Roll No.:.....

National Institute of Technology, Delhi

Name of the Examination: B.Tech.

Branch	**: ECE**	**Semester**	**:IIIrd**
Title of the Course	**:Electromagnetic Theory**	**Course Code**	**:ECL203**

Time: 3 Hours Make-up Exam **Maximum Marks: 50**

Note :Read the given instructions for each section

Section A: Attempt all questions, each question is of one (01) mark

Q1. Significance of gauss's law for magnetic fields in steady state -
(i) Non-existence of monopole; (ii) existence of source and sink; (iii) both (i) & (ii); (iv) None (1)

Q2. Velocity of electromagnetic wave in free space is –
(i) 1.5×10^8 m/s; (ii) 3×10^8 m/s; (iii) 2×10^8 m/s; (iv) none (1)

Q3. Complete the statement: $\oint H.dl =$
(i) I; (ii) Q; (iii) ρ_v; (iv) zero (1)

Q4. The force experienced by current carrying conductor lying parallel to magnetic field
(i) Bqvsinθ; (ii) Bqv; (iii) zero; (iv) None (1)

Q5. The Lorentz force equation is -
(i) F = QE; (ii) F = Q(E - v × B); (iii) F = Q(E + v × B); (iv) None (1)

Q6. Who introduced the concept of displacement current?
(i) Faraday; (ii) Lenz; (iii) Maxwell; (iv) Lorentz (1)

Q7. According to Lenz's law, the direction of induced emf and hence current –
(i) can be found by right hand rule; (ii) always opposes the cause producing it;
(iii) depends on whether the coil is wound with a right or left and spiral; (iv) none (1)

Q8. Potential is an example of -
(i) Scalar; (ii) Vector; (iii) Number; (iv) None (1)

Q9. The unit of the permittivity of free space is –
(i) F/m; (ii) C^2/Nm^2; (iii) C^2Jm; (iv) None (1)

Q10. Identify the law: $J = \sigma E$
(i) Maxwell's equation; (ii) Ohm's law; (iii) Ampere's law; (iv) None (1)

Section B: Attempt any four (04) questions. Each question is of 5 marks

Q11. (a) Calculate electric field intensity at a point A(1, 2, 3) in free space caused by a charge Q_1 = 5nC at point P(2, 3, 5) and another charge Q_2 = 4nC at R(3, 0, 3). (3)
(b) State Divergence and Stokes theorem along with mathematical expression. (2)

Q12. (a) A linear, homogeneous, isotropic dielectric material has permittivity $\varepsilon_r = 3.6$ and is covering the space between z = 0 and z = 1. If V = -6000z V in the material find – (i) E; (ii) P; (iii) Surface charge of free density 'ρ_s'; (iv) Surface charge density of polarization charge 'ρ_{Ps}' (2)
(b) Determine the tangential and normal component from the boundary conditions at an interface separating two dielectrics ε_{r1} and ε_{r2}. Also derive the law of refraction from these boundary conditions. (3)

Q13. (a) Find the magnetic field a distance 's' from a long straight wire carrying a steady current 'I'. (2)

(b) Let plane $z = 0$ and $z = 4$ carry current $K = -10a_x$ A/m and $K = 10a_x$ A/m respectively. Determine $\boldsymbol{H}$ at $(1, 1, 1)$ and $(0, -3, 10)$. (3)

Q14. (a) Show that the boundary conditions between two magnetic media on the magnetization vector are -

$\frac{M_{1t}}{\chi_{m1}} - \frac{M_{2t}}{\chi_{m2}} = K$ and $\frac{\mu_1}{\chi_{m1}} M_{1n} = \frac{\mu_2}{\chi_{m2}} M_{2n}$ (3)

(b) State Biot-Savart law and Ampere's circuit law. (2)

Q15. An electric field in free space is given by – $E = 50 \cos(10^8 t + \beta x) a_y$ V/m

(a) Find the direction of wave propagation.

(b) Calculate 'β' and the time it takes to travel a distance of '$\lambda/2$' (5)

Section C: Attempt any two (02) questions. Each question is of 10 marks

Q16. A line charge density of 70.8π is distributed along the z-axis from z = -5 to z = $-\infty$ and z = +5 to z = $+\infty$. Find E at (2, 0, 0). (10)

Q17. (a) A plane wave propagating through a medium $\varepsilon_r = -8$, $\mu_r = 2$ has $E = 0.5e^{-\beta} \sin(10^8 t - \beta z) a_x$ V/m. Determine:(i) β,(ii) Loss tangent, (iii)η, and (iv) H. (8)

(b) The ratio J/J_d (conduction current density to displacement current density) is very important at high frequencies. Calculate the ration at 1 GHz for – distilled water ($\mu = \mu_o$, $\varepsilon = 81\varepsilon_o$, $\sigma = 2 \times 10^{-3}$ S/m) (2)

Q18.(a) The point charge Q = 18nC has a velocity of 5×10^6 m/s in the direction $a_v = 0.04a_x - 0.05a_y + 0.2a_z$. Calculate the magnitude of the force exerted on the charge by the field:

(i) $B = -3a_x + 4a_y + 6a_z$mT (ii) $E = -3a_x + 4a_y + 6a_z$ kV/m (iii) B and E together (6)

(b) Derive the expression for α, β, and η for the wave propagation in lossy dielectrics. (4)