RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree
Second Year - Semester I Examination - February 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 $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2\ N^{-1}\ m^{-2}$.

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(1) (a) i. State Stoke's theorem. [10 pts.]

ii. Using Stoke's theorem, prove that the curl of the gradient of a scalar Φ is zero. [14 pts.]

(b) i. The vector fields are classified on the basis of different associations of curl and divergence. What are these combinations? Illustrate by giving examples. [12 pts.]

ii. Using the above associations, obtain the Laplace and Poisson's equations. [8 pts.]

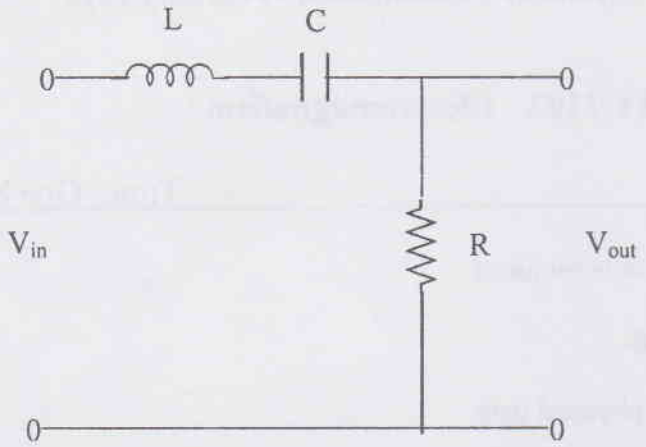
(c) Explain the reasons and meaning of $\vec{\nabla}.B = 0$ [6 pts.]

Contd.

(2) (a) i. Show that for a purely capacitive AC circuit with a sinusoidal applied emf, the current leads the voltage across the capacitor by $\frac{\pi}{2}$. [10 pts.]

ii. Prove that the average power dissipation in a purely capacitive circuit is zero. [10 pts.]

(b) The circuit shown in the figure can be used as a filter to pass signals that lie in a certain frequency band.



i. Show that the gain (V_{out}/V_{in}) for an input voltage of frequency ω is given by

$$\frac{V_{out}}{V_{in}} = \frac{1}{\sqrt{1+\left[\frac{(\omega^2/\omega_0^2)-1}{\omega RC}\right]^2}}$$, where ω_0 is the resonance frequency. [15 pts.]

ii. Let R =100 Ω, C = 0.05 μF and L = 0.127 H. Calculate the gain of this circuit for input frequencies f_1 = 1.5 kHz and f_2 = 2.0 kHz. [10 pts.]

(c) What is the impedance of an RLC circuit at the resonance frequency? [5 pts.]

Contd.

(3) (a) i. Describe the physical significance of the Poynting vector. [5 pts.]

ii. The amplitude of the magnetic field in an electromagnetic wave is $B_m = 4.1 \times 10^{-8}$ T. What is the average intensity of this wave? [10 pts.]

(b) A plane electromagnetic sinusoidal wave propagates in the x- direction. The wavelength is 50 m, and the electric field vibrates in the xy plane with an amplitude of 22 V m^{-1}.

i. Calculate the sinusoidal frequency. [10 pts.]

ii. Calculate the magnitude and direction of **B** when the electric field has its maximum in the negative y- direction. [10 pts.]

iii. Write an expression for **B**, using numerical values for B_m, k and ω [10 pts.]

(c) What is the fundamental source of electromagnetic radiation? [5 pts.]

End.