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

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

3rd Semester Regular / Back Examination 2017-18
ELECTROMAGNETIC THEORY
BRANCH: EEE
Time: 3 Hours
Max Marks: 100
Q.CODE: B1116

Answer Question No.1 and 2 which are compulsory and any four from the rest.
The figures in the right hand margin indicate marks.

Q1 **Answer the following questions: *multiple type or dash fill up type*** **(2 x 10)**

a) Where surfaces ρ=2 and z=1 intersect is i) an infinite plance ii)a semi-infinite plane iii) a circle iv) a cylinder v) a cone.

b) The curl of the gradient of a scalar field defined by $V = 2x^2y + 3y^2z + 4z^2x$ is ___.

c) The flux density at a given point in space is given by $\mathbf{B} = 4xa_x + 2kya_y + 8a_z$ Wb/m^2. The value of k is ___.

d) The divergence of curl of a vector is ___.

e) If in free space, the electric field is given by $\mathbf{E} = 20\cos(\omega t - 50x)a_y$ V/m the displacement current density is ___.

f) An electric potential filed is produced by point charge 1 μC and 4 μC located at (-2,1,5) and (1,3,-1) respectively. The energy stored in the field is ___.

g) The unit of magnetic charge is ___.

h) The flux through each turn of a 100 turn coil is (t^3 – 2t) mWb, where t is in seconds. The induced emf at t=2 s is ___.

i) The skin depth of Copper at 50 Hz is ___ given σ=5.8x10^7 S/m and μ=μ_0.

j) Microwaves have a frequency range of approximately ___.

Q2 **Answer the following questions: *Short answer type*** **(2 x 10)**

a) In what aspects field theory is superior to circuit theory in understanding electromagnetics?

b) What do you understand by harmonic and solenoidal fields?

c) Convert points P(1,3,5) from Cartesian to cylindrical coordinates.

d) What are the constraints in application of Gauss's Law?

e) State the significance of uniqueness theorem.

f) State Ampere's circuit law and derive the third of Maxwell's equations from it.

g) What do you understand by relaxation time?

h) Define attenuation constant and phase constant of a medium.

i) Write two application of method of images.

j) What is intrinsic impedance of a medium?

Q3 **a)** Describe in details the various coordinate systems used in Electromagnetics. **(10)**

b) Evaluate both sides of the Stoke's theorem for the field **(5)**
$\mathbf{F} = 3y^2z\,a_x + 6x^2z\,a_y + 9xz^2\,a_z$.

Q4 **a)** Derive the expression of electric field due to a line charge using both Coulomb's Law and Gauss's law. **(10)**

b) Given that $\mathbf{E} = (3x^2 + y)a_x + x\,a_y$ kV/m, find the work done in moving a -2 μC charge from (0, 5, 0) to (2, -1, 0) by taking a straight line path (0,5,0)→(2,5,0)→(2,-1,0). **(5)**

Q5 **a)** Explain various aspects of polarization in dielectrics. Derive the expression for dielectric constant and electric susceptibility. **(10)**

b) A homogeneous dielectric (ϵ_r=2.5) fills region 1 (x<0) while region 2 (x>0) is free space. If $\mathbf{D}_1 = 12a_x - 10a_y + 4a_z$ nC/m^2, find D_2. Also, if E_2=12 V/m find E_1. **(5)**

Q6 **a)** Describe the various aspects of magnetization in materials. **(10)**

b) A current distribution gives rise to the vector magnetic potential $\mathbf{A} = x^2 y\,a_x + y^2 x\,a_y - 4xyz\,a_z$ Wb/m^2. Calculate the flux through the surface defined by z=1, 0≤ x ≤1 and -1 ≤ y ≤ 4. **(5)**

Q7 **a)** Explain Faraday's law describing in detail transformer and motional electromotive forces under all the three conditions. **(10)**

b) A conducting circular loop of radius 20 cm lies in the z=0 plane in a magnetic field $\mathbf{B} = 10\cos 377t\,a_z$ mWb/m^2. Calculate the induced voltage in the loop. **(5)**

Q8 **a)** A plane wave propagating through a medium with ϵ_r=8, μ_r=2 has $\mathbf{E} = 0.5\exp(-z/3)\sin(10^8 t - \beta z)a_x$ V/m. Determine: **(10)**

i) β,
ii) wave velocity,
iii) loss tangent,
iv) H field
v) intrinsic impedance.

b) State Maxwell's equations in differential and integral forms. **(5)**

Q9 **a)** Derive Poynting theorem and find the expression for time average power crossing a given surface S in terms of Poynting vector. **(10)**

b) Given that in air, $\mathbf{H} = 0.1\sin(\pi \times 10^8 t + \beta y)\,a_x A/m$, find the time average power density in the wavefront. **(5)**