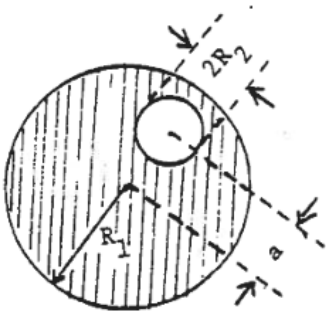**University of California, Berkeley Physics**
5B midterm Exam *(spring 2021)*
Maximum score: 100 points

1. (20 points)

 A sphere of radius R_1 has charge density ρ, uniform within its volume, except for a small spherical hollow region of radius R_2, located a distance a from the center.

(a) Find E at the center of the hollow sphere.

(b) Find the potential at the same point.

2. (30 points).

 A parallel plate capacitor with area A and separation d has charge Q and -Q on the two plates. The capacitor is not connected to anything. Then a thick metal plate of thickness L is placed in between the plates, a distance x from the positively charged plate (x+L<d), as illustrated in the following figure.

(a) Find the electrical field in region I, II, and III. What is the potential difference between the two capacitor plates?

(b) Now if we want to pull the thick metal plate out of the capacitor to a position far away, how much work do we have to do?
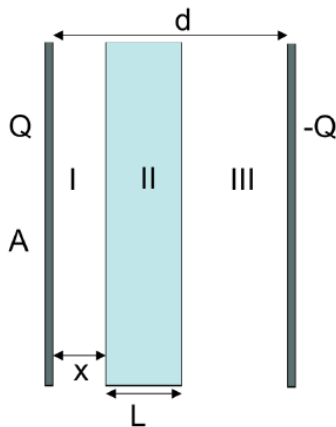
3. (20 points)

 An infinitely long wire carriers 1 amp. It is bent so as o have a semi-circular detour around the orgin, with radius 1 cm. Calculate the magnetic field at the origin.

4. (30 points)

Consider current flowing oppositely through two parallel square plates separated by a distance d, as illustrated in the Figure below. The square plates have a dimension of a (with a>>d). Opposite surface current density of j and -j are flowing on the top and bottom plate, respectively.

(a) Calculate the magnetic field right above the top plate, right below the bottom plate, and between the two plates. (Neglecting the fringe magnetic fields due to the finite size of the plates.)

(b) Calculate the magnetic force acting on the top plate.