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

**Autonomous Institute Affiliated to VTU**

## January / February 2025 Semester End Main Examinations

**Programme: B.E.** **Semester: III**

**Branch: Electrical and Electronics Engineering** **Duration: 3 hrs.**

**Course Code: 23EE3ESEFT /19ES3GCFTH /22EE3PCFTH** **Max Marks: 100**

**Course: Electromagnetic Field Theory / Field Theory**

**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 | CO | PO | Marks |
|---|---|---|---|---|---|---|
| 1 | a) | | Develop an expression for Electric Flux Intensity (E) due to various charge distribution. | CO1 | PO1 | 06 |
| | b) | | Develop and analyze an expression for the electric field intensity due to infinite sheet charges. | CO2 | PO2 | 06 |
| | c) | | Given the flux density $\overline{D} = \frac{16}{r}[\cos(2\theta)\ \bar{a}_\theta]c/m^2$, analyze and evaluate both sides of the divergence theorem precisely for the region $1< r < 2$ m, $1 < \theta < 2$ rad, $1 < \varphi < 2$ rad. | CO3 | PO3 | 08 |
| | | | **OR** | | | |
| 2 | a) | | Develop an expression for Electric Flux density (D) due to various charge distribution. | CO1 | PO1 | 06 |
| | b) | | Develop and analyze an expression for the electric field intensity due charged circular ring. | CO2 | PO2 | 06 |
| | c) | | Given the flux density $\overline{D} = \left[4xz\,\bar{a}_x - y^2\,\bar{a}_y + yz\,\bar{a}_z\right]c/m^2$. Analyze and evaluate both sides of the divergence theorem for the region of free space that includes the volume $0 < x, y, z < 1$. | CO3 | PO3 | 08 |
| | | | **UNIT - II** | | | |
| 3 | a) | | Given a surface charge density of 8 Nc/m$^2$ on the plane x=2, a line charge density of 30 Nc/m on the line x=1, y=2, a one micro coulomb point charge at P (-1, -1, 2), Evaluate $V_{AB}$ for points A (3, 4, 0) and B (4, 0, 1). | CO2 | PO2 | 06 |
| | b) | | Develop an expression for relation between electric field intensity (E) & scalar potential (V). | CO2 | PO2 | 06 |
| | c) | | Develop and analyze an expression for electric boundary conditions between conductor and free space. | CO2 | PO2 | 08 |

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|---|---|---|---|---|---|---|
| | | | **OR** | | | |
| | 4 | a) | State principal of energy conservations of charges, starting from the same obtain the equation of continuity of current. | ***CO2*** | ***PO2*** | **06** |
| | | b) | Estimate and analyze the work done in carrying a -2C charge from $P_1(2, 1, -1)$ to $P_2(8, 2, -1)$ in field $E=a_x y+a_y x$ V/m:<br>i). Along parabola $x=2y^2$;<br>ii). Along the straight line joining $P_1$ & $P_2$. | ***CO2*** | ***PO2*** | **07** |
| | | c) | Develop and analyze an expression for electric boundary conditions between conductor and dielectric space. | ***CO2*** | ***PO2*** | **07** |
| | | | **UNIT - III** | | | |
| | 5 | a) | Analyses and develop an expression for Laplace and Poisson's Equations & also verify whether Laplace equations satisfied or not:<br>$\boldsymbol{i}).V = Aln(x^2 + y^2)$ $\boldsymbol{ii}).V = (2xy^3z^3)$ | ***CO2*** | ***PO2*** | **10** |
| | | b) | Write Laplace's equation in cylindrical co-ordinates, using this equation and evaluate and analyze an expression for potential distribution in the angular space between two infinite long co-axial cylinders. Also evaluate the capacitance of the same. | ***CO2*** | ***PO2*** | **10** |
| | | | **OR** | | | |
| | 6 | a) | Analyses and develop an expression for Laplace and Poisson's Equations & also Verify whether Laplace equations satisfied or not:<br>$\boldsymbol{i}).V = rcos\emptyset + z;$ $\boldsymbol{ii}).rcos\theta + \emptyset$ | ***CO2*** | ***PO2*** | **10** |
| | | b) | Using Laplace equation find the expression for potential distribution in the space between two plates of a parallel plate capacitor also find the capacitance of the system. | ***CO2*** | ***PO2*** | **10** |
| | | | **UNIT - IV** | | | |
| | 7 | a) | Develop and analyze an expression for the magnetic field intensity due axis of a circular conductor. | ***CO2*** | ***PO2*** | **06** |
| | | b) | If $\overline{H} = 10\sin\theta\bar{a}_\emptyset\, A/m$, 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 $\bar{a}_r$ direction. | ***CO3*** | ***PO3*** | **08** |
| | | c) | Analyze and develop an expression for Lorentz force equation due to a moving point charge. | ***CO2*** | ***PO2*** | **06** |
| | | | **OR** | | | |
| | 8 | a) | Develop and analyze an expression for the magnetic field intensity due to infinitely straight long conductor. | ***CO2*** | ***PO2*** | **06** |

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| | | b) | Given $\overline{H} = \left[\frac{3r^2}{sin\theta}\right] a_\theta + 54\, rcos\theta a_\emptyset\, A/m$ in free space:<br>a) Evaluate the total current in the $a_\theta$ direction through the conical surface $\theta = 20^\circ; 0 \leq \emptyset \leq 2\pi, 0 \leq r \leq 5$ by whatever side of Stokes' theorem you like best.<br>b) Check the result by using the other side of Stokes' theorem. | ***CO3*** | ***PO3*** | **08** |
| | | c) | Develop and analyses an expression for Scalar Magnetic Potential [SMP] & Vector Magnetic Potential [VMP]. | ***CO2*** | ***PO2*** | **06** |
| | | | **UNIT - V** | | | |
| | 9 | a) | What is physical significance of displacement current and write Maxwell's equations in point form and integral for time varying field in free space. | ***CO2*** | ***PO2*** | **10** |
| | | b) | Analyze and develop an expression for electromagnetic waves in free space. | ***CO2*** | ***PO2*** | **10** |
| | | | **OR** | | | |
| | 10 | a) | Analyze and develop an expression for uniform plane wave in good conductor | ***CO2*** | ***PO2*** | **10** |
| | | b) | State and explain Poynting theorem and Consider the region defined by \|x\|,\|y\|&\|z\| and \|z\| <1: Let<br>$\varepsilon_R = 5, \mu_R = 4\ and\ \sigma = 0.$<br>$if\ J_d = 20\cos(1.5 \times 10^8 t - bx)\, a_y \mu\, A/m^2$<br>Evaluate:<br>a) D,E:<br>b) Use the point form of Faraday's law and an integration with respect to time to find H &B;<br>c) Use $\nabla \times H = J_d + J_c\ evaluate\ J_d$ | ***CO3*** | ***PO3*** | **10** |

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