



**RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES**

B.Sc. (General) Degree in Applied Sciences
Second Year - Semester I Examination – April / May 2016

PHY 2102 - ELECTROMAGNETISM

Answer any two questions

Time: One hour

Symbols have their usual meaning.

Some fundamental constants and physical data;

Permeability of free space $\mu_0 = 4\pi \times 10^{-7} \text{ N A}^{-2}$,

Speed of light in vacuum $c = 3.0 \times 10^8 \text{ m s}^{-1}$,

Permittivity of free space $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$,

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

- (1) (a) (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 marks]

- (ii) Using the above combinations, obtain the Laplace and Poisson's equations.

[06 marks]

- (iii) “The curl of the gradient of a scalar function is zero” State whether the above statement is true or false. Explain.

[10 marks]

- (b) (i) Write the Maxwell's equations and explain the physical significance of each equation. Solve them in free space.

[12 marks]

- (ii) Consider the potential function $V = -\alpha xy$, where α is a constant. Obtain the value of the electric field.

[10 marks]

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- (2) (a) (i) Describe the Physical significance of the Poynting vector. [06 marks]
- (ii) Calculate the Poynting vector for a long straight wire of resistance R , radius a and length l , which carries a constant current I along the wire. Recall that the magnetic field at the surface of the wire is given by $B = \mu_0 I / 2\pi a$. [16 marks]
- (iii) Hence, show that the rate at which electromagnetic energy flows into the wire equals the rate of energy (or power) dissipated as joule heat. [08 marks]
- (b) The magnetic field of a plane electromagnetic wave is given by $\mathbf{B} = B_0 \sin(kx - \omega t) \mathbf{j}$.
- (i) What is the wavelength λ of the wave? [04 marks]
- (ii) Write an expression for the electric field \mathbf{E} associated with this magnetic field. [08 marks]
- (iii) What is the direction and magnitude of the Poynting vector associated with this wave? [08 marks]
- (3) (a) (i) "The voltage across an inductor leads the current by $\pi/2$ " Explain the above statement. [10 marks]
- (ii) When a particular inductor is connected to a sinusoidal voltage with 110 V amplitude, a peak current of 3 A appears in the inductor. Calculate the peak current and the inductive reactance if the frequency of the applied voltage is doubled. [14 marks]
- (iii) The sum of the peak voltages across each of the elements in a series RLC circuit is usually greater than the peak applied voltage. Doesn't this violate Kirchhoff's voltage law? Explain. [10 marks]
- (b) (i) What is it meant by the Quality factor (Q) of a circuit? [06 marks]
- (ii) Explain how the quality factor is related to the response characteristics of a receiver. Which variable most strongly determines the quality factor? [10 marks]

End.