A long thin wire has a linear charge density of λ. Find an expression for the electric field at the distance R from the wire.

We'll use the Gauss's law. Let's put wire into a cylinder with radius R and height Δl. Then the electric flow is

$$\Phi_{\mathbf{E}} = \frac{Q}{\varepsilon_0} = \frac{\lambda \Delta l}{\varepsilon_0}.$$

(in SI system).

On the other hand, because of symmetry:

1. field strength vector is directed perpendicular to the wire, straight from her (or directly to it).
2. module of this vector at any point on the surface of the cylinder is the same.

   Then the flow through this surface can be calculated as follows:

$$\Phi_{\mathbf{E}} = \sum_i \Delta S_i E_i = E \sum_i \Delta S_i = ES = E 2\pi R \Delta l.$$

   Equating the two expressions obtained, we have:

$$\frac{\lambda \Delta l}{\varepsilon_0} = E 2\pi R \Delta l,$$
$$E = \frac{\lambda}{2\pi \varepsilon_0 R}.$$

(or $E = 2\lambda / R$ in CGS system).