Physics 503 **Homework Set 8** **Fall 2016**

Zangwill 7.4 The Potential inside an Ohmic Duct The z-axis runs down the center of an infinitely long heating duct with a square cross section. For a real metal duct (not a perfect conductor), the electrostatic potential $\phi(x, y)$ varies linearly along the side walls of the duct. Suppose that the duct corners at $(\pm a, 0)$ are held at potential $+V$ and the duct corners at $(0, \pm a)$ are held at potential $-V$. Find the potential inside the duct beginning with the trial solution

$$\phi(x, y) = A + Bx + Cy + Dx2 + Ey2 + Fxy.$$

Zangwill 7.7 A Potential Patch by Separation of Variables The square region defined by $-a \leq x \leq a$ and $-a \leq y \leq a$ in the $z = 0$ plane is a conductor held at potential $\phi = V$. The rest of the $z = 0$ plane is a conductor held at potential $\phi = 0$. The plane $z = d$ is also a conductor held at zero potential (see the picture in Zangwill).

(a) Find the potential for $0 \leq z \leq d$ in the form of a Fourier integral.

(b) Find the total charge induced on the upper surface of the lower $(z = 0)$ plate. The answer is very simple. Do not leave it in the form of an unevaluated integral or infinite series.

(c) Sketch field lines of $\mathbf{E}(\mathbf{r})$ between the plates.

Zangwill 7.10 An Electrostatic Analog of the Helmholtz Coil A spherical shell of radius R is divided into three conducting segments by two very thin air gaps located at latitudes θ_0 and $\pi - \theta_0$. The center segment is grounded. The upper and lower segments are maintained at potentials V and $-V$, respectively (see the picture in Zangwill). Find the angle θ_0 such that the electric field inside the shell is as nearly constant as possible near the center of the sphere.