CLASSICAL ELECTRODYNAMICS I
Homework Set 3
February 6, 2015

1. A line charge with linear density λ is placed parallel to, and a distance R away from, the axis of a conducting cylinder of radius b held at fixed voltage such that the potential vanishes at infinity. Define a coordinate system with the axis of the cylinder passing through the origin, and with the direction from the origin to the line charge as the x axis.

   (a) Find the magnitude and position of the image charge(s).

   (b) Find the potential $\Phi(r, \theta)$ at any point, expressed in polar coordinates.

   (c) Find the potential, $V = \Phi(b, \theta)$, on the surface of the cylinder.

   (d) Find the asymptotic form of the potential for $r \gg R$.

   (e) Find the force (per unit length) on the line charge.

   (f) Find the induced surface-charge density $\sigma(\theta)$ on the cylinder.

   (g) Find the asymptotic form of $\sigma(\theta)$ for $R \gg b$.