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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 :  $2 \times 10$
- (a) What do you mean by the gradient of a scalar function ?
- (b) Is the projection of a vector on another vector unique ?

P.T.O.

- (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 ?
3. (a) How much energy is required to assemble a point charge ? Do you think that a point charge can really exist ?
- (b) A cylindrical conductor of radius 'a' and of infinite length has uniform charge

distribution  $\rho_s$  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  $50 \mu\text{s/m}$ ; the outer one, extending from 6 cm to 9 cm, has a conductivity of  $100 \mu\text{s/m}$ . 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  $x=0, y=2\text{ m}$  and in the  $-a_z$  direction at  $x=0, y=-2\text{ m}$ . 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 ?

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(b) Calculate the directivity of

(i) the Hertzian monopole

(ii) the quarter wave monopole.

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