ECE 5404: Multivariable Control

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Test#4

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Each problem is worth 10 points.

1. Find the minimizing control and the corresponding minimum cost for the system
   $\dot{x}_1(t) = 2x_1(t)$
   $\dot{x}_2(t) = -3x_2(t) + u(t)$
   $J(x(.), u(.)) = \int_0^\infty \{x^T(t) \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix} x(t) + u^2(t)\} dt$

2. Assuming that the assumptions of the Kalman Filter are true, is the following true? Prove your answer.
   $E[\{x(t) - \hat{x}(t)\} x^T(t)] = E[\{x(t) - \hat{x}(t)\}\{x(t) - \hat{x}(t)\}^T]$

3. Design a feedback controller that minimizes
   $J(x(.), u(.)) = E[25x^2(\infty) + u^2(\infty)]$
   for the following system:
   $\dot{x}(t) = 5x(t) + 3u(t) + 2w(t)$
   $m(t) = 3x(t)$
   Given that $S_w = 1$

4. Design an LQR based control design such that the steady state value for the output *y*(*t*) is 2 for the following system.
   $\dot{x}(t) = 3x(t) + u(t)$
   $y(t) = 5x(t)$
   You can take the value of any weights to be unity.