1. Exercise 4.17 of the textbook.

2. Exercise 4.23 of the textbook. When $Q = C^TC$, the control $u(t) = -R^{-1}B^TPx(t)$ can be considered as the stationary Linear Quadratic (LQ) optimal state feedback control for the LTI system:

$$\dot{x}(t) = Ax(t) + Bu(t), \quad y(t) = Cx(t).$$

The associated performance cost is

$$J = \frac{1}{2} \int_0^\infty x^T(t)Qx(t) + u^T(t)Ru(t)dt = \frac{1}{2} \int_0^\infty y^T(t)y(t) + u^T(t)Ru(t)dt.$$