

KATHMANDU UNIVERSITY
End Semester Examination
January/February 2024

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

26 JAN 2024

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

SECTION "B"
[4Q. × 10 = 40 marks]

Attempt *ANY FOUR* questions. *Symbols have their usual meaning.*

1.
 - a. Derive the expression for the Magnetic field component in the direction of propagation in TE mode of propagation in a rectangular waveguide. [5]
 - b. Obtain the general wave equation for a two wire transmission line. Also find the expression for characteristic impedance. [3+2]
2.
 - a. Explain in detail about the effect of electromagnetic field exposure and safety. [3+2]
 - b. A 45Ω lossless transmission line is connected to a load impedance $Z_L = 25 - j50 \Omega$. Using Smith chart, find the position d and length l of a short-circuit stub required to match the load at a frequency of 200 MHz. Assume that the transmission line is a coaxial line filled with a dielectric material for which $\epsilon_r = 9$. [5]
3.
 - a. Obtain the expression for propagation constant, attenuation constant (α) and phase constant (β) using Maxwell equations for an electromagnetic wave travelling in a good conductor. [5]
 - b. If $\vec{V} = 60 \sin\theta/r^2$ V in free space and point P is located at $r = 3\text{m}$, $\theta = 60^\circ$, $\phi = 25^\circ$. Find V_p , E_p , D and ρ_v at point P. [3]
 - c. Consider a wave propagating through seawater whose conductivity is 5 S/m and $\mu = \mu_0$. If frequency of propagating wave is 2 MHz, find the skin depth and wave velocity. [2]
4.
 - a. Differentiate between the transmission line and the waveguide. Derive an expression for cut off frequency in rectangular waveguide. [1+4]
 - b. The time domain expression for the electric field of a uniform plane wave travelling in free space is given by the following expression: [5]
$$\vec{E} = 50 \cos(10^8 t + \beta x) \hat{a}_y \text{ v/m}$$

Find

 - i. The direction of wave propagation
 - ii. The operating frequency
 - iii. The phase constant and time taken by wave to travel a distance of $\frac{\lambda}{2}$
 - iv. The time domain expression for the magnetic field starting from the Maxwell's equations
 - v. The phasor form of the electric field and magnetic field

5. a. Find the expression of reflection coefficient for a uniform plane wave considering the normal incidence at the boundary. [5]
- b. Write short notes on: [2 × 2.5=5]
- i. VSWR
 - ii. Cavity resonator

KATHMANDU UNIVERSITY
End Semester Examination
January/February 2024

26 JAN 2024

Marks Scored:

Level : B.E.

Year : III

Exam Roll No. :

Time: 30 mins.

Course : EEEG 309

Semester : I

F. M. : 10

Registration No.:

Date :

SECTION "A"

[20Q. \times 0.5 = 10 marks]

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

- A plane electromagnetic wave of frequency 100 MHz is travelling in vacuum along the x-direction. At a particular point in space and time, $\vec{B} = 2 \times 10^{-8} \vec{K}$ T. Where \vec{K} is the unit vector in the z-direction. What is \vec{E} at this point?
a. $0.6\vec{j}$ v/m b. $6\vec{j}$ v/m c. $0.1\vec{j}$ v/m d. $3\vec{j}$ v/m
- The Maxwell's divergence equation in case of static electric field \vec{E} is expressed as ____
a. $\nabla \cdot \vec{E} = 0$ b. $\nabla^2 \cdot \vec{E} = 0$ c. $\nabla \times \vec{E} = 0$ d. $\nabla \cdot \vec{E} = 1$
- The divergence of a curl is always ____
a. 0 b. 1 c. -1 d. ∞
- Which of the following represents the Laplace equation?
a. $\Delta^2 V = 0$ b. $\Delta^2 V = \rho_v / \epsilon_0$ c. $\Delta^2 V = -\rho_v / \epsilon_0$ d. $\Delta^2 V = -\epsilon_0 / \rho_v$
- For EM wave expressed as $\vec{E}(z,t) = 5 \sin(2 \times 10^6 t + 9z) \vec{a}_y$ v/m, the value of phase constant is ____
a. 5 rad/m b. 2 rad/m c. 10 rad/m d. 9 rad/m
- Which of the following represents the Maxwell's equation?
a. $\Delta \times \vec{H} = \vec{J} + \partial \vec{B} / \partial t$ b. $\Delta \times \vec{H} = \vec{J} + \partial \vec{D} / \partial t$ c. $\Delta \times \vec{E} = \vec{J} + \partial \vec{B} / \partial t$ d. $\Delta \times \vec{H} = \vec{J} - \partial \vec{B} / \partial t$
- For a conducting medium with conductivity σ , permeability μ and permittivity ϵ , the skin depth at an angular frequency ω is proportional to ____
a. σ b. $\frac{1}{\omega}$ c. $\frac{1}{\mu}$ d. $\frac{1}{\sqrt{\sigma}}$
- Which of the following is true for time varying field?
a. $\Delta \times \vec{E} = 0$ b. $\Delta \times \vec{E} = 1$ c. $\Delta \times \vec{E} = \partial \vec{B} / \partial t$ d. $\Delta \times \vec{E} = -\partial \vec{B} / \partial t$
- The phase constant for a wave propagating through a good conductor is given by
a. $\omega \sqrt{\mu \epsilon}$ b. $\sqrt{j \omega \sqrt{\mu \epsilon}}$ c. $\sqrt{-j \omega \sqrt{\mu \epsilon}}$ d. $\sqrt{\omega \sqrt{\mu \epsilon}}$

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. 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
12. Poynting theorem relates the electric field intensity, \vec{E} and a magnetic field intensity, \vec{H} to the rate of energy flow per unit area at a point P as
 a. $\vec{P} = \vec{E}/\vec{H}$ b. $\vec{P} = \vec{H}/\vec{E}$ c. $\vec{P} = 1/(\vec{E}/\vec{H})$ d. $\vec{P} = \vec{E} \times \vec{H}$
13. For reflection coefficient 0.6, the value of SWR is _____
 a. 1 b. 2 c. 3 d. 4
14. For distortion less transmission, the transmission line parameters are related as _____
 a. $R=0, G \neq 0$ b. $R/G = C/L$ c. $R=0, G = 0$ d. $R/G = L/C$
15. The mode supported by transmission line is _____
 a. TM b. both TM and TE
 c. TEM d. TE
16. A transmission line has characteristic impedance of 50Ω and a resistance of $0.1 \Omega/\text{cm}$. If the line is distortion less, the value of attenuation constant is _____
 a. $0.1 \text{ N}_p/\text{m}$ b. $0.2 \text{ N}_p/\text{m}$ c. $0.001 \text{ N}_p/\text{m}$ d. $0.002 \text{ N}_p/\text{m}$
17. 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
18. In a wave guide if TE 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. $E_z \neq 0, H_z \neq 0$
19. A lossless transmission is 80 cm long and operates at a frequency of 600 MHz. The line parameters are $L=0.25\mu\text{H}/\text{m}$, $C=100\text{pF}/\text{m}$ then the characteristic impedance is
 a. 60Ω b. 50Ω c. 40Ω d. 30Ω
20. The modes of lowest order in rectangular cavity resonator are _____
 a. $\text{TM}_{100}, \text{TE}_{011}, \text{TE}_{101}$ b. $\text{TM}_{110}, \text{TE}_{110}, \text{TE}_{101}$
 c. $\text{TM}_{110}, \text{TE}_{011}, \text{TE}_{111}$ d. $\text{TM}_{110}, \text{TE}_{011}, \text{TE}_{101}$