Total No. of printed pages = 3

ECE 181603

16/6/23

Roll No. of candidate | | | | | | | | | | |

2023

B.Tech. 6th Semester End-Term Examination

ELECTROMAGNETIC WAVES

New Regulation(w.e.f 2017-18) & New Syllabus (w.e.f)

Full Marks – 70 Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer Question No.1 and any *Four* from the rest.

Answer the following (MCQ/ Fill in the blanks) : $(10 \times 1 = 10)$

1. (i) The mathematical perception of the gradient is said to be

(a) Tangent (b) Chord

(c) Slope (d) Arc

(ii) Divergence of gradient of a vector function is equivalent to

(a) Laplacian operation (b) Curl operation

(c) Double gradient operation (d) Null vector

(iii) The gradient can be replaced by which of the following?

(a) Maxwell equation (b) Volume integral

(c) Differential equation (d) Surface integral

(iv) Find the value of Stokes's theorem for $y\,i + zj + x\,k$

(a) $i + j$ (b) $j + k$

(c) $i + j + k$ (d) $-i - j - k$

(v) Which of the following theorem convert line integral to surface integral?

(a) Gauss divergence and Stokes's theorem

(b) Stokes's theorem only

(c) Green's theorem only

(d) Stokes's and Green's theorem

[Turn over

(vi) Which of the following parameters is not a primary parameter?

(a) Resistance (b) Attenuation constant

(c) Capacitance (d) Conductance

(vii) The leakage current in the transmission lines is referred to as the

(a) Resistance (b) Radiation

(c) Conductance (d) Polarization

(viii) Which parameter is unity in air medium?

(a) Permittivity (b) Absolute permeability

(c) Relative permeability (d) Permeability

(ix) In a rectangular wave guide the dominant mode is

(a) TE_{01} (b) TE_{10}

(c) TM_{01} (d) TM_{10}

(x) For any wave guide, the dominant mode is the mode with

(a) Highest wavelength (b) Lowest phase constant

(c) Highest frequency (d) Highest propagation constant

2. (a) Write Maxwell's equations in free space for time varying fields both in differential and integral form. (4)

(b) Derive the electric flux through a sphere. A solid conducting sphere of radius 3 cm has a charge distribution of 8 micro colombe. A conducting spherical shell of inner radium 5 cm & outer radius of 6 cm is concentric with the saled sphere and has a charge of – 4 micro colombe. What is the magnitude and direction of the electric field at 5.5 cm and at 4 cm. (6)

(c) State the significance of stokes theorem. (3)

(d) What is the physical significance of curl of a vector field. (2)

3. (a) For a transmission line the per unit length parameter are $0.1\Omega/m$, $0.2\mu H/m$, $10pF/m$ and $0.02\ \varpi/m$. Find the complex propagation constant at (i) 1 MHz and (ii) 1 GHz. (3)

(b) Write a short note on characteristic impedance. A transmission line has primary constants, $R = 0.1\Omega/m$, $G = 0.01\Omega/m$, $L = 0.01\mu H/m$ and $C = 100pF/m$. Find the characteristic impedance of the line at 2GHz. (6)

(c) Write down the conditions for a line to be distortionless. What should be the value of R for a transmission line so that the line can be treated as low-loss line, if it has $L = 0.25\mu H/m$, $C = 100\,pF/m$, $G = 0$ and frequency of operation is 100 MHz. (6)

4. (a) A 50Ω transmission line is connected to a parallel combination of a 100Ω resistance and a 1 nF capacitance, find the VSWR on the line at a frequency of 2 MHz. Also find the maximum and minimum resistance seen on the line. (4)

(b) Derive the wave equation for loss-less or non-conducting medium and also show the wave equation for sinusoidal time variation of the wave. (6)

(c) In a non-magnetic medium, $E = 4\sin(2\pi \times 10^7 t - 0.8x)a_z\, V/m$, find ε_r, η and the time average power carried by the wave. (5)

5. (a) Determine the expression of E and H for a plane wave in arbitrary direction. (8)

(b) Derive the condition for plane wage at dielectric interface and hence show the Snell's law from the condition. (7)

6. (a) A rectangular waveguide with dimensions, $a = 2.5cm$ and $b = 1cm$, is to operate below 15.1 GHz. How many TE and TM modes can the wave guide transmit if the waveguide is filled with a medium characterized by $\sigma = 0$, $\varepsilon = 4\varepsilon_o$ and $\mu_r = 1$? Calcualte the cutoff frequencies of the modes. (6)

(b) Explain rectangular waveguide with its cutoff frequency and the lowest order mode. (5)

(c) State poynting theorem. Explain its significance. (4)

7. (a) Derive the tangential and normal component of electric field at a dielectric-dielectric boundary. (7)

(b) What do you mean by transmission line? Derive and expression for transmission line equation. (8)
