1. The transfer function
\[ G(s) = \frac{s - 3}{s^3 - s^2 + s + 2} \]
is placed in a unity negative feedback loop under proportional control with gain \( k = 1 \). Use the Nyquist criterion to predict the number of unstable closed-loop poles. Verify the answer by finding the closed-loop transfer function and its poles.

2. A controller is sought for the following plant:
\[ G(s) = \frac{s + 2}{s^3 + 3.2s^2 + 1.6s + 3} \]

Consider the following design specifications relative to a step input command:
- Steady-state error less than 10%
- Settling time less than 8 seconds
- Overshoot less than 30%

1. Translate the design specifications into the frequency domain and represent the constraints in a Bode plot of the target loop.
2. Use SISOtool to find a simple controller (lead-lag suggested) that meets the specifications.
3. Find the closed-loop transfer function using the `feedback` command and display the step response, indicating that the specifications have been met.

3. Find a state-space representation for the transfer function of Problem 1 by hand. Then obtain one using Matlab. Are they the same? Why? Finally, find the transfer function from the Matlab-generated state-space representation and verify that it is the same as the original.

4. a. Find all equilibrium points of the following nonlinear system for \( u = 1 \).
\[
\dot{x}_1 = -x_1^2 + x_1x_2 + u \\
\dot{x}_2 = x_1 + x_2u
\]
b. Linearize the system about \( u = 1 \) and the equilibrium point located in the 4th quadrant of the \( x_1, x_2 \) plane. Find the state-space matrices of the linearization.