B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025

Third Semester

Electronics and Communication Engineering

20ECPC302 - ELECTROMAGNETIC FIELDS AND WAVEGUIDES

Regulations - 2020

Duration: 3 Hours   Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)
Answer ALL Questions

|		Marks	K – Level	CO
1.	If the vectors A and B are conservative, then (a) A X B is solenoidal (b) A X B is conservative (c) A + B is solenoidal (d) A - B is solenoidal	1	K2	CO1
2.	In the expression for the cross product $|A \times B| = |A||B|\sin\theta$, what does θ represent? (a) The angle between A and B (b) The magnitude of A (c) The magnitude of B (d) The sum of the magnitudes of A and B	1	K1	CO1
3.	Two-point charges, $Q_1 = +9$ µC and $Q_2 = 4$ µC, are separated by a distance r = 12 cm. What is the magnitude of the electric force in N? (a) 22.475 (b) 22 (c) 12 (d) 12.34	1	K1	CO2
4.	The potential difference between two points in an electric field is 100 V. If a charge of 2 µC is moved between these points, the work done is (a) 50 µJ (b) 100 µJ (c) 200 µJ (d) 400 µJ	1	K2	CO2
5.	What happens to excess charge on a conductor in electrostatic equilibrium? (a) Distributes uniformly throughout the volume (b) Concentrates at the center (c) Distributes on the surface (d) Disappears	1	K1	CO3
6.	What is the expression for energy stored in a capacitor? (a) $(1/2)CV^2$ (b) CV^2 (c) $(1/2)C^2V$ (d) C^2V	1	K1	CO3
7.	According to Lenz's Law, the direction of the induced current will (a) Enhance the change in flux (b) Oppose the change in flux (c) Maintain the same flux (d) Produce no effect on the flux	1	K1	CO4
8.	The speed of electromagnetic waves in a vacuum depends on (a) The permittivity and permeability of free space (b) The electric field strength (c) The magnetic field strength (d) The displacement current	1	K1	CO4
9.	The electric field component of a wave in free space is given by E = 10 cos $(10^7 t + kz)$ ay, V/m. It can be inferred that (a) The wave propagates along ay. (b) The wave amplitude is 10 V/m. (c) The wave number k = 0.33 rad/m. (d) The wave attenuates as it travels.	1	K2	CO5
10.	The cut-off frequency of the dominant mode of a rectangular waveguide with an aspect ratio of more than 2 is 12 GHz. The inner broad wall dimension is: (a) 3 cm (b) 2 cm (c) 1.25 cm (d) 1.5 cm	1	K2	CO6

PART - B (12 × 2 = 24 Marks)
Answer ALL Questions

11.	When a vector field is said to be solenoidal or irrotational?	2	K1	CO1
12.	Convert point P(1, 3, 5), from Cartesian to spherical coordinates.	2	K2	CO1
13.	Why magnetic monopole does not exist in the universe?	2	K1	CO2
14.	Determine J at(3,2,1) if H = xyz a_x +xyz a_y A/m.	2	K2	CO2
15.	Draw the B-H curve for classifying magnetic materials.	2	K1	CO3
16.	State Poisson's and Laplace's equations and explain their significance.	2	K2	CO3
17.	Define Faraday's law of electromagnetic induction.	2	K1	CO4

K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate; K6 – Create   *13999*

18. Differentiate conduction current and displacement current.   2   K2   CO4

19. Define skin effect and skin depth.   2   K1   CO5

20. Define the characteristic of good conductor.   2   K1   CO5

21. Compare TE and TM modes in a waveguide.   2   K2   CO6

22. Define Bessel's function.   2   K1   CO6

PART - C (6 × 11 = 66 Marks)
Answer ALL Questions

23. a) If $A = \rho\,cos\varphi\,a_\rho + z\,sin\varphi\,a_z$ around the edge L of the wedge defined by $0 < \rho <$ 11   K3   CO1
    2, $0 \le \varphi \le 60°$, z = 0. Confirm this by applying Stokes's theorem.
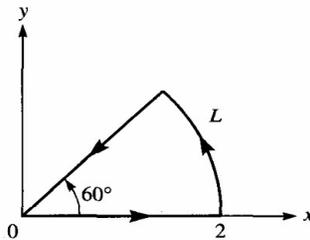
OR

   b) A vector field is given by $F = (x^2 + y)\mathbf{i} + (y^2 + z)\mathbf{j} + (z^2 + x)\mathbf{k}$. Calculate the   11   K3   CO1

   divergence of F, and evaluate the surface integral of F over a cube with sides of

   length 2 centered at the origin, applying the divergence theorem.

24. a) Apply gauss law to find charge enclosed in hollow sphere whose surface is   11   K3   CO2
    uniformly charged.

OR

   b) Use amperes circuital law to determine the magnetic field intensity of coaxial   11   K3   CO2
   cable.

25. a) Derive an expression for the capacitance of a coaxial capacitor with inner radius   11   K2   CO3
   'a' and outer radius 'b' with length L.

OR

   b) With neat sketches, derive the boundary conditions for two different media in the   11   K2   CO3
   magnetic field.

26. a) From the basic laws derive the time varying Maxwell's equation and explain the   11   K2   CO4
   significance of each equation in detail.

OR

   b) Derive the Wave Equation for free space and solve for electromagnetic fields.   11   K2   CO4

27. a) Illustrate the wave propagation in a lossy dielectric with relevant equations and   11   K2   CO5
   neat sketch.

OR

   b) Obtain the Poynting theorem for the conservation of energy in electromagnetic   11   K2   CO5
   fields and summarize the physical meaning of each term in the resulting equation.
   Also, bring the Poynting theorem in complex form.

28. a) A frequency of 3 GHz is impressed on a hollow rectangular waveguide of   11   K3   CO6
   dimensions 6 cm x 4 cm. Compute (a) cut-off wavelength, (b) guide wavelength,
   (c) phase constant, (d) phase velocity, (e) wave impedance for the TE10 mode of
   propagation.

OR

   b) Examine the propagation of TM mode in a rectangular waveguide with relevant   11   K3   CO6
   expressions.