BRAINWARE UNIVERSITY

Term End Examination 2024-2025
Programme – B.Tech.(RA)-2022/B.Tech.(RA)-2023
Course Name – Physics II: Electromagnetism and Field Theory/Physics II : Electromagnetism and Field Theory
Course Code - BSCR401
(Semester IV)

Full Marks : 60 **Time : 2:30 Hours**

[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

Group-A
(Multiple Choice Type Question) 1 x 15=15

1. *Choose the correct alternative from the following :*

(i) Identify which of the following is an example of a real-world Faraday cage.
a) A car b) A moving box
c) A lightning rod d) Shipping pallets

(ii) Select the type of substances define as dielectrics.
a) Conductors b) Semiconductors
c) Insulators d) None of these

(iii) Estimate the position of the center of gravity of positive and negative charges in a non-polar molecule.
a) Coincides b) gets separated by 1cm
c) gets separated 1m d) None of these

(iv) Identify when a material exhibits dielectric properties.
a) When the displacement current is much greater than the conduction current. b) When the displacement current is zero.
c) When the conduction current is almost zero. d) When the displacement current is equal to the conduction current.

(v) Represent the microscopic arrangement of charges in a dielectric material.
a) Positive b) Negative
c) Neutral d) None of these

(vi) Estimate where the speed of electromagnetic waves remains the same.
a) for all wavelengths b) in all media
c) for all intensities d) for all frequencies

(vii) Write the integral form of Ampere's law.
a) $\oint \vec{H}.\vec{dl} = \mu_0 I$ b) $\oint \vec{B}.\vec{dl} = \frac{\mu_0}{I}$

c) $\oint \vec{B}.\vec{dl} = \mu_0 I$ d) $\oint \vec{B}.\vec{ds} = \mu_0 I$

(viii) Identify the correct relation governing good conductors.

a) $\vec{\nabla}\times\vec{H} = \vec{D}$ b) $\vec{\nabla}\times\vec{H} = \vec{J_c}$

c) $\vec{\nabla}\times\vec{E} = \frac{\partial \vec{B}}{\partial t}$ d) $\vec{\nabla}\times\vec{J_c} = \frac{\partial \vec{B}}{\partial t}$

(ix) Predict the most accurate statement among the choices.

a) The magnetic flux inside an exciting coil is lower than its outside surface.
b) The magnetic flux inside an exciting coil is zero.
c) The magnetic flux inside the exciting coil is greater than its outside surface.
d) The magnetic flux inside the exciting coil is same as on its outside surface.

(x) Estimate the factors that do not influence the induced emf when a magnet moves towards a coil.

a) The number of turns of the coil
b) The motion of the magnet
c) The magnetic moment of the magnet
d) The resistance of the coil

(xi) Select the correct value of resistance for an open coil.

a) Zero resistance and inductance
b) Infinite resistance and zero inductance
c) Infinite resistance and normal inductance
d) Zero resistance and high inductance

(xii) Estimate the condition under which an e.m.f. is induced in a conductor according to Faraday's Law.

a) Lies perpendicular to the magnetic flux Lies perpendicular to the magnetic flux
b) Lies in a magnetic field
c) Cuts magnetic flux
d) Moves parallel to the direction of the magnetic field

(xiii) Indicate which of the given laws does not belong to Maxwell's four fundamental equations.

a) Planck's law
b) Gauss's Law
c) Faraday's law
d) Ampere's Law

(xiv) Estimate which among the following has the maximum penetrating power.

a) X-rays
b) Gamma rays
c) Microwave
d) Infrared radiation

(xv) Write Maxwell's electromagnetic wave equation in terms of the electric field vector in free space.

a) $\nabla^2\vec{E} = -\varepsilon_0\mu_0\frac{\partial^2\vec{E}}{\partial t^2}$ b) $\nabla^2\vec{E} = \varepsilon_0\mu_0\frac{\partial^2\vec{E}}{\partial t^2}$

c) $\nabla\vec{E} = \varepsilon_0\mu_0\frac{\partial\vec{E}}{\partial t}$ d) $\nabla^2\vec{E} = \varepsilon_0\mu_0\frac{\partial\vec{E}}{\partial t}$

Group-B

(Short Answer Type Questions) 3 x 5=15

2. Explain how the magnetic field inside a bar magnet can be represented using the concept of magnetic dipoles. (3)

3. Define the concept of an electrostatic field and its governing equation. (3)

4. Construct the equation for the vector potential A and solve it for a given current density J. (3)

5. Describe Lenz's law and generalize its importance in energy conservation. (3)

6. Explain the physical significance of each Maxwell's equation. (3)

OR

Compare and contrast the transverse nature and polarization of plane electromagnetic waves. (3)

Group-C

(Long Answer Type Questions) 5 x 6=30

7. Describe the physical meaning of the divergence and curl of the magnetic field. (5)

8. Determine the magnetic field at the center of a circular loop using Biot-Savart law. (5)

9. Summarize the behavior of boundary conditions at the interface of two dielectric materials. (5)

10. Explain electromagnetic wave as transverse wave. (5)

11. Illustrate that the electric field inside a uniformly charged solid sphere varies linearly with radius r. (5)

12. Explain and derive the Lorentz force theorem from Maxwell's equations. (5)

OR

Derive the wave equation for electromagnetic waves in a vacuum using Maxwell's equations. (5)

****