

The Open University of Sri Lanka

B.Sc/B.Ed. Degree Programme

Final Examination 2011/2012

Applied Mathematics

AMU 3185/AME 5185 – Electro Magnetic Theory & Special Relativity

Duration: - Two Hours.



Date: - 04.12.2012

Time: - 9.30 a.m. – 11.30 a.m.

Answer Four Questions Only.

01. (a) State Coulomb's Law.

Give an expression to find the force between two point charges and state clearly the units of the quantities in the expression.

(b) Two small positively charged spheres have a combined charge of 5.0×10^{-5} C. If each sphere is repelled from the other by an electrostatic force of 1.0N when the spheres are 2.0m apart, what is the charge on each sphere?

(c) A certain charge Q is divided into two parts q and $Q - q$, which are then separated by a certain distance. What must q be in terms of Q to maximize the electrostatic repulsion between the two charges?

02. (a) Let e_i , $i = 1, 2, \dots, n$ be a system of collinear point charges situated at points A_i , $i = 1, 2, \dots, n$. Let P be any point and let θ_i be any angle between A_iP and the positive direction of the line charges. Prove that, along any line of force PQ ,

$$\sum_{i=1}^n e_i \cos \theta_i = \text{constant}.$$

(b) Point charges e_1 and e_2 ($e_1 > e_2$) are situated at points P and Q respectively. Prove that extreme lines of force which pass through P to Q make, on leaving at P an angle α with PQ , where $\cos \alpha = \frac{e_1 - e_2}{e_1}$.

03. (a) State Gauss's Law.

(b) A sphere of radius R has a charge density $\rho = \frac{r}{R} \rho_0$ where ρ_0 is a constant and r is the distance from the center of the sphere.

(i) What is the total charge inside the sphere?

(ii) Find the electric field everywhere (both inside and outside the sphere).

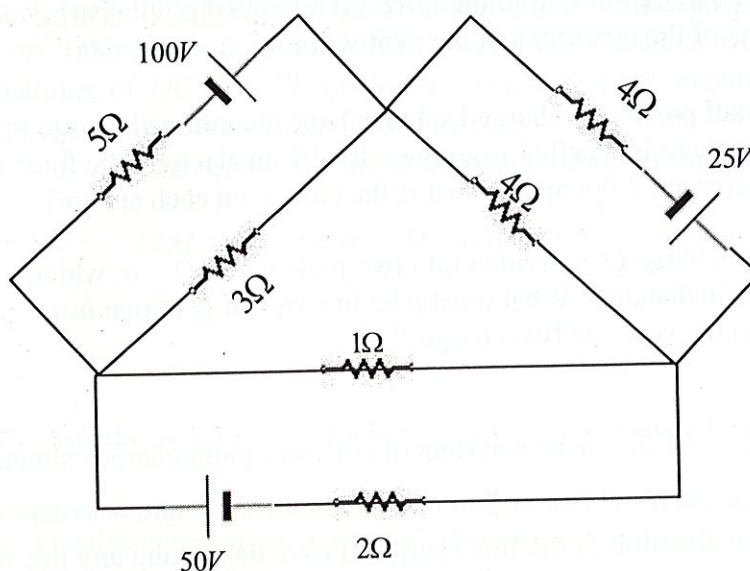
04. State Biot-Savart's law.

A thin straight conductor AB of length l carrying a current I is situated along the y -axis such that the end A of conductor is at a distance y_1 from the origin O and B at a distance y_2 from O .

- (i) Find an expression for the magnetic field \underline{H} at a point on the x -axis distant x_1 from the origin.
- (ii) If the center of the conductor coincides with origin and if $x_1 \gg l$, then find the magnitude of \underline{H} .

05. (a) State Kirchhoff's Laws.

(b) Find the current that passes through the resistor 2Ω in the network given below.



06. (a) With the usual notations obtain the Lorentz inverse transformation for

$$x' = \alpha x - \alpha v t$$

$$y' = y$$

$$z' = z$$

$$t' = \frac{-\alpha v}{c^2} x + \alpha t$$

- (b) In the inertial system S , an event is observed to take place at point A on the x -axis and 10^{-6} s later another event S' takes place at point B , 900m further down. Find the magnitude and direction of the velocity of S' with respect to S in which these two events appear simultaneous.