1. An electric quadrupole is four charges arranged on the corners of a square as shown. This system has zero monopole strength (zero net charge) and zero dipole moment.

(a) Draw 8 electric field lines per charge.
(b) Determine the electric field $\vec{E}(x)$ at points on the $x$ axis.
(c) Find a simple form for $\vec{E}(x)$ for points far away on the $x$ axis $x \gg a$. (Hint: binomial expansion.)

2. A solid spherical insulator has radius $a$ and constant charge density $\rho$.

(a) Derive the potential $V_{\text{out}}(r)$ outside the sphere. Let $V_{\text{out}}(\infty) = 0$.
(b) Derive the potential $V_{\text{in}}(r)$ inside the sphere.
(c) Draw equipotential contours, three inside and three outside. (Remember that the separation $\Delta V$ between contours is constant.)

3. Two long parallel wires each have radius $a$ and are separated a distance $d$, where $d \gg a$. Determine the capacitance per length $c$.

4. A hollow cylinder has outer radius $r$, wall thickness $w$ and length $L$. It is made from a material with electrical conductivity $\sigma$. Determine the resistance $R$ of the cylinder when its ends are connected to a battery of voltage $V$.

5. A regular tetrahedron is made of 6 wires, each wire having resistance $R$. Find the effective resistance $R_{\text{eff}}$ between any two vertices.