EPCET LIBRARY BANGALORE-49

**CBCS SCHEME**

USN | | | | | | | | | | |

**BEC401**

# Fourth Semester B.E./B.Tech. Degree Examination, June / July 2026
## Electromagnetic Theory

Time: 3 hrs. Max. Marks: 100

***Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.***
***2. M : Marks , L: Bloom's level , C: Course outcomes.***

| | | Module – 1 | M | L | C |
|---|---|---|---|---|---|
| **Q.1** | **a.** | Transform the vector field, to spherical co-ordinates.<br>i) $10a\hat{x}$ at $p(x=-3, y=2, z=4)$<br>ii) $10a\hat{y}$ at $Q(r=5, \phi=30°, z=4)$ | **06** | **L3** | **CO1** |
| | **b.** | State and explain Coulomb's law of force between two point charges in vector form. | **06** | **L2** | **CO1** |
| | **c.** | Point charges of 50 nC each located at A ( 1, 0, 0 ) , B ( -1, 0, 0), C (0,1,0) and D ( 0, -1, 0) in free space . Find total force on the charge at A. | **08** | **L3** | **CO1** |
| | | **OR** | | | |
| **Q.2** | **a.** | Derive an expression for electric field intensity due to Infinite line charge. | **08** | **L2** | **CO1** |
| | **b.** | A uniform line charge of 16 nC/m is located along the line defined by $y = -2$, $z = 5$. Find $\vec{E}$ at P(1,2,3) | **06** | **L3** | **CO1** |
| | **c.** | Three infinite uniform sheets of charge are located in free space as follows $\rho_{S1} = 3$ nc/m$^2$ at $z = -4$ , $\rho_{s2} = 6$ nc/m$^2$ at $z = 1$ and $\rho_{s3} = -8$ nc/m$^2$ at $z = 4$. Find $\vec{E}$ at the point<br>i) $P_A$ (-1, -5, 2)<br>ii) $P_B$ (-2, 4, 5) | **06** | **L3** | **CO1** |
| | | **Module – 2** | | | |
| **Q.3** | **a.** | State and prove Gauss's law for point charge. | **06** | **L2** | **CO2** |
| | **b.** | Given $\vec{D} = 0.3r^2 \hat{a}_r$ nC/m$^2$ in free space.<br>i) Find the total charge within the sphere r = 3<br>ii) Find the total flux leaving the sphere r = 4 | **06** | **L3** | **CO2** |
| | **c.** | Obtain the expression for work done in moving a point charge in an electric field. | **08** | **L2** | **CO2** |
| | | **OR** | | | |
| **Q.4** | **a.** | Evaluate both sides of Divergence theorem for the field $\vec{D} = 2xya\hat{x} + x^2a\hat{y}$ C/m$^2$ and rectangular parallelopiped formed by planes x = 0 and y = 0 and 2 z = 0 and 3. | **08** | **L3** | **CO2** |
| | **b.** | Derive the expression for equation of continuity. | **06** | **L2** | **CO2** |
| | **c.** | Calculate work done in moving a 4C charge from B ( 1,0,0) to A ( 0,2,0) along the path $y = 2 - 2x$, $z = 0$ in the field $\vec{E} = 5xa\hat{x} + 5a\hat{y}$ V/m . | **06** | **L3** | **CO2** |



VTU-22-06-2026 01:19:16pm - EP - EP - EP

| | | | | | |
|---|---|---|---|---|---|
| | | **Module – 3** | | | |
| **Q.5** | **a.** | Derive the expression for Poisson's equation and Laplace's equation. | **06** | **L2** | **CO3** |
| | **b.** | Using Laplace's equation, derive the expression for capacitance per unit length of a co-axial cable using the following boundary condition V = Vo at r = $R_1$ and V = 0 at r = $R_2$ and $R_2 > R_1$ where $R_1$ and $R_2$ are inner and outer radius of co-axial cable. | **08** | **L3** | **CO3** |
| | **c.** | State and prove Amper's Circuital Law. | **06** | **L2** | **CO3** |
| | | **OR** | | | |
| **Q.6** | **a.** | Define stokes theorem and evaluate both sides of the stokes theorem for the field $\vec{H}=6xy\,a\hat{x}-3y^2\,a\hat{r}\,A/m$ and the rectangular path around the region $2 \le x \le 5$, $-1 \le y \le 1$ and $z = 0$. Let the direction of $\vec{ds}$ be $a\hat{z}$. | **12** | **L3** | **CO3** |
| | **b.** | Define Curl. Write Curl equation in various co-ordinate s / m | **08** | **L2** | **CO3** |
| | | **Module – 4** | | | |
| **Q.7** | **a.** | Derive an expression for Lorentz force equation. | **06** | **L2** | **CO4** |
| | **b.** | A conductor 4 m long lies along the y – axis with a current of 10 A in the $a\hat{y}$ direction. Find the force on the conductor if the field in the region is $\vec{B}=0.005\,a\,\hat{x}$ Tesla. | **06** | **L3** | **CO4** |
| | **c.** | Find the magnetization in a magnetic material where<br>i) M = $1.8 \times 10^{-5}$ H /m and $\lvert\vec{H}\rvert$ = 120 A /m<br>ii) Mr = 22, where there are $8.3 \times 10^{28}$ atoms /$m^3$ and each atom has a dipole moment of $4.5 \times 10^{-27}$ A $m^2$<br>iii) $\lvert\vec{B}\rvert$ = 300 mT and $\chi_m$ = 15 | **08** | **L3** | **CO4** |
| | | **OR** | | | |
| **Q.8** | **a.** | Obtain the expression for magnetic force between the differential current elements. | **06** | **L2** | **CO4** |
| | **b.** | If $\vec{B}=0.05x\,a\hat{y}$ Tesla in a material for which Xm = 2.5.<br>Find i) Mr ii) μ iii) $\vec{H}$ iv) $\vec{M}$ v) $\vec{J}$ vi) $\vec{Jb}$ | **06** | **L2** | **CO1** |
| | **c.** | Derive the expression for boundary conditions between the two magnetic materials. | **08** | **L2** | **CO4** |
| | | **Module – 5** | | | |
| **Q.9** | **a.** | List and explain Maxwell's equations in point form and integral form. | **08** | **L2** | **CO5** |
| | **b.** | Derive expression for uniform plane wave for a free space. | **08** | **L2** | **CO5** |
| | **c.** | Find the frequency at which conduction current density and displacement current are equal in a medium with $\sigma=2\times10^{-4}$ mho / m and $\epsilon_r=81$ | **04** | **L3** | **CO5** |
| | | **OR** | | | |
| **Q.10** | **a.** | State and prove Poynting theorem. | **10** | **L2** | **CO5** |
| | **b.** | Let μ = $10^{-5}$ H/m $\epsilon = 4 \times 10^{-9}$ F/m and σ = 0 and Pv = 0.<br>Determine 'K' so that each of the following pairs of fields satisfy Maxwell's equation.<br>i) $\vec{D}=2x\,a\hat{x}-3y\,a\hat{y}+4z\,a\hat{z}$, $\vec{H}=Kx\,a\hat{x}+10ya\hat{z}-25za\hat{z}\,A/m$<br>ii) $\vec{E}=(20y-kt)a\hat{x}\,v/m$, $\vec{H}=(y+2\times10^6t)a\hat{z}\,A/m$ | **10** | **L2** | **CO5** |