1. **Find the capacitance per unit length of two coaxial metal cylindrical tubes of radii $a$ and $b$.**

2. **A chargeless region is bounded by two conducting surfaces.**

   (a) **If conductor 1 is maintained at potential $V_1$ and 2 is grounded the potential in the region is given by the function $\Phi_1(x, y, z)$. If conductor 2 is maintained at potential $V_2$ and 1 is grounded the potential in the region is given by the function $\Phi_2(x, y, z)$. Now if conductor 1 is maintained at potential $V_1$ and conductor 2 is maintained at potential $V_2$ prove that the potential in the region will be given by the function $\Phi = \Phi_1 + \Phi_2$.**

   (b) **If a charge $Q_1$ is placed on conductor 1 while 2 is chargeless the potential in the region is given by the function $\Phi_1(x, y, z)$. If a charge $Q_2$ is placed on conductor 2 while 1 is chargeless the potential in the region is given by the function $\Phi_2(x, y, z)$.**
   **Now if charge $Q_1$ is placed on conductor 1 and charge $Q_2$ is placed on 2 prove that the potential in the region will be given by the function $\Phi = \Phi_1 + \Phi_2$.**

   **This result can be extended to a region bounded by any number of conductors.**

3. **A point charge $q$ is placed a distance $a$ from the center of a grounded conducting sphere of radius $R$, $a > R$.**

   (a) **In the method of images find the quantity and the position of the image charge. Justify that this image charge makes the potential of the whole conductor 0.**

   (b) **Find the force of attraction between the point charge and the sphere.**

**(c) If the sphere was not grounded, what would be the potential of the sphere when the charge $q$ is placed at the distance $a$ from the center of the sphere?**

**4. A metal sphere of radius $R$ carrying a charge $q$ is surrounded by a thick concentric metal shell of inner radius $a$ and outer radius $b$. The shell carries no net charge.**

**(a) Find the surface charge density $\sigma$ at radius $R, a$ and $b$.**

**(b) Find the potential at the center, using infinity as the reference point.**

**(c) If the outer surface $r = b$ is grounded how do the answers to part (a) and (b) change ?**

**5. The points on the $xy$ plane is maintained at potential $V_0 \sin(\alpha x + \beta)$. The potential goes to 0 as $z \to \pm\infty$. Find the potential at all the points above and below the $xy$ plane.**

**6. Find the electric potential for $z \neq 0$ due to the infinite $xy$ plane carrying a uniform charge density $\sigma$.**
**How can we get this potential by solving the two dimensional Laplace's equation**

$$\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial z^2} = 0$$

**by the variable separation method ?**
**(We can also start with the three dimensional Laplace's equation. But two is good enough to demonstrate the process.)**