2022

B.A./B.Sc.

Second Semester

CORE – 3

PHYSICS

Course Code:PHC 2.11

(Electricity & Magnetism)

Total Mark: 70 *Pass Mark: 28*

Time: 3 hours

Answer five *questions, taking* one *from each unit.*

UNIT–I

1. (a) Calculate the electric field intensity on the surface of uranium nucleus whose atomic number Z is 92. The nuclear radius of uranium is 7×10^{-15} m. 3
   (b) Derive the expression of mechanical force per unit area on the surface of a charged conductor. 5
   (c) Using Gauss' law, find the electric field due to a uniformly charged solid sphere. 6

2. (a) A dipole consisting of charges – 3.0 nC and + 3.0 nC separated by a distance of 5.0 mm is situated in a uniform electric field of 6.0×10^5 NC^{-1} at an angle 30^o with the field. Calculate the dipole moment and the torque acting on it. 3
   (b) Derive the expression of electrostatic energy of a charged sphere. 5
   (c) Find the electrostatic potential due to an electric dipole and discuss its special cases. 6

UNIT–II

3. (a) For a point charge placed near an infinite grounded conducting plane, find the electric potential and field strength at any point due to a point charge q using the method of electrical image. Also determine the electric field, surface charge density and total induced charge on the conductor. 5+6=11

(b) A parallel-plate capacitor consists of two plates of area 500 cm^2, separated by a thin sheet of mica of thickness 0.075 mm. What is the capacitance in practical unit? Given that relative permittivity of mica is 6.5. 3

4. (a) Assuming the earth to be a spherical conductor of radius 6400 km, calculate its capacitance. 3

(b) What is polarization is dielectrics? Show that $D = \varepsilon_0 E + P = \sigma$, where the symbols have their usual meaning in dielectrics. 1+3=4

(c) What is a capacitor? Find the capacitance of a parallel plate capacitor filled with composite dielectric. How will the capacitance change when it is filled with a single dielectric slab? 1+4+2=7

UNIT–III

5. (a) Two infinitely long straight parallel wires separated by a distance of 3 cm carry currents of 4 A and 6 A respectively in the same direction. Find the force per unit length between the two wires. Is the force attractive or repulsive? 3

(b) What is Lorentz force? Derive the expression of force on a current carrying conductor placed in a magnetic field. 4

(c) State Biot-Savart's law. Derive the expression of magnetic field on the axis of a circular current loop using Biot-Savart's law. 1+6=7

6. (a) The magnetic field inside a 0.5 m long solenoid which has 500 turns is 2.52×10^{-3} T. Find the current in the solenoid. 3

(b) State and prove Ampere's circuital law. Express Ampere's circuital law in differential form. 5

(c) Derive the expression of torque on a current loop placed in a uniform magnetic field. 6

UNIT–IV

7. (a) A 10 ohm resistance coil has 1000 turns and at a certain time, 5.5×10^{-4} Wb of flux passes through it. If the flux falls to 0.5×10^{-4} Wb in 0.1 second, find the emf generated and the charge flowing through the coil. 4

(b) Describe how Maxwell modified Ampere's circuital law for varying currents. 5

(c) Discuss the growth process of current in LR circuit. 5

8. (a) What is mutual inductance? If a current of 3 ampere in one coil causes the flux in another coil of 1000 turns to change by 10^{-4} Wb in each turn, then what is the mutual inductance? 4

(b) State and explain Kirchhoff's laws with suitable illustrations. 4

(c) Describe a parallel resonant circuit and show that

$$f_r = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$$

where the symbols have their usual meaning. 6

UNIT–V

9. (a) Discuss how matrix method is used in circuit analysis. 4

(b) State and prove Thevenin's and Norton's theorem. 5+5=10

10. (a) State and prove reciprocity theorem. 4

(b) Describe the working principle and theory of a ballistic galvanometer. 10
