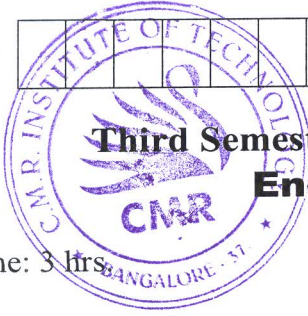


# CBCS SCHEME

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15EC36



## Third Semester B.E. Degree Examination, June/July 2023 Engineering Electromagnetics

Time: 3 hrs.

Max. Marks: 80

*Note: Answer any FIVE full questions, choosing ONE full question from each module.*

### Module-1

- 1 a. State and explain Coulomb's law in vector form. (04 Marks)  
b. Point charges of 60 nano coulombs each are located at A(2, 0, 0), B(-2, 0, 0), C(0, 2, 0) and D(0, -2, 0) in free space. Find the total force on the charge at 'A'. (08 Marks)  
c. Define electric field intensity and electric flux density and also establish the relationship between them. (04 Marks)

OR

- 2 a. Derive an expression for electric field intensity due to infinite line charge distribution. (08 Marks)  
b. Find the electric field at the origin, if the following charge distributions are present in free space:  
i) Point charge 15nc at P(1, 2, 3).  
ii) Uniform line charge of  $\rho_L = 3nc/m$  at  $x = 2, y = 3$   
iii) Uniform surface charge of  $\rho_S = 0.2nc/m^2$  at  $x = 2$ . (08 Marks)

### Module-2

- 3 a. State and prove Gauss law for point charge. (05 Marks)  
b. Find the volume charge density at the point indicated.  
 $\vec{D} = 4\rho z \sin \phi \hat{a}_\rho + 2\rho z \cos \phi \hat{a}_\phi + 2\rho^2 \sin \phi \hat{a}_z$  c/m<sup>2</sup> at  $p\left(1, \frac{\pi}{2}, 2\right)$  (06 Marks)  
c. State and prove Gauss Divergence theorem. (05 Marks)

OR

- 4 a. Derive the expression for energy expended in moving a point charge in an uniform electric field in arbitrary direction. (05 Marks)  
b. Let  $V = \frac{\cos 2\phi}{r}$  in free space in cylindrical system. Find  $\vec{E}$  at P(2, 30°, 1). (06 Marks)  
c. Derive point form of continuity equation of current. (05 Marks)

### Module-3

- 5 a. With the usual notations, deduce the Poisson's and Laplace equation from the Maxwell's for equation. (04 Marks)  
b. Determine whether the following equations satisfy the Laplace equation or not.  
i)  $V = 2x^2 - 4y^2 + z^2$   
ii)  $V = r^2 \cos \phi + \theta$  (06 Marks)  
c. State and prove uniqueness theorem. (06 Marks)

OR

- 6 a. State and explain Biot-Savart's law. (04 Marks)  
 b. Solve Laplace's equation to determine the capacitance of a coaxial cable when the inner radius is 'a' and outer radius is 'b' respectively. (08 Marks)  
 c. An air cored toroid having a cross sectional area of  $6\text{cm}^2$  and mean radius 15cm is wound uniformly with 500 turns carrying a current of 4A. Determine the magnetic flux density. (04 Marks)

Module-4

- 7 a. Derive Lorentz force equation. (06 Marks)  
 b. A conductor 4m long lies along y axis with a current of 10A in the  $\vec{a}_y$  direction. Find the force on the conductor if the field in the region is  $\vec{B} = 0.008 \vec{a}_x$  Tesla. (04 Marks)  
 c. Discuss the magnetic field boundary conditions using Maxwell's equations. (06 Marks)

OR

- 8 a. Derive an expression for the force on a differential current element placed in a magnetic field. (06 Marks)  
 b. Define: i) Magnetization ii) Permeability. (04 Marks)  
 c. Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical tube of length 60cm and of diameter 6cm, given that medium is air. Derive the expression used. (06 Marks)

Module-5

- 9 a. Explain displacement current density and conduction current density and write Maxwell's equation related to both. (06 Marks)  
 b. Find the frequency at which conduction current density and displacement current density are equal in a medium with  $\alpha = 2 \times 10^{-4} \text{U/m}$  and  $\epsilon_r = 81$ . (04 Marks)  
 c. State and prove Poynting theorem. (06 Marks)

OR

- 10 a. List Maxwell's equations in differential and integral form for both static and time varying fields. (06 Marks)  
 b. Derive the expression of  $\alpha$ ,  $\beta$ ,  $\gamma$  and  $v_p$  for uniform plane wave in a good conductor. (06 Marks)  
 c. The depth of penetration in a certain conducting medium is 0.1m and the frequency of the electromagnetic wave is 1.0MHz. Find the conductivity of the conducting medium. (04 Marks)

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