Registration No : | | | | | | | | | | |

Total Number of Pages : 02 **B.Tech**
PEL3I001

3rd Semester Back Examination 2019-20
ELECTROMAGNETIC THEORY
BRANCH : EEE
Max Marks : 100
Time : 3 Hours
Q.CODE : HB823

Answer Question No.1 (Part-1) which is compulsory, any EIGHT from Part-II and any TWO from Part-III.
The figures in the right hand margin indicate marks.

Part-I

Q1 **Only Short Answer Type Questions (Answer All-10)** **(2 x 10)**

a) What do you mean by a gradient of a scalar function?
b) Define the divergence theorem.
c) Write down the gradient of a scalar function ∇f in rectangular, cylindrical coordinates.
d) Two self-inductances of two coils are 800mH and 200mH. The coefficient of coupling is 0.8 Calculate an effective inductance when the coils are connected in (i) parallel aiding (ii) in parallel opposing
e) Differentiate between the plane wave and uniform plane wave.
f) Why is the induced electric field not a conservative field?
g) What is the significance of boundary conditions when solving Laplace's equation?
h) Define the transmission coefficient in terms of the reflection coefficient.
i) Find the gradient of a scalar field defined by $f(x,y,z) = 6x^2y^3 + e^z$ at the point P(2,1,3).
j) A lossless transmission line is terminated at open circuit. What is the minimum length of the line so that the input impedance is inductive?

Part-II

Q2 **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 x 8)**

a) Can a surface charge exist at the interface between a dielectric and a conducting medium? Explain.
b) Express the following vector in rectangular coordinate system.

$$\vec{F} = \rho \sin\phi \ \vec{a}_\rho - \rho \cos\phi \ \vec{a}_\phi$$

c) State Maxwell's equations in differential and integral forms.
d) Starting with the equation of continuity, and assuming Ohm's law, show that the charge density in a conductor is given by the following first order differential equation:

$$\frac{\partial \rho_v}{\partial t} + \frac{\sigma}{\varepsilon}\rho_v = 0$$

Where, σ and ε are respectively the conductivity and permittivity of the medium. Assume a linear, homogenous and isotropic medium.
e) If $\vec{F} = 3y^2\vec{a}_x + 4z\vec{a}_y + 6y\vec{a}_z$. Verify the Stoke's theorem for the open surface $z^2 + y^2 = 4$ in the $x = 0$ plane.
f) Explain various aspects of polarization in dielectrics. Derive the expression for dielectric constant and electric susceptibility.

g) If the magnetic field intensity in a source-free, dielectric medium is given by $\vec{H} = H_0[\cos(\alpha x - \omega t) + \cos(\alpha x + \omega t)]\vec{a}_z$ A/m, determine the electric field intensity using Maxwell's equation from Ampere's law. What is the displacement current density in the medium?

h) Define dispersive medium. Find the attenuation and phase constant of good conductor. What do you mean by skin effect?

i) A charged ring of radius a carries a uniform charge distribution. Determine the potential and the electric field intensity at any point on the axis of the ring

j) Find the maximum rate of a function $f = 12x^2 + yz^2$ with respect to distance at point P (-1, 0, 1). Determine the rate of change of f in the x, y, and z directions. What is the rate of change of f in the direction of point Q (1, 1, and 1) from P?

k) Express the vector position $\vec{r} = x\vec{a}_x + y\vec{a}_y + z\vec{a}_z$ in the spherical co-ordinate system.

l) Determine the capacitance and inductance per unit length of a coaxial transmission line with inner and outer radii of 3 mm, and 6mm respectively. The insulating material that separates the conductors is polyethylene with a permittivity of $2.5\varepsilon_0$

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 State the divergence theorem. What are its advantages and limitations? Verify the divergence theorem for a vector field $\vec{F} = x\,\vec{a}_x + xy\,\vec{a}_y + xyz\,\vec{a}_z$ in the region bounded by a sphere of radius 2.x **(16)**

Q4 For electromagnetic fields to exist in a linear, homogeneous, isotropic, surfaces-free conduction region, show that the $\vec{H}$ field must satisfy the following equation: $\nabla^2\vec{H} - \mu\varepsilon\frac{\partial^2\vec{H}}{\partial t^2} - \mu\sigma\frac{\partial\vec{H}}{\partial t} = 0$. **(16)**

Q5 Obtain the expressions for the lines of force of an electric dipole .Show that the magnitude of the electric field intensity of an electric dipole is $\vec{E} = \frac{p}{4\pi\varepsilon_0 r^3}[1 + 3\cos^2\theta]^{\frac{1}{2}}$. **(16)**

Q6 Why Pointing vector is required? Derive the time-average power in z-direction of uniform planein terms of Pointing vector. **(16)**