ARYA INSTITUTE OF ENGINEERING &

TECHNOLOGY

GUESS PAPERS

(II B. Tech. III Semester-2025)

3EE4-08: ELECTROMAGNETIC FIELD

Unit 1:

Short Answers: (2 Marks Each)

Q.1 If A = $2a_x - 3a_\gamma + a\_z$ **and** B = $4a_x - 2a_\gamma + 5a\_z$**, find** A × B**.**
Q.2 Find the gradient of the scalar function **U = $\rho^2 z \cos^2\varphi$**.
Q.3 What is the use of divergence and curl in electromagnetic field analysis?
Q.4 What is divergence of a vector?
Q.5 If P = $3x^2 y\, a_x + 4z\, a_\gamma$, find div P
Q.6 What do you mean by scalar and vector quantities?

Analytical Answers: (5 to 10 marks)

Q.1 Define the following vector fields: (i) Solenoidal, (ii) Irrotational, (iii) Conservative.
Q.2 Find the divergence of the vector field P = $x^2 y z\, a_x + x z\, a_\gamma$.
Q.3 Find the divergence of the vector field Q = $\rho \sin\theta\, a\rho + V z\, a_\gamma + z \cos\theta\, a\varphi$.
Q.4 A vector field is given by F = $5x^2 a_x + 3yz\, a_\gamma + 4xz\, az$. Find curl F.
Q.5 State and prove Stoke's theorem?

Descriptive Answers: (5 to 20 Marks)

Q.1 Given a point **P (−2, 6, 3)** and a vector **A = y a_x + (x + z) a_γ**, express both **P** and **A** in (i) Cylindrical coordinates and (ii) Spherical coordinates.
Q.2 Convert the point **(x, y, z) = (4, –3, 5)** into
(a) Cylindrical coordinates
(b) Spherical coordinates.
Also express the vector **A = $2a_x - 4a_\gamma + 3a\_z$** in cylindrical and spherical coordinate systems.
Q.3 Explain physical interpretation of Gradient, Divergence and Curl?

Unit 2

Short Answers: (2 Marks Each)

Q.1 Define electric flux density.
Q.2 State the boundary conditions for electric fields.
Q.3 Write the Coulomb's law?
Q.4 Define dielectric strength?
Q.5 Give the relation between potential gradient and electric field?

Analytical Answers: (5 to 10 marks)

Q.1 Explain the concept of electric dipole and derive the expression for electric field intensity due to a dipole.
Q.2 Explain the Electrical potential?
Q.3 Derive formulation for electric field due to line charge?
Q.4 What is electric Diploe? Explain in details?
Q.5 What is electrostatic potential? Derive the formula of potential due to uniformly charged line?

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Descriptive Answers: (5 to 20 Marks)

Q.1 Conducting Spherical shells with radius a= 5cm & b=30 cm are maintained at a potential difference of 100 V such that V (r=b) = 0 V and V(r=a) = 100 V. Determine V and E in the region between the shells.

Q.2 Derive and explain electric field due to sheet of charge?

Q.3 What is Gauss's Law? Consider a uniform charged sphere of radius 'a' with uniform charge density ρ_v C/m^3. Find D everywhere using Gauss's law.

Unit 3:

Short Answers: (2 Marks Each)

Q.1 What do you understand by dielectric constant?
Q.2 Define current density?
Q.3 Define permittivity for dielectric materials?
Q.4 What is dielectric strength?
Q.5 Write equation for continuity of current?

Analytical Answers: (5 to 10 marks)

Q.1 Derive Poisson's and Laplace's equations from Gauss's law.

Q.2 A dielectric has $\varepsilon_r = 5$, electric field $\mathbf{E = 4\,a_x + 3\,a_\gamma + 2\,az}$ **V/m**. Find **D** and **polarization vector P**.

Q.3 Derive the expression for energy stored in parallel plate capacitor

Q.4 Explain the Displacement current?

Q.5 Explain Ohm's law for point charge?

Descriptive Answers: (5 to 20 Marks)

Q.1 A parallel-plate capacitor has plate area **A**, separation **d**, and is filled with a dielectric of permittivity **ε**. Derive expressions for:

(a) Capacitance
(b) Electric field
(c) Energy stored
(d) Force between the plates.

Q.2 Explain the boundary conditions for electrostatic fields and dielectrics?

Q.3 Two extensive homogeneous isotropic dielectrics meet on plane Z=0. For $Z \geq 0$, $\square_{r1}=4$ and for $Z \leq 0$, $\square_{r2}=3$. A uniform field $E1=5a_x-2a_y+3a_z$ kV/m exists for $Z \geq 0$. Find

(a) E2 For $Z \leq 0$
(b) The angles E_1 and E_2 make with interface
(c) The energy densities in J/m^3 in both dielectrics.
(d) The energy within a cube of side 2 m centred at (3, -4,5)

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Unit 4:

Short Answers: (2 Marks Each)

Q.1 State the Biot–Savart law.
Q.2 State Ampere's law.
Q.3 What is the energy density of a magnetic field?
Q.4 Discuss magnetic flux density?
Q.5 Define magnetic vector potential.
Q.6 What do you mean by magnetic scalar potential?

Analytical Answers: (5 to 10 marks)

Q.1 Derive the expression for magnetic field intensity due to an infinitely long straight current-carrying conductor.
Q.2 What is the current density which produces a magnetic field of $H=28 \sin x\, a_y$?
Q.3 A magnetic material has $\mu_r = 10/\pi$ and is in a magnetic field of strength $H = 5\rho^3 a_\phi$ A/m. Find the magnetization.
Q.4 Explain and derive Magnetic Flux density Maxwell's equation?
Q.5 Explain and derive Vector and Scalar Magnetic Potentials?

Descriptive Answers: (5 to 20 Marks)

Q.1 Discuss steady magnetic fields produced by current-carrying conductors.

Q.2 Explain various applications of Ampere's Law?

Q.3 Explain and state Biot-Savart law?

Unit 5:

Short Answers: (2 Marks Each)

Q.1 Define Magnetic torque?
Q.2 Define Magnetic moment?
Q.3 What is magnetic dipole moment?
Q.4 What do you understand by flux linkage?
Q.5 Define difference between paramagnetic and ferromagnetic materials?

Analytical Answers: (5 to 10 marks)

Q.1 Explain the boundary conditions for a magnetic field at an interface.
Q.2 A ferrite material operates in the linear region with **B = 0.05 T** and **μr = 50**. Calculate **M** and **H**.
Q.3 Planes Z=0 and Z=4 carry current K= -10 a_x A/m and 10 a_x A/m respectively, determine H at (1,1,1).
Q.4 Explain the concept of magnetic dipole moment and magnetization in magnetic materials?
Q.5 Explain in brief various types of magnetic materials?

Descriptive Answers: (5 to 20 Marks)

Q.1 The xy-plane is an interface between two media.

- **Medium 1 ($z < 0$): $\mu_r = 6$**
- **Medium 2 ($z > 0$): $\mu_r = 4$**

The interface carries a surface current K = (1/π) a_x mA/m, and $B_1 = 5a_x + 8a_\gamma$ mWb/m². Find H_2 and B_2.

Q.2 Explain magnetization and magnetic permeability.

Q.3 (a) Derive the expression for magnetic boundary conditions at an interface.

(b) Explain in detail the force experienced by a moving charge in electric and magnetic fields.

Q.4 Discuss the magnetic boundary conditions

Unit :6

Short Answers: (2 Marks Each)

Q.1 Write all four Maxwell's equations for time-varying electromagnetic fields.
Q.2 What is the Lorentz force equation?
Q.3 Write the uniqueness theorem?
Q.4 What is the difference between transformer and motional electromotive forces?
Q.5 Define motional electromotive force?

Analytical Answers: (5 to 10 marks)

Q.1 What are transformer EMF and motional EMF? Derive the expression for transformer EMF.
Q.2 Explain the concept of energy stored in an inductor. Derive the expression for magnetic energy density.
Q.3 Write the Maxwell's equation for static fields in point and integral form. Also discuss the laws associated with these equations

Descriptive Answers: (5 to 20 Marks)

Q.1 Explain Faraday's law of electromagnetic induction in detail.

Q.2 Describe analogy between electric and magnetic field?

Unit 7:

Short Answers: (2 Marks Each)

Q.1 Define the Poynting vector.
Q.2 State the Poynting theorem.
Q.3 What is meant by the term "electromagnetic"?
Q.4 Define the term "wave impedance."
Q.5 What do you mean by skin depth & skin resistance?
Q.6 What is displacement current?

Analytical Answers: (5 to 10 marks)

Q.1 Prove that $\nabla \times \mathbf{H} = \mathbf{J} + \partial \mathbf{D}/\partial \mathbf{t}$.
Q.2 If a wave with a frequency of 100 MHz propagates in free space, Find the propagation constant.
Q.3 Explain Wave equation for conducting medium?
Q.4 Derive the formula of propagation constant for lossy dielectric material?
Q.5 Define Maxwell's equation for time varying fields?

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Descriptive Answers: (5 to 20 Marks)

Q.1 Derive the expressions for the attenuation constant (α) and phase constant (β) for a lossy dielectric medium.

Q.2 Discuss electromagnetic wave propagation in good conductors.

Q.3 (a) State and explain Poynting theorem.

(b) Define and explain intrinsic impedance of a medium.

(c) Write short notes on:

(1) Lossless dielectrics (2) Good conductors.

Q.4 Derive the wave equation in a conducting medium. Also derive expressions for:

(a) Attenuation constant (α)

(b) Phase constant (β)

(c) Wave velocity.