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B. M. S. College of Engineering, Bengaluru - 560019

Autonomous Institute Affiliated to VTU

May 2023 Semester End Main Examinations

Programme: B.E. **Semester: III**
Branch: EE/ET/EC **Duration: 3 hrs.**
Course Code: 19ES3GCFTH **Max Marks: 100**
Course: Field Theory **Date: 19.05.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

UNIT - I

1. a) Analyze and develop and an expression for EFI ($\bar{E}$) due to various charge distribution **06**

   b) A circular ring of charge with radius 5m lies in z=0 plane with centre at origin. If . $\rho_l = 10\text{nC/m}$. Evaluate the point charge 'Q' placed at the origin which will produce same 'E' at the point (0,0,5)m. **06**

   c) Analyse and evaluate both sides of the divergence theorem precisely for the region if the flux density is $\vec{D} = \frac{16}{r}\cos(2\theta)\, a_\theta \text{C/m}^2; 1 < \text{r} < 2\text{ m},\ 1 < \theta < 2\text{ rad}, 1 < \phi < 2\text{ rad}$. **08**

UNIT - II

2. a) Analyse and develop an expression for boundary conditions between conductor and free space. **08**

   b) Let $J = \frac{25}{\rho}a_\rho - \frac{20}{\rho^2+0.01}a_z$ A/m^2 **06**
   a) Evaluate the total current crossing the plane z = 0.2 in the a_z direction for $\rho<0.4$.
   b) Calculate $\partial\rho_v/\partial t$.
   c) Find the outward current crossing the closed surface defined by $\rho = 0.01$, $\rho = 0.4$, z = 0, and z = 0.2.

   c) An Electric field is $\vec{E} = -8xya_x - 4x^2a_y + a_z$V/m. Analyse and estimate the work done in carrying a 6 C charge from point B(1, 8, 5) to A (2,18, 6) along (i) path $y=3x^2+z$, z=x+4 and (ii) straight line from B to A. Show that work done remains same and is independent of the path selected. **06**

OR

3. a) A potential field in free space is expressed as V = 20/(xyz)V. **08**
   a) Evaluate the total energy stored within the cube 1 <x,y,z<2
   b) What value would be obtained by assuming a uniform energy density equal to the value at the center of the cube?

   b) Analyse and develop an expression for boundary conditions at the interface of conductor and dielectric. **08**

   c) List the properties of dielectrics **04**

UNIT - III

4. a) Analyse and develop an expression for Laplace and Poisson's Equations. Also Verify whether Laplace equation is satisfied or not: **10**

$$(i)V = x^2 - y^2 + z^2 \ (ii)V = r\cos\phi + z \ (iii)V = r\cos\theta + \phi$$

b) Write Laplace's equation in spherical co-ordinates. Using this equation analyze and obtain an expression for potential difference between concentric spherical shells. Also find the capacitance of the same **10**

UNIT - IV

5. a) Analyse and Develop an expression for the magnetic field intensity due to Straight Conductor of Finite Length. **07**

b) If $\vec{H} = 10 \sin\theta \, \hat{a}_\phi$ A/m, analyze and evaluate both sides of the Stokes' theorem for the surface r = 3, $0 \le \theta \le 90^\circ$, $0 \le \varphi \le 90^\circ$. Let the surface have the $\hat{a}_r$ direction. **07**

c) Analyse and develop an expression for magnetic boundary conditions between two media of different permeabilities. **06**

UNIT - V

6. a) Write Maxwell's equations in point form and integral form for time varying fields in free space. Describe the relationship between $\vec{E}$ & $\vec{H}$ in free space-using the concept of intrinsic impedance of the medium (η) **07**

b) Let the internal dimension of a co-axial capacitor be a=1.2 cm, b=4 cm and l=40 cm. The homogenous material inside the capacitor the parameters: $\epsilon = 10^{-11}$F/m, $\mu = 10^{-5}$H/m and $\sigma = 10^{-5}$ S/m. If the Electric field intensity is $E = \left(\frac{10^6}{\rho}\right)\cos(10^5 t)\, a_\rho$ V/m, evaluate the following: **05**

i) Current density $\vec{J}$.
ii) The total conduction current ' I_c' through the capacitor
iii) The total displacement current ' I_d' through the capacitor
iv) The ratio of the amplitude of ' I_d' to that of ' I_c'

c) Analyze and develop an expression for electromagnetic waves in free space. **08**

OR

7. a) Analyse and develop an expression for uniform plane wave in good conductor **10**

b) State and explain Poynting theorem. Let $\mu = 3 \times 10^{-5}$ H/m, $\varepsilon = 1.2 \times 10^{-10}$ F/m, and $\sigma = 0$ everywhere. If $H = 2\cos(10^{10}t - \beta x)\, a_z$ A/m, use Maxwell's equations to obtain expressions for B, D, E, and β. **10**

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