

ELECTRICAL AND ELECTRONICS ENGINEERING

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET204	ELECTROMAGNETIC THEORY	PCC	3	1	0	4

Preamble : The purpose of the course is to familiarize the students with the fundamentals of electrostatics, magnetostatics, time-varying fields and electromagnetic waves.

Prerequisite : Engineering Mathematics, Engineering Physics,

Course Outcomes : After the completion of the course the student will be able to:

CO 1	Apply vector analysis and coordinate systems to solve static electric and magnetic field problems.
CO 2	Apply Gauss Law, Coulomb's law and Poisson's equation to determine electrostatic field parameters
CO 3	Determine magnetic fields from current distributions by applying Biot-Savart's law and Amperes Circuital law.
CO 4	Apply Maxwell Equations for the solution of timevarying fields
CO 5	Analyse electromagnetic wave propagation in different media.

Mapping of course outcomes with programme outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	3										
CO 2	2	3										
CO 3	2	3										
CO 4	2	3										
CO 5	2	3										

Assessment Pattern:

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand*	20	20	50
Apply*	20	20	30
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

*Numerical problems to test the understanding and application of principles to be asked.

End Semester Examination Pattern : There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions:

Course Outcome 1 (CO1):

1. Transform the vector $\mathbf{B} = 5\mathbf{a}_x - 7\mathbf{a}_y$ to Cylindrical Co-ordinate System at the point P ($r=4, \Phi=120^\circ, z=2$).
2. Drawing necessary sketches, obtain the rectangular co-ordinates x, y, z of the point P, in terms of its cylindrical co-ordinates r, Φ, z . Assume the same origin for both co-ordinate systems.
3. Distinguish between Divergence and Gradient. Explain the physical significance of Divergence.
4. State and prove Divergence Theorem.

Course Outcome 2 (CO2):

1. A $2\mu\text{C}$ positive charge is located in vacuum at $P_1(3, -2, 4)$ and $5\mu\text{C}$ negative charge is at $P_2(1, -4, -2)$. Determine: (i) the vector force on the negative charge. (ii) the magnitude of the force on the charge at P_1 ?
2. Apply Gauss's Law to obtain the electric field intensity due to an infinite sheet of charge.
3. Derive an expression for the capacitance of a co-axial cable.

Course Outcome 3(CO3):

1. Derive the magnetic field intensity at a point on a line through the centre and perpendicular to the plane of a circular loop of radius 'r' m carrying current 'I' A. The point is at a distance 'h' m from the centre of the loop.
2. State Ampere's Circuital law. Express it in integral and differential forms.
3. State Biot-Savart's Law and express it in vector form.

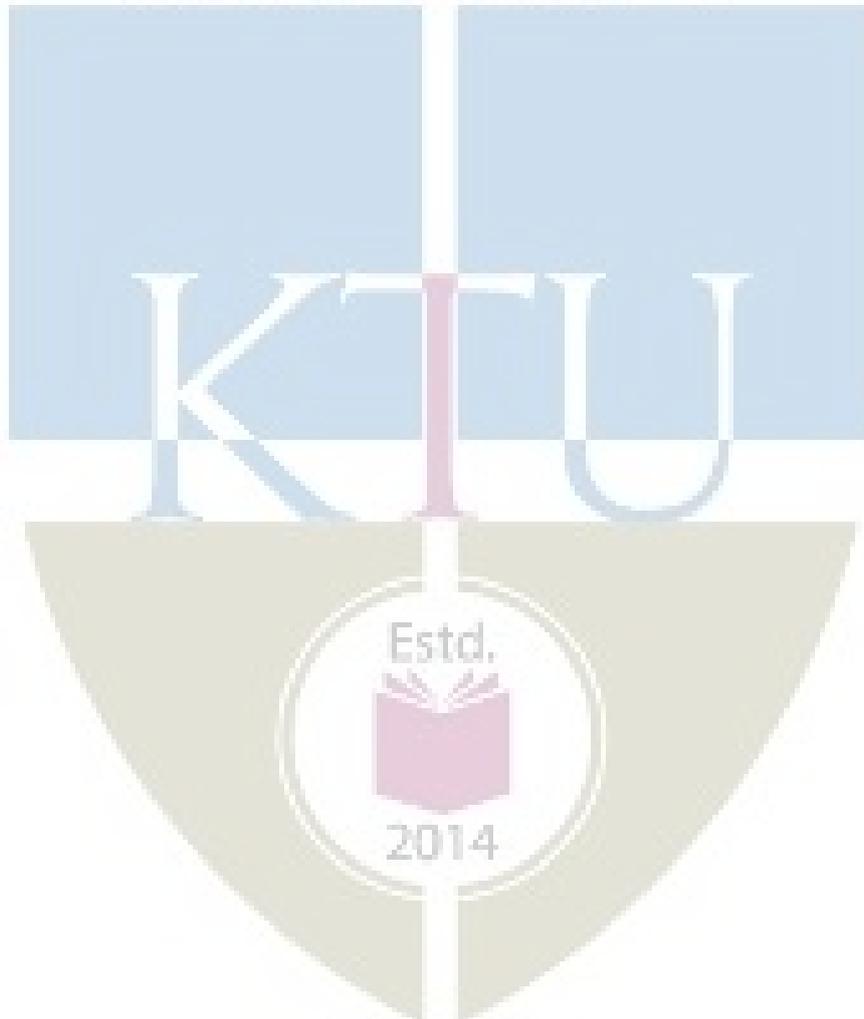
Course Outcome 4 (CO4):

1. Formulate the Maxwell's equation in differential form and integral form for time-varying fields.
2. Derive general wave equations from Maxwell's equations.
3. Explain how Ampere's circuital law can be modified for time-varying fields.

Course Outcome 5 (CO5):

1. Define a) intrinsic impedance b) characteristic impedance.
2. Derive wave equations for Uniform plane wave in free space.
3. A 9375 MHz uniform plane wave is propagating in free space. If the amplitude of the electric field intensity is 20 V/m and the material is assumed to be loss less find α , β , λ , intrinsic impedance, propagation constant and amplitude of magnetic field intensity.

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Model Question paper

PAGES: 2

QP CODE:

Reg. No: _____

Name : _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FOURTH SEMESTER
B.TECH DEGREE EXAMINATION,

MONTH & YEAR

Course Code: EET 204

Course Name: ELECTROMAGNETIC THEORY

Max. Marks: 100

Duration: 3 Hours

PART A

Answer all Questions. Each question carries 3 Marks

1. State Stokes Theorem and explain.
2. What do you understand by Curl of a vector? Explain its physical significance?
3. Define electric dipole. What is the electric field intensity due to an electric dipole?
4. Explain the term electric field intensity.
5. State Biot-Savarts Law.
6. What is conduction current and displacement current?
7. Explain group velocity and phase velocity.
8. Which of Maxwell's equation states that the magnetic field is a non-conservative field in both static and dynamic conditions? Comment.
9. Explain electromagnetic interference.
10. What is SWR?

PART B

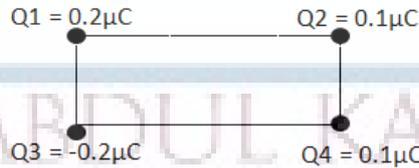
Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. (a) Transform vector $A = 5 a_r + 2 \sin\phi a_\theta + 2 \cos\theta a_\phi$ in spherical to Cartesian coordinate system. (6)
- (b) Evaluate both sides of the Divergence theorem for the region $r \leq 1$ and if $A = 3r \sin^2\theta \cos^2\phi a_r$. (8)
12. (a) Derive co-ordinate transformation between Cartesian and Spherical systems. (10)
- (b) Explain the physical significance of divergence of a vector field. (4)

Module 2

13. (a) State and Prove Gauss's Law. (4)
 (b) Four point charges are located at the four corners of the rectangle as shown. Length and breadth of rectangle are 5cm and 2 cm respectively. Find the magnitude and direction of the resultant force on Q1. (10)



14. (a) Derive the expression of electric field intensity due to infinite line charge having line charge density ρ C/m. (6)
 (b) Using Gauss's Law derive an expression for the capacitance per unit length between two infinitely long concentric conducting cylinders. The medium between two cylinders is completely filled with air. (8)

Module 3

15. (a) State the boundary conditions at the boundary of two magnetic media of permeability μ_1 and μ_2 . (10)
 (b) Flux lines are received at an iron-air boundary at 88° . If the iron has a relative permeability of 350, determine the angle from the normal with which the flux emerges into air. (4)
16. (a) Find the incremental contribution ΔH to magnetic field intensity at the origin caused by a current element in free space, IdL equal to $3\pi a_z nA$, located at (3, -4, 0). (8)
 (b) Derive the magnetic field intensity on the axis of a circular loop carrying current. (6)

Module 4

17. (a) A 10GHz plane wave travelling in free space has an amplitude 15V/m. Find velocity of propagation, wavelength, amplitude of H, characteristic impedance of media, propagation constant. (10)
 (b) What is skin effect and skin depth? (4)
18. (a) Explain about Poynting Theorem. Show that the power flow along a concentric cable is the product of voltage and current using pointing Theorem. (10)
 (b) What is uniform plane wave? What are its properties? (4)

Module 5

19. (a) Explain in detail impedance matching of lines. (10)
 (b) Explain the term propagation constant and phase velocity as applied to transmission lines. (4)
20. (a) Derive the basic transmission line equation. (9)
 (b) What are the different parameters of transmission lines? (5)

Syllabus

Module 1:

Introduction to Co-ordinate Systems – Rectangular, Cylindrical and Spherical Co- ordinate Systems – Co-ordinate transformation; Gradient of a Scalar field, Divergence of a Vector field and Curl of a Vector field- their physical interpretation; Divergence Theorem, Stokes' Theorem;

Module 2:

Coulomb's Law, Electric field intensity, Field due to a line charge, surface charge distribution. Electric Flux and Flux Density; Gauss's law and its application to determine the field due to an infinite line charge, infinite sheet charge; Electric Potential-Potential Gradient, conservative property of electric field, Equipotential surfaces; Electric Dipole; Capacitance - capacitance of co-axial cable, two wire line; Poisson's and Laplace's equations;

Module 3:

Biot-Savart's Law, Magnetic Field intensity due to a finite and infinite wire carrying current; Magnetic field intensity on the axis of a circular and rectangular loop carrying current; Magnetic flux Density; Magnetic Vector Potential; Ampere's circuital law and simple applications; Inductance and mutual inductance. Boundary conditions for electric fields and magnetic fields;

Conduction current and displacement current densities; Continuity equation for current; Maxwell's Equation in Differential and Integral form from Modified form of Ampere's circuital law, Faraday's Law and Gauss's Law.

Module 4:

Wave Equations from Maxwell's Equations; Uniform Plane Waves, Wave equations in Phasor form; Propagation of Uniform Plane waves in free space, loss-less and lossy dielectric medium, Uniform Plane waves in good conductor; Skin effect and skin depth, phase velocity and groupvelocity, Intrinsic Impedance, Attenuation constant and Propagation Constant in all medium; Poynting Vector and Poynting Theorem.

Module 5:

Transmission line: Waves in transmission line, Line parameters, Transmission line equation & solutions, Propagation constants, Characteristic impedance, Wavelength, Velocity of propagation. Standing Wave Ratio(SWR), impedance matching. Solution of problems. Electromagnetic interference.

Text Books

1. Matthew N.O. Sadiku, *Principles of Electromagnetics*, Oxford University Press, 6th Edition.
- 2 Hayt W. H. and J. A. Buck, *Engineering Electromagnetics*, McGraw-Hill, 8th Edition.

Reference Books

- 1 Joseph A. Edminister, *Electromagnetics, Schaum's Outline Series*, Tata McGraw-Hill, Revised 2nd Edition.
- 2 John Kraus and Daniel Fleisch, *Electromagnetics with Applications*, McGraw-Hill, 5th edition
- 3 Cheng D K, *Fundamentals of Engineering Electromagnetics*, Addison-Wesley.
- 4 Guru B. S. and H. R. Hizroglu, *Electromagnetic Field Theory Fundamentals*, PWS Publication Company, Boston, 1998.
- 5 Gangadhar K. A. and P. M. Ramanathan, *Electromagnetic Field Theory*, Khanna Publishers, 2009

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Module 1:	9
1.1	Introduction to coordinate systems – Rectangular, cylindrical and spherical coordinate Systems – Coordinate transformation. Numerical Problems.	3
1.2	Gradient of a scalar field, Divergence of a vector field and curl of a vector field- physical interpretation. Numerical Problems.	3
1.3	Divergence Theorem, Stokes' Theorem. Numerical Problems.	3
2	Module 2:	9
2.1	Coulomb's Law, Electric field intensity, Field due to a line charge, surface charge distribution. Numerical Problems.	2
2.2	Electric Flux and Flux Density; Gauss's law and its application to determine the field due to an infinite line charge, Infinite sheet charge. Numerical problems.	3

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2.3	Electric Potential-Potential Gradient, conservative property of electric field, Equipotential surfaces. Numerical Problems.	2
2.4	Electric Dipole, Capacitance, Poisson's and Laplace's equations. Numerical Problems.	2
3	Module 3:	11
3.1	Biot-Savart's Law, Magnetic Field intensity due to a finite and infinite wire carrying current. Magnetic field intensity on the axis of a circular and rectangular loop carrying current. Numerical Problems.	3
3.2	Magnetic flux Density; Magnetic Vector Potential; Ampere's circuital law and simple applications, Numerical Problems.	3
3.3	Boundary conditions for electric fields and magnetic fields. Conduction current and displacement current densities; Continuity equation for current; Electrostatic Energy Density.; Numerical Problems.	3
3.5	Maxwell's Equation in Differential and Integral form from Modified form of Ampere's circuital law, Faraday's Law and Gauss's Law; Numerical Problems.	2
4	Module 4:	8
4.1	Wave Equations from Maxwell's Equations; Uniform Plane Waves, Wave equations in Phasor form. Numerical Problems.	3
4.2	Propagation of Uniform Plane waves in free space, loss-less and lossy dielectric medium, Uniform Plane waves in good conductor-properties in different medium. Numerical Problems.	3
4.3	Skin effect and skin depth, Poynting Vector and Poynting Theorem. Numerical Problems.	2
5	Module 5:	8
5.1	Transmission line: Waves in transmission line, Line parameters. Numerical Problems.	3
5.2	Transmission line equation & solutions, Physical significance of solutions, Propagation constants, Characteristic impedance, Wavelength, Velocity of propagation. Numerical Problems.	3
5.3	SWR, impedance matching .Solution of problems. Electromagnetic interference Solution of problems.	2