

Department of Electronics & Communication Engineering
 Institute of Engineering & Technology, Lucknow
 IEC303 – Electromagnetic Field Theory (Class Test – 2)

Max. Mark 15

Time Allowed: 1 Hour

Note: Attempt all questions. Each question carries an equal mark.

Q.No.	Question	Marks	CO
Q.1	A uniform plane wave propagating in a medium has $E = 2e^{-\alpha z} \sin(10^8 t - \beta z) a_y$ V/m. If the medium is characterized by $\epsilon_r = 1$, $\mu = 20$, and $\sigma = 3$ S/m, find α and β .	3	3
Q.2	State and explain the concept of loss tangent and explain how it is helpful in classifying a material as a good dielectric or as a good conductor.	3	3
Q.3	An air line has a characteristic impedance of 70 ohm and a phase constant of 3 rad/m at 100 MHz. Calculate the inductance per meter and the capacitance per meter of the line.	3	3
Q.4	Explain the terms: input impedance, reflection coefficient, and standing wave ratio for a transmission line.	3	4
Q.5	Draw the equivalent circuit of a two-conductor transmission line and explain its primary parameters.	3	5

B.Tech.

(SEM III) ODD SEMESTER EXAMINATION 2024-25

ELECTROMAGNETIC FIELD THEORY & WAVE PROPAGATION

[TIME: 3 hrs.]

[Max. Marks: 70]

Note: Attempt All Questions. All Question carry equal marks.

- Q1. Answer ALL parts. Marks
- (a) Express the field $E = 2xyza_x - 3(x + y + z)a_z$, in cylindrical coordinates. 3.5
- (b) Analyze how the divergence and curl of a vector field can be used to classify physical phenomena, such as fluid flow or electromagnetic fields. Provide a real-world example for each case. 3.5
- (c) Evaluate the application of Stokes' theorem and divergence theorem in converting complex integrals. Compare their roles in simplifying Maxwell's equations in different coordinate systems. 3.5

OR

- Apply Gauss's law to a non-uniform charge distribution (e.g., a spherical shell with varying charge density). Derive the electric field and evaluate its behavior at different regions.
- (d) Point charges of 1 mC and -2mC are located at (3,2,-1) and (-1, -1, 4), respectively. Calculate the electric force on a 10 nC charge located at (0, 3,1) and the electric field intensity at that point. 3.5

OR

A radial field $H = \frac{2.39 \times 10^9}{r} \cos\phi a_r$ A/m, exists in free space. Find the magnetic flux crossing the surface defined by $-\pi/4 \leq \phi \leq \pi/4, 0 \leq z \leq 1$ m.

- Q2. Answer ALL parts.
- (a) Evaluate the integral and differential forms of Maxwell's equations for static, time-varying, and harmonically varying fields. Compare the implications of each form in practical scenarios. 7
- (b) Apply Maxwell's equations to derive the wave equation in free space and in a lossy conducting medium. Discuss the differences in wave propagation in these two environments. 7

OR

Derive the Poynting theorem from Maxwell's equations and evaluate its significance in calculating the power flow in a lossless medium.

- Q3. Answer ALL parts.
- (a) Evaluate the behavior of a uniform plane wave as it transitions from a perfect dielectric to a lossy dielectric. Compare the impact on wave impedance, propagation constant, and attenuation. 7

OR

Calculate the depth of penetration for a plane wave in a good conductor at microwave frequencies. Discuss its practical implications in the design of shielding materials.

(b) Determine the propagation constant γ for a material having $\mu_r = 1$, $\epsilon_r = 8$, and $\sigma = 0.25 \text{ pS/m}$, if the wave frequency is 1.6 MHz. 7

Q4. Answer ALL parts.

(a) Evaluate the differences between transmission lines with and without losses. Discuss how the propagation constant, attenuation constant, and phase constant are affected by the inclusion of losses. 7

(b) A transmission line with air as dielectric has the characteristic impedance of 60 ohm and phase constant of 4 rad/m at 500 MHz. Calculate the inductance per meter and the capacitance per meter of the line. 7

A transmission line of characteristic impedance of $Z_0 = 50 \text{ ohm}$ is terminated by a load $R_L = Z_L = 100 \text{ ohm}$. Find VSWR, Z_{min} , and Z_{max} .

Q5. Answer ALL parts.

(a) A high frequency radio link has to be established between two-points at a distance of 2500 km on earth's surface. Considering the ionospheric height to be 200 km and its critical frequency 5 MHz, calculate the MUF for the given path. 7

(b) Analyze the roles of space waves and surface waves in ground wave propagation. Explain how the characteristics of these waves are influenced by the conductivity and dielectric constant of the earth. 7

OR

Evaluate the relationship between the Maximum Usable Frequency (MUF), Lowest Usable Frequency (LUF), and Optimum Frequency (OF). Discuss their significance in determining reliable communication frequencies for long distances.