Code No: R2021025 **R20** SET - 1

II B. Tech I Semester Regular/Supplementary Examinations, January - 2023
ELECTRO MAGNETIC FIELDS
(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 70

Answer any **FIVE** Questions, each Question from each unit
All Questions carry **Equal** Marks
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UNIT-I

1 a) State and explain Coulomb's law of electrostatic field in vector form. [7M]

b) Three equal point charges of 2μC are in free space at (0,0,0), (2,0,0) and (0,2,0), respectively. Find net force on Q_4=5μC at (2,2,0). [5M]

c) Define the term electric field intensity E. [2M]

Or

2 a) State and explain Gauss law. List the applications of Gauss law. [7M]

b) Prove that electric field intensity is equal to the negative gradient of the potential, i.e., $E = - \nabla V$. [7M]

UNIT-II

3 a) Derive the boundary conditions for the tangential and normal components of Electrostatic fields at the boundary between two perfect dielectrics. [8M]

b) Explain about convection and conduction currents. [6M]

Or

4 a) Explain about Ohm's law in point form. [7M]

b) Determine the capacitance of a capacitor consisting of two parallel metal plates 30cm by 30cm surface separated by 5mm in air with $\varepsilon_0 = 8.854 \times 10^{-12}$. What is the energy stored by the capacitor if it is charged to a potential difference of 500V? [7M]

UNIT-III

5 a) Derive integral form of Ampere's circuital law and explain its applications? [7M]

b) Explain about force on a current element in a magnetic field. [7M]

Or

6 a) Deduce the Biot-Savart's law from Ampere's circuital law. [5M]

b) State Ampere's circuital law and apply it to determine the magnetic field intensity due to an infinite sheet of current density $\overline{K} = K_y \widehat{a_y}$ in z=0 plane. [9M]
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UNIT-IV

7	a)	Define the terms mutual inductance and self-inductance.	[4M]
	b)	Derive the expression for self-inductance of a toroid.	[6M]
	c)	Find the inductance of an ideal solenoid with 300 turns, length L=0.50m and a circular cross section of radius 0.02m.	[4M]

Or

8		Find the mutual inductance between two toroidal windings which are closely wound on iron core of relative permeability 900. The mean radius of the core is 5cm and radius of its cross-section is 5cm. Each winding has also 800 turns.	[14M]

UNIT-V

9	a)	Discuss the Maxwell's equations for time varying fields.	[6M]
	b)	Explain the concept of displacement current and obtain an expression for the Displacement current density.	[8M]

Or

10	a)	What is the Faraday's law of electromagnetic induction? Explain the significance of the terms transformer emf and generator emf.	[8M]
	b)	State Poynting theorem and derive the equation.	[6M]

Code No: R2021025 **R20** SET - 2

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UNIT-I

1 a) State and explain Gauss law with any one of the example. [9M]

b) A point charge, $Q_1 = 2\mu C$ is at (2,3,6) and another charge, $Q_2 = 5\mu C$ is at (0,0,0) in free space. Find the force on Q_1 due to Q_2. [5M]

Or

2 a) Derive Poisson's and Laplace's equations starting from Gauss's law. [8M]

b) Two positive point charges are located at (1m, 2m, 0) and (2m, 4m, 0). At what points the field intensity due to charges is zero? [6M]

UNIT-II

3 a) Explain the Boundary Conditions for Electrostatic Fields. [7M]

b) State and explain the different types of polarization. [7M]

Or

4 a) State the point form of Ohm's law. What is the analogous relation in the static electric field? [5M]

b) A parallel plate capacitor consists of two square metal plates with 50mm side separated by 10mm. A slab of sulphur ($\varepsilon_r = 4$) 6mm thick is placed on the lower plate and the air gap is of 4mm. Find the capacitance of the capacitor. [6M]

c) Define conductor and list its important features. [3M]

UNIT-III

5 a) State and explain the Ampere's circuital law for steady currents. Mention its applications and limitations. [10M]

b) Write a brief note on Lorentz force equation. [4M]

Or

6 a) Explain about force on a straight and a long current carrying conductor in a magnetic field. [8M]

b) If a stationary charge is placed in a magnetic field, what is the force experienced by it? [3M]

c) State Lorentz law of force. [3M]
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UNIT-IV

7	a)	Derive the expression for magnetic flux intensity due to solenoid of the coil.	[7M]
	b)	Explain the concept of self and mutual inductances.	[7M]

Or

8	a)	Determine the inductance of a solenoid of 2500 turns wound uniformly over a length of 0.25m on a cylindrical paper tube, 4cm in diameter and the medium is air.	[6M]
	b)	Derive the expression for energy stored and density in a magnetic field.	[8M]

UNIT-V

9	a)	Derive Maxwell's fourth equation with suitable theorem.	[6M]
	b)	State and explain Faraday's laws of electromagnetic induction with its integral and point forms.	[8M]

Or

10	a)	State and explain Maxwell's equations in integral and point form for general time-varying fields.	[7M]
	b)	Discuss in brief about statically and dynamically induced EMF.	[7M]

Code No: R2021025 **R20** SET - 3

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Time: 3 hours Max. Marks: 70

Answer any **FIVE** Questions, each Question from each unit
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UNIT-I

1	a)	Explain about Maxwell's two equations for Electrostatic fields.	[6M]
	b)	Justify when the Poisson's equation is Laplace's equation.	[3M]
	c)	State the Coulomb's law in SI units and indicate the parameters used in the equations with the help of a diagram.	[5M]

Or

2	a)	Derive an expression for the electric field intensity due to a finite length line charge along the Z-axis at an arbitrary point Q(x,y,z).	[6M]
	b)	State Gauss's law. Using divergence theorem and Gauss's law, relate the density D to the volume charge density ρ_v.	[8M]

UNIT-II

3	a)	State the continuity equation and discuss its physical interpretation.	[5M]
	b)	Derive an expression for the capacitance of Parallel plate capacitor.	[5M]
	c)	What are dielectrics? Explain qualitatively the reason for their conductivity being zero.	[4M]

Or

4		Discuss in brief about boundary conditions between conductor to dielectric, dielectric to dielectric and conductor to free space.	[14M]

UNIT-III

5	a)	Derive the expression Maxwell's equation $\nabla . \vec{B} = 0$.	[5M]
	b)	State and explain Biot-Savart's law.	[4M]
	c)	Explain about Lorentz force equation.	[5M]

Or

6	a)	State Ampere's circuital law and apply it to determine the magnetic field intensity due to an infinitely long current filament.	[8M]
	b)	Define the following: (i) Magnetic force (ii) Magnetic Field Intensity (iii) Magnetic flux density	[6M]
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UNIT-IV

7	a)	Derive the expressions for the self-inductances of a solenoid and toroid.	[12M]
	b)	What is the Neumann formula for mutual inductance?	[2M]

Or

8	a)	Current in a coil is increased from 0 to 10 Amps at a uniform rate is 5 sec. It is found that this coil develops self-induced emf of 100V where as an emf of 20V is reduced in a neighboring coil. Compute self-inductance of the first coil and mutual inductance between the two coils.	[8M]
	b)	Discuss the concept of self and mutual inductances.	[6M]

UNIT-V

9	a)	Define displacement current and derive the equation?	[6M]
	b)	Explain Faraday's law of electromagnetic induction and derive the expression for induced emf.	[8M]

Or

10	a)	State and explain Faraday's laws of electromagnetic induction.	[6M]
	b)	Explain the Maxwell's equations for harmonically time varying fields.	[8M]

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UNIT-I

1 a) Using Gauss law, derive expressions for electric field intensity due to line and a surface charge distribution. [10M]
c) Show that the field intensity of a line charge satisfies the conservative property. [4M]

Or

2 a) State and prove Gauss's law. List the limitations of Gauss's law. [8M]
b) A point charge of 15nC is situated at the origin and another point charge of 12nC is located at the point (3,3,3) m. Find $\overline{E}$ and V at the point (0,-3,-3). [6M]

UNIT-II

3 a) Find the expression for electric field intensity and potential due to electric dipole situated at the origin. [7M]
b) What is dipole moment? Obtain expression for the potential and field due to an electric dipole. [7M]

Or

4 a) Derive boundary conditions in the presence of dielectrics. [7M]
b) Explain about Torque on an electric dipole in an electric field. [7M]

UNIT-III

5 a) Explain about force between two straight long and parallel current carrying conductors. [9M]
b) Describe the magnetic field due to a current element. [5M]

Or

6 a) Discuss the application of Ampere's circuital law for symmetrical surface infinite sheet current. [7M]
b) The point charge Q=18nC has a velocity of $5x10^{-6}$ m/s in the direction of $\widehat{a_v} = 0.04\widehat{a_x} - 0.05\widehat{a_y} + 0.2\widehat{a_z}$. Calculate the magnitude of the force exerted on the charge by the field $\overline{B} = -3\widehat{a_x}+4\widehat{a_y}+6\widehat{a_z}$. [7M]
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UNIT-IV

7 a) Explain in detail about self and mutual inductances. [8M]

b) A toroidal coil of 500 turns is wound on a steel ring of 0.5m mean diameter and $2x10^{-3}$ m^2 cross-sectional area. An excitation of 4000 Am^{-1} produces a flux density of 1T. Find the inductance of the coil. [6M]

Or

8 a) Derive an expression for energy density in a magnetic field. [7M]

b) A magnetic circuit comprising a toroid of 500 turns and an area of $6cm^2$ and mean radius of 15cm and carries a current of 4A. Find reluctance and flux assume μ_r=1. [7M]

UNIT-V

9 a) State the Faraday's law in differential form. How it is derived in integral form? [7M]

b) Show that $\overline{\nabla}$ x E = - $\frac{\partial B}{\partial t}$ [7M]

Or

10 a) Explain how the concept of displacement current was introduced by Maxwell to account for the production of magnetic field in empty space. [7M]

b) Discuss the physical interpretation of Maxwell's equations. [7M]