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 magneticfield 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 **B**= 5$\mathbf{a}_x$-7$\mathbf{a}_y$ to Cylindrical Co-ordinate System at the point P (r=4, Φ=120^o, 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 2μC positive charge is located in vacuum at P_1(3,-2,4) and 5μC 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.

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 Strokes 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-conservational 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$\hat{r}$ + 2 sinϕa$\hat{\theta}$ +2 cosθ a$\hat{\phi}$ in spherical to Cartesian coordinate system. **(6)**

    (b) Evaluate both sides of the Divergence theorem for the region r ≤ 1 and if A= 3r sin^2θ cos^2ϕ a$\hat{r}$. **(8)**

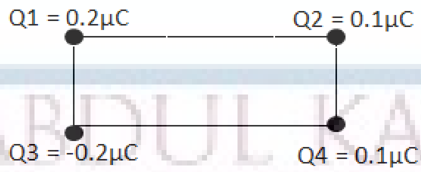
12. (a) Derive co-ordinate transformation between Cartesian and Spherical systems. **(10)**

    (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 μ1 and μ2. **(10)**

(b) Flux lines are received at an iron-air boundary at88^0. 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 $3\pi\ a\hat{z}$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, 5thedition

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

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

.