KATHMANDU UNIVERSITY
End Semester Examination [C]
June/July 2024

07 JUL 2024

Level : B.E.
Year : III
Time : 2 hrs. 30mins.

Course : EEEG 309
Semester : I
F. M. : 40

SECTION "B"
[4Q. × 10 = 40 marks]

Attempt ANY FOUR questions. Symbols have their usual meaning. Students are required to write answer in their own words as far as practicable. Smith chart will be provided.

1.
a. Let $\vec{D}= 5\ r^2\ a_r$ mC/m^2 for r $\leq$ 0.08 m and $\vec{D}= 0.205/r^2\ a_r$ μC/m^2 for r $\geq$ 0.08. Find volume charge density for r = 0.06m and r = 0.09m [4]
b. Starting from the Maxwell's equation, derive the expression for the attenuation constant and the phase constant for a uniform plane wave travelling through a perfect dielectric. [6]

2.
a. A lossless transmission line of length 0.434λ and characteristic impedance 100 Ω is terminated in an impedance 260+j180 (Ω). Using Smith Chart, find (a) voltage reflection coefficient (b) standing wave ratio (c) the input impedance [5]
b. Inner conductor of radius 'a' of a coaxial cable held at potential V_0 while the other conductor of radius 'b' is grounded. Determine (i) potential distribution between the conductor (ii) surface charge density (ii) capacitance per unit length. [5]

3.
a. The maximum amplitude of the electric field of a 250 MHz uniform plane wave propagating in free space along the negative Z direction is 0.5 V/m. The electric field is polarized in the Y direction and its maximum value is observed at t = 0 and Z = -12 cm. Obtain the phase of the sinusoidal waveform and expression for the instantaneous forms of the electric and magnetic fields. Also specify the orientation of the magnetic field vector. [5]
b. Draw a two wire transmission line configuration and obtain the expression for the characteristic impedance in terms of primary constants. [5]

4.
a. Derive an expression for the cut off frequency in a rectangular waveguide. [5]
b. Write the Maxwell's equations and express them in phasor form. [3]
c. Consider a wave propagating through seawater whose conductivity is 9 S/m and μ = μ_0. If frequency of propagating wave is 6 MHz, find the skin depth and wave velocity. [2]

5.
a. What happens when a uniform plane wave is incident on a boundary between two different mediums? What type of relationship exists between transmission coefficient and reflection coefficient? Explain with proper derivation. [5]
b. Write short notes on: [2.5×2=5]
(i) Optical waveguides (ii) Voltage Standing Wave Ratio (VSWR)

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Registration No.:

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SECTION "A"
[20Q. × 0.5 = 10 marks]

Choose and encircle in the most appropriate option from each set of choices

1. Maxwell in his equations of electromagnetism introduced the concept of _____
   a. AC current
   b. Displacement current
   c. Inductance
   d. Reactance

2. For loss less transmission, the transmission line parameters are related as _____
   a. R=0, G ≠ 0
   b. R/G = C/L
   c. R=0, G = 0
   d. R/G = L/C

3. If the reflection coefficient is zero, then VSWR equals to_____
   a. 0.1
   b. 0.3
   c. 0.5
   d. 1

4. The propagation mode supported by transmission line is _____
   a. TM
   b. TM and TE
   c. TEM
   d. TE

5. For short-circuited transmission line, the reflection coefficient equals to _____
   a. Zero
   b. Infinite
   c. 1
   d. -1

6. Which of the following is true for not time varying field?
   a. $\Delta x\vec{E} = 0$
   b. $\Delta x\vec{E} = 1$
   c. $\Delta x\vec{E} = \partial\vec{B}/\partial t$
   d. $\Delta x\vec{E} = -\partial\vec{B}/\partial t$

7. If reflection coefficient is 1 then transmission coefficient is equal to _____
   a. -1
   b. 1
   c. 0
   d. 2

8. In a wave guide if TM mode exists for z-direction propagation then _____
   a. $E_z=0,\ H_z \neq 0$
   b. $E_z \neq 0,\ H_z=0$
   c. $H_z=0,\ E_z=0$
   d. $E_z \neq 0,\ H_z \neq 0$

9. Which of the following represents the Laplace equation?
   a. $\Delta^2 V = 0$
   b. $\Delta^2 V = \rho_v/\varepsilon_0$
   c. $\Delta^2 V = -\rho_v/\varepsilon_0$
   d. $\Delta^2 V = -\varepsilon_0/\rho_v$

10. Conversion of point $P(r,\theta,z) = (4, 5\pi/6, 3)$ into rectangular co-ordinate yields _____
    a. $P(x,y,z) = P(-2\sqrt{3}, 2, 3)$
    b. $P(x,y,z) = P(2\sqrt{3}, 3, 3)$
    c. $P(x,y,z) = P(\sqrt{3}, 1, 3)$
    d. $P(x,y,z) = P(-\sqrt{3}, 3, 3)$

11. For TM mode of propagation in a rectangular waveguide, which of the following is the dominant mode of propagation?
    a. TM_{01}
    b. TM_{10}
    c. TM_{00}
    d. TM_{11}

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12. Let ω be the angular frequency. What is the characteristic impedance of a transmission line having resistance R, inductance L, capacitance C and conductance of dielectric G?
a. $\sqrt{((G+J\omega l)/(R+J\omega C))}$ b. $\sqrt{((C+J\omega l)/(G+J\omega R))}$
c. $\sqrt{((R+J\omega l)/(C+J\omega G))}$ d. $\sqrt{((R+J\omega l)/(G+J\omega C))}$

13. If a plane electromagnetic wave satisfies the equation $(\partial^2 E_x/\partial z^2) = C^2(\partial^2 E_x/\partial t^2)$ where $C^2 = \varepsilon_0\mu_0$, the wave propagates in the _____
a. X-direction
b. Y-direction
c. Z direction
d. XY plane at angle of 45 degrees between X and Z direction

14. The degenerate modes in a waveguide is characterized by
a. Modes having zero cut off frequency b. Modes having same cut off frequency
c. Modes having lowest cut off frequency d. Modes having no phase shift

15. As the speed decreases if we change the medium of electromagnetic waves from air to water, the frequency _____
a. also decreases b. also increases
c. remains same d. may increase or decrease

16. The Smith chart consists of _____
a. Constant r and variable x circles b. Variable r and constant x circles
c. Variable r and variable x circles d. Constant r and constant x circles

17. Which of the following represents the Maxwell's equation for free space?
a. $\Delta x\vec{H} = \vec{J} + \partial\vec{B}/\partial t$ b. $\Delta x\vec{H} = \vec{J} + \partial\vec{D}/\partial t$ c. $\Delta x\vec{E} = \vec{J} - \partial\vec{D}/\partial t$ d. $\Delta x\vec{H} = +\partial\vec{D}/\partial t$

18. The cut off frequency of a rectangular waveguide in the dominant mode is 10GHz. The width of the waveguide is _____
a. 2cm b. 1.5cm c. 3cm Ω d. 1cm

19. For EM wave expressed as $\vec{E}(z,t) = 5\ \mathrm{Sin}(2x10^6\ t + z)\ \breve{a}_y$ v/m, the value of phase constant is _____
a. 5 rad/m b. 2 rad/m c. 10 rad/m d. 1 rad/m

20. The attenuation constant for a wave propagating through a perfect dielectric medium is equal to_____
a. 0 N_p/m b. 1 N_p/m c. 2 N_p/m d. 3 N_p/m