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## GIET UNIVERSITY, GUNUPUR – 765022

B. Tech (Fifth Semester – Regular) Examinations, December – 2022

### BPCEC5040 – Electromagnetic Waves

(ECE)

Time: 3 hrs

Maximum: 70 Marks

#### Answer ALL Questions

The figures in the right hand margin indicate marks.

#### PART – A: (Multiple Choice Questions)

(1 x 10 = 10 Marks)

##### Q.1. Answer ALL questions

- |  | [CO#] | [PO#] |
|--|-------|-------|
| a. A point charge $2\text{nC}$ is located at origin. What is the potential at $(1,0,0)$ ?                                  | CO2   | PO2   |
| (i) 12   |       |       |
| (ii) 14  |       |       |
| (iii) 16   |       |       |
| (iv) 18  |       |       |
| b. The Stoke's theorem uses which of the following operation?  | CO2   | PO1   |
| (i) Divergence   |       |       |
| (ii) Gradient  |       |       |
| (iii) Curl   |       |       |
| (iv) Laplacian   |       |       |
| c. The spherical equivalent of the vector $\mathbf{B} = y\mathbf{i} + (x + z)\mathbf{j}$ located at $(-2,6,3)$ is given by | CO1   | PO2   |
| (i) $(7,64.62,71.57)$  |       |       |
| (ii) $(7,-64.62,-71.57)$   |       |       |
| (iii) $(7,-64.62,71.57)$   |       |       |
| (iv) $(7,64.62,-71.57)$  |       |       |
| d. The point form of Ampere law is given by  | CO3   | PO1   |
| (i) $\text{Curl}(\mathbf{B}) = \mathbf{I}$   |       |       |
| (ii) $\text{Curl}(\mathbf{D}) = \mathbf{J}$  |       |       |
| (iii) $\text{Curl}(\mathbf{V}) = \mathbf{I}$   |       |       |
| (iv) $\text{Curl}(\mathbf{H}) = \mathbf{J}$  |       |       |
| e. Find the power of a wave given that the RMS value of E and H are 6 and 4.5 respectively.                                | CO3   | PO2   |
| (i) 24   |       |       |
| (ii) 27  |       |       |
| (iii) 29   |       |       |
| (iv) 32  |       |       |
| f. The normal component of which quantity is always discontinuous at the boundary?   | CO4   | PO1   |
| (i) E  |       |       |
| (ii) D   |       |       |
| (iii) H  |       |       |
| (iv) B   |       |       |
| g. In free space, which parameter will be unity?   | CO4   | PO1   |
| (i) Permittivity   |       |       |
| (ii) Absolute permittivity   |       |       |
| (iii) Relative permittivity  |       |       |
| (iv) Permeability  |       |       |
| h. EM waves do not travel inside metals. State True/False.   | CO4   | PO3   |
| (i) True   |       |       |
| (ii) False   |       |       |
| i. Which of the following is true regarding attenuation?   | CO5   | PO1   |
| (i) Conductor loss   |       |       |
| (ii) Di-electric loss  |       |       |
| (iii) Sum of both conductor loss and dielectric loss   |       |       |
| (iv) Attenuation is different from the losses  |       |       |
| j. We say a transmission line is matched when  | CO5   | PO1   |
| (i) $Z_L = Z_0$  |       |       |
| (ii) $Z_L = \sqrt{Z_0}$  |       |       |
| (iii) $Z_L = Z_0/2$  |       |       |
| (iv) $Z_L = 2Z_0$  |       |       |

#### PART – B: (Short Answer Questions)

(2 x 10 = 20 Marks)

##### Q.2. Answer ALL questions

- |   | [CO#] | [PO#] |
|---|-------|-------|
| a. State coulombs law   | CO2   | PO1   |
| b. State the condition for the vector F to be irrotational.                 | CO2   | PO1   |
| c. What are the ranges of the variables in the Spherical coordinate system. | CO1   | PO1   |

d. Define electric potential.	CO3	PO1
e. Relate Maxwell's second equation with electrostatic potential.	CO3	PO1
f. The electric field in free space is given by $E = 50 \cos(10^8 t + \beta x) a_y$ . What is the direction of wave propagation? Calculate $\beta$	CO4	PO2
g. What is loss tangent? Give its significance.	CO5	PO1
h. Write wave equations in electric and magnetic fields	CO4	PO1
i. Define Characteristic impedance	CO5	PO1
j. What is a finite line? Write down the significance of this line	CO5	PO1

**PART – C: (Long Answer Questions)**

**(10 x 4 = 40 Marks)**

Answer ALL questions

	Marks	[CO#]	[PO#]
3. a. Express the vector $\vec{A} = \frac{k}{\rho^2} \vec{a}_\rho + 5 \sin 2\phi \vec{a}_z$ in cartesian coordinate system.	5	CO2	PO2
b. Two point charges of equal mass M and charge Q are suspended at a common point by 2 threads of negligible mass and length L. Show that at equilibrium $Q^2 = 16\pi\epsilon_0 MgL^2 \sin^2 \alpha \tan \alpha$ with an inclination angle of $\alpha$ .	5	CO2	PO2
(OR)			
c. Derive the expression of electric field intensity due to surface charge.	6	CO1	PO 2
d. Find the total charge over volume with volume charge density of $-5 \times 10^{-5} \mu\text{C}/\text{m}^3$ . The radius of the cylinder is 1 cm, the range of z varies from 2 cm to 4 cm. Find the total charge Q.	4	CO2	PO 2
4. a. Derive the wave equation for time varying electric field and magnetic field.	5	CO2	PO2
b. In free space, electric field is given as, $\vec{E} = 20 \cos(\omega t - 50x) \vec{a}_y$ V/m. Calculate $\vec{J}_d$ and $\vec{H}$ in terms of $\omega$ .	5	CO3	PO2
(OR)			
c. Derive the expression for Helmholtz equation.	6	CO2	PO2
d. The phasor form of a vector is given by, $\vec{A}_s = (4 - j3) e^{-j\beta x} \vec{a}_y$ . Convert it to instantaneous form.	4	CO2	PO2
5. a. Comment on the nature of wave parameters when the wave propagates through good conductor.	6	CO3	PO1
b. Calculate the attenuation and phase constant for a uniform plane wave with frequency of 10GHz in a medium where $\mu = \mu_0$ , $\epsilon_r = 2.3$ and $\sigma = 2.56 \times 10^{-4} \text{Mho}/\text{m}$ .	4	CO3	PO2
(OR)			
c. Briefly discuss the Ampere circuital law.	4	CO1	PO1
d. Explain Poynting Theorem and derive the expression of poynting vector	6	CO3	PO 2
6. a. Derive transmission line equations.	5	CO5	PO 2
b. A 70 m long lossless transmission line has a inductance and capacitance of 12 mH and 7nF respectively. Determine, (i) Velocity of propagation. (ii) Phase constant for an operating frequency of 60KHz.	5	CO5	PO 2
(OR)			
c. Find out the point P(2, 3, 5) in cylindrical coordinate system and Q(2, $\frac{\pi}{6}$ , 3) in cartesian coordinate system.	6	CO2	PO2
d. Prove that $\nabla \cdot (\nabla \times A) = 0$	4	CO2	PO 2

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