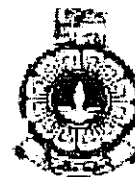


The Open University of Sri Lanka
B.Sc./B.Ed Degree Programme – Level 05
Final Examination 2008/2009
Applied Mathematics
AMU 3185/AME 5185 – Electro Magnetic Theory & Special Relativity
Duration: - Two and Half Hours.



Date: - 14.07.2009

Time: - 10.00 a.m. – 12.30 p.m.

Answer FOUR Questions only.

01.(a) State the Coulomb's Law.

- (b) A uniform electric field of 5000 NC^{-1} exists in the region between two oppositely charged parallel plates.
- What is the force on an electron in this region?
 - What is the acceleration of an electron when acted on by this force?
- (c) Find the centripetal acceleration of the electron in a circular orbit about the proton in the hydrogen atom.

(Assume that the mass of electron is $m = 9.1 \times 10^{-31} \text{ kg}$, the charge of electron is $e = 1.6 \times 10^{-19} \text{ C}$ and the radius of the orbit of electron is $r = 5.3 \times 10^{-11} \text{ m}$).



02. (a) State Biot–Savart Law.

- (b) Find an expression for field–intensity \vec{H} at the centre of a circular wire of radius a carrying a current I in the anti–clockwise direction on XY plane.
- (c) Two narrow circular coils P and Q have a common axis and placed 10 cm apart. Coil P has 10 turns of radius 5 cm with a current of 1 A passing through it. Coil Q has a single turn of radius 7.5 cm . If the magnetic field at the centre of the coil P is to be zero, what current should be passed through coil Q ?

03. (a) State the Gauss's theorem.

- (b) A rectangular plane surface of width w and length l is placed with edges parallel to the x and y axes respectively. The electric field \vec{E} is everywhere parallel to the z axis and its magnitude is given by $E = (ax - b)$.
- Calculate the flux through the surface.
 - Show that the total flux through the surface is given by $\phi = wl \left(\frac{al}{2} - b \right)$.

(c) A spherical charge distribution of radius a is given by

$$\rho = \begin{cases} \rho_0 \left(1 - \frac{r}{a}\right) & \text{for } r \leq a \\ 0 & \text{for } r > a. \end{cases}$$

Calculate,

- (i) total amount of charge,
 (ii) the electric field through at a point distant r from the centre
 (a) outside
 and
 (b) inside
 the charge distribution.

04. (a) Briefly explain the capacitance of a capacitor and derive the formulae of the resultant capacitance of the capacitors when they connect by series and parallel.

(b) Two rectangular metal plates, each $10\text{cm} \times 20\text{cm}$, are placed parallel to each other with a spacing of 2mm . One plate is earthed. Find the capacitance of this arrangement.

(c) A $20\mu\text{F}$ capacitor is charged to a potential difference of 1000 volts and is disconnected from supply. Its terminals are then connected to those of an uncharged $10\mu\text{F}$ capacitor. Find the resulting potential difference across the common terminals of two capacitors.

05.(a) State the basic postulates of special theory of relativity and with the usual notation derive the Lorentz transformation equations.

(b) Prove that the results of two successive Lorentz transformations is a Lorentz transformation.

(c) Let u and u' are the velocities of a particle in two inertial systems S and S' respectively. Initially S and S' coincide and S' has the velocity v relative to S in x -direction.

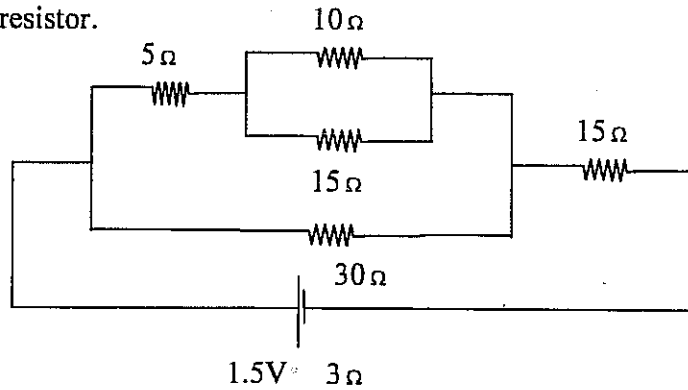
$$\text{Show that } u^2 = \frac{u'^2 + v^2 + 2u'v \cos \theta - \left(u' \frac{v}{c} \sin \theta'\right)^2}{\left(1 + \frac{v^2}{c^2} u' \cos \theta'\right)^2},$$

where θ' is the angle which u' makes with x -axis and c is the velocity of light.

06.(a) State Ohm's Law and Kirchhoff's Laws.

(b) Referring the following circuit diagram, find

- (i) the current delivered by the source,
- (ii) its terminal potential difference,
- (iii) the current in 10Ω resistor.



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