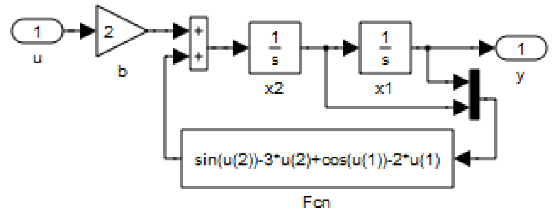
Embedded Control and Mechatronics

Spring 2012 **ECE-456**

Dr. F. Pourboghrat **Quiz-1 (Make-Up)** **Name:**

#1) The Simulink model of a nonlinear system is shown in the figure.



a) For $x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$, write the system's **state equation**: $\begin{cases} \dot{x} = f(x,u) \\ y = x_1 \end{cases}$.

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

c) Find the **linearized state model** of the system at equilibrium/operating point: $x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$, $u = -0.5$.

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

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

I. [xe,ue,ye,dxe]=trim('q12',[],[],0,[],[],1) (Compare to: [X,U,Y,DX]=TRIM('SYS',X0,U0,Y0,IX,IU,IY))

II. [A,B,C,D]=linmod('q12',xe,ue) (Compare to: [A,B,C,D]=LINMOD('SYS',X,U))

III. sys=ss(A,B,C,D); G=tf(sys), Gz=c2d(G,1),

IV. t=0:1:9; u=idinput(10,'PRBS'); y=lsim(G,u,t);

V. T1=arx([y,u],[2 2 1]); GG=tf(T1); Gzh=GG(1), Gh=d2c(Gzh),

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

I. find a **balanced reduced (first-order) model** Gr(s) of system G(s), (Hint: use "balreal" and "modred")

II. draw the **Bode-plot** of G(s) and the reduced-order model Gr(s),

III. Draw the **step-response** of G(s) and the reduced-order model Gr(s),