Problem 2-23) The magnetic field $\boldsymbol{B}$ produced by the current I_1 at the location of the second wire is $\boldsymbol{B}_{12} = \mu_0 I_1 \hat{\boldsymbol{\varphi}}/(2\pi d)$. Here $\hat{\boldsymbol{\varphi}}$ is the azimuthal unit-vector of the cylindrical coordinates.

Next, assume that the density (per unit length) of the mobile charges in the second wire is Q. If these charges move along the length of the wire with velocity $\boldsymbol{V}$, the amount of charge crossing any cross-section per unit time will be QV; therefore, $I_2 = QV$. The force per unit length is thus given by the Lorentz force law as follows:

$$\boldsymbol{F}_{12} = Q\boldsymbol{V} \times \boldsymbol{B} = -\left(\frac{\mu_0 I_1 I_2}{2\pi d}\right)\hat{\boldsymbol{\rho}}.$$

Here $\hat{\boldsymbol{\rho}}$ is the radial unit-vector of the cylindrical coordinates. From symmetry we find that

$$\boldsymbol{F}_{21} = +\left(\frac{\mu_0 I_1 I_2}{2\pi d}\right)\hat{\boldsymbol{\rho}}.$$

The wires thus attract each other when I_1 and I_2 are in the same direction; they repel each other when I_1 and I_2 are in opposite directions.