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MAR-21-210165

B. Tech. EXAMINATION, March 2021

Semester V (NS)

ELECTROMAGNETIC FIELD THEORY

EC-314

Time : 3 Hours *Maximum Marks : 100*

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : Attempt *Five* questions in all, selecting *one* question from each Sections A, B, C and D. Q. No. **9** is compulsory. Use of non-programmable calculators is allowed.

Section A

1. (a) Using the Divergence theory, evaluate m :

$$\iint \mathrm{E}.ds = 4xza_x - y^2a_y + yza_z$$

over the cube bounded by $x = 0$; $x = 1$; $y = 0$; $y = 1$; $z = 0$, $z = 1$. **10**

(b) Derive the Stoke's theorem and give any one application of the theorem in electromagnetic fields. **10**

2. State and prove Gauss's Law. Explain the variation of the electric field with respect to the radius of the sphere for the following geometries :

(a) Single Sphere of charge

(b) Two Concentric shells of charge $q1$ and $q2$.

(c) Spherical volume distribution of charge. **20**

Section B

3. (a) Using Biot-Savart's Law, derive the magnetic field intensity of a circular disc along the axis of the disc. And deduce the equation to the centre of the circular disc. **10**

(b) State and explain Ampere's circuit law and show that the field strength at the end of a long solenoid is one half of that at the centre. **10**

4. (a) Derive the scalar and magnetic vector potential of magnetic field. **10**

(b) Obtain the expression for energy stored in the magnetic field and also derive the expression for magnetic energy density. **10**

Section C

5. (a) State Maxwell's equations and obtain them in differential form. Also derive them harmonically varying field. **10**

(b) Show that the ratio of the amplitudes of the conduction current density and displacement current is $\frac{\sigma}{\omega\varepsilon}$, for the applied $E = E_m \cos \omega t$. Assume $\mu = \mu_0$, what is the amplitude ratio, if the applied field is $E = E_m e^{-t/\tau}$, where τ is real. **10**

6. (a) State Poynting theorem and derive an expression for Poynting theorem. **10**

(b) Derive the expression for total magnetic field when a vertically polarized wave is incident obliquely on a perfect conductor. **10**

Section D

7. Derive the expressions for the voltage and current at any point on the transmission line in terms of propagation constant, length and characteristic impedance of the line. Hence deduce an expression for input impedance in terms of reflection coefficient. **20**

8. What are the special considerations of radio frequency lines ? A radio frequency line with $Z_0 = 70$ ohm is terminated by $Z_L = 115 - j80$ ohm at attenuation constant = 2.5 m. Find the VSWR and the maximum and minimum line impedances. Derive the formula used. **20**

(Compulsory Question)

9. (a) Mention the criteria for choosing an appropriate coordinate system for solving a field problem easily. Explain with an example. **2**

(b) Prove that curl grad $\varphi = 0$. **2**

(c) Name few applications of Gauss law in electrostatics. https://www.hptuonline.com **2**

(d) Write the equation for capacitance of coaxial cable. **2**

(e) Sketch Gauss law for the magnetic field. **2**

(f) State the expression for H due to infinite sheet of current. **2**

(g) Write down the Maxwell's equation for free space in integral form. **2**

(h) What is the relationship between E and H or brief about intrinsic impedance for a dielectric medium ? **2**

(i) Why frequency and phase distortion occur in transmission line ? Write the condition of no distortion in terms of line parameters. **2**

(j) A 100-ohm load is to be matched to a 50-ohm line. Determine the characteristic impedance of a quarter wavelength matching section. **2**