EM THEORY & TRANSMISSION LINES
(ECEN 2203)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) What is the major factor for determining whether a medium in free space, a lossless dielectric, a lossy dielectric or a good conductor?
(a) Attenuation constant (b) Loss tangent
(c) Constitutive parameters (σ, μ, ε) (d) Perfect Conductor.

(ii) Poynting vector gives
(a) Rate of energy flow (b) Direction of polarization
(c) Intensity of electric field (d) Intensity of magnetic field.

(iii) A uniform plane wave is one in which:
(a) $\vec{E}$ and $\vec{H}$ are perpendicular (b) $\vec{E}$ and $\vec{H}$ lies in a plane
(c) $\vec{E}$ and $\vec{H}$ are parallel (d) $\vec{E}$ and $\vec{H}$ are 45° out of phase.

(iv) Which one of the following conditions will not guarantee a distortion less transmission line?
(a) $R = 0, G = 0$ (b) $LG = RC$
(c) $R \gg \omega L, G \gg \omega C$ (d) $R \ll \omega L, G \ll \omega C$

(v) If a line is terminated in an open circuit, then VSWR (Voltage Standing Wave Ratio) is
(a) 0 (b) 1 (c) ∞ (d) −1

(vi) The characteristics impedance of a lossless transmission line is given by
(a) $Z_0 = \sqrt{LC}$ (b) $Z_0 = \sqrt{L/C}$
(c) $Z_0 = \sqrt{CG/L}$ (d) $Z_0 = LC$

(vii) The direction of wave vector represents the direction of
(a) power (b) electric field
(c) magnetic field (d) all of them.

(viii) A lossy, isotropic and charge free medium means
(a) $\sigma = 0, \epsilon$ is not constant and $\rho = 0$ (b) $\sigma = 0, \epsilon$ is constant and $\rho = 0$
(c) $\sigma \neq 0, \epsilon$ is not constant and $\rho = 0$ (d) $\sigma \neq 0, \epsilon$ is constant and $\rho = 0$

(ix) The radiation pattern of Pyramidal Horn antenna is
(a) Omni directional (b) Bidirectional
(c) Isotropic (d) Multidirectional.

(x) In a dielectric medium, electromagnetic wave with different wavelength experiences different velocity due to
(a) diffraction (b) refraction
(c) dispersion (d) all of the above.

Group – B

2. (a) What do you mean by displacement current? Derive modified amperes circuital law.

(b) In a medium characterized by σ=0, μ-μ_0, ε=4ε_0 and E = 20sin(10^8t-βz)a_y V/m calculate β and H.

6 + 6 = 12

3. (a) Derive expression for the continuity equation. Derive the modified Ampere's circuit law. What is the origin of the 'displacement current'?

(b) A parallel-plate capacitor with plate area of 5 cm^2 and plate separation of 3 mm has a voltage $50 \sin 10^3 t$ V applied to its plates. Calculate the displacement current assuming $\epsilon = 2\epsilon_0$.

(2 + 3 + 1) + 6 = 12

Group – C

4. (a) Write the Maxwell's equations. Hence derive the electromagnetic wave equation for lossy, isotropic, homogeneous and charge free medium. Show that $\beta^2 - \alpha^2 = (nk_0)^2$, where α, β, n and k_0 represent the attenuation constant, phase constant, refractive index and free-space wave number, respectively.

(b) A wave, within a nonmagnetic medium with $\epsilon_r = 3\epsilon_0$, is represented as $\mathbf{E} = 200e^{-0.05z} \cos(160 \times 10^6 \pi t - \beta z)\, \hat{\mathbf{a}}_\mathbf{x}$.
Determine
(i) refractive index of the medium,
(ii) intrinsic impedance of the medium,
(iii) phase constant β, and
(iv) the corresponding magnetic field.

(1 + 3 + 2) + (1 + 1 + 1 + 3) = 12

5. (a) Write short note on
(i) Linear polarization (ii) circular polarization and (iii) elliptical polarization.

(b) Differentiate between dynamic and dc resistance of a conductor. Analyze wave propagation in lossy dielectric.

6 + 6 = 12

Group – D

6. (a) Show that a one eighth wavelength transmission line can be used to transform any load impedance to the characteristic impedance.

(b) The measurement on a distortion less transmission line at 1000 Hz gave the following results.
$Z_0 = 60\ \Omega$
$\alpha = 0.01$ Neper/m and $\beta = 0.035$ rad/m.
Calculate the primary constants (R, L, G, and C) and phase velocity on the line.

5 + 7 = 12

7. (a) A lossy transmission line having length l characteristics impedance Z_0 and propagation constant γ is terminated at a load impedance Z_L. Show that the input impedance can be expressed as $Z_{in} = Z_0 \left[\frac{Z_L + Z_0 \tanh \gamma l}{Z_0 + Z_l \tanh \gamma l}\right]$.

(b) Derive the condition for distortion-less transmission line.

8 + 4 = 12

Group – E

8. (a) What is an antenna array? Why is it used instead of an antenna? Differentiate between broadside and end fire array.

(b) The field pattern of an omni-directional antenna in elevation plane is defined as:

$F(\theta) = 1$ for $45° \le \theta \le 135°$
$= 0$ for all others values of θ.

Find the directivity of this omni-directional antenna.

(2 + 2 + 3) + 5 = 12

9. (a) A magnetic field strength of 5μA/m is required at a point on $\theta = \frac{\pi}{2}$, which is 2 km from an antenna in air. Neglecting ohmic loss, how much power must the antenna transmit if it is a Hertzian dipole of length $\lambda/25$?

(b) Show that the directive gain of a Hertzian dipole is $G(\theta, \phi) = 1.5 \sin^2 \theta$.

6 + 6 = 12

Department & Section	Submission Link
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ECE Sec B	https://classroom.google.com/w/MzExNTkwMjY1ODQy/tc/Mzc0Mjg2Mzc2MTQ2
ECE Sec C	https://classroom.google.com/u/2/w/MzEyNDA4OTM2MTAz/tc/Mzc0MjU3NDkzOTUz
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