KUMARAGURU
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B.E DEGREE EXAMINATIONS: DEC 2022

(Regulation 2018)

Third Semester

ELECTRONICS AND COMMUNICATION ENGINEERING

U18ECT3004: Electromagnetic Fields

COURSE OUTCOMES

CO1: Describe the fundamental concepts of static electric field (K2).
CO2: Explain the fundamental concepts of static magnetic field (K2).
CO3: Solve electrostatic and magneto static boundary problems (K3).
CO4: Analyze the effect of static electric and magnetic fields under various configurations (K4).
CO5: Analyze the significance of Maxwell's equations for time varying field (K4).
CO6: Apply Maxwell's equations to analyze wave propagation in various mediums (K3).

Time: Three Hours   **Maximum Marks: 100**

Answer all the Questions:-
PART A (10 x 1 = 10 Marks)

1. Match List I with List II   CO1 [K$_2$]

List I	List II
A. Electric field intensity due to an infinite sheet charge	i. $\oint A.\,dl = \int (\nabla X A).\,ds$
B. Coulomb's law	ii. $\oint D.\,ds = Q_{encl}$
C. Stokes' theorem	iii. $\frac{Q_1 Q_2}{4\pi\varepsilon_0 R^2}\overline{a_R}$
D. Gauss's law	iv. $\frac{\rho_S}{2\varepsilon_0}\overline{a_N}$

	A	B	C	D
a)	ii	i	iii	iv
b)	iii	iv	ii	i
c)	iv	iii	i	ii
d)	iii	i	ii	iv

2. The electric field intensity at a point situated 4 m from a point charge is 200 N/C. If the   CO1 [K$_2$]
   distance is reduced to 2 m, the field intensity will be ------------

   a) 400 N/C   b) 800 N/C

   c) 600 N/C   d) 1200 N/C

3. Which of the following statements are correct? CO4 [K_2]
   1. The thinner the dielectric, the more the capacitance.
   2. Capacitance increases with increase in plate area & decrease in distance between the plates.
   3. Capacitance increases with decrease in plate area and value of applied voltage.
   4. In a capacitor the electric charge is stored in metal plates.
   a) 1,2,3
   b) 1,3,4
   c) 1,2,4
   d) 2,3,4

4. The Lorentz force equation is given by ------------ CO2 [K_2]
   a) $F=Q(E-v.B)$
   b) $F=Q(E+v.B)$
   c) $F=Q(E-v \times B)$
   d) $F=Q(E+v \times B)$

5. Assertion (A): No Magnetic flux exists in a closed surface. CO2 [K_2]
   Reason (R) : Number of magnetic field lines leaving the surface is equal to the number of field lines entering the surface
   a) Both A and R are Individually true and R is the correct explanation of A
   b) Both A and R are Individually true but R is not the correct explanation of A
   c) A is true but R is false
   d) A is false but R is true

6. Which of the following is correct? CO4 [K_2]
   1) $W_H = \frac{1}{2} LI$ 2) $W_H = \frac{1}{2} LI^2$ 3) $W_H = \frac{1}{2} L/I^2$ 4) $W_E = \frac{1}{2} CV^2$
   a) 1,2
   b) 2,4
   c) 3,4
   d) 1,4

7. In magnetic boundary conditions, --------------- and -----------are continuous. CO3 [K_2]
   a) Htangential, Btangential
   b) Hnormal, Btangential
   c) Hnormal, Bnormal
   d) Htangential, Bnormal

8. The phase constant of a dielectric with frequency 3×10^6 rad/sec in free space is ------------- CO6 [K_3]
   a) 1.0
   b) 0.01
   c) 0.1
   d) 0.001

9. Assertion (A): In a lossy dielectric medium, depth of penetration of a plane wave increases with decreasing frequency. CO6 [K_2]
   Reason (R): The rate of attenuation is very high in lossy dielectric medium.
   a) Both A and R are Individually true and R is the correct explanation of A
   b) Both A and R are Individually true but R is not the correct explanation of A
   c) A is true but R is false
   d) A is false but R is true

10. The magnitude of average poynting vector of the electromagnetic wave with electric and magnetic field intensities given by 4 v/m and 8 A/m respectively is ------------- W/m2 CO5 [K_3]

| a) | 22 | b) | 32 |
| c) | 16 | d) | 40 |

PART B (10 x 2 = 20 Marks)
(Answer not more than 40 words)

11.	Convert the point P (3, 4, -10) from Cartesian to Cylindrical co-ordinate system.	CO1	[K2]
12.	Electric potential is given by, $V = x^2 + 2y^2 + 4z^2$ Volts. Find E at P(1,3,2).	CO1	[K3]
13.	State Biot Savart's Law.	CO2	[K2]
14.	A square coil in a magnetic field with a length of a side 10 m carries a current 1 Ampere. Find the magnetic dipole moment.	CO2	[K3]
15.	A capacitor having capacitance of 5 uF is charged to a potential difference of 10,000 V. Obtain the energy stored in the capacitor.	CO4	[K3]
16.	Find the inductance of a solenoid of 300 turns wound tightly on a cylindrical tube of 5 cm diameter. The length of the tube is 50 cm and the solenoid is in air.	CO4	[K3]
17.	Recall Poynting theorem with its physical significance.	CO5	[K2]
18.	What is FEM? What is its significance?	CO5	[K2]
19.	Recall the expressions for attenuation and phase shift constant of a wave in good conductor.	CO6	[K2]
20.	Summarize the biological effects of Electromagnetic waves.	CO6	[K2]

Answer any FIVE Questions:-
PART C (5 x 14 = 70 Marks)
(Answer not more than 350 words)

21.	a)	Develop the expression for Electric field intensity E due to an infinitely long, straight charge distribution of uniform density ρ_l at any point P.	10	CO1	[K2]
	b)	Determine the divergence of the vector at P(2, 30°, 5) $P = \rho\sin\phi\ a_\rho + \rho^2 z\ a_\phi + z\cos\phi\ a_z$	4	CO1	[K3]
22.	a)	Deduce the expression for torque developed in a rectangular closed circuit carrying current I in a uniform field. Also find the torque on a conductor with flux density 4 T, current 3.0 A and area 5 m².	10	CO2	[K3]
	b)	State and prove Ampere's circuital law.	4	CO2	[K2]
23.	a)	Obtain Poisson's and Laplace's equations for electrostatic field. Also check whether the potential field $V = 2x^2 - 3y^2 + z^2$ satisfies Laplace's equation.	8	CO4	[K3]

| b) | Formulate the expression for continuity equation for current. | 6 | CO4 | [K_3] |

24. a) Elaborate the boundary conditions for electric field when a wave travels between two different dielectric medium. 　8　CO3　[K_2]

　　b) Differentiate between self and mutual inductance. Coil 1 of a pair of coupled coils has a continuous current of 5A, and the corresponding fluxes ϕ_1 and ϕ_{12} are 0.6mWb and 0.4 mWb respectively. If the turns are N_1=500 and N_2=1500, find L1, L2, and M. 　6　CO4　[K_3]

25. a) From the basic laws derive the time varying Maxwell's equation and explain the significance of each equation in details. 　10　CO5　[K_3]

　　b) For a lossy dielectric σ = 5 s/m, εr =1 and E = 100 sin3t. Find J_C and J_D. 　4　CO5　[K_3]

26. a) Using Maxwell's equations, derive the electromagnetic wave equations for a conducting medium. 　8　CO6　[K_2]

　　b) If a uniform plane wave is travelling in a lossy dielectric which is having ε_r of 2.5, μr of 4, σ of 10^{-3} mho/m at 10 MHz, then evaluate its attenuation constant, phase constant and velocity. 　6　CO6　[K_3]

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