2025

(NEP—2020)

(2nd Semester)

ELECTRONICS (MAJOR)

(Magnetism and Electromagnetism)

Full Marks : 75

Time : 3 hours

Use of simple calculator is allowed

The figures in the margin indicate full marks for the questions

(SECTION : A—OBJECTIVE)

(*Marks* : 10)

Tick (✓) the correct answer in the brackets provided : 1×10=10

1. Which of the following is more suitable for the core of an electromagnet?

(a) Soft iron ( )

(b) Air ( )

(c) Steel ( )

(d) Tungsten steel ( )

2. The source of a magnetic field is

(a) an isolated magnetic pole ( )

(b) static electric charge ( )

(c) magnetic substances ( )

(d) current loop ( )

3. When the relative permeability of a material is slightly less than one, it is called

(a) diamagnetic material ( )

(b) paramagnetic material ( )

(c) ferromagnetic material ( )

(d) electromagnets ( )

4. Which of the following expressions concerning the Biot-Savart law is incorrect?

(a) $dB \quad I$ ( )

(b) $dB \quad dl$ ( )

(c) $dB \quad r^2$ ( )

(d) dB sin ( )

5. Ohm's law for magnetic circuit is

(a) $F \quad S$ ( )

(b) $F \quad / S$ ( )

(c) $F \quad {}^{2}S$ ( )

(d) $F \quad / S^{2}$ ( )

6. According to Faraday's laws of electromagnetic induction, an e.m.f. is induced in a conductor whenever it

(a) lies in a magnetic field ( )

(b) cuts magnetic flux ( )

(c) moves parallel to the direction of the magnetic field ( )

(d) lies perpendicular to the magnetic flux ( )

7. If both the number of turns and the core length of an inductive coil are doubled, then its self-inductance will be

(a) doubled ( )

(b) quadrupled ( )

(c) halved ( )

(d) unaffected ( )

8. Area contained within the hysteresis loop represents

(a) magnetic energy of the specimen ( )

(b) susceptibility of the substance ( )

(c) loss of energy per unit volume per cycle ( )

(d) retentivity of the material ( )

9. In a magnetic material, hysteresis loss takes place primarily due to

(a) flux density lagging behind magnetizing force ( )

(b) molecular friction ( )

(c) its high retentivity ( )

(d) rapid reversals of its magnetization ( )

10. The mutual inductance of two coils is maximum when the coils are

(a) inclined at an angle of 45° ( )

(b) at right angle to each other ( )

(c) facing each other ( )

(d) touching each other ( )

(SECTION : B—SHORT ANSWERS)

(*Marks* : 15)

Answer *five* questions, taking at least *one* from each Unit : 3×5=15

UNIT—I

1. Write short notes on magnetic dipole and magnetic dipole moment.

2. Briefly explain ferromagnetic materials, paramagnetic materials and diamagnetic materials.

UNIT—II

3. State and explain Ampere's circuital law.

4. A mild steel ring having a cross-sectional area of $5\,cm^2$ and a mean circumference of 40 cm has a coil of 200 turns wound uniformly around it. Calculate *(a)* reluctance of the ring and *(b)* current required to produce a flux of 800 Wb in the ring. Take relative permeability of mild steel as 380.

UNIT—III

5. State Faraday's laws of electromagnetic induction and express mathematically.

6. Explain two applications of eddy currents.

UNIT—IV

7. Explain magnetic hysteresis.

8. Explain rate of change of stored energy.

(SECTION : C—DESCRIPTIVE)

(*Marks* : 50)

Answer *five* questions, taking at least *one* from each Unit : 10×5=50

UNIT—I

1. *(a)* Derive an expression for magnetic field on equatorial line of a bar magnet. What is the magnitude of equatorial field due to a bar magnet of length 5 cm at a distance of 60 cm from its mid-point? The magnetic moment of the bar magnet is 0·40 Am^2. 5+2=7

(b) Explain the following magnetic terms : 1×3=3

(i) Magnetic flux density

(ii) Magnetic field strength

(iii) Magnetic potential

2. *(a)* State and explain laws of magnetic force. Two magnetic S poles are located 5 cm apart in air. If each pole has a strength of 5 mWb, find the force of repulsion between them. 3+2=5

(b) Show that $_r$ 1 $_m$, where the symbols have their usual meaning. A specimen of iron is uniformly magnetized by a magnetizing field of 500 Am^{1}. If the magnetic induction in the specimen is 0·2 Wbm^{2}, find the relative permeability and susceptibility. 3+2=5

UNIT—II

3. *(a)* Using Ampere's circuital law, derive an expression for magnetomotive force around a long straight conductor. Calculate the magnetizing force and flux density at a distance of 5 cm from a long straight circular conductor carrying a current of 250 A and placed in air. 6+2=8

(b) A wire 2·5 m long is bent into a circle. If the current flowing through the wire is 100 A, find the magnetizing force at the centre of the circle by applying Biot-Savart law. 2

4. *(a)* Applying Biot-Savart law, derive an expression for magnetic field strength due to a finite length of wire carrying current. A current of 15 A is passing along a straight wire. Calculate the force on a unit N-pole placed 0·15 m from the wire. 6+2=8

(b) Length of a solenoid is 0·2 m and it has 120 turns. Find the magnetic field in its interior, if a current of 2·5 A is flowing through it. Given $_0$ 4 10 ^{7} Hm ^{1}. 2

UNIT—III

5. *(a)* Describe dynamically induced e.m.f. and statically induced e.m.f. 6

(b) Derive an expression for energy stored in a solenoid. 4

6. *(a)* Describe how to determine the direction of induced e.m.f. and current by Lenz's law and Fleming's right-hand rule. 5

(b) Explain the three methods of defining coefficient of self-induction (*L*). Two magnetically coupled coils have self-inductances, L_1 100 mH and L_2 400 mH. If the coefficient of coupling is 0·8, find the value of mutual inductance between the coils. What would be the maximum possible mutual inductance? 3+2=5

UNIT—IV

7. *(a)* Explain Steinmetz hysteresis law. The volume of a transformer core built up of sheet steel laminations is 5000 cm^3 and the gross cross-sectional area is 240 cm^2. Because of the insulation between the plates, the net cross-sectional area is 90% of the gross. The maximum value of flux is 22 mWb and the frequency is 50 Hz. Find *(i)* the hysteresis loss/m^3/cycle and *(ii)* power loss in watts. Take hysteresis coefficient as 250. 3+2=5

(b) Derive the expression for decay of current in an inductive circuit. 5

8. *(a)* Describe the details of transient current rise in an *R-L* circuit. 5

(b) Explain hysteresis loop. 5

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