Code: 9A04406

1

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

ELECTROMAGNETIC THEORY & TRANSMISSION LINES

(Electronics and Communication Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

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1 (a) Give the statements of strokes and divergence theorems.

(b) Through Gauss law, prove divergence theorem and interpret the Gauss law in the point relation?

2 Derive Poisson's and Laplace's equations. Explain their applications

3 (a) State and prove ampere's work law? And derive the expansion of its differential vector form in cylindrical co-ordinates?

(b) Find the flux density at the center of a square loop of 10 turns carrying a current of 10 Amps. The loop is in air and has a side of 2 m.

4 State and explain Faraday's law of induction. And hence Introduce the concept of time varying electromagnetic fields through this law.

5 (a) Prove the perpendicular nature and direction of uniform plane waves.

(b) A plane wave traveling in a dielectric with $\epsilon_r = 3$ has a peak electric field of 6 V/m. Find the phase velocity, phase constant and peak magnetic field.

6 A uniform plane wave is propagating in the a_z direction through a lossy material with $\gamma = 0.1 + 1.2\ m^{-1}$ and $\eta = 300 + j25\ \Omega$. Let E = 100 V/m at z = 0.

(i) Find $P_{z,\,av}$ at z = 0 and

(ii) How much average power per cubic meter is being dissipated at P (2, 3, and 4)?

7 The characteristic impedance of a certain line is $710\angle -16^0$ when the frequency is 1 KHz. At this frequency the attenuation is 0.01 neper/km and the phase constant is 0.035 rad/km. Calculate the primary constants and the phase velocity.

8 A certain transmission line 2 m long operating at $\omega = 10^6$ radians/sec has α = 8 db/m, β = 1 radian/m, and $Z_0 = 60 + j40\ \Omega$. If the line is connected to a source of $10\angle 0^0$, $Z_g = 40\ \Omega$ and terminated by a load $20 + j50\ \Omega$. Determine:

(i) the i/p impedance (ii) the sending end current (iii) the current at the middle of the line.

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1 (a) Find the energy stored in a system of four equal point charges Q = 5 nC arranged in a line with 2 m separation between them?

(b) State divergence theorem and discuss its application?

2 (a) Differentiate between conduction current and convection current.

(b) Prove that $\nabla.J = 0$ for static fields.

3 (a) Using Biot-Savart law derive an expression for inductance per unit length of long co-axial cable.

(b) A coil of 500 turns is wound on a closed iron ring of radius 10 cm and cross section area of $5\ cm^2$ find the self inductance of the coil if $\mu_r = 800$ for iron.

4 Are all the Maxwell's equations independent? Explain through justifications.

5 (a) Compare wave propagation in good conductors and in good dielectrics.

(b) A non magnetic medium has an intrinsic impedance of $240\angle 30^0\ \Omega$. Find its
(i) Loss tangent. (ii) Dielectric constant. (iii) Complex permittivity.
(iv) Attenuation constant at 1MHz.

6 Consider the boundary between free space and glass having $\epsilon_r = 4$, $\mu_r = 1$, and $\sigma = 0$. If a uniform plane wave with $E_m = 1$ V/m and a frequency of 200 MHz is incident from free space normal to the glass, determine (i) the time domain forms of the incident, reflected, and transmitted fields (ii) the time average power transmitted through a 5 m^2 surface of the glass and (iii) the SWR in free space.

7 An open wire line which is 200 km long is correctly terminated. The generator at the sending end has V_{oc} = 10 V, f = 1 KHz and internal impedance of 500 Ω. Z_0 of the line is 683 - j138 Ω and propagation constant is 0.0074 + j0.0356 per km. Determine sending end voltage, current, and power and receiving end voltage, current, and power.

8 (a) Discuss about quarter wave transformer.

(b) Explain the reactance properties of transmission lines.

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3

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1 (a) Derive the boundary relations for static electric fields at the interface between:
(i) Dielectric- Dielectric. (ii) Dielectric – Conductor.

(b) Two perfectly conducting infinite planes are separated by a distance 'd' carrying uniformly distributed surface charges of equal and opposite densities ρ_0 and $-\rho_0$, find the potential difference between the two when the medium is free space

2 (a) Show that the electric potential due to electric dipole satisfies Laplace's equation.

(b) Develop an expression for potential difference at any point between spherical shells in terms of applied potential using Laplace's equation.

3 (a) Discuss the concept of energy storage in magnetic field?

(b) Find the energy stored in the field in establishing a current of 'I' amps in a solenoid of 'n' turns.

4 Explain with justification the modification of static field continuity equation for time varying fields.

5 A wave propagating in a lossless dielectric has the components, E = 500 cos $(10^7 t - \beta z)a_x$ V/m and H = 1.1 cos $(10^7 t - \beta z)a_y$. If the wave is traveling at V = 0.5c.
Find: (i) μ_r (i) ε_r (iii) β (iv) λ (v) η.

6 (a) Write instantaneous electric and magnetic field expressions for the case of oblique incidence of a uniform plane wave with parallel polarization on a perfect conducting plane boundary.

(b) Determine reflection coefficients of an EM wave incident normally on:
(i) A sheet of copper.
(ii) A sheet of iron. Use f = 1 MHz. Assume $\sigma = 1 \times 10^6$ mhos/m, $\mu = 1000\ \mu_0$ for iron.

7 The characteristic impedance of a uniform transmission line is 2309.5 Ω at frequency of 800 Hz. At this frequency the propagation constant was found to be $0.054 \angle 87.9^0$. Determine the primary constants.

8 Describe about smith chart and transients on transmission lines.

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4

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1 (a) Explain the concept of energy density with the help of a simple parallel plate capacitor

(b) A sphere with volume of $0.5\ \mathrm{m}^3$ has a charge density of $4\ \mathrm{nC/m}^3$, if its center is at origin find electric field intensity at a point (0, 3, 6)

2 (a) Define the following with respect to a medium:
(i) Homogeneous. (ii) Isotropic. (iii) Charge free.

(b) Derive relative permeability expression from the concept of magnetic polarization.

3 (a) In a certain region the current density is given by $\mathrm{j} = 3\mathrm{x}\,\mathrm{i}_\mathrm{x} + (\mathrm{y} - 3)\,\mathrm{i}_\mathrm{y} + (2 + \mathrm{z})\,\mathrm{i}_\mathrm{z}\ \mathrm{A/m}^2$. Find the total current flowing out of a spherical surface of radius 5 cm.

(b) Write about the principle of radiation from a wire carrying time varying current.

4 (a) In time varying fields are electric and magnetic fields dependent? Explain.

(b) In free space electric flux density $\mathrm{D} = \mathrm{D}_0 \sin(\omega\mathrm{t} + \beta\mathrm{z})\mathrm{i}_\mathrm{x}$, find the magnetic flux density using Maxwell's equations?

5 The electric field intensity of a 300 MHz uniform plane wave in free space is given as E = (20 + j50) $(a_x + 2a_y)\ e^{-j\beta z}$ V/m.
(i) Find ω, λ, v, and β
(ii) Find E at t = 1ns, z = 10 cm.
(iii) What is $|H|_{max}$?

6 Explain reflection of uniform plane wave by a perfect dielectric in the case of oblique incidence for perpendicular polarization and obtain expression for E_r/E_i.

7 The constants of a line per Km are R = 6 Ω, L = 2.2 mH, C = 0.005 mF, and G = 0.25 x 10^{-6} mhos. Calculate at the frequency of 1 KHz (i) the terminating impedance for which no reflection will be set up in the line. (ii) The attenuation in db suffered by signal while traveling a distance of 100 Km when the line is properly terminated and the phase velocity with which the signal would transmit.

8 (a) Explain how standing waves occur in an imperfectly matched transmission line.

(b) Discuss the importance of a half wave length line.

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