1. Consider the problem of determining the electrostatic potential outside a perfectly conducting, uncharged circular cylinder of radius $R$ that is placed with its axis parallel to a line charge of charge/length $\lambda$ and a distance $d$ away along the $x$-axis. Take both the cylinder and the line charge to be parallel to the $z$-axis and infinitely extended. Also take $d > R$.

(a) Show that the problem can be solved by means of two image line charges, one at the center and another at the point of inversion relative to the given line charge. What are their line charge densities?

(b) Determine the potential and electric field everywhere in the exterior of the cylinder, $s > R$.

(c) Determine the induced surface charge density on the cylinder as a function of the azimuthal angle $\phi$ on the cylinder.

(d) Which is the total charge on the conductor?

(e) Determine the direction and magnitude of force on the given line charge per unit length. According to what power of inverse distance does the force drop off at large distances, $d \gg R$?

Here are some relations that you may find useful ($A^2 < 1$):

\[
\int_0^{2\pi} d\gamma \frac{1}{1 - A \cos \gamma} = \frac{2\pi}{\sqrt{1 - A^2}}
\]

\[
\int_0^{2\pi} d\gamma \frac{\cos \gamma}{1 - A \cos \gamma} = \frac{2\pi}{A} \left( -1 + \frac{1}{\sqrt{1 - A^2}} \right)
\]

2. Two infinite parallel grounded conducting planes are held a distance $a$ apart. A point charge $q$ is placed in the region between them, a distance $x$ from one plate. Find the force on $q$. Check that your answer is correct for the special cases $a \to \infty$ and $x = a/2$.

3. A long metal pipe of square cross-section (side $a$) is grounded on three sides, while the fourth (which is insulated from the rest) is maintained at constant potential $V_0$.

(a) Find the potential inside the metal pipe.

(b) Find the charge per unit length on the section opposite to $V_0$. 