TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2083 Baishakh**

| **Exam.** | **Back (New Course)** | | |
|---|---|---|---|
| **Level** | BE | **Full Marks** | 60 |
| **Programme** | BEI, BCT | **Pass Marks** | 24 |
| **Year / Part** | II / II | **Time** | 3 hrs. |

***Subject:*** - Electromagnatics *(ENEX 254)*

- ✓ *Candidates are required to give their answers in their own words as far as practicable.*
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary formula sheet is attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. Given the points C (-3, 2, 1) and D ($r = 5$, $\theta = 20°$, $\phi = -70°$) express the distance vector from C to D in spherical co-ordinate system at D. [5]
2. State Gauss's Law. A uniform line charge density of 5 nC/m is at $y = 0$, $z = 2$m in free space, while -5 nC/m is located at $y = 0$, $z = -2$m. A uniform surface charge density of 0.3 nC/$m^2$ is at $y = 0.2$m and -0.3 nC/$m^2$ is at $y = -0.2$m. Find $|\vec{E}|$ at the origin. [1+5]
3. Derive the expression for electric boundary conditions between two perfect dielectric materials. [5]
4. A dipole of moment $\vec{p} = 6\vec{a}_z$ nC.m is located at the origin in free space. (a) Find V at P ($r = 4$, $\theta = 20°$, $\phi = 0°$) (b) Find $\vec{E}$ at P. [2+2]
5. Can scalar magnetic potential be defined similar to as scalar electric potential. Explain. If $\vec{A} = x^2y\hat{a}_x + xy^2\hat{a}_y - 4xyz\hat{a}_z$ Wb/m, determine the total magnetic flux crossing the surface $z = 1$, $0 < x < 1$, $-1 < y < 4$. [3+3]
6. Using the concept of Vector Magnetic Potential, derive the expression for magnetic field intensity due to infinitely long filament carrying current I. [6]
7. Explain the significance of Curl with example. Evaluate both sides of Stoke's theorem for the field $\vec{H} = 4xy\hat{a}_x - 2y^2\hat{a}_y$ A/m & the rectangular path around the region $3 \le x \le 6$, $-2 \le y \le 2$, $z = 0$. Let the positive direction of $\vec{dS}$ be $\hat{a}_z$. [2+4]
8. Explain motional emf with necessary derivations. List out the Maxwell's equations in point form for time varying fields. [3+3]
9. Explain uniform plane wave. Derive the equation of EM wave when travelling in Lossy dielectric medium. [2+4]
10. An $\vec{H}$ field in free space is given as $\vec{H}(x,t) = 10\cos(10^8t - \beta x)\vec{a}_y$ A/m. Find (a) $\omega$ (b) $\beta$ (c) $\lambda$ (d) $\vec{E}(x,t)$ at P (0.1, 0.2, 0.3) at $t = 1$ ns. [1+1+1+3]
11. A distortionless line has the characteristic impedance of 50 Ω, the attenuation constant of 22 mNp/m and the phase velocity of $2\times10^8$ m/s. Determine the line parameters R, L, C and G at 300 MHz. [4]

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## DIVERGENCE

CARTESIAN $\nabla.\vec{D} = \frac{\partial D_x}{\partial x} + \frac{\partial D_y}{\partial y} + \frac{\partial D_z}{\partial z}$

CYLINDRICAL $\nabla.\vec{D} = \frac{1}{\rho}\frac{\partial(\rho D_\rho)}{\partial \rho} + \frac{1}{\rho}\frac{\partial D_\emptyset}{\partial \emptyset} + \frac{\partial D_z}{\partial z}$

SPHERICAL $\nabla.\vec{D} = \frac{1}{r^2}\frac{\partial(r^2 D_r)}{\partial r} + \frac{1}{rsin\theta}\frac{\partial(D_\theta sin\theta)}{\partial \theta} + \frac{1}{rsin\theta}\frac{\partial D_\emptyset}{\partial \emptyset}$

## GRADIENT

CARTESIAN $\nabla V = \frac{\partial V}{\partial x}\overrightarrow{a_x} + \frac{\partial V}{\partial y}\overrightarrow{a_y} + \frac{\partial V}{\partial z}\overrightarrow{a_z}$

CYLINDRICAL $\nabla V = \frac{\partial V}{\partial \rho}\overrightarrow{a_\rho} + \frac{1}{\rho}\frac{\partial V}{\partial \emptyset}\overrightarrow{a_\emptyset} + \frac{\partial V}{\partial z}\overrightarrow{a_z}$

SPHERICAL $\nabla V = \frac{\partial V}{\partial r}\overrightarrow{a_r} + \frac{1}{r}\frac{\partial V}{\partial \theta}\overrightarrow{a_\theta} + \frac{1}{rsin\theta}\frac{\partial V}{\partial \emptyset}\overrightarrow{a_\emptyset}$

## CURL

CARTESIAN $\nabla X\vec{H} = (\frac{\partial H_z}{\partial y} - \frac{\partial H_y}{\partial z})\overrightarrow{a_x} + (\frac{\partial H_x}{\partial z} - \frac{\partial H_z}{\partial x})\overrightarrow{a_y} + (\frac{\partial H_y}{\partial x} - \frac{\partial H_x}{\partial y})\overrightarrow{a_z}$

CYLINDRICAL $\nabla X\vec{H} = (\frac{1}{\rho}\frac{\partial H_z}{\partial \emptyset} - \frac{\partial H_\emptyset}{\partial z})\overrightarrow{a_\rho} + (\frac{\partial H_\rho}{\partial z} - \frac{\partial H_z}{\partial \rho})\overrightarrow{a_\emptyset} + \frac{1}{\rho}[\frac{\partial(\rho H_\emptyset)}{\partial \rho} - \frac{\partial H_\rho}{\partial \emptyset})\overrightarrow{a_z}$

SPHERICAL $\nabla X\vec{H} = \frac{1}{rsin\theta}[\frac{\partial(H_\emptyset sin\theta)}{\partial \theta} - \frac{\partial H_\theta}{\partial \emptyset}]\overrightarrow{a_r} + \frac{1}{r}[\frac{1}{sin\theta}\frac{\partial H_r}{\partial \emptyset} - \frac{\partial(rH_\emptyset)}{\partial r}]\overrightarrow{a_\theta} + \frac{1}{r}[\frac{\partial(rH_\theta)}{\partial r} - \frac{\partial H_r}{\partial \theta})\overrightarrow{a_\emptyset}$

## LAPLACIAN

CARTESIAN $\nabla^2 V = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2}$

CYLINDRICAL $\nabla^2 V = \frac{1}{\rho}\frac{\partial}{\partial \rho}(\rho\frac{\partial V}{\partial \rho}) + \frac{1}{\rho^2}\frac{\partial^2 V}{\partial \emptyset^2} + \frac{\partial^2 V}{\partial z^2}$

SPHERICAL $\nabla^2 V = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial V}{\partial r}\right) + \frac{1}{r^2 sin\theta}\frac{\partial}{\partial \theta}\left(sin\theta\frac{\partial V}{\partial \theta}\right) + \frac{1}{r^2 sin^2\theta}\frac{\partial^2 V}{\partial \emptyset^2}$

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TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

# Examination Control Division

**2082 Bhadra**

| **Exam.** | **Regular (New Course)** | | |
|---|---|---|---|
| **Level** | BE | **Full Marks** | 60 |
| **Programme** | BEI,BCT | **Pass Marks** | 24 |
| **Year / Part** | II / II | **Time** | 3 hrs. |

## ***Subject:*** - Electromagnatics *(ENEX 254)*

- ✓ *Candidates are required to give their answers in their own words as far as practicable.*
- ✓ *Attempt __All__ questions.*
- ✓ *The figures in the margin indicate __Full Marks__.*
- ✓ ***__Necessary formula sheet is attached herewith.__***
- ✓ *Assume suitable data if necessary.*

1. Given a point P (-2,6,3) and vector field $\vec{A} = y\vec{a_x} + (xy + z)\vec{a_y}$, express P and $\vec{A}$ in cylindrical co-ordinate system; and evaluate $\vec{A}$ at P. [5]
2. State Divergence theorem. A uniform sheet of charge $\rho_s = 20\varepsilon_0$ C/m$^2$ is located in the plane x = 2 in free space. A uniform line charge $\rho_L$ = 0.5nC/m lies along the line x = 6, y = 3 in free space. Find the potential at point P(4, 6, –2) if V = 8 V at A(2, 6, 4). [1+5]
3. Derive the expression for electric field intensity in different regions of coaxial cable with inner conductor of radius 'a' and outer conductor of radius 'b'. [5]
4. The region y < 0 contains a dielectric material for which $\varepsilon_{r1}$= 2.5, while the region y > 0 is characterized by $\varepsilon_{r2}$ = 4. Let $\vec{E_1} = -30\hat{a}_x + 50\hat{a}_y + 70\hat{a}_z$V/m, find the electric field intensities, flux densities in region 2, and the angle $\theta_1$. [2+2+1]
5. Find the capacitance of spherical capacitor by using the solution of one-dimensional Laplace. [4]
6. State Stoke's theorem. Let $\mu_{r1}$ = 2 in region 1, defined by 2x+3y-4z > 1, while $\mu_{r2}$ = 5 in region 2 where 2x+3y-4z < 1. In region 1, $\vec{H_1} = 50\vec{a_x} - 30\vec{a_y} + 20\vec{a_z}$ A/m. Find (a) $\vec{H_2}$ (b) $\theta_2$. [1+5]
7. Derive the expression for magnetic field intensity due to infinitely long current carrying element using Ampere's circuital law. Given the vector magnetic potential $\vec{A} = -\left(\frac{10}{\rho^2}\right)\vec{a_z}\, wb/m$, find the current density $\vec{J}$. [3+3]
8. Derive the expression for net emf in electromagnetic induction. How the equation $\nabla \times \vec{H} = \sigma\vec{E}$ changes for time varying field? [4+2]
9. Define Poynting vector. Derive the expression for average power density when wave propagating in Lossy dielectric. [2+4]
10. In phasor form, the electric field intensity of auniform plane wave in free space is expressed as $\vec{E_s} = (40 - j30)e^{-j20z}\vec{a}_x$ V/m. Find (a) β (b) ω (c) f (d) $\vec{H_s}$. [1+1+1+3]
11. The parameters of a certain transmission line operating at 6x10$^8$ rad/s are L = 0.4 μH/m, C = 40 pF/m, G = 80 mS/m, and R = 20 Ω/m. Find γ, α, β and $Z_0$. [1+1+1+2]

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## DIVERGENCE

CARTESIAN

$$\nabla.\vec{D} = \frac{\partial D_x}{\partial x} + \frac{\partial D_y}{\partial y} + \frac{\partial D_z}{\partial z}$$

CYLINDRICAL

$$\nabla.\vec{D} = \frac{1}{\rho}\frac{\partial(\rho D_\rho)}{\partial \rho} + \frac{1}{\rho}\frac{\partial D_\phi}{\partial \phi} + \frac{\partial D_z}{\partial z}$$

SPHERICAL

$$\nabla.\vec{D} = \frac{1}{r^2}\frac{\partial(r^2 D_r)}{\partial r} + \frac{1}{r sin\theta}\frac{\partial(D_\theta sin\theta)}{\partial\theta} + \frac{1}{r sin\theta}\frac{\partial D_\phi}{\partial\phi}$$

## GRADIENT

CARTESIAN

$$\nabla V = \frac{\partial V}{\partial x}\overrightarrow{a_x} + \frac{\partial V}{\partial y}\overrightarrow{a_y} + \frac{\partial V}{\partial z}\overrightarrow{a_z}$$

CYLINDRICAL

$$\nabla V = \frac{\partial V}{\partial \rho}\overrightarrow{a_\rho} + \frac{1}{\rho}\frac{\partial V}{\partial \phi}\overrightarrow{a_\phi} + \frac{\partial V}{\partial z}\overrightarrow{a_z}$$

SPHERICAL

$$\nabla V = \frac{\partial V}{\partial r}\overrightarrow{a_r} + \frac{1}{r}\frac{\partial V}{\partial \theta}\overrightarrow{a_\theta} + \frac{1}{r sin\theta}\frac{\partial V}{\partial \phi}\overrightarrow{a_\phi}$$

## CURL

CARTESIAN

$$\nabla X\vec{H} = (\frac{\partial H_z}{\partial y} - \frac{\partial H_y}{\partial z})\overrightarrow{a_x} + (\frac{\partial H_x}{\partial z} - \frac{\partial H_z}{\partial x})\overrightarrow{a_y} + (\frac{\partial H_y}{\partial x} - \frac{\partial H_x}{\partial y})\overrightarrow{a_z}$$

CYLINDRICAL

$$\nabla X\vec{H} = (\frac{1}{\rho}\frac{\partial H_z}{\partial \phi} - \frac{\partial H_\phi}{\partial z})\overrightarrow{a_\rho} + (\frac{\partial H_\rho}{\partial z} - \frac{\partial H_z}{\partial \rho})\overrightarrow{a_\phi} + \frac{1}{\rho}[\frac{\partial(\rho H_\phi)}{\partial \rho} - \frac{\partial H_\rho}{\partial \phi})\overrightarrow{a_z}$$

SPHERICAL

$$\nabla X\vec{H} = \frac{1}{r sin\theta}[\frac{\partial(H_\phi sin\theta)}{\partial\theta} - \frac{\partial H_\theta}{\partial\phi}]\overrightarrow{a_r} + \frac{1}{r}[\frac{1}{sin\theta}\frac{\partial H_r}{\partial\phi} - \frac{\partial(rH_\phi)}{\partial r}]\overrightarrow{a_\theta} + \frac{1}{r}[\frac{\partial(rH_\theta)}{\partial r} - \frac{\partial H_r}{\partial\theta})\overrightarrow{a_\phi}$$

## LAPLACIAN

CARTESIAN

$$\nabla^2 V = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2}$$

CYLINDRICAL

$$\nabla^2 V = \frac{1}{\rho}\frac{\partial}{\partial\rho}(\rho\frac{\partial V}{\partial\rho}) + \frac{1}{\rho^2}\frac{\partial^2 V}{\partial\phi^2} + \frac{\partial^2 V}{\partial z^2}$$

SPHERICAL

$$\nabla^2 V = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial V}{\partial r}\right) + \frac{1}{r^2 sin\theta}\frac{\partial}{\partial\theta}\left(sin\theta\frac{\partial V}{\partial\theta}\right) + \frac{1}{r^2 sin^2\theta}\frac{\partial^2 V}{\partial\phi^2}$$

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