1) (a) Consider a thin slab of resistive material, as in the first figure, with resistivity $\rho$ and thickness $d$. Find the resistance of a square piece, with edge length $L$, measured between opposing thin faces of thickness $d$, assuming that a highly conducting electrode covers each of the two faces. Show that it is independent of $L$. (This is the two-dimensional “resistivity”, often quoted as having units $\Omega$/square.)

(b) Consider an extended network of identical resistors $R_o$, constructed as in the second figure. All wires are connected at the crossings, and the individual cells are squares of side $a$. Find the resistance of a large square piece cut from such a network, with edges of length $L$ cut horizontally and vertically relative to the figure. Assume that there are highly-conducting electrodes attached to two opposite edges, and that $L$ is large enough that the manner in which wires are cut at the edges does not matter.

(c) Find the resistance of an $L \times L$ square piece of the same network as described in (b), but with the large square cut at a 45° angle relative to the direction of the resistors and wires.

(d) Find the resistivity of a 3-dimensional extended network, constructed as in the third figure, with $a \times a \times a$ cubic units connected at the corners, and resistors $R_o$ running along the edges.

2) Consider a thin sheet of carbon paper with a small circular region of radius $a$ at its center that has been painted with silver conductive paint. The 2-D resistivity of the carbon paper is $R$ (this is the resistivity as defined in the above problem; it would be measured in ohms per square). The conductive paint is sufficiently conductive that we consider it a perfect conductor, so that the painted region becomes an equipotential region. Far from the center a steady, uniform sheet of current flows, with linear current density $K$ in one direction. Assume that the edges of the sheet are sufficiently far from the painted region that they may be considered to be at infinity.

(a) Solve for the potential vs. position in the sheet, using cylindrical coordinates centered at the painted region, and assuming that $V = 0$ at the center. Note as shown in class that the current will be constrained to flow in-plane, making this effectively a problem in cylindrical coordinates.

(b) Find the total current that will flow through the circle of conductive paint.

3) Griffiths problem 7.1 (page 290)

4) Griffiths problem 7.4 (p. 291)

5) Griffiths problem 7.8 (p. 300)

6) The current in a long ideal single-layer solenoid ($n$ turns per length, radius $a$) is changing vs. time according to $I = A \cos \omega t$.

(a) Find the electric field vs. time both inside and outside the solenoid, with direction, assuming that $\phi$ is relatively small so that the B field is the same as would be found for this current in magnetostatics. (In other words we neglect any change in $B$ due to the Maxwell term in Ampere’s law, introduced later in the chapter.)

(b) Find the emf per turn in the solenoid.