Total number of printed pages – 7 **B. Tech**

CPEE 5307

Fifth Semester Examination – 2007

ELECTROMAGNETIC THEORY

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

   (b) Is the projection of a vector on another vector unique ?

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

   (d) Is a wire carrying steady current in electrostatic equilibrium ?

   (e) What do you mean by vector magnetic potential ?

   (f) Why is the induced electric field not a conservative field ?

   (g) What is the significance of Lenz's law ?

   (h) What do you mean by the plane of incidence ?

   (i) What do you conclude if the directivity of an antenna is unity ?

   (j) What is an end-fire array ?

2. The position vector of point P and Q are given as $5a_x+12a_y+a_z$ and $2a_x-3a_y+a_z$ respectively.

(i) What is the distance vector from P to Q ?

(ii) What is its length ?

(iii) Is the length segment parallel to the xy plane ?

(iv) What are the coordinates of point P and Q ? 10

3. (a) How much energy is required to assemble a point charge ? Do you think that a point charge can really exist ? 5

(b) A cylindrical conductor of radius 'a' and of infinite length has uniform charge

distribution ρ_s over its surface. Compute and sketch the field intensity everywhere in space. Calculate the flux passing through a cylindrical surface of radius 'b' (b>a) and length 1. 5

4. The radius of an inner spherical conductor is 3 cm and the radius of the outer spherical conductor is 9 cm. There are two media; the inner one extending from 3 cm to 6 cm, has a conductivity of 50 µs/m; the outer one, extending from 6 cm to 9 cm, has a conductivity of 100 µs/m. Determine on per unit length basis (a) resistance of each region and (b) the total resistance. 10

5. (a) Explain Ampere's force law. 4

(b) A filamentary current of 30 A flows in the a_z direction in free space along the line $x=0, y=2$ m and in the $-a_z$ direction at $x=0, y=-2$ m. A filamentary loop in the $y=0$ plane is 2 m on a side and centered on the point C (2, 0, 0). If the loop current is 2 mA in the a_z direction in the side nearest the z axis, find :

(i) the vector force on each side of the loop, and

(ii) the total vector force on the loop. 6

6. State Poynting's theorem. What is Poynting's vector ? Obtain expression for the average energy densities for time-harmonic fields. 3+2+5

7. Explain the Brewster angle. What is the difference between the critical angle and the Brewster angle ? Why the Brewster angle is also called a polarizing angle ? Is the Brewster angle possible for a perpendicularly polarized wave ? Justify your answer. 2+2+2+4

8. (a) Define a monopole antenna. Can you cite examples of such antennas that are used in our daily lives ? 4

(b) Calculate the directivity of

(i) the Hertzian monopole

(ii) the quarter wave monopole.

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