VIT Vellore Institute of Technology

Reg. No. : 21BEC1851

Final Assessment Test (FAT) – November/December 2022

Programme	**B.Tech.**	Semester	**Fall Semester 2022-23**
Course Title	**ENGINEERING ELECTROMAGNETICS**	Course Code	**BECE205L**
Faculty Name	**Prof. Chandrasekaran N**	Slot	**B1+TB1**
		Class Nbr	**CH2022231001171**
Time	**3 Hours**	Max. Marks	**100**

Section A (7 X 10 Marks)
Answer <u>All</u> questions

1. Three concentric spherical shells $r = 1$, r = 2, and $r = 3$ m respectively have charge distributions 2, - 4 , and 5 mC/m^2 **[10]**
   (i) Calculate the flux through $r = 2.5$ m
   (ii) Find **D** at $r = 3.5$ m
   (iii) Determine the charge enclosed by the surface $r = 1.5$ m

2. Given that $J = \frac{5e^{-10^4 t}}{r} a_r$ A/m^2 at $t = 0.1$ ms determine, **[10]**
   (i) the amount of current passing the surface $r = 2$ m and (5 marks)
   (ii) the charge density ρ_v on that surface (5 marks)

3. (a) An airplane with a metallic wing of span 36 m flies at 410 m/s in a region where the vertical component of the earth's magnetic field is 0.4 μWb/m^2. Find the emf induced on the airplane wing. (5 marks) **[10]**
   (b) The electric field amplitude of a uniform plane wave propagating in the $\mathbf{a}_z$ direction is 250 V/m. If $E = E_x a_x$ and $\omega = 1$ M rad/s, find:
   (i) the frequency
   (ii) wavelength
   (iii) period
   (iv) amplitude of **H** (5 marks)

4. A 50 Ω transmission line of length 6.6 mm is terminated in series load of resistance 60 Ω and inductance of 4.25 nH. The phase velocity in the transmission line is one third of the velocity of light. Calculate the following parameters at 3 GHz using Smith chart. **[10]**
   (i) Reflection coefficient at the input and load
   (ii) Input admittance
   (iii) Distance of maxima and minima from the load

5. An antenna having a load impedance of 70 + j100 Ω is to be matched with a 50 Ω line using single stub matching circuit. Find the distance and length of the required open circuited shunt stub for the same characteristic impedance. **[10]**

6. A rectangular waveguide with dimensions a = 2.5 cm, b = 1 cm is to operate below 10 GHz. Determine the first five propagating modes if the guide is filled with a medium characterized by $\sigma = 0$, $\epsilon = 4\epsilon_0$ and $\mu_r = 1$. **[10]**

7. a. Find the gradient of $r = \sqrt{x^2 + y^2 + z^2}$. Comment on the direction of maximum increase of the function r. (5 marks) **[10]**

b. What is meant by EMI and EMC? What are the different sources of EMI? Explain the areas in which this study is important. (5 marks)

Section B (2 X 15 Marks)
Answer All questions

8. a. A rectangular loop of wire in free space joins points *A* (1, 0, 1) to *B* (3, 0, 1) to *C* (3, 0, 4) to *D* (1, 0, 4) to *A*. The wire carries a current of 6 mA flowing in the $\mathbf{a}_z$ direction from *B* to *C*. A filamentary current of 15 A flows along the entire z-axis in the $\mathbf{a}_z$ direction. Find [15]

(i) Force **F** on side BC

(ii) Force **F** on side AB

(iii) Total force $\mathbf{F}_{Total}$ on the loop (10 marks)

b. An infinite line carrying a current of 3 A in the $\mathbf{a}_y$ direction lies on the y- axis. Find the magnetic flux density at P (7m, 0, 0). (5 marks)

9. a. Find the minimum value of pure resistive load to achieve VSWR of 5 for a 50 Ω transmission line. (5 marks) [15]

b. Why λ/4 length of transmission line is called as impedance transformer? (3 marks)

c. Design a microstrip line on a 0.5 mm alumina substrate (ϵ_r = 9.9, tan δ = 0.001) for a 50 Ω characteristic impedance. Find the length of the line required to produce a phase delay of 270° at 10 GHz and compute the total loss on this line. Note: - Constant A = 2.121 and surface resistance as 0.050 Ω. (7 marks)