Hint on Problem 12b:

First show that $\mathbf{x}^T\mathbf{Q}_i\mathbf{x} + \mathbf{p}_i^T\mathbf{x} + r_i \leq 0$ if and only if

$$\left[\begin{array}{cc} \mathbf{I} & \mathbf{Bx} \\ (\mathbf{Bx})^T & -\mathbf{p}_i^T\mathbf{x} - r_i \end{array} \right] \succeq 0.$$

"$\succeq$" means "positive semi-definite".

(For partial credit, use this fact without proof.)