# Embedded Control and Mechatronics

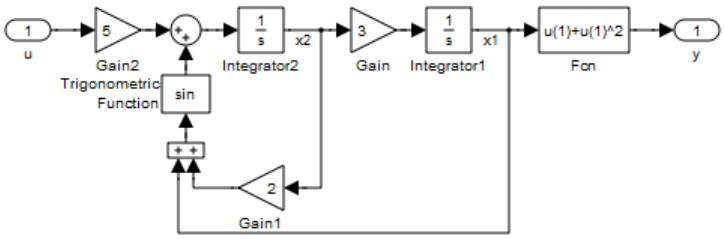
**Fall 2011** **ECE-456**

**Dr. F. Pourboghrat** **Quiz-2** **Name:**

(**Solve the following two problems and verify them with Matlab/Simulink**)

(**Due: Wed 11/02/2011, at the beginning of class**)

#1) Consider the Simulink model of a nonlinear system, as shown in the figure.




a) Write down the mathematical equation for the states and the output of the system from the Simulink model.

b) Find the equilibrium point of the system for $y = 0$.

c) Write the linearized state-space model of the system around the equilibrium-point.

d) Find the transfer function of the linearized model. ( **Hint**: Differentiate $y$ twice, substitute for $\dot{x}_1$ and $\dot{x}_2$, and apply Laplace transform, or directly use the formula $G(s) = C(sI - A)^{-1}B + D$ ).

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#2) Consider a dynamic system with transfer function $G(s) = \frac{2}{s^2-5s+4}$.

a) Write the state equation of the system in control canonical form.

b) Find the eigenvalues of the linearized system (poles of the transfer function) and determine if the system is stable.

c) Consider a control of the form $\boldsymbol{u = -Kx + r}$ , where $\boldsymbol{r}$ is a unit-step reference. Find the closed-loop transfer function of the system in terms of the elements of the gain vector $\boldsymbol{K = [k_1, k_2]}$. (**Hint**: Plug in for $\boldsymbol{u}$ in the system's equation).

d) Find the gain vector $\boldsymbol{K}$ such that the closed-loop eigenvalues are placed at -1 and -2.

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