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B. E. (Fourth Semester) Examination, April-May 2021

(Electronics & Telecommunication Engg. Branch)

ELECTROMAGNETIC FIELDS AND TRANSMISSION LINES

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Attempt all questions. Part (a) of each unit is compulsory carry 2 marks. Attempt any two parts from (b), (c) and (d) each carry 7 marks. Assume suitable data if required*

Unit-I

1. (a) Write the differential volume and surfaces in spherical co-ordinates system. 2

(b) Trabnsform the vector 7

$$\vec{A} = \sin^2\theta\cos\phi\, a_r + \cos^2\phi\, a_\theta - \sin\phi\, a_\phi$$

from spherical to cylinderical coordinates and than evaluate it at $P = (2, \pi/2, \pi/2)$

(c) Find the vector component of $\vec{F} = 10a_x - 6a_y + 5a_z$ that is parallel to $\vec{G} = 0.1a_x + 0.2a_y + 0.3a_z$ and find the vector component of $\vec{F}$ that is perpendicular to $\vec{G}$ 7

(d) An infinite uniform line charge $\rho_l = \frac{2nC}{m}$ lies along the x axis in free space, while point charges of 8 nC each are located at (0, 0, 1) and (0, 0, −1). Find $\vec{E}$ at (2, 3, −4). 7

Unit-II

2. (a) Define divergence of a vector and write significance of divergence. 2

(b) Let $\vec{F} = 6xyz^2a_x + 3x^2z^2a_y + 6x^2yza_z\frac{C}{m^2}$. Find the

total charge lying within the region bounded by x = 1 and 3, y = 0 and 1, and z = −1 and 1 by separately evaluating each side of the divergence theorem. 7

(c) In free space, a line charge $\rho_l = 80\frac{nC}{m}$ lies along the entire z axis, while a point charge of 100 nC is located at (1, 0, 0). Find the potential difference V_{PQ} given P (2, 1, 0) and Q (3, 2, 5). 7

(d) Given the potential field $V = \frac{(50\sin\theta)}{r^2}$ in free spcace : 7

(i) determine whether V satisfies Laplace's equation

(ii) find the total charge stored inside the spherical shell $1 < r < 2$.

Unit-III

3. (a) Write Biot Savart's Law. 2

(b) Find $\vec{H}$ in rectanular components at P (2, 3, 4) if there is a current filament located at $x = -1, y = 2$. 7

(c) A current element $I_1\overrightarrow{\Delta L_1} = 10^{-5} a_z$ Am, is located at $P1$ (1, 0, 0), while a second element, $I_2\overrightarrow{\Delta L_2} = 10^{-5}$ $(0.6a_x - 2a_y + 3a_z)$ Am, is located at $P2(-1, 0, 0)$ both in free space. Find the vector force on $I_2\overrightarrow{\Delta L_2}$ by $I_1\overrightarrow{\Delta L_1}$. 7

(d) The magnetic flux density in a magnetic material with $Xm = 9$ is given in a certain region as $\vec{B} = 0.005y^2 a_x T$. At $y = 0.8$ m, find the magnitude of J, $\vec{J}_b$ and $\vec{J}_T$. Note $\begin{cases} x_n = 9 \\ y = 0.8m \end{cases}$ 7

Unit-IV

4. (a) Write Faraday's law. 2

(b) Write Maxwell's equation in integral and differential form and prove that in air EMW moves with velocity of light. 7

(c) Assume a homogeneous material of infinite extent with $\epsilon = 2\times10^{-10}\frac{F}{m}$, $\mu = 1.25\times10^{-5}\frac{H}{m}$, and

$\sigma = 0$. Let $\vec{E} = 400\cos(10^9 t - kz)a_x\frac{V}{m}$. If all the field vary sinusoidally, use Maxwell's equations to find $\vec{D}, \vec{B}, \vec{H}$ and k. 7

(d) State and prove Poynting Theorem. 7

Unit-V

5. (a) Differentiate lossless and distortion less transmission line. 2

(b) Define reflection coefficient and standing wave ratio and derive the relationship between these two for incorrectly terminated two wire transmission line. 7

(c) An open wire transmission line having characteristic impedance of 600Ω is terminated by a resistive load of 900Ω. Calculate the voltage standing wave ratio and design a single with matching to match the load. 7

(d) A lossless transmission line having $Z_0 = 120\Omega$ is operating at $\omega = 5\times10^8$ rad/sec. If the velocity on the line is 2.4×10^5 m/sec. Find (i) L (ii) C (iii) Let Z_L be represented by an inductance 0.6 μH in

series with a 100Ω, them find reflected coefficient and standing wave ratio. 7