Electromagnetic Theory: Homework 8
Due: 16 September 2014

1 Griffiths, Introduction to Electrodynamics, 2.3, page 65.

2 Force on a charge on a square loop
Consider a square loop with sides of length $L$ in the $xy$-plane. Suppose that it is positively charged with uniform charge density $\lambda$. A positive test charge, $Q$, is placed at one corner as illustrated.

![Diagram of square loop with test charge Q](image)

a) Describe how you would use the result of Prob 2.3 to determine the force exerted on the test charge. You do not necessarily need to get an expression for the force; just a procedure.

b) Suppose that an additional test charge, with charge $Q'$ were placed at the center of the loop and the original test charge is still at the illustrated location. Would the size of the charge density on the loop have any effect on the force exerted on $Q'$? Explain your answer, without doing any detailed calculations.

3 Electric field produced by a ring of charge
Consider a ring of charge with radius $R$ that lies in the $xy$-plane (see Fig 2.9).

a) Suppose that the charge density along the ring is uniform, i.e. $\lambda(r') = \lambda$, which is constant. Determine the electric field at a distance $z$ above the center of the ring.

b) For the above case determine the limit for $z \gg R$. What would you have expected in this limit? Does this agree?

c) Suppose that the charge density along the ring is $\lambda(r') = \lambda \sin \phi'$, where $\lambda$ is constant and $\phi'$ refers to locations along the ring in cylindrical coordinates. Determine the electric field at a distance $z$ above the center of the ring.

d) For the above case determine the limit for $z \gg R$. What would you have expected in this limit? Does this agree?
Hint: Use cylindrical coordinates. This will results in the appearance of $\hat{s}$ within the integrals. This unit vector varies with $\phi'$ and to integrate correctly it must be expressed in terms of $\hat{x}$ and $\hat{y}$ within the integral. Once this is done, you could integrate.

4 Electric field produced by a charged disk

Consider a disk of radius $R$ and which carries a surface charge distributed according to

$$\sigma(r') = s^n \cos \phi'$$

where $s'$ and $\phi'$ are cylindrical coordinates for locations on the disk and $n$ is an integer.

a) Determine the total charge on the disk.

b) Determine the electric field at the center of the disk.