Mansoura University
Faculty of Engineering
Department: Computer & Sys.
MSC Exam

Course: Modern Control Theory
Total : 100 Marks
Time : 3 hours
Date :8-9-2013

**1-a- define the controllability and observability** **[25 marks]**

**-b- investigate the observability condition for linear time-invariant system**

**-c-for the system shown**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} \mathbf{u}$$

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

**Determine the conditions on a, b, c, and d. So that the system is completely controllable and observable.**

**-d- for the system** $T(s) = \frac{y(s)}{u(s)} = \frac{s+a}{(s+17)(s+75)}$

**Determine the value of a, so that the system is either controllable or observable.**

**-e- for the system shown**

$$x(k+1) = \begin{bmatrix} 1 & 0 \\ -0.5 & 0.5 \end{bmatrix} x(k) \qquad y(k) = \begin{bmatrix} 5 & 1 \end{bmatrix} x(k)$$

**Test the Controllability and Observability.**

**2-a- explain the main tasks in any SCADA system.** **[20 marks]**

**-b- Find three different state space representations for the system described by**

$$T(s) = \frac{1}{s^3 + 10s^2 + 27s + 18}$$

**3- a- list the key features of SCADA software.** **[25 marks]**

**-b- A system is described by**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -2 & -2 & 0 \\ 0 & 0 & 1 \\ 0 & -3 & -4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} u_1(t) \\ u_2(t) \end{bmatrix}$$

$$y(t) = \begin{bmatrix} 4 & 1 \end{bmatrix} x(t)$$

**-i- Find the change of variables $x=Mq$ which uncouples this system.**

**-ii- If** $x(0) = \begin{bmatrix} 10 \\ 5 \\ 2 \end{bmatrix}$ **, and if** $u(t) = \begin{bmatrix} t \\ 1 \end{bmatrix}$ **, Find $x(t)$**

**4-a- explain the different types of interfaces within the microcontroller. [20 marks]**

**-b- A system is described by the coupled input-output equations**

$$\dot{Y_1} + 2(Y_1 + Y_2) = U_1$$

$$\ddot{Y_2} + 4\dot{Y_2} + 3Y_2 = U_2$$

**Find** $y(t) = \begin{bmatrix} y_1(t) \\ y_2(t) \end{bmatrix}$ **if** $y_1(0) = 1$, $y_2(0) = 2$, $\dot{y}_2(0) = 0$ **and** $u_2(t) = \delta(t)$.

**5-a- For the discrete transfer function: [20 marks]**

$$T(z) = \frac{0.013667z^2 + 0.00167z - 0.0050}{z^3 - 1.7085z^2 + 0.9425z - 0.1653}$$

**Find the state equations in four solutions.**

**-b- Draw a simulation diagram and express the following nonlinear, time-varying system is state space form:**

$$y(k+3) + y(k+2)y(k+1) + a\,sin(\omega k)y^2(k) = u(k) - 3u(k+1)$$

*With all best wishes*

*Dr. Sabry F. Saraya*