

R18

Code No: 153AR

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech II Year I Semester Examinations, April/May - 2023

ELECTROMAGNETIC FIELDS

(Electrical and Electronics Engineering)

Time: 3 Hours

Max. Marks: 75

Note: i) Question paper consists of Part A, Part B.

ii) Part A is compulsory, which carries 25 marks. In Part A, Answer all questions.

iii) In Part B, Answer any one question from each unit. Each question carries 10 marks and may have a, b as sub questions.

PART – A**(25 Marks)**

- 1.a) State Coulomb's law. [2]
- b) State Gauss's law and give its expression. [3]
- c) What is Capacitance? Give expression. [2]
- d) What are dielectrics? What is the difference between dielectric and insulators? [3]
- e) Define Self-inductance. [2]
- f) Give the expressions relating B and H with the current density J. [3]
- g) What is displacement current? [2]
- h) What are the different types of emf's produced in a conductor placed in a magnetic field? [3]
- i) What are uniform plane waves? [2]
- j) Define characteristic impedance or intrinsic impedance. [3]

PART – B**(50 Marks)**

- 2.a) Derive the expression for energy density in electrostatic fields.
- b) Two point charges $Q_1 = 2\text{nC}$, $Q_2 = 4\text{ nC}$ are located at points (1,1,1) and (1,0,0) respectively. Determine the potential at point (1,1,0). [5+5]

OR

- 3.a) Obtain an expression for potential of a electric dipole in electric field.
- b) Calculate the force on a unit positive charge at $P(x=2\text{m}, y=0)$ due to the charges Q_1 at origin and Q_2 at $(x=1\text{m}, y=0)$ where $Q_1=1000\text{ Pico coulombs}$ $Q_2= -2000\text{ Pico coulombs}$. [5+5]

- 4.a) Derive Laplace and Poisson equation.
- b) State and prove the boundary conditions at the boundary between two dielectrics in electric fields. [5+5]

OR

- 5.a) Briefly explain the behavior of Conductors and Insulators in electric field.
- b) Explain in detail about Equation of continuity. [5+5]

6.a) Derive the expression for the magnetic vector potential in the cases of an infinitely long, straight, conductor in free space.

b) Explain in detail about Biot-Savart's law. [6+4]

OR

7.a) Using Biot-Savart's law, find the magnetic field intensity on the axis of a circular loop with radius R and carrying a steady current I .

b) State and Explain Ampere's Law. [6+4]

8.a) Explain the Faraday's laws of electromagnetic induction.

b) Write a note on Motional Electromotive forces. [6+4]

OR

9. Derive the Maxwell's equations in good conductors for time varying fields and static fields in point and integral forms. [10]

10.a) Derive Poynting theorem and give its significance

b) Obtain the plane wave equation in lossy dielectrics. [5+5]

OR

11.a) Deduce the equation of the propagation of the plane electromagnetic waves in free space.

b) Briefly explain the propagation in good conductors. [5+5]

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papers 2023

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech II Year I Semester Examinations, August/September - 2022

ELECTROMAGNETIC FIELDS
(Electrical and Electronics Engineering)

Time: 3 Hours

Max.Marks:75

Answer any five questions
All questions carry equal marks

- - -

- 1.a) Determine the electric field intensity at a point P(0,0,h)m due to a standard surface charge distribution lying in $z = 0$ plane.
- b) If $V=x-y+xy+2z$ volts, determine Electric field intensity at (1,2,3) and the electrostatic energy stored in a cube of side 2 m centred at the origin. [7+8]
- 2.a) Derive the expressions for electrostatic energy and energy density.
- b) Explain the process of vector conversion from cylindrical coordinate system to spherical coordinate system. [7+8]
- 3.a) State and derive the current continuity equation.
- b) Explain about current density and derive its equation. [8+7]
- 4.a) Derive the expressions for Poisson's equation, Laplace's equation.
- b) A cylindrical capacitor has radii $a=1$ cm and $b=2.5$ cm. If the space between the plates is filled with an inhomogeneous dielectric with $\epsilon_r = \frac{(10+\rho)}{\rho}$ where ρ is in cm. Calculate the capacitance per meter of the capacitor. [8+7]
- 5.a) Define Magnetic flux density and prove that $\text{div}(\mathbf{B})=0$. [7+8]
- b) An infinitely long conductor is bent in to an L shape as shown in figure.
If a direct current of 5 A flows in the current, find the magnetic field intensity at
(i) (2, 2, 0) and (ii) (0, 0, 2)



- 6.a) Differentiate between self and mutual inductances.
- b) Plane $y=1$ carries current $\mathbf{K}= 50 \mathbf{a}_z$ mA/m . Find \mathbf{H} at (i) (0, 0, 0) (ii) (1, -5, 5). [6+9]
- 7.a) Express Maxwell's equations for time varying fields both in point form and integral form and also make their word statements.
- b) In a dielectric, $\sigma= 10^{-4}$ S/m, $\mu_r= 1$, $\epsilon_r=4.5$, the conduction current density is given as $\mathbf{J}_c= 0.4 \cos (2 \pi \times 10^8 t)$ A/m². Determine the displacement current density. [9+6]
- 8.a) Explain wave propagation in free space and derive the necessary equations.
- b) An electromagnetic wave in free space has a phase shift constant of 0.524 rad/m. The same wave has a phase shift constant of 1.81 rad/m upon entering a perfect dielectric. Assuming $\mu_r= 1$, find ϵ_r and the velocity of the propagation. [8+7]

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech II Year I Semester Examinations, March - 2021

ELECTROMAGNETIC FIELDS

(Electrical and Electronics Engineering)

Time: 3 hours

Max. Marks: 75

Answer any five questions
All questions carry equal marks

- - -

- 1.a) Derive an expression for electric field intensity due to an electric dipole.
b) State and describe the coulombs law with units. [8+7]
2. A spherical volume charge density distribution is given by $\rho = \rho_0 (1 - r^2/a^2)$; ($r \leq a$) and $\rho = 0$ ($r > a$).
a) Calculate the total charge Q
b) Find the electric field intensity E outside the charge distribution.
c) Find the electric field intensity inside.
d) Show that the maximum value of E is at $r = 0.745 a$. [15]
- 3.a) What is the necessity of studying the dielectric boundary conditions?
b) Two parallel conducting plates 3 cm apart and situated in air are connected to a source of constant potential difference of 72 kV. (i) Find the electric field intensity between the plates. Comment on the result given that the dielectric strength of air is 30 kV/cm. (ii) If a mica sheet ($\epsilon_r = 4$) of thickness 1 cm is introduced between the plates, what are the field intensities in air and mica. Comment on the result given that the dielectric strength of mica is 1000 kV/cm. [8+7]
- 4.a) Derive the ohms law in point form.
b) State and explain continuity equation of current in integral form and point form. [8+7]
- 5.a) Using Biot savarts law, find H inside a long solenoid carrying a current I and show that H at the ends of a such solenoid is half of that in the middle.
b) Evaluate the inductance of a solenoid of 2800 turns wound uniformly over a length 0.6 m on a cylindrical paper tube 4 cm in diameter. The medium is air. [8+7]
- 6.a) State and explain Biot-Savart's Law.
b) Determine the force per meter length between two long parallel wires A & B separated by 6 cm in air carrying currents of 42 Amps. (i) In same direction. (ii) In the opposite direction. [7+8]
- 7.a) Write and explain differential and integral form's of Maxwell's equations for fields varying harmonically with time.
b) What is displacement current? Explain briefly. [9+6]
- 8.a) Define poynting vector and derive the expression for poynting theorem.
b) A plane transverse electromagnetic wave has a power density of 1.2 W/m^2 in a medium with $\epsilon_r = 3$ and $\mu_r = 1$. Find the amplitudes of electric and magnetic field intensities. [8+7]

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Time: 3 Hours

Max. Marks: 75

Answer any five questions

All questions carry equal marks

- 1.a) Derive the expression for electric field intensity due to an electric dipole.
- b) Determine the field strength at a point situated 6 cm away from two equal charge of $Q_1 = +109\text{C}$ and other charge of $Q_2 = 109\text{C}$, if the distance between them is 9m. [8+7]
- 2.a) Consider an infinite line charge along z-axis. Show that the work done is zero if a point charge Q is moving in a circular path of radius ρ , centered at the line charge.
- b) A scalar potential is given by $V = 7y + 12x$ volts, find \vec{E} at the origin. [8+7]
- 3.a) List out the properties of dielectric materials.
- b) Deduce the relation of tangential and normal components of electric field in the boundary condition of two perfect dielectric materials. [6+9]
- 4.a) Explain and derive Laplace's equation.
- b) Derive the expression for the capacitance of a two wire line. [7+8]
- 5.a) Derive an expression for the force on a differential current element.
- b) The field $\vec{B} = -2\vec{a}_x + 3\vec{a}_y + 4\vec{a}_z$ mT is present in free space. Find the vector force exerted on a straight wire carrying 12A in the \vec{a}_{AB} direction, given A(1,1,1) and B(3,5,6). [8+7]
- 6.a) State and explain Biot-Savart's law.
- b) A solenoid has an inductance of 20 mH. If the length of the solenoid is increased by two times and the radius is decreased to half of its original value, find the new inductance. [8+7]
7. Derive the Maxwell's equations both in integral form and differential form for Time varying fields. [15]
- 8.a) State and prove the Poynting theorem.
- b) What is plane wave? Derive the equation for plane waves in free space. [8+7]

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B.Tech II Year I Semester Examinations, October - 2020

ELECTROMAGNETIC FIELDS
(Electrical and Electronics Engineering)

Time: 2 hours

Max. Marks: 75

Answer any five questions
All questions carry equal marks

- 1.a) Solve the electric field at a point on the axis of a uniformly charged infinite sheet.
- b) Three point charges 3, 4, 5 coulombs are situated in free space at the three corners of an equilateral triangle with side 5 cm. Calculate the energy density within the triangle. [8+7]
- 2.a) Derive the expression for Electric Potential at any point due to a point charge located at the origin.
- b) Point charges of 50 nC each are located at A(1,0,0), B(-1,0,0), C(0,1,0) and D(0,-1,0) in free space. Determine the total force on the charge at A. [8+7]
3. Derive the boundary conditions for (i) Dielectric-Dielectric interface (ii) Conductor-Dielectric interface. [15]
- 4.a) Obtain the expression for Ohm's Law in point form.
- b) Determine force with which the plates of a parallel plate capacitor attract each other? [7+8]
- 5.a) Derive the expression for the force between two finite current carrying loops?
- b) Evaluate H everywhere for an infinitely long coaxial transmission line of radius 'a' placed along z-axis which carries current along a_z . Sketch magnitude of H as a function of current. [8+7]
- 6.a) Obtain the relation between Magnetic vector potential and Magnetic flux density.
- b) If $H = y a_x - x a_y$ A/m on plane $z=0$, determine the current density. [8+7]
- 7.a) Given the fields $V = 80z \cos x \cos^3 t \times 10^8$ kV and $A = 26.7z \sin x \sin 3 \times 10^8 t a_x$ mWb/m in free space, Evaluate E and H.
- b) Explain the Faradays laws of electromagnetic induction. [7+8]
- 8.a) A uniform plane wave at a frequency of 1 GHz is travelling in a large block of dielectric with $\epsilon_r = 55$, $\mu_r = 1$ and $\sigma = 0.05$ S/m. Determine γ , η , β and λ .
- b) Express Maxwell equations in Phasor form. [8+7]

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B.Tech II Year I Semester Examinations, September - 2021

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Time: 3 hours

Max. Marks: 75

Answer any five questions

All questions carry equal marks

- - -

- 1.a) State and explain Gauss Law.
 b) A Point charge of 20nC is located at (4,-1,3) and a uniform Line charge of -25nC/m lies along the intersection of the planes $x = -4$ and $z = 6$. Calculate \vec{D} at (3,-1,0). [7+8]
- 2.a) Derive Electric Field Intensity at a point due to surface charge.
 b) Given the surface charge density, $\rho_s = 2\mu\text{C}/\text{m}^2$, existing in the region $\rho < 0.2\text{m}, z = 0$, and is zero elsewhere, Find \vec{E} at P($\rho = 0, z = 0.5$). [8+7]
- 3.a) Derive Equation of Continuity.
 b) Let $V = \frac{(\cos 2\theta)}{\rho}$ in free space. Find the volume charge density at point P(0.5, 60° , 1). [8+7]
- 4.a) Derive capacitance of a two-wire line.
 b) Obtain boundary conditions for Dielectric-Dielectric material. [8+7]
- 5.a) State Biot Savart's Law and Ampere's circuital Law.
 b) Given points C(5,-2,3) and P(4,-1,2), a current element $I d\vec{L} = 10^{-4} (4, -3, 1)\text{A}\cdot\text{m}$ at C produces a field $d\vec{H}$ at P. Specify the direction of $d\vec{H}$ by a unit vector \vec{a}_H and also find $|d\vec{H}|$ [8+7]
- 6.a) Derive Equation for self inductance of solenoid.
 b) A conductor of length 2.5m located at $z = 0, x = 4\text{m}$ carries a current of 12.0A in the $-\mathbf{a}_y$ direction. Find the uniform \mathbf{B} in the region if the force on the conductor is $1.20 \times 10^{-2}\text{N}$ in the direction $(-\mathbf{a}_x + \mathbf{a}_z)/\sqrt{2}$. [8+7]
- 7.a) Explain statically and dynamically induced electro motive forces.
 b) A certain material has $\sigma = 0, \mu_r = 1$. If $\vec{E} = 800 \sin(10^6 t - 0.01z) \mathbf{a}_y \frac{\text{V}}{\text{m}}$. Make use of Maxwell equation to find ϵ_R . [7+8]
- 8.a) Derive electromagnetic Wave Equation.
 b) State and explain Poynting Theorem. [8+7]