Embedded Control and Mechatronics

Spring 2012 **ECE-456**

Dr. F. Pourboghrat **Quiz-1** **Name:**

#1) The differential equation model of a nonlinear time-invariant system is: $\ddot{y} = -(\dot{y}^2 + 4)y + 5u$.

a) Given $x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} y \\ \dot{y} \end{bmatrix}$, write the **state equation** of the system, as $\begin{cases} \dot{x} = f(x,u) \\ y = x_1 \end{cases}$.

b) Draw a **Simulink model** of the system.

c) Find the **equilibrium/operating point** of the system, for $y = 0$ fixed, (Hint: set all derivatives equal to zero).

d) Find the **linearized state model** of the system at the equilibrium/operating point: $x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$, $u = 0$.

e) Find the **transfer function** G(s) = $\left.\frac{Y(s)}{U(s)}\right|_{IC=0}$ of the linearized system.

f) Find the **poles and zeros** of the above transfer function G(s), and check the **stability** of the system.

g) **Explain** what the following Matlab commands do?

I. [xe,ue,ye,dxe]=trim('sim_model',[],[],0,[],[],1) (Compare to: [X,U,Y,DX]=TRIM('SYS',X0,U0,Y0,IX,IU,IY))

II. [A,B,C,D]=linmod('sim_model',xe,ue) (Compare to: [A,B,C,D]=LINMOD('SYS',X,U))

h) **Write** a short Matlab code to:

I. express the transfer function G(s), found in part (f),

II. find the poles “p”, zeros “z”, and DC-gain “G0” of G(s),

III. find the equivalent linear state model “sys” of G(s),

IV. Check the controllability and observability of the above linear state model “sys”.