EASTERN UNIVERSITY, SRI LANKA

FIRST EXAMINATION IN SCIENCE - 2015/2016

SECOND SEMESTER (May/June–2018)

PH 103 ELECTRICITY AND MAGNETISM - I

Time: 1 hour

Answer ALL Questions

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1. Define the terms *electric field strength* and *electric potential* in an electric field. Write down the relationship between the electric field and the potential gradient.

   A thin circular ring of radius a carries a uniform positive charge Q.

   (a) Show that the electric potential at point P at a distance x from the center of the ring is given by

   $$V(x) = \frac{Q}{4\pi\varepsilon_0}\frac{1}{\sqrt{a^2 + x^2}}.$$

   Hence, show that the electric field at point P is

   $$E(x) = \frac{Qx}{4\pi\varepsilon_0}\frac{1}{\sqrt[3]{a^2 + x^2}}.$$

   (b) Show that the magnitude of maximum field strength at $x = \frac{a}{\sqrt{2}}$ will be

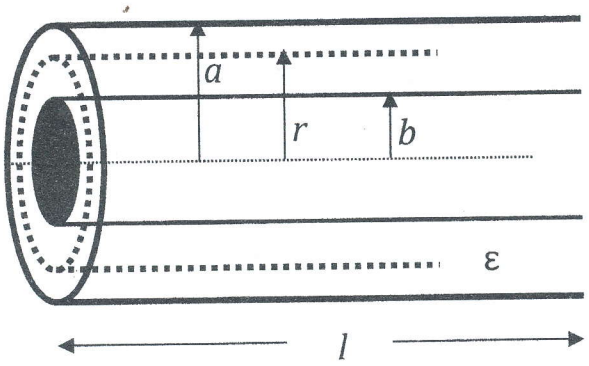
   $$E_{\max}(x) = \frac{Q}{6\sqrt{3\pi\varepsilon_0 a^2}}$$

   along the axis of the ring.

2. Define the term *capacitance* of a conductor.

   State and prove Gauss's theorem in electrostatics.

   Consider a coaxial cylindrical capacitors of inner radius b and outer radius a respectively as shown in the figure. It has a length l and consists a total charge distribution Q. Assuming the radius of the Gaussian surface as r:



a) Write down a general expression for electric field intensity E in terms of r.

b) Write down a general expression for potential difference between two points along r.

c) Hence, find the potential difference between two coaxial cylinders.

d) Calculate the capacitance between the cylinders, and hence determine the corresponding energy stored in the cylinder.