Problem 2.59) Imagine a cylindrical can of arbitrary length L and radius R, where $R_1 < R < R_2$, centered on the z-axis. The integral of the E-field over the closed cylindrical surface must be zero because (i) inside the metallic shell there cannot be any E-field, and (ii) E_z must vanish at the top and bottom facets of the can (because of symmetry). Therefore, the integral form of Maxwell's 1st equation, namely, $\oint \boldsymbol{D} \cdot d\boldsymbol{s} = Q_{\text{total}}$, requires that the total free charge Q_{total} contained within the can must be zero.

Since the wire has a charge of $\lambda_0 L$ inside the can, the inner surface of the metallic shell must have an equal and opposite charge. The surface charge density on the inner surface of the shell is thus $\sigma_1 =-(\lambda_0 L)/(2\pi R_1 L) = -\lambda_0/(2\pi R_1)$ [coulomb/m^2]. Since the shell is initially charge-neutral, the same amount of charge, albeit with opposite sign, must appear on its external surface. Therefore, $\sigma_2 = \lambda_0/(2\pi R_2)$ [coulomb/m^2].