510702

Roll No. _____ Total No. of Pages: 3

510702

B. Tech. V - Sem. (Main/Back) Exam., (Academic Session 2021- 2022)

Electronics & Communication Engineering

5EC4 – 02 Electromagnetics Waves

Time: 3 Hours **Maximum Marks: 120**

Min. Passing Marks:

Instructions to Candidates:

Part – A: *Short answer questions (up to 25 words) 10 × 2 marks = 20 marks. All **ten** questions are compulsory.*

Part – B: *Analytical/Problem solving questions 5 × 8 marks = 40 marks. Candidates have to answer **five** questions out of **seven**.*

Part – C: *Descriptive/Analytical/Problem Solving questions 4 × 15 marks = 60 marks. Candidates have to answer **four** questions out of **five**.*

Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.

Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. Smith Chart 2. NIL

PART – A

Q.1 What are the source quantities in the electromagnetic model? [2]

Q.2 What is the physical definition of the gradient of a scalar field? [2]

Q.3 State Helmholtz's theorem in words. [2]

Q.4 Define electric susceptibility. What is its unit? [2]

Q.5 Write Laplace's equation for a simple medium in vector notation. [2]

Q.6 Define wavenumber. How wavenumber is related to wavelength? [2]

Q.7 Define reflection coefficient and transmission coefficient. What is the relation between them? [2]

Q.8 What is an evanescent mode? [2]

Q.9 Define antenna pattern. [2]

Q.10 Why is it required to achieve an impedance match in a transmission line? [2]

PART – B

Q.1 A lossless transmission line operating at 4.5 GHz has L=2.4 μH/m and $Z_0 = 85\Omega$. Calculate the phase constant and phase velocity. [8]

Q.2 Write the differential form of Maxwell's equations and what is the physical significance of each. [8]

Q.3 A perpendicularly polarized wave propagates from dielectric region ($\varepsilon_r = 8.5$, $\mu_r = 1$ and $\sigma = 0$) to free space, with an angle of incidence of 15°. If E_0^i= 1 μv/m, find H_0^i, E_0^r, H_0^r, E_0^t and H_0^t (i.e. incident, reflected and transmitted field quality). [8]

Q.4 The magnetic field intensity of a plan wave traveling in a lossy earth (Assume $\sigma = 10^{-4}$ s/m, $\varepsilon_r = 9$ and $f = 1$ GHz) is given by $\overline{H} = (\hat{a}y + j2\hat{a}z)H_0e^{-\alpha x}e^{-j\beta x}$, where $H_0 = 1$ μ A/m. Find inside the earth phase constant, phase velocity, wavelength and the skin depth. [8]

Q.5 A standard X-band (8.2 – 12.4 GHz) rectangular waveguide (with dimension of 0.9 in × 0.4 in) is filled with lossless dielectric ($\varepsilon_r = 2.56$) for the lowest order mode of the waveguide determine cutoff frequency and guide wavelength at 10GHz. [8]

Q.6 A Hertzian dipole of length L = 2m operates at 1 MHz. Find the radiation efficiency if the copper conductor has $\sigma_c = 57$ MS/m, $\mu_r = 1$ and radius a = 1 mm. [8]

Q.7 Write the boundary conditions that exist at the interface of free space and a magnetic material of infinite permeability. [8]

PART – C

Q.1 A load impedance 30 + j 10 (Ω) is connected to a lossless transmission line of length 0.101 λ and characteristics impedance 50 (Ω). Use a Smith chart to find (a) the standing wave ratio, (b) the voltage reflection coefficient, (c) the input impedance, (d) the input admittance and (e) the location of the voltage minimum on the line. [15]

Q.2 A uniform plane wave in air is normally incident on an infinite lossless dielectric material having $\varepsilon = 3\,\varepsilon_0$ and $\mu = \mu_0$. If the incident wave is $\overline{E}_i = 10\cos(\omega t - z)\hat{a}y$ v/m find – [15]

(a) λ and ω of the wave in air and transmitted wave in the dielectric medium

(b) The incident $\overline{H}_i$ field

(c) Γ and τ

(d) The total electric field and the time average power in both regions

Q.3 For a parallel plate waveguide – [15]

(a) Find the frequency (in terms of f_c) at which the attenuation constant due to conductor losses for the TMn mode is minimum.

(b) Obtain the formula for this minimum attenuation constant.

(c) Calculate this α_c (minimum) for TM_1 mode if the parallel plates are made of copper ($\sigma = 5.8 \times 10^7$ s/m) and spaced 5cm apart in air.

Q.4 (i) For an Hertzian dipole, show that the time average power density is related to the radiation power according to - $P_{ave} = \frac{1.5\sin^2\theta}{4\pi r^2} P_{rad}$ [10]

(ii) Sketch the normalized E-field and H-field pattern for a half wave dipole and a quarter wave monopole antenna. [5]

Q.5 (i) Assume a parallel polarized electromagnetic plane wave which is incident on the surface of a dielectric at 62° from air. Calculate the permittivity of the dielectric if at this angle there is no reflection from the surface. [10]

(ii) Describe the general statements about electromagnetic boundary conditions. [5]
