14-05-2025 — C3 (JAVA)

16-05-2025 — C4 (DST)

19-05-2025 — physics

21-05-2025 — math

30-05-2025 — AECR

ELECTRICITY AND MAGNETISM

Theory: 60 Lectures

Vector Analysis:

Scalar and Vector product, gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

(12 Lectures)

Electrostatics:

Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

(22 Lectures)

Magnetism:

Magnetostatics: Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para-and ferromagnetic materials.

(10 Lectures)

Electromagnetic Induction:

Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

(6 Lectures)

Maxwell`s equations and Electromagnetic wave propagation:

Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization. **(10 Lectures)**

2024(Old)
(Session : 2022-25)

Time : 3 hours

Full Marks : 75

Candidates are required to give their answers in their own words as far as practicable.

The figures in the margin indicate full marks.

Answer from both the Groups as directed.

Group – A
(Compulsory)

1. Answer **all** questions of the following : $1 \times 10 = 10$

   (a) What do you understand by electric flux ?

   (b) State Stoke's theorem.

   (c) What is Solenoid ?

   (d) What do you understand by gradient of scalar field ?

(e) Define electric dipole.

(f) What do you understand by magnetic susceptibility ?

(g) Write equation of continuity of current.

(h) State Lenz's law.

(i) State Gauss's theorem of electrostatics.

(j) What do you mean by magnetic vector potential ?

2. What is uniform and non-uniform polarization ? 5

Group – B

(Descriptive Type Questions)

Answer any **four** questions of the following : 15×4 = 60

3. Calculate the capacity of a parallel plate condenser. What will be the capacity if the space between the plates is partially filled with a slab of thickness 't' and dielectric constant K ?

4. What is Biot-Savart Law ? Apply it to determine the magnetic fields due to a long straight wire carrying current.

5. Write the Maxwell's equations. Explain the physical significance of each equation.

6. What is electromagnetic induction ? Describe experiments to illustrate how this phenomenon occurs.

7. State and prove the Ampere's Circuital law.

8. What do you mean by the flux of an electric field ? Calculate the flux passing over a closed surface. Does it represent the flow of anything ?

INTEGRAL CALCULUS, VECTOR CALCULUS AND TRIGONOMETRY

Theory: 75 Lectures, Tutorial: 15 Lectures

UNIT I - INTEGRAL CALCULUS

Integration of rational and irrational functions. Integration by substitution, by parts, partial fractions, Integration by transformations, Integration by substitution, Integration by parts.

Evaluation of definite integrals, reduction formulae, curve tracing, length and area, Surface area and volume of solids of revolution.

UNIT II – VECTOR CALCULUS & TRIGONOMETRY

Scalar and Vector point functions, vector function of scalar variables, Continuity of a vector function. Differentiation of a vector with respect to the scalar variable "t". Differentiation of a vector function. Derivatives of a sum of vectors, derivatives of a product of vectors (both scalar and vector products).

Gradient, Divergence and curl and second order vector differential operators in Cartesian coordinates systems.

Demoivre's Theorem and applications.

2024(Old)
(Session : 2022-25)

Time : 3 hours

Full Marks : 100

Candidates are required to give their answers in their own words as far as practicable.

The figures in the margin indicate full marks.

Answer from both the Groups as directed.

Group – A

(Compulsory)

1. Answer the following questions : 1×10 = 10

(a) Find $\int \frac{dx}{\sqrt{x^2 + a^2}}$.

(b) Write the reduction formula of $\int_0^{\pi/2} \cos^n x dx$.

(c) Find $\int \sqrt{a^2 - x^2}\, dx$.

(d) Define definite integral.

(e) Show that $\int_0^a f(x)dx = \int_0^a f(a-x)dx$.

(f) Write the value of div $(\nabla\phi \times \nabla\psi)$.

(g) Write the value of curl grad ϕ.

(h) Write the vector differential operator.

(i) Define scalar point functions.

(j) Write the value of $(\cos\theta + i\sin\theta)^{-n}$.

2. Integrate $\int \frac{dx}{\sin x + \sin 2x}$. 5

3. Integrate $\int \frac{dx}{(1+x)\sqrt{1-x^2}}$. 5

Group – B

Answer any **four** questions of the following :

4. (a) Show that : $\int_0^1 \frac{\log(1+x)}{1+x^2} dx = \frac{\pi}{8}\log 2$. 10

(b) Integrate : $\int \frac{dx}{\sin x\,(3 + 2\cos x)}$. 10

5. (a) Show that : $\int_0^{\pi/2} \frac{\sqrt{\sin x}}{\sqrt{\sin x} + \sqrt{\cos x}} dx = \frac{\pi}{4}$. 10

(b) Integrate : $\int \frac{dx}{(1+x)\sqrt{1+3x+3x^2}}$. 10

6. (a) Obtain a reduction formula for $\int \tan^n x dx$. 10

(b) Find the area of the loop of the curve $y^2 = x(x-1)^2$. 10

7. (a) Find the entire length of the cardioid $r = a(1 + \cos\theta)$. 10

(b) Find the surface of the solid generated by the revolution of the astroid $x^{2/3} + y^{2/3} = a^{2/3}$ about the x-axis. 10

8. (a) Prove that the necessary and sufficient condition for the vector function $\vec{u}(t)$ to have constant direction is $\vec{u} \times \frac{d\vec{u}}{dt} = \vec{0}$. 10

(b) Prove that curl $\left(\vec{a} \times \vec{b}\right) = \left(\vec{b} \cdot \nabla\right)\vec{a}$

$$-\left(\vec{a} \cdot \nabla\right)\vec{b} + \vec{a}\,\text{div}\,\vec{b} - \vec{b}\,\text{div}\,\vec{a}. \qquad 10$$

9. (a) If $\vec{a}$ is a constant vector, prove that

$$\text{div}\,\vec{a} = 0. \qquad 10$$

(b) State and prove De Moivre's theorem. 10