)

(Marks : 15)

Answer *five* questions, taking at least *one* from each Unit :

3×5=15

UNIT—I

1. Write a short note on Coulomb's law in magnetism.
2. Explain permanent magnets and electromagnets.

UNIT—II

3. Explain Ohm's law for magnetic circuit.

4. A straight wire carries a current of 3 A. Calculate the magnitude of the magnetic field at a point 15 cm away from the wire.

UNIT—III

5. Explain the production of induced e.m.f. and current.
6. Explain self-inductance of a long solenoid.

UNIT—IV

7. Explain Steinmetz hysteresis law.
8. Derive the expression for energy stored per unit volume.

(SECTION : C—DESCRIPTIVE)

(Marks : 50)

Answer *five* questions, taking at least *one* from each Unit :

10×5=50

UNIT—I

1. (a) What is magnetic field? Obtain an expression for magnetic field on axial line of a bar magnet. 1+5=6
- (b) A bar magnet of length 0.1 m has a pole strength of 50 A m. Calculate the magnetic field at distance of 0.2 m from its centre on (i) its axial line and (ii) its equatorial line. 2+2=4
2. (a) Describe the classification of magnetic materials. 6
- (b) Two poles, one of which is 5 times as strong as the other, exert on each other a force equal to 0.8×10^3 kgf, when placed 10 cm apart in air. Find the strength of each pole. 2
- (c) Define magnetic dipole and magnetic dipole moment. 2

UNIT—II

3. (a) State Ampere's circuital law. Apply this law to find magnetic field strength of a long solenoid. 2+5=7

(b) A 0.5 m long solenoid has 500 turns and has a flux density of 2.52×10^{-3} T at its centre. Find the current in the solenoid. Given $\mu_0 = 4\pi \times 10^{-7}$ Hm⁻¹. 3

4. (a) State Biot-Savart law. Apply this law to find magnetizing force on the axis of a circular coil. 2+5=7

(b) An electric current is flowing in a circular coil of radius a . At what distance from the centre on the axis of circular coil will the magnetic field be 1/8th of its value at the centre? 3

UNIT—III

5. (a) State and explain Faraday's laws of electromagnetic induction. A magnetic field of flux intensity 10 T acts normal to a coil of 50 turns having 100 cm² area. Find e.m.f. induced, if the coil is removed from the magnetic field in 0.1 sec. 3+2=5

(b) What are eddy currents? Discuss briefly the important applications of eddy currents. 1+4=5

6. (a) Explain the three-way method for defining coefficient of mutual inductance (M). Two coils are wound side-by-side on a paper-tube former. An e.m.f. of 0.25 V is induced in coil A when the flux linking it changes at the rate of 10^3 Wb/s. A current of 2 A in coil B causes a flux of 10^{-5} Wb to link coil A. What is the mutual inductance between the coils? 3+2=5

(b) Derive an expression for coefficient of coupling. Two coils, A and B, have self-inductances of 120 H and 3000 H respectively. A current of 1 A through coil A produces flux linkages of 100 Wb turns in coil B. Calculate (i) the mutual inductance between the coils, (ii) the coupling coefficient. 3+2=5

UNIT—IV

7. (a) Derive the expression for rise of current in an inductive circuit. 6

(b) Describe the details of transient current decay in an R - L circuit. 4

8. (a) Derive the expression for energy stored in a magnetic field. 6
- (b) The reluctance of a magnetic circuit is known to be 10^5 A T/Wb and excitation coil has 200 turns. Current in the coil is changing uniformly at 200 A/s. Calculate (i) inductance of the coil, (ii) voltage induced across the coil and (iii) energy stored in the coil when instantaneous current at $t = 1$ sec is 1 A. Neglect the resistance of the coil. 4

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