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RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree
Second Year - Semester I Examination – September/October 2013

PHY 2102 - Electromagnetism

Answer any two questions Time: One hour

Use of a non-programmable calculator is permitted.

Symbols have their usual meaning.

Some fundamental constants and physical data;

Permeability of free space $\mu_0 = 4\pi \times 10^{-7}\ N\ A^{-2}$,
Speed of light in vacuum $c = 3.0 \times 10^{8}\ m\ s^{-1}$,
Permittivity of free space $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2\ N^{-1}\ m^{-2}$.

$$\vec{\nabla} = \hat{i}\frac{\partial}{\partial x} + \hat{j}\frac{\partial}{\partial y} + \hat{k}\frac{\partial}{\partial z}$$

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(1) (a) i. State Stoke's theorem. [06 pts.]

ii. Using Stoke's theorem, prove that the curl of the gradient of a scalar Φ is zero. [12 pts.]

(b) i Write the Maxwell's equations and explain the significance of each equation. [16 pts.]

ii Using the 1st Maxwell's equation, show that one could obtain the Laplace's equation for a potential V in free space. [08 pts.]

(c) If $\Phi(x, y, z) = 3x^2y - y^3x^2$, calculate the gradient Φ at the point (1,-2,-1). [08 pts.]

Contd.

(2) (a) i Show that for a purely capacitive AC circuit with a sinusoidally applied emf, the current leads the voltage across the capacitor by 90°. [08 pts.]

ii Plot the current and voltage across the capacitor and draw the phasor diagram for the capacitive circuit. [08 pts.]

iii State the difference between the resistance and the reactance? [04 pts.]

(b) i If the frequency is doubled in a series RLC circuit, what would happen to the resistance, the inductive reactance, and the capacitive reactance? [12 pts.]

ii A series RLC circuit is used in a radio to tune into a FM station broadcasting at 99.7 MHz. The resistance in the circuit is 12 Ω and the inductance is 1.4 μH. What capacitance should be used to tune into above station? [10 pts]

(c) Does the phase angle depend on frequency? What is the phase angle when the inductive reactance equals the capacitive reactance? [08 pts.]

(3) (a) i. Describe the physical significance of the Poynting vector. [05 pts.]

ii. What is the average magnitude of the Poynting vector at a distance 5 km from an isotropic radio transmitter, broadcasting with an average power of 250 kW? [10 pts.]

(b) A harmonic plane electromagnetic wave whose **E** field has the form $E_z(y,t) = E_{0Z}\mathrm{Sin}[\omega(t - y/c) + \phi]$, wherere ϕ is a constant phase angle. Determine the corresponding **B** field and make a sketch of the wave. [25 pts.]

(c) Do all current-carrying conductors emit electromagnetic waves? Explain. [10 pts.]

End.