# INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

## ELECTRICAL AND ELECTRONICS ENGINEERING

## TUTORIAL QUESTION BANK

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| **Course Title** | **ELECTRO MAGNETIC FIELD** | | | | |
| **Course Code** | AEEB10 | | | | |
| **Programme** | B.Tech | | | | |
| **Semester** | THREE | | | | |
| **Course Type** | Professional Core | | | | |
| **Regulation** | **IARE - R18** | | | | |
| **Course Structure** | **Theory** | | | **Practical** | |
| | **Lectures** | **Tutorials** | **Credits** | **Laboratory** | **Credits** |
| | 3 | 1 | 4 | - | - |
| **Chief Coordinator** | Mr. T Anil Kumar, Assistant Professor | | | | |
| **Course Faculty** | Mr. T. Anil Kumar, Assistant Professor | | | | |

## COURSE OBJECTIVES:

**The students will try to learn:**

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| I | The concepts of electro-statics, magneto-statics and time varying fields that allows required foundations in structure of power generation, transmission and distribution systems. |
| II | The nature of wave propagation in free space, conductors and dielectrics to frame multi-disciplinary assignments with real time constraints. |
| III | The fundamentals of electromagnetic fields and wave propagation to figure out the complex engineering problems with solutions and also helps in pursuing higher studies. |

## COURSE OUTCOMES:

**After successful completion of the course, Students will be able to:**

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| CO 1 | Make use of coloumb's law for obtaining force and electric filed intensity due to line, surface and volume charge distribution. |
| CO 2 | Recognize the basic nomenclatures of point charge that helps in characterizing the behavior of electro-static fields . |
| CO 3 | Make use of the Gauss law for obtaining electric field intensity, density and deduce Poisson's, Laplace equations. |

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| CO 4 | Determine the potential and torque due to electric dipole used in structuring the principle of electrical equipments. |
| CO 5 | Realize the behavior of conductors and dielectrics, their by compute the capacitance of different configured plates. |
| CO 6 | Make use of Biot-Savart law and Ampere circuital law for obtaining magnetic field intensity due to circular, square, rectangular and solenoid current carrying wire. |
| CO 7 | Predict the force due to moving charge in the magnetic field of various configuration for developing principles of electrical machines. |
| CO 8 | Signify the magnetic dipole, dipole moment for obtaining torque due to magnetic dipole helps in structuring electrical devices.. |
| CO 9 | Calculate the self inductance and mutual inductance for different configurations of wires and energy stored in the coil. |
| CO 10 | State the Faraday's laws of electromagnetic induction and note the nature of emf induced in the coil for fixed and variable fields. |
| CO 11 | List out the differential and integral forms of Maxwell's equation in time varying fields and fields varying harmonically with time for obtaining numerical solutions of complex engineering problems. |
| CO12 | Make use of the Maxwell Equations to produce a wave equation for the free- space, insulators and conductors for propagation of electromagnetic waves. |

## MAPPING OF EACH CO WITH PO(s), PSO(s):

| Course Outcomes | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| CO 1 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO 2 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO 3 | 3 | - | 2 | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO 4 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO 5 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO 6 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO 7 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO 8 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO 9 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO 10 | 3 | - | 2 | - | - | - | - | - | - | - | - | - | 2 | - | - |
| CO 11 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO 12 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - |

# TUTORIAL QUESTION BANK

| UNIT - I | | | | |
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| **INTRODUCTION TO ELECTROSTATICS** | | | | |
| **PART – A (SHORT ANSWER QUESTIONS)** | | | | |
| **S. No** | **QUESTION** | **Blooms Taxonomy Level** | **How Does This Subsume The Level** | **Course Outcome** |
| 1 | Differentiate between the mass of electron and proton. | Remember | The learner to Recall characteristics of electron and proton to understand force on them. | CO 1 |
| 2 | State coloumb's law and explain its importance.. | Remember | The learner to Recall the nature of positive and negatively charged particles to determine force on them. | CO 1 |
| 3 | Define electric field and write its properties. | Remember | --- | CO 1 |
| 4 | Explain force between two charges due to electric field. | Understand | The learner to Recall the nature of positive and negatively charged particles to determine force on them. | CO 1 |
| 5 | Define electric field intensity and write general expression of field intensity. | Understand | The learner to Recall the nature of positive and negatively charged particles to determine force on them. | CO 2 |
| 6 | Obtain the expression for electric field intensity on n charge. | Remember | The learner to Understand the spread of electric field surrounding point charge. | CO 2 |
| 7 | Find the expression for electric field intensity on line charge. | Understand | The learner to Recall coloumb's law to know expression for electric field intensity. | CO 1 |
| 8 | Express the electric field intensity on surface charge. | Remember | The learner to Recall coloumb's law to know expression for electric field intensity. | CO 1 |
| 9 | State Guass law and define Gaussian surface. | Remember | The learner to Know the electric field density of point charge. | CO 3 |
| 10 | List out any three applications of Guass law. | Understand | The learner to List the properties of electric field density. | CO 3 |
| 11 | Express the work done on point charge in terms of electric field intensity.. | Remember | The learner to Know the relation between force and distance. | CO 2 |
| 12 | Define potential difference and write relevant expression. | Remember | The learner to Recall the expression for potential of point charge. | CO 2 |

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| 13 | Identify each term of the Poisson's equation and explain in brief. | Understand | --- | CO 3 |
| 14 | State Maxwell's curl equation and its relevance. | Remember | --- | CO 3 |
| 15 | Define potential gradient and write relevant expression. | Remember | The learner to<br>Recall vector algebra for calculating gradient of any quantity. | CO 2 |
| 16 | Extract laplace's equation and define laplace operator. | Understand | The learner to<br>Recall the potential gradient. | CO 3 |
| 17 | Discover the importance of elecro-statics in field analysis. | Understand | --- | CO 1 |
| 18 | Define electric flux density and write its expression | Remember | The learner to<br>Know the surface charge distribution. | CO 2 |
| 19 | Differentiate between dot product and cross product. | Understand | The learner to<br>Understand the magnitude and phase of any quantity from vector analysis. | CO 1 |
| 20 | Convert Cartesian co-ordinates to cylindrical co-ordinates. | Understand | The learner to<br>Recall different types of co-ordinate systems. | CO 1 |
| 21 | Convert Cartesian co-ordinates to spherical co-ordinates. | Understand | The learner to<br>Recall different types of co-ordinate systems. | CO 1 |
| **PART – B (LONG AN SWER QUESTIONS)** | | | | |
| 1 | State and explain COLOUMB's law in vector and scalar form. | Understand | The learner to<br>Understand the characteristics of electron and proton. | CO 1 |
| 2 | Determine the expressions for electric field intensity due to line and surface charge distribution. | Apply | The learner to<br>Make use of coloumb's law to determine electric field intensity. | CO 1 |
| 3 | Prove the divergence of electric flux density is equal to volume charge density | Understand | The learner to<br>Make use of coloumb's law to determine electric field intensity. | CO 1 |
| 4 | Solve the potential gradient equation to obtain the POISSON's equation and deduce LAPLACE's equation . | Understand | The learner to<br>Recall vector algebra for calculating gradient of any quantity. Know the expression for potential due to point charge | CO 3 |
| 5 | State and prove Guass law in conductors. Write its importance in electro-magnetic fields. | Understand | The learner to<br>Explain the surface charge distribution in a material and relation between E and D. | CO 3 |
| 6 | Explain the concept of electric field intensity and potential gradient derive the relevant expressions of both. | Understand | The learner to<br>Understand the characteristics of point charge and recall coloumb's law. | CO 2 |
| 7 | Determine the expressions for electric field intensity and work done on point charge. | Understand | The learner to<br>Understand the characteristics of point charge and recall coloumb's law. | CO 2 |

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| 8 | Explain the MAXWELL's curl equation for static electric field and its relevance in electric circuits. | Apply | The learner to<br>Make use of Gauss law to determine electric field intensity. | CO 3 |
| 9 | Determine the solution of laplace equation in spherical co-ordinates. | Understand | The learner to<br>Derive laplace equation and recall vector analysis for solution of laplace equation. | CO 3 |
| 10 | Find the solution of laplace equation in cylindrical co-ordinates. | Apply | The learner to<br>Make use vector analysis for the solution of potential equation. | CO 3 |
| 11 | Interpret the solution of laplace equation in rectangular co-ordinates. | Apply | The learner to<br>Make use vector analysis for thesolution of potential equation. | CO 3 |
| 12 | Explain electric field, electric field intensity and electric field due to point charge. | Understand | The learner to<br>Understand the characteristics of point charge and recall coloumb's law. | CO 2 |
| **PART – C (ANALYT ICAL QUESTIONS)** | | | | |
| 1 | A charge Q2 = $121*10^{-9}$ C is located in vaccum at<br>P2( -0.03,0.01,-0.04)m. Find force on Q2 due to Q1 = 100μC at<br>P1(0.03,0.08,0.02)m | Apply | The learner to<br>Make use of coloumb's law for calculating unknown parameters. | CO 1 |
| 2 | Determine the potential at (0,0,4)m caused by a total charge $10^{-8}$ C distributed uniformly along a disc of radius 4m lying in the z = 0 plane and centered at origin. | Understand | The learner to<br>Understand relation between charge and distance to calculate potential. | CO 2 |
| 3 | 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 Q4 = 5μC at (2,2,0). | Apply | The learner to<br>Make use of coloumb's law for calculating unknown parameters. | CO 1 |
| 4 | Calculate electric field E at point P(3,-4,2) in free space caused by A) a charge Q1 = 4μC at N1(0,0,0) . B) a charge Q2 = 2μC at N2(-1,2,4). | Understand | The learner to<br>Understand relation between charge and distance to calculate electric field inetensity. | CO 2 |
| 5 | Find the work done in moving a point charge 5μC from (4,π,0) to (6,π,0) in the field of Vector(E) = $10^6$ /p ap + $10^4$ /p az | Understand | The learner to<br>Understand relation between charge , force and distance to find work done. | CO 2 |
| 6 | Given a field Vector(E) = $(-6y/x^2)$ax + (6/x)ay + 5 az v/m. Calculate the potential difference VAB given A(-7,2,1) and B(4,1,2). | Understand | The learner to<br>Understand relation between E and distance to find electric potential. | CO 2 |
| 7 | Obtain the relation between electric field strength and potential. The potential is given as V = $80x^{0.6}$ V. Assuming free space conditions, find:<br>i) E<br>ii) Find E if the volume charge density at ρ = 0.5 C/m3 | Understand | The learner to<br>Understand relation between V and distance to find electric field intensity. | CO 1 |
| 8 | Planes x=2 and y=3 respectively carry | Understand | The learner to | CO 1 |

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| | charges 10 nC/$m^2$ and 15 nC/$m^2$ . If the line x=0, Z=2 carries charge 10π nC/m. Calculate E at (1,1,-1) due to the 3 charge distributions. | | Understand relation between q and distance to find electric field intensity. | |
| 9 | Determine whether or not the following potential field satisfy the Laplace equation:<br>(i)$V = x^2 - y^2 + z^2$<br>(ii) $V = rCos\Phi + z$ | Understand | The learner to<br>Recall the expression of laplace equation. | CO 1 |
| **UNIT – II** | | | | |
| **CONDUCTORS AND DIELECTRICS** | | | | |
| **PART – A (SHORT ANSWER QUESTIONS)** | | | | |
| 1 | Explain formation of di-pole in electro-static fields. | Understand | --- | CO 4 |
| 2 | Define dipole moment and deduce its expression. | Remember | --- | CO 4 |
| 3 | Find the expression for electric potential due to dipole. | Understand | The learner to<br>Recall potential due to point charge. | CO 4 |
| 4 | Obtain the expression for electric field due to dipole. | Understand | The learner to<br>Recall characteristics of point charge. | CO 4 |
| 5 | Extract the torque generated due to electric dipole. | Understand | The learner to<br>Recall relation between force and distance. | CO 4 |
| 6 | Define capacitor, capacitance and write its importance. | Remember | --- | CO 5 |
| 7 | What is the property of capacitor and write the expression for it? | Remember | --- | CO 5 |
| 8 | Relate area of plates and thickness if isolated sphere for its capacitance. | Remember | --- | CO 5 |
| 9 | What amount of the capacitance is offered by spherical spheres? | Remember | The learner to<br>Recall the relation between potential, distance and charge to find capacitance. | CO 5 |
| 10 | Explain the capacitance of capacitor with two parallel plates separated by dielectric medium. | Understand | The learner to<br>Recall the relation between potential, distance and charge to find capacitance. | CO 5 |
| 11 | Calculate the capacitance between the parallel plates with two dielectrics. | Remember | The learner to<br>Recall the relation between potential, distance and charge to find capacitance. | CO 5 |
| 12 | Express the capacitance of co-axial cable with inner and outer radii a and b. | Understand | The learner to<br>Recall the relation between potential, distance and charge to find capacitance. | CO 5 |
| 13 | Explain the voltage dependency of capacitor in its energy storage. | Understand | The learner to<br>Recall the relation between potential, | CO 5 |

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| | | | distance and charge to find energy stored in capacitance. | |
| 14 | Determine the expression for energy density in a static electric field. | Understand | The learner to<br>Recall the relation between potential, distance and charge to find energy stored in capacitance. | CO 5 |
| 15 | Define conductor and write its importance. | Remember | --- | CO 5 |
| 16 | Define insulator and write its importance. | Remember | --- | CO 5 |
| 17 | Define polarization and give the importance of polarization. | Remember | The learner to<br>Know the charge distribution in dielectric materials. | CO 5 |
| 18 | Determine the expression for dielectric polarization. | Understand | The learner to<br>Know the charge distribution in dielectric materials. | CO 5 |
| 19 | Define dielectric constant. | Remember | The learner to<br>Recall the capacitance between plates. | CO 5 |
| 20 | Define current density. | Remember | The learner to<br>Know the charge distribution in dielectric materials. | CO 5 |
| 21 | State conduction current density. | Remember | The learner to<br>Know the charge distribution in dielectric materials. | CO 5 |
| 22 | Explain point form of ohm's law using current density. | Remember | The learner to<br>Know the charge distribution in conductor materials. | CO 5 |
| **PART – B (LONG AN SWER QUESTIONS)** | | | | |
| 1 | Explain formation of electric dipole and deduce expression for dipole moment. | Understand | --- | CO 4 |
| 2 | Determine the expression for electric potential due to electric dipole and explain its dependency on distance. | Understand | The learner to<br>Make use of potential due to point charge to determine potential due to dipole. | CO 4 |
| 3 | Illustrate the expression for electric field intensity due to electric dipole. | Understand | The learner to<br>Make use of E due to point charge to determine electric field intensity due to dipole. | CO 4 |
| 4 | Extract the expression for torque on an electric dipole in an electric field. | Understand | The learner to<br>Determine the relation between force and distance to find torque due to dipole. | CO 4 |
| 5 | Explain the element capacitor along with properties and its importance. | Understand | The learner to<br>Derive the relation between potential, distance and charge to find capacitance. | CO 5 |
| 6 | Demonstrate capacitance between parallel plate when they are separated by single dielectric medium.. | Understand | The learner to<br>Derive the relation between potential, | CO 5 |

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| | | | distance and charge to find capacitance. | |
| 7 | Predict the expression for capacitance of the spherical condenser when one conductor is at infinity. | Understand | The learner to<br>Derive the relation between potential, distance and charge to find capacitance. | CO 5 |
| 8 | Find the capacitance of a two concentric spherical shells with radii a and b. | Understand | The learner to<br>Derive the relation between potential, distance and charge to find capacitance. | CO 5 |
| 9 | Extract the expression for capacitance of the cylindrical condenser with inner and outer radii a and b. | Understand | The learner to<br>Derive the relation between potential, distance and charge to find capacitance. | CO 5 |
| 10 | Develop the expression for capacitance between parallel plate with two dielectrics. | Understand | The learner to<br>Derive the relation between potential, distance and charge to find capacitance. | CO 5 |
| 11 | Explain and derive the expression for energy stored in parallel plate capacitor. | Understand | The learner to<br>Derive the relation between potential, distance and charge to find energy stored in capacitance. | CO 5 |
| 12 | Interpret the expression for energy density in a static electric field using its capacitance. | Understand | The learner to<br>Derive the relation between potential, distance and charge to find energy stored in capacitance. | CO 5 |
| 13 | Show that the energy stored in parallel plate capacitor is dependent on permittivity . | Understand | The learner to<br>Derive the relation between potential, distance and charge to find energy stored in capacitance. | CO 5 |
| 14 | State and derive the expression for equation of continuity. Relate equation of continuity in electrical circuits. | Understand | The learner to<br>Explain the charge distribution in dielectrics and conductors to obtain their characteristics. | CO 5 |
| 15 | Demonstrate current density relation with specific conductivity of material and its importance in circuits. | Understand | The learner to<br>Explain the charge distribution in dielectrics and conductors to obtain their characteristics. | CO 5 |
| 16 | Explain polarization and prove that its scalar value is equal to volume density. | Understand | The learner to<br>Explain the charge distribution in dielectrics and conductors to obtain their characteristics. | CO 5 |
| 17 | Predict the expression for Guass law in dielectrics and identify difference from Guass law in conductors.. | Understand | The learner to<br>Explain the charge distribution in dielectrics and conductors to obtain their characteristics. | CO 5 |
| **PART – C (ANALYTICAL QUESTIONS)** | | | | |
| 1 | Calculate the capacitance of a parallel plate capacitor with the following details: | Understand | The learner to<br>Derive the relation between charge, | CO 5 |

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| | Plate area = 150 $cm^2$, dielectric $\epsilon_{r1}$ = 5, $d_1$ = 3 mm, $\epsilon_{r2}$ = 4, $d_2$ = 4 mm. If 220V is applied across plates, what will be the voltage gradient across each dielectric? | | potential and distance to determine capacitance. | |
| 2 | Predict the capacitance of a capacitor of two parallel plates 30cm by 30cm, separated by 5mm in air. Calculate the energy stored by the capacitor if it is charged to a potential difference of 500V? | Understand | The learner to<br>Derive the relation between charge, potential and distance to determine capacitance. | CO 5 |
| 3 | The capacitance of the capacitor formed by two parallel plates, each 100$cm^2$ in area separated by a dielectric 2mm thickness is $2*10^{-4}$. A potential difference of 20KV is applied. Determine<br>Total dielectric flux in coloumbs<br>The potential gradient in KV/m.<br>The relative permeability of the material. | Understand | The learner to<br>Derive the relation between charge, potential and distance to determine capacitance. | CO 5 |
| 4 | The capacitance of the capacitor formed by two parallel plates, each 50$cm^2$ in area separated by a dielectric 1 mm thickness are. if 100 micro joules of energy required to increase the distance between the plates to 3 mm, calculate the initial and final voltage across the plates. Assume perfect insulation. | Understand | The learner to<br>Derive the relation between charge, potential and distance to determine capacitance. | CO 5 |
| 5 | The capacitance of the capacitor formed by two parallel plates, each 1.5$m^2$ in area separated by a dielectric 5 mm thickness. There are two dielectrics in between the plates. The first dielectric has a thickness of 3mm with a relative permeability of 6 and second dielectric has a thickness of 2mm with a relative permeability of 4. Calculate capacitance and derive formula used. | Understand | The learner to<br>Derive the relation between charge, potential and distance to determine capacitance. | CO 5 |
| 6 | A parallel plate capacitor has a separation of 1cm. A thin piece of glass with $\varepsilon r$ = 6.5 and thickness 0.2cm is inserted between the plates. The dielectric strength of air is 30 kV/cm and that of glass is 290 kV/cm. If 29 kV is applied across the capacitor find whether glass or air will breakdown. | Understand | The learner to<br>Derive the relation between charge, potential and distance to determine capacitance. | CO 5 |
| 7 | A conducting wire of diameter 1mm and conductivity 5x107 S/m, has 1029 free electrons/m3 when an electric field of 10mV/m is applied. Determine<br>(i) The charge density of free electrons<br>(ii) The current density<br>(iii) The current in the wire | Understand | The learner to<br>Explain the charge distribution in dielectrics and conductors to obtain their characteristics | CO 5 |

| UNIT – III | | | | |
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| MAGNETOSTATICS | | | | |
| PART – A (SHORT ANSWER QUESTIONS) | | | | |
| 1 | Explain the magnetic flux and indicate its direction. | Understand | The learner to<br>Understand the formation of magnetic field due to different magnets. | CO 6 |
| 2 | Define magnetic flux density. | Remember | The learner to<br>Recall the formation of magnetic field on surface due to different magnets. | CO 6 |
| 3 | Define magnetic flux intensity. | Remember | The learner to<br>Understand the formation of magnetic field due to different magnets. | CO 6 |
| 4 | Predict the relation between magnetic flux density and intensity. | Understand | The learner to<br>Understand the formation of magnetic field due to different magnets. | CO 6 |
| 5 | What is the role of permeability in the magnetic circuit? | Understand | The learner to<br>Recall the properties of non-magnetic core. | CO 6 |
| 6 | Define intensity of magnetization. | Remember | The learner to<br>Understand the formation of magnetic field due to different magnets and properties of core. | CO 6 |
| 7 | Define magnetic susceptibility. | Remember | The learner to<br>Understand the formation of magnetic field due to different magnets and properties of core. | CO 6 |
| 8 | Extract the relation between B, H, I and I. | Understand | The learner to<br>Understand the formation of magnetic field due to different magnets and properties of core. | CO 6 |
| 9 | State Biot-savart's law and write its application. | Remember | The learner to<br>Recall the formation of magnetic field due to different magnets. | CO 6 |
| 10 | Find the expression for magnetic field intensity of entire conductor. | Understand | The learner to<br>Make use of Biot-savart law to predict properties of magnetic fields. | CO 6 |
| 11 | Interpret the expression for magnetic field intensity of solenoid. | Understand | The learner to<br>Make use of Biot-savart law to predict properties of magnetic fields. | CO 6 |
| 12 | State ampere's circuital law and its importance. | Remember | The learner to<br>Recall the formation of magnetic field due to different magnets. | CO 6 |
| 13 | Determine the expressions for H and B of toroid. | Understand | The learner to<br>Make use of Biot-savart law to predict properties of magnetic fields. | CO 6 |
| 14 | Predict the expression for magnetic flux in general. | Remember | The learner to<br>Recall the formation of magnetic field due to different magnets. | CO 6 |

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| 15 | Find the expression for magnetic field intensity of a long current carrying conductor. | Understand | The learner to<br>Make use of Biot-savart law to predict properties of magnetic fields. | CO 6 |
| 16 | Extract the ampere's circuital law in differential form. | Understand | The learner to<br>Recall the formation of magnetic field due to different magnets. | CO 6 |
| 17 | Extract the integral form of the ampere's circuital law . | Understand | The learner to<br>Recall the formation of magnetic field due to different magnets. | CO 6 |
| 18 | Mention the applications of ampere's circuital law | Understand | The learner to<br>Recall the formation of magnetic field due to different magnets. | CO 6 |
| 19 | Express the MAXWELL's third equation. | Remember | The learner to<br>Recall the formation of magnetic field due to different magnets. | CO 6 |
| 20 | Calculate the magnetic flux density at the center of a current carrying loop when the radius of loop is 2cm, loop current is 1mA and loop is placed in air. | Understand | The learner to<br>Make use of Biot-savart law to predict properties of magnetic fields. | CO 6 |
| **PART – B (LONG AN SWER QUESTIONS)** | | | | |
| 1 | Define magnetic induction, magnetic field, magnetic flux density, magnetic field Intensity, permeability and magnetic susceptibility. | Remember | The learner to<br>Recall the formation of magnetic field due to different magnets and properties of non-magnetic core. | CO 6 |
| 2 | State and explain importance of Bio-Savart's law electro-magnetic fields. | Understand | The learner to<br>Explain how magnetic flux is distributed surrounding conductor. | CO 6 |
| 3 | Using Bio-Savart's law find the expression for magnetic field intensity due to a long current carrying conductor. | Apply | The learner to<br>Make use of Biot-savart law to predict properties of magnetic fields. | CO 6 |
| 4 | With help of Bio-Savart's law find the expression for magnetic field intensity at any point on the axis of a circular current carrying coil. | Apply | The learner to<br>Make use of Biot-savart law to predict properties of magnetic fields. | CO 6 |
| 5 | Using Bio-Savart's law find the expression for magnetic field intensity due to a circular current loop. | Apply | The learner to<br>Make use of Biot-savart law to predict properties of magnetic fields. | CO 6 |
| 6 | Extract the expression for maxwell's second equation. | Understand | The learner to<br>Explain how magnetic flux is distributed surrounding conductor. | CO 6 |
| 7 | Using Bio-Savart's law find the expression for magnetic field intensity inside a long solenoid carrying current I. | Apply | The learner to<br>Make use of Biot-savart law to predict properties of magnetic fields. | CO 6 |
| 8 | Show that the magnetic field intensity at the end of solenoid is half of that in middle. | Understand | The learner to<br>Make use of Biot-savart law to predict properties of magnetic fields. | CO 6 |
| 9 | Determine the expression of maxwell's third equation. | Understand | The learner to<br>Explain how magnetic flux is distributed surrounding conductor. | CO 6 |

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| 10 | State and explain importance of ampere's circuital law . | Understand | The learner to<br>Explain how magnetic flux is distributed surrounding conductor. | CO 6 |
| 11 | Explain any two applications of ampere's circuital law. | Understand | The learner to<br>Explain how magnetic flux is distributed surrounding conductor. | CO 6 |
| 12 | Determine the magnetic field intensity using ampere's circuital law due to an infinite sheet of current. | Apply | The learner to<br>Make use of Ampere circuital law to predict properties of magnetic fields. | CO 6 |
| 13 | Determine the magnetic field intensity using ampere's circuital law due to long current carrying conductor. | Apply | The learner to<br>Make use of Ampere circuital law to predict properties of magnetic fields. | CO 6 |
| **PART – C (ANALYTICAL QUESTIONS)** | | | | |
| 1 | A circular coil of radius 1of 1.5cm carries a current 1.5A, if the coil has 25 turns , find the field at the center. | Apply | The learner to<br>Make use of Biot-savart law to predict properties of magnetic fields. | CO 6 |
| 2 | A steady current I amperes flows in a conductor bent in the form of circular. Find the magnetic field at the center of the loop. | Apply | The learner to<br>Make use of Biot-savart law to predict properties of magnetic fields. | CO 6 |
| 3 | A steady current I amperes flows in a conductor bent in the form of square loop of side a. Find the magnetic field at the center of the loop. | Apply | The learner to<br>Make use of Biot-savart law to predict properties of magnetic fields. | CO 6 |
| 4 | A uniform solenoid 100mmbin diameter and 400mm long has 100 turns of wire and a current of I = 3A . fid the magnetic field on the axis of the solenoid a) at the center b) at on end c) half the way. | Apply | The learner to<br>Make use of Biot-savart law to predict properties of magnetic fields. | CO 6 |
| 5 | A current of 1A is flowing in a circular coil of radius 10cm and 20 turns. Calculate the intensity of magnetic field at a distance 10cm on the axis of the coil and at the centre. | Apply | The learner to<br>Make use of Biot-savart law to predict properties of magnetic fields. | CO 6 |
| 6 | State Biot-Savart's Law. Given points C(5,−2, 3) and P(4,−1, 2); a current element IdL = $10^{-4}$ [4ax − 3ay + az]Am at C produces a field dH at P. Find dH. | Apply | The learner to<br>Make use of Biot-savart law to predict properties of magnetic fields. | CO 6 |
| 7 | The magnitude of H at a radius of 1m from a long linear conductor is 1A/m. Determine current in the wire. | Apply | The learner to<br>Make use of Ampere circuital law to predict properties of magnetic fields. | CO 6 |
| 8 | Calculate the magnetic flux density at the center of a current carrying loop when the radius of loop is 2cm, loop current in 1mA and loop is paced in air. | Apply | The learner to<br>Make use of Ampere circuital law to predict properties of magnetic fields. | CO 6 |
| 9 | A current of 1A is flowing in a circular coil of radius 10cm and 20 turns. Calculate the intensity of magnetic field at | Apply | The learner to<br>Make use of Ampere circuital law to predict properties of magnetic fields. | CO 6 |

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| | a distance 10cm on the axis of the coil and at the centre. | | | |
| 10 | A circular loop located on $X^2 + Y^2 = 9$, Z = 0, carries a direct current of 10 Amps along $U_O$. Find H at (0,0,4) and (0,0,-4). | Apply | The learner to<br>Make use of Ampere circuital law to predict properties of magnetic fields. | CO 6 |
| **UNIT – IV** | | | | |
| **FORCE IN MAGNETIC FIELD AND MAGNETIC POTENTIAL** | | | | |
| **PART – A (SHORT ANSWER QUESTIONS)** | | | | |
| 1 | Combine electromagnetic forces to extract the Lorentz force equation. | Remember | The learner to<br>Recall expressions for force on electric and magnetic fields | CO 7 |
| 2 | Estimate the expression for force on straight current carrying conductor in an magnetic field. | Understand | The learner to<br>Understand formation of magnetic field and flow of charge in conductor. | CO 7 |
| 3 | Extract the expression for force between two straight long and parallel current carrying conductors. | Understand | The learner to<br>Understand formation of magnetic field and flow of charge in conductor. | CO 7 |
| 4 | Find the expression for force on infintely long current carrying conductor in an magnetic field. | Understand | The learner to<br>Understand formation of magnetic field and flow of charge in conductor. | CO 7 |
| 5 | Obtain the expression for torque on a current loop placed in a magnetic field. | Understand | The learner to<br>Recall the relation between force and distance to find torque. | CO 8 |
| 6 | Express the magnetic field intensity in terms of scalar magnetic potential. | Understand | The learner to<br>Recall relation between magnetic field intensity and length to determine magnetic potential. | CO 7 |
| 7 | Where the concept of scalar magnetic potential is valid? | Understand | The learner to<br>Recall relation between magnetic field intensity and length to determine magnetic potential. | CO 7 |
| 8 | Express magnetic flux density in terms of magnetic potential. | Understand | The learner to<br>Recall relation between magnetic field intensity and length to determine magnetic potential. | CO 7 |
| 9 | Find the poisson's equation in magneto-statics. | Understand | The learner to<br>Explain relation between magnetic field intensity and length to determine magnetic potential and deduce Poisson's equation. | CO 7 |
| 10 | Predict the scalar poisson's equations. | Understand | The learner to<br>Explain relation between magnetic field intensity and length to determine magnetic potential and deduce Poisson's equation. | CO 7 |
| 11 | Interpret the self inductance of a solenoid. | Understand | The learner to<br>Understand relation between magnetic | CO 9 |

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| | | | flux and current in conductor to calculate inductance. | |
| 12 | Relate the self inductance of a toroid dependency on current through it. | Understand | The learner to Understand relation between magnetic flux and current in conductor to calculate inductance. | CO 9 |
| 16 | Illustrate the Neumann's formula for solving mutual inductance between coils. | Understand | The learner to Understand formation of magnetic field and its travel through the core. | CO 9 |
| 17 | Extract the expression for energy stored in magnetic field. | Understand | The learner to Understand relation between magnetic flux and current in conductor to calculate inductance. | CO 9 |
| 18 | Find the expression for energy density in a magnetic field. | Understand | The learner to Understand relation between magnetic flux and current in conductor to calculate inductance. | CO 9 |
| **PART – B (LONG ANSWER QUESTIONS)** | | | | |
| 1 | Explain the force due to motion of charged particle in magnetic field. | Understand | The learner to Demonstrate the formation of magnetic flux and flow of charge in conductor to determine force between them. | CO 7 |
| 2 | Determine the expression for Lorentz force equation and explain its relevance in electrical circuits. | Understand | The learner to Recall expression for force due to electric and magnetic field and relate basic law of electric circuit. | CO 7 |
| 3 | Obtain the expression for force on straight current carrying conductor in an magnetic field. | Understand | The learner to Demonstrate the formation of magnetic flux and flow of charge in conductor to determine force between them. | CO 7 |
| 4 | Determine the expression for force between two current carrying conductor in an magnetic field. | Understand | The learner to Demonstrate the formation of magnetic flux and flow of charge in conductor to determine force between them. | CO 7 |
| 5 | Develop the expression for the torque on a current loop placed in a magnetic field. | Understand | The learner to Determine relation between force and length to calculate torque on current loop. | CO 7 |
| 6 | Explain the concept of scalar and vector magnetic potential along with their expressions. | Understand | The learner to Understand the relation between magnetic flux and length of conductor to extract magnetic potential experienced by it. | CO 7 |
| 7 | Demonstrate the expression for vector magnetic potential, A which satisfies the vector poisson's equation. | Understand | The learner to Understand the relation between magnetic flux and length of conductor | CO 7 |

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| | | | to extract magnetic potential experienced by it. | |
| 8 | Define and estimate the self and mutual inductance of coil with N turns. | Understand | The learner to<br>Recall how magnetic flux is developed when some current allowed through conductor. | CO 9 |
| 9 | Determine the expression of self-inductance of solenoid with lenth l and radius r. | Understand | The learner to<br>Recall how magnetic flux is developed when some current allowed through conductor. | CO 9 |
| 10 | Find the expression of self-inductance of toroid if current through it is I with N turns. | Understand | The learner to<br>Determine how magnetic flux is developed when some current allowed through conductor to obtain its properties. | CO 9 |
| 11 | Find the expression for mutual inductance M between two coils and its role in electric circuits. | Understand | The learner to<br>Determine how magnetic flux is developed when some current allowed through conductor to obtain its properties | CO 9 |
| 12 | Interpret the expression for energy stored and energy density in a magnetic field. | Understand | The learner to<br>Determine how magnetic flux is developed when some current allowed through conductor to obtain its properties | CO 9 |
| **PART – C (ANALYT ICAL QUESTIONS)** | | | | |
| 1 | A circular coil of radius 1of 1.5cm carries a current 1.5A, if the coil has 25 turns, find the field at the center. | Understand | The learner to<br>Use the expression of magnetic field intensity to calculate unknown parameter in magnetic field. | CO 7 |
| 2 | Two long parallel conduction carrying 100A. If the conductors are separated by 200mm. Find the force per meter of each conductor if the current flow direction is in opposite direction. | Understand | The learner to<br>Use the expression of force between parallel conductors to find unknown parameter in magnetic field. | CO 7 |
| 3 | Two coils A and B with 800 turns and 1200 turns respectively, have a common magnetic circuit. A current of 0.5A in A will produce a flux of 3mwb and 80% of the flux links with coil B. calculate self inductance of each coil and mutual inductance. | Understand | The learner to<br>Use the expressions of H, B, L and M in a given circuit to determine unknown parameter in magnetic field. | CO 9 |
| 4 | What is the maximum torque on a square loop of 100 turns in a field of uniform flux density B = 1wb/mt2. The loop has 10cm side and carries a current of 3A. What is the magnetic moment of the loop? | Understand | The learner to<br>Use the expressions of H, B, L and M in a given circuit to determine unknown parameter in magnetic field. | CO 9 |

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| 5 | A toroidal coil of 500 turns is wound on a steel ring of 0.5m. Mean diameter and $2*10^{-2}$ $m^2$ cross sectional area. An excitation of 4000A/m produces a flux density of 1 tesla. Compute the inductance of the coil. If a 10mm long gap is cut in the ring, determine the current required to maintain the flux density at 1 tesla. Also find the inductance under these new conditions. | Understand | The learner to<br>Use the expression of inductance due to toroid to calculate unknown quantities in magnetic field | CO 9 |
| 6 | Two mutually coupled coils are connected in series with L1 = 0.5H, L2 = 0.6H and M = 0.1H. , current flowing through it is increasing at rate of 1A/sec. Derive the expression for voltage induced in coils i) When they in series aiding connection. ii) When they in series opposite connection. | Understand | The learner to<br>Use the expressions for equivalent inductance due to coupled coils to calculate unknown quantities of magnetic fields. | CO 9 |
| 7 | A solenoid with 300 turns is 300 mm long and 30mm in diameter. If the current is 500mA. Calculate i) Inductance ii) Energy stored in solenoid. Assume μr = 1. | Understand | The learner to<br>Use the expression of inductance due to solenoid to calculate unknown quantities in magnetic field | CO 9 |
| 8 | A Rectangular loop of wire in free space joins points A(1, 0, 1) to B(3, 0, 1) to C(3, 0, 4) to D(1, 0, 4) to A. The wire carries a current of 6 mA, flowing in the $a_z$ direction from B to C. A filamentary current of 15 A flows along the entire z axis in the $a_z$ direction. Find F on side BC. | Understand | The learner to<br>Understand the flux distribution in various shaped conductors to determine their properties. | CO 7 |
| 9 | Find the torque vector on a square loop having corners (-2,-2,0), (2,-2,0), (2,2,0) and (-2,2,0) about the origin by $B = 0.6a_x - 0.4a_y$ T when a current of 0.5A is flowing through the loop. | Understand | The learner to<br>Understand the flux distribution in various shaped conductors to determine their properties. | CO 7 |
| **UNIT – V** | | | | |
| **TIME VARYING FIELDS AND FINITE ELEMENT METHOD** | | | | |
| **PART – A (SHORT ANSWER QUESTIONS)** | | | | |
| 1 | State faraday's law of electro-magnetic induction. | Understand | The learner to<br>Recall formation of magnetic field in conductor due to variable current. | CO 10 |
| 2 | Determine the expression for emf induced in the coil. | Understand | The learner to<br>Explain formation of magnetic field in conductor due to variable current and its effects. | CO 10 |
| 3 | Examine the MAXWELL's equations for static fields. | Understand | The learner to<br>Recall expressions of E,D and Vin electro-static fields. | CO 11 |

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| 4 | List out the MAXWELL's equations for static fields in integral form. | Remember | The learner to<br>Recall expressions of E,D and Vin electro-static fields in integral form. | CO 11 |
| 5 | Express the MAXWELL's equations for time varying fields from constant fields. | Understand | The learner to<br>Demonstrate electrical quantities of time varying fields using electro-static fields conclusions in integral form. | CO 11 |
| 6 | Interpret the MAXWELL's equations for time varying fields in integral form. | Understand | The learner to<br>Demonstrate electrical quantities of time varying fields using electro-static fields conclusions. | CO 11 |
| 7 | Find the expression for statically induced emf. | Understand | The learner to<br>Explain formation of magnetic field in conductor due to variable current and its effects. | CO 10 |
| 8 | Determine the expression for dynamically induced emf. | Understand | The learner to<br>Explain formation of magnetic field in conductor due to variable current and its effects. | CO 10 |
| 9 | Find the expression for displacement current density from capacitor current equation. | Understand | The learner to<br>Recall charge distribution in capacitor to find current displacement in it. | CO 11 |
| 10 | Show the expression for induced emf from Faraday's disc generator. | Understand | The learner to<br>Explain formation of magnetic field in conductor due to variable current and its effects. | CO 10 |
| 11 | Find the expression for wave equation. | Understand | The learner to<br>Recall expressions for fields during electric and magnetic supply to know wave equation. | CO 12 |
| 12 | State and explain skin effect. | Remember | The learner to<br>Recall expressions for fields during electric and magnetic supply to know wave equation | CO 12 |
| 13 | State and explain poynting theorem. | Remember | The learner to<br>Recall expressions for fields during electric and magnetic supply to know wave equation | CO 12 |
| 14 | Explain wave equations in conductor and insulator. | Understand | The learner to<br>Recall expressions for fields during electric and magnetic supply to know wave equation | CO 12 |
| **PART – B (LONG ANSWER QUESTIONS)** | | | | |
| 1 | Explain the Faraday's law of electro-magnetic induction and derive the expression for induced emf. | Understand | The learner to<br>Demonstrate how magnetic flux is developed in coil when variable current flows through it and their by applications. | CO 10 |

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| 2 | Demonstrate the expression for the integral form of Faraday's law of electromagnetic induction. | Understand | The learner to<br>Demonstrate how magnetic flux is developed in coil when variable current flows through it and their by applications. | CO 11 |
| 3 | Explain about induced emf and derive the expression for statically and dynamically induced emf. | Understand | The learner to<br>Demonstrate how magnetic flux is developed in coil when variable current flows through it and their by applications. | CO 10 |
| 4 | Prove that curl of H is not equal to zero and derive the expression for modified Ampere law from faradays laws . | Understand | The learner to<br>Use the expression obtained from constant magnetic field and modify using time constraints. | CO 11 |
| 5 | Explain Faraday's Disc Generator with neat sketch and derive the expression for induced emf. | Understand | The learner to<br>Demonstrate how magnetic flux is developed in coil when variable current flows through it and construct machine generate emf. | CO 10 |
| 6 | Explain the complete concept of displacement currents. | Understand | The learner to<br>Determine charge distribution in between plates for given area to know its current displacement. | CO 11 |
| 7 | List and explain differential , integral form of Maxwell's equation in electromagnetic fields . | Understand | --- | CO 11 |
| 8 | Demonstrate the wave equation from the MAXWELL's equations in free space. | Understand | The learner to<br>Combine field characteristics of electric and magnetic fields to determine wave propagation in free space. | CO 11 |
| 9 | Explain propagation of plane wave in good conductor along with skin effect. | Understand | The learner to<br>Combine field characteristics of electric and magnetic fields to determine wave propagation in conductor. | CO 12 |
| 10 | State and explain POYNTING theorem in detail in electromagnetic fields. | Understand | The learner to<br>Combine field characteristics of electric and magnetic fields to determine wave propagation in conductor. | CO 12 |
| 11 | Discuss on the propagation of wave in the dielecrics. | Understand | The learner to<br>Combine field characteristics of electric and magnetic fields to determine wave propagation in free space | CO 12 |
| **PART – C (ANALYTICAL QUESTIONS)** | | | | |
| 1 | A square loop of wire 25cm * 25cm is placed in an alternating field with the | Understand | The learner to<br>Use the expression of generated emf to | CO 10 |

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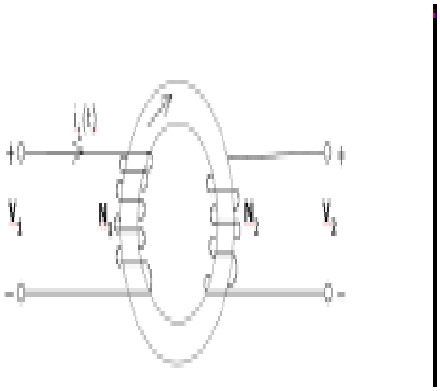
| | maximum intensity of 1A/m. If the plane of the loop is perpendicular to the magnetic field and varying at a frequency of 10MHz. Find induced enf in the loop. | | calculate unknown parameters in voltage equation. | |
| 2. | Determine the conduction and displacement current densities in a material having conductivity of $10^{-3}$ s/m and $\epsilon r = 2.5$ if the electric field in material is , $E = 5.8*10^{-6} \sin(9.0*10^{9}t)$ V/m. | Understand | The learner to<br>Use the expressions of conduction and displacement current to determine unknown electrical quantities. | CO 11 |
| 3 | A conductor of length 100cm move s at right angles to a uniform field of str ength 10000 lines per $cm^2$ , with a velocity of 50 meters/sec. Calculate the emf induced in it. Compute also the value of the induced emf when the conductor moves at an angle of 30 degrees to the direction of the field. | Understand | The learner to<br>Use the expression of generated emf to calculate unknown parameters in voltage equation. | CO 10 |
| 4 | In a material for which $\sigma = 5.0(\Omega m)^{-1}$ and $\sigma r = 1$ the electric field intensity is $E = 250\sin(10^{10}t)$ V/m. Calculate the conduction and displacement current densities and the frequency at which they have equal magnitudes. | Understand | The learner to<br>Use the expressions of conduction and displacement current to determine unknown electrical quantities. | CO 11 |
| 5 | The magnetic circuit has a uniform cross-section of $10{-}3m^2$ .If the circuit is energized by a current $i_1 = 3 \sin 100\pi t$ Amperes in the coil of $N_1$=200 TURNS. Find the emf induced in the coil of $N_2$=100 TURNS. Assume that $\mu$=500 $\mu_0$  | Understand | The learner to<br>Use the expression of generated emf to calculate unknown parameters in voltage equation. | CO 10 |
| 6 | The loop shown in Figure 3 is inside a uniform magnetic field B = 50Ux mW b $/m^2$ . If side DC of the loop cuts the flux lines at frequency of 50Hz and the loop | Understand | The learner to<br>Use the expression of generated emf to calculate unknown parameters in voltage equation. | CO 10 |

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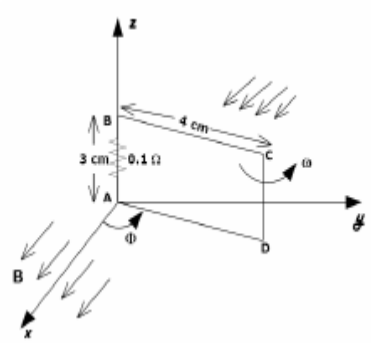
| | lies in yz-plane at time t=0. Find induced EMF at t=1ms.<br>  | | | |

**Prepared by:**
Mr. T. Anil Kumar, Assistant Professor

**HOD, EEE**