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

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B. Tech

PCEE 4302

Sixth Semester Regular Examination – 2014

ELECTROMAGNETIC THEORY

BRANCH : ELECTRICAL

QUESTION CODE : F 235

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2 × 10

(a) If $V = xza_x - xya_y + yza_z$, express V in cylindrical co-ordinate system.

(b) What do you mean by gradient of a scalar function ?

(c) Why the B field of an infinitely long, straight, current carrying conductor cannot have a component in the direction of the current ?

(d) What is the relation between vector magnetic potential and magnetic flux through a given area ?

(e) What is the significance of the negative sign in the equation $E = -\text{grad}(V)$?

(f) Under what circumstances the net voltage around a closed-loop is equal to zero ?

(g) If a vector field is solenoidal at a given point in free space, does it necessarily follow that the vector field is zero at that point ?

(h) Can Stoke's theorem be applied to closed surfaces ? Justify.

P.T.O.

(i) State the boundary conditions at the interface between two dielectrics.

(j) Write the Poisson's and Laplace equations for homogeneous and non-homogeneous fields.

2. Four identical 3 nC charges are located at $P_1(1, 1, 0)$, $P_2(-1, 1, 0)$, $P_3(-1, -1, 0)$ and $P_4(1, -1, 0)$ in a rectangular co-ordinate frame. Find the electric field at p(1,1,1). 10

3. (a) Define divergence and curl of a vector field with appropriate diagram. Derive an expression for the divergence of the vector field in Cartesian co-ordinate system. 5

(b) Verify the divergence theorem for the function $A = r^2 a_r + r \sin\theta \cos\theta a_\theta$ over the surface of a quarter of a hemisphere defined by $0 < r < 3$, $0 < \Phi < \pi/2$, $0 < \theta < \pi/2$. 5

4. Two co-axial conducting cylinders of radius 2 cm and 5 cm have a length of 1 m.The region between the cylinders is filled with a dielectric of $\varepsilon_{r1} = 2$ from r = 2cm to r = 4cm and $\varepsilon_{r2} = 3$ from r = 4cm to r = 5cm. Find the capacitance between the cylinders. Derive the formula you use. 10

5. State Poynting theorem. What is Poynting vector ? Obtain the expression for the average energy density for the time harmonic field. 3 + 2 + 5

6. (a) Derive the boundary condition between two dielectrics. 4

(b) Two extensive homogeneous isotropic dielectric meet on a plane z = 0. For $z > 0$, $\varepsilon_{r1} = 4$ and for $z < 0$, $\varepsilon_{r2} = 3$. A uniform electric field $E1 = 5a_x - 2a_y + 3a_z$ kV/m exists for $z > 0$. Find

(i) E_2 for $z < 0$.

(ii) The angles E_1 and E_2 make with the surface.

(iii) The energy densities in both the dielectrics. 6

7. (a) State and prove Stokes' theorem. 5

(b) Show that the vector $A = (y^2 - z^2 + 3xyz - 2x)a_x + (3xyz + 2xy)a_y + (3xy - 2xz + 2z)a_z$ is both irrational and solenoidal. 5

8. Write short notes on : 5×2

(a) Boundary conditions in electric field.

(b) Poynting vector and power flow.