Roll No.: .....

National Institute of Technology, Delhi

Name of the Examination: B. Tech

Branch	**: EEE**	**Semester**	**: III**
Title of the Course	**: Electromagnetic Field Thoery**	**Course Code**	**: EEL- 203**

Time: 3Hours **Maximum Marks: 50**

Note:

- Answers should be CLEAR, TO THE POINT AND LEGIBLE.
- All parts of a single question must be answered together. ELSE QUESTION SHALL NOT BE EVALUATED.
- All questions in Section A are compulsory. Attempt any 4 questions from Section B and 2 questions from Section C.
- Assume any data, if it is missing
- Symbols have their usual meaning.

Section A

Q[1]: **(1×10)**

[i]- If $\boldsymbol{A} = \nabla V$, V is said to be _____ potential of **A**.

[ii]- Given field, $\boldsymbol{A} = 3x^2yz\,\boldsymbol{a_x} + x^3z\,\boldsymbol{a_y} + (x^3y - 2z)\,\boldsymbol{a_z}$, it can be said that **A** is____

[iii]- For plane wave propagating in free space, what must be the relationship between phase velocity (v_p), group velocity (v_g) and speed of light, c _____

[iv]- The relation between bound volume current density ($\boldsymbol{J_b}$) and Magnetization (**M**) is defined by_____

[v]- The electric and magnetic fields $\boldsymbol{E}(z,t) and\ \boldsymbol{B}(z,t)$, respectively corresponding to scalar potential $\varphi\,(z,t) = 0$ and vector potential $\boldsymbol{A}(z,t) = \hat{\imath}\,tz$ are_____

[vi]- Magnetic dipole moment is define by _____

[vii]- A charge of 1Coulomb is placed near a grounded conducting plate at a distance of 1m. The force between them is_____

[viii]- Gauss law for the electric field in differential form is expressed as_____

[ix] - When phase velocity of an electromagnetic wave depends on frequency in any medium, the phenomenon is called as_____

[x]- The integral form of the Ampere's law for the magnetostatic field is expressed as_____

Section -B

Q1: What do you mean by boundary value problems? Show that a solution of the Laplace's equation satisfies a given set of boundary conditions is the only possible solution. **(5.0)**

Q2: In the Free space $(z \leq 0)$, a plane wave with $\boldsymbol{H_i} = 10\cos(10^8\, t - \beta z)\ \boldsymbol{a_x}\ mA/m$ is incident normally on a lossless medium $(\epsilon = 2\,\epsilon_0, \mu = 8\mu_0)$ in the region $(z \geq 0)$. Determine the reflected wave $\boldsymbol{H_r}, \boldsymbol{E_r}$ and the transmitted wave $\boldsymbol{H_t}, \boldsymbol{E_t}$. **(5.0)**

Q3: The lossy dielectric has an intrinsic impedance of 200 exp $(j\pi/6)$ Ω at a particular radian frequency ω. If, at that frequency, the plane wave propagating through the dielectric has the magnetic field component, $\boldsymbol{H} = 10\, e^{-\alpha x}\cos\left(\omega t - \frac{1}{2}\, x\right)\ \boldsymbol{a_y}$ A/m. Find **E** and α. **(5.0)**

Q4: Define the phenomenon of skin effect in the conductor? A uniform plane wave propagating in a medium has $\boldsymbol{E} = 2\, e^{-\alpha z}\sin(10^8\, t - \beta z)\ \boldsymbol{a_y}$ V/m. If the medium is characterized by $\epsilon_r = 1, \mu_r = 20\ and\ \sigma = 3\ S/m$. Find the values of $\alpha, \beta\ and\ \boldsymbol{H}$. **(5.0)**

Q5: State and prove the Poynting's theorem of the electromagnetic wave using the Maxwell's curl equations and describe the physical significance of Poynting vector. **(5.0)**

Section C

Q[1]: What is difference between convection and conduction current? A circular ring of radius $\boldsymbol{r}$ carries a uniform charge ρ_c C/m and is placed on the xy-plane with axis the same as z-axis. Show that

(i)- $\boldsymbol{E}(0,0,h) = \frac{\rho_c\, r\, h}{2\epsilon_0\,[r^2+h^2]^{3/2}}\ \boldsymbol{a_z}$

(ii)- What values of the h give the maximum value of the **E**?

(iii)- If the total charge on the ring is Q, find **E** as $r \to 0$ **(10)**

Q[2]: Define the magnetic vector potential through the Gauss's law for the magnetic fields. Deduce the expressions of the Biot-Savart and Ampere's laws through magnetic vector potential. **(10)**

Q[3]: Derive the wave equations for the voltage and current to a given transmission line and discuss about their general solutions. A distortionless line has $Z_0 = 60\,\Omega$, $\alpha = 20\ mNp/m$ and $u = 0.6\ c$, where c is the speed of light in vacuum. Find $R,\ L, G, C, and\ \lambda$ at 100 MHz. **(10)**

**********END OF THE QUESTION PAPER**********