(viii) Line integral of a magnetic field is
(a) depend upon the path taken (b) independent of the path
(c) constant (d) none of these.

(ix) Laplacian of a scalar is
(a) ∇V (b) $\nabla \times V$ (c) $\nabla \times \nabla \times V$ (d) $\nabla^2 V$.

(x) A line of length l has characteristic impedance Z0. The line is cut into half. The value of characteristic impedance becomes
(a) $Z_0/2$ (b) $Z_0/4$ (c) $2Z_0$ (d) Z_0.

Group – B

2. (a) Transfer the vector $\vec{A} = 3\hat{a}_x - 4\hat{a}_y + 4\hat{a}_z$ in to spherical coordinate at a point P (-2, -3, 4).

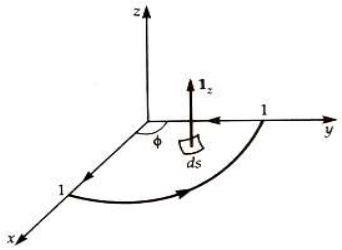
(b) Given $\vec{A} = 6\hat{a}_x - 2\hat{a}_y + 3\hat{a}_z$. find the expression of unit vector $\hat{B}$ such that $\hat{B}$ is parallel to $\vec{A}$.

(c) Find the distance between $P_1(6, 110^o, 0)$ and $P_2(2, 40^o, -10)$.

6 + 4 +2 = 12

3. (a) State Stoke's theorem.

Given $\vec{A} = 2\rho\cos\phi\hat{a}_\rho + \rho\hat{a}_\phi$ in cylindrical coordinates. For the contour shown in the following Figure , verify Stoke's Theorem.



(b) Check whether the field $\vec{A} = (x + z)\hat{a}_x + (-3z)\hat{a}_y + (x - 3y + 4z)\,\hat{a}_z$ is solenoidal and irrotational.

(2 + 6) + 4 = 12

Group – C

4. (a) Derive the electric flux density $\vec{D}$ with the help of Gauss's Law at any point due to infinite sheet of charge.

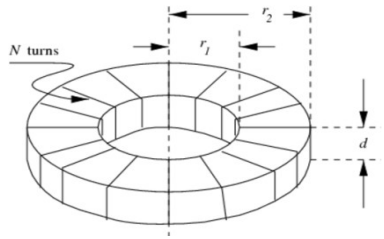
(b) Calculate the charge density at $(6, \frac{\pi}{4}, 7)$ and also find the total charge enclosed by a cylinder of radius 2 meter with $-2m \le z \le 2m$ where $\vec{D} = z\rho\sin\phi\,\hat{a}_z$.

(c) Consider $\vec{E} = 18\hat{a}_x - 11\hat{a}_y + 8.5\,\hat{a}_z$ V/m at conductor-free space boundary and find (i) |E| (ii) E_n (iii) Et (iv) ρ_s

(d) Derive the continuity equation.

3+ 3 +3+ 3 = 12

5. (a) Find the self-inductance of a toroid of rectangular cross-section shown in Figure below.



(b) Given that $\bar{H}_1 = 50\hat{a}_x$ A/m in region 3x-7y > 0 where $\mu_1 = 2\,\mu_0$. Calculate $\bar{H}_2$ and $\bar{B}_2$ in region 3x-7y < 0, where $\mu_2 = 5\,\mu_0$.

(c) A conductor 4 m long lies along the y axis with a current of 8 A in the $\hat{a}_y$ direction. Find the force on the conductor if the field in the regions is $\bar{B} = 0.05\ \hat{a}_x$ T.

5 + 5 + 2 = 12

Group – D

6. (a) What is inconsistency in Ampere's law? How was it rectified by Maxwell?

(b) Find the amplitude of displacement current density in airspace within a large power transformer where
$\vec{B} = 5\cos(3\times10^9 t - y)\hat{a}_x T$

(c) Prove that the ratio of conduction current and displacement current is $\frac{\sigma}{\varepsilon\omega}$. where ω is the angular frequency, σ is the conductivity and ε is the permittivity of the medium.

4 + 4 + 4 = 12

7. (a) For an aluminium wire having a diameter of 3 mm , calculate the ratio of ac to dc resistance at 50Hz and 10 MHz.

(b) Describe the term 'Standing wave'.

(c) The electric field intensity of a uniform plane wave in air is 7500V/m in the $\hat{a}_y$ direction. The wave is propagating in the $\hat{a}_x$ direction at a frequency of 2×10^9 rad/s. Find: (i) the wavelength (ii) the frequency (c) the amplitude of $\vec{H}$.

(d) What is complex Poynting vector?

2+ 4 + 5 + 1= 12

Group – E

8. (a) A 600Ω transmission line is 100 m long, operates at 300kHz with $\alpha = 2.4\times10^{-3}$ Np/m and $\beta = 0.02$ rad/m, and supplies a load impedance $Z_R = 424.3\angle45^0\ \Omega$. Find $\hat{V_S}$ for a receiving voltage $\hat{V_R} = 50\angle50^0$.

(b) For loss less two wire transmission line, show that phase velocity $u = \frac{1}{\sqrt{LC}}$.

(c) Derive the expression of characteristic impedance of transmission line.

4 + 4 + 4 = 12

9. (a) Describe lossless line and distortionless line.

(b) An open wire transmission line has the following primary constants: R=5Ω/km, L=4.5mH/km, C=0.009μF/km, G=0.27μΩ^{-1}/km. Determine characteristic impedance, attenuation constant, phase constant and velocity of propagation.

(c) A 60Ω lossless transmission line is terminating in a load with impedance $Z_L = (35 - j50)\Omega$. The wavelength is 5cm. Find :
(i) the reflection coefficient at the load.
(ii) the standing wave ratio on the line.

4+ 5 + 3= 12

B.TECH/EE/3RD SEM/ELEC 2103/2018
FIELD THEORY
(ELEC 2103)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) The magnetic field B is defined as
(a) force per unit current (b) force per unit charge
(c) force per unit length (d) per unit volume

(ii) The relation between the magnitude of displacement current J_d and conduction current J_c through a capacitor are
(a) $J_d > J_c$ (b) $J_d < J_c$ (c) $J_d = J_c$ (d) $J_d = J_c = 0$.

(iii) For a lossless line propagation, constant (γ) is given by
(a) $j\omega\sqrt{LC}$ (b) $j\omega\sqrt{\frac{L}{C}}$ (c) $j\omega\sqrt{C}$ (d) $j\omega\sqrt{L}$.

(iv) $\nabla.\vec{J} = -\frac{\partial \rho_v}{\partial t}$, this equation is known as:
(a) Point form of Ohm's Law (b) Point form of Gauss's Law
(c) continuity equation (d) Laplacian of a vector.

(v) Attenuation constant in a good conductor is
(a) $1/\sqrt{\pi f \mu \sigma}$ (b) $\sqrt{\pi f \mu \sigma}$ (c) $1/\beta$ (d) 0.

(vi) For a distortion-less Transmission line
(a) $\frac{R}{C} = \frac{G}{L}$ (b) $R^2C=LG$ (c) R=0=G (d) $\frac{R}{L} = \frac{G}{C}$.

(vii) Let a point in spherical and cylindrical coordinates are (r, θ, φ) and (ρ, φ, z). The radial component r in spherical coordinates is related to components in cylindrical coordinate as
(a) ρ (b) ρ cos φ (c) z $\tan^{-1}$ φ (d) $(\rho^2 + z^2)^{1/2}$.