Classical E&M Homework 03

March 21, 2005

Due date: March 28, 2005

1. Jackson 2.1 (3 points each, if you provide a plot for (a), 2 more points. Total 20 points.)

2. Jackson 2.7 (6 points for (a), 4 points for (b), 5 points each for (c) and (d))

3. Suppose an infinite $x - y$ plane with the following potential distribution:

$$\Phi(r) = \frac{V_0}{\sqrt{1 + (r/a)^2}} \quad r = \sqrt{x^2 + y^2}$$

   (a) Using the appropriate Green function, find the potential along the z axis. (10 points)

   (b) Try to find a general solution. (15 points)

4. Let's consider again the example of the two hemispheres at different potentials (Section 2.7).

   (a) Show that the potential at the center of the sphere is *zero*. (10 points)

   (b) Can you show that the potential on $x - y$ plane is zero as expected from the symmetry? (15 points)

5. A point charge Q is placed between the two infinite plates of conductor separated by a distance D. Lower plate, at $z = -D/2$ is grounded, while the upper plate at $z = D/2$ is maintained at a constant potential V.

   (a) Using the method of images (You might need to sum infinite series. Jackson's problem 2.6 would be helpful.) calculate the force on the charge. (9 points)

   (b) Try to find an approximate formula for the force when Q is very near the plates (5 points)

   (c) Repeat (b) for the case when Q is half-way between the two plates. (5 points)

(d) Milikan used charged oil-drops between two plates with constant potential difference. (You might have done similar experiment during your undergraduate courses.) In the analysis of the experiment, he (or even probably *you*) neglected the force due to the image charges. How serious is this? (6 points)