

The Open University of Sri Lanka  
 B.Sc Degree programme  
 Electro magnetic Theory and Special Relativity  
 Final Examination 2006/2007  
 AMU3185/AME5185



Duration: Two and half hours.

Date: 02.06.2007

Time : 01.00 p.m. – 04.30 p.m.

Answer **FOUR** Questions only.

01. Three infinitely long parallel straight wires carrying charges  $q, -\alpha q, q$  per unit length, where  $\alpha \geq 2$  cut a perpendicular plane  $OXY$  at the points  $A, O$  and  $B$  whose rectangular Cartesian co-ordinates are  $(-a, 0), (0, 0)$  and  $(a, 0)$  respectively.

Show that  $\theta_1 - \alpha\theta + \theta_2 = \beta$  (constant)

where  $\theta_1 = \widehat{PAO}, \theta = \widehat{POB}, \theta_2 = \pi - \widehat{PBA}, P$  being any point on a line of force in the  $OXY$  - plane.

Also, show that the equation of the force in plane polar co-ordinates  $(r, \theta)$ , takes the form  $r^2 \sin[\beta + (\alpha - 2)\theta] = a^2 \sin(\beta + \alpha\theta)$ , where  $P \equiv (r, \theta)$ .

02. (i) Explain briefly the following terms.

- (a) Electric potential
- (b) Potential difference
- (c) Equi-potential surface

(ii) Show that the potential  $V_r$  at a point distance  $r$  from a point charge  $Q$  is given by

$$V_r = \frac{1}{4\pi\epsilon} \frac{Q}{r}.$$

(iii) A charge  $2q$  is uniformly distributed inside an insulating material in the form of a sphere of radius  $r$ .

Show that the potential at a distance  $\frac{r}{2}$  from the centre is  $\frac{11q}{16\pi\epsilon_0 r}$ .

03. (i) State the Kirchoff's Laws for steady currents in linear conductors.

(ii) A cable  $AB$  of length  $l$  of uniform wire develops a leak at a certain point  $P$  through which current leaks to earth. To locate the fault two observations are made. The resistance between  $A$  and the earth through the cable when  $B$  is earthed is observed to be equal to that of a length  $a$  of the wire, and that between  $B$  and the earth when  $A$  is earthed, to be that of a length  $b$ .

Show that the point  $P$  intersects  $AB$  in ratio  $\left(\frac{a(l-b)}{b(l-a)}\right)^{\frac{1}{2}}$ , and find the resistance of the leak as a measure of the length of the wire.

04. (i) Define the following terms,

- |                    |                     |
|--------------------|---------------------|
| (a) Electric field | (b) Flux density    |
| (c) Electric force | (d) Zero potential. |

(ii) A thin rod of finite length  $2l$  carries a charge spread uniformly along it such that its linear charge density is  $\lambda$ ,

(a) Calculate the electric field  $E$  at a point  $P$  a distance  $y$  from the rod.

(b) Using part (a), obtain the field at a point distance  $y$  from a charged infinity rod.

05. (i) State the Biot –Savart Law.

(ii) Compute the magnetic field  $B$  at the centre of a square loop of 10 turns carrying steady current of 10 amperes, The loop is placed in air and its sides are 1 meter each. Assume, that the conductors are thin.

(iii) Derive an expression for the magnetic field at the centre of a circular current carrying loop.

06. A coil of 800 turns is wound on a wooden form and a current of 5 A through the coil produces a magnetic flux of  $200 \mu wb$ .

Calculate

(i) The inductance of the coil.

(ii) The average value of the emf introduced in the coil when the current is reversed in 0.2s.