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Examination: B.Tech. End Semester Examination, November-2022

Branch : Electrical Engineering | Semester : VIIth

Course : Modern Control Systems | Code : EE-411

Time: 03:00 Hours | **Maximum Marks: 50**

Instruction: Attempt all the questions.

Q. 1. Construct the state-space model for a system characterized by the differential equation

$$\frac{d^3y}{dt^3} + 6\frac{d^2y}{dt^2} + 11\frac{dy}{dt} + 6y = u$$

and also represent the block diagram of the state model. **[05]**

Q. 2. Consider the system with Matrices

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

Construct the state equation model and find the Observability of the given system using both Gilbert's method and Kalman's test. **[05]**

Q. 3. Solve the following difference equation:

$2x(k) - 2x(k-1) + x(k-2) = u(k)$; where $x(k) = 0$, $for\ k < 0$ and

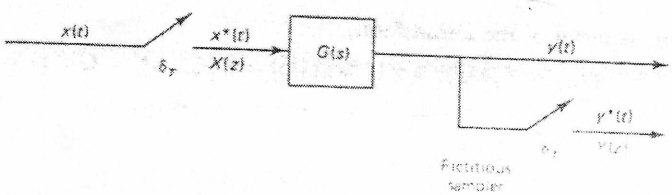
$$u(k) = \begin{cases} 1, k = 0,1,.. \\ 0, k < 0 \end{cases}$$

[05]

Q. 4. Obtain the pulse transfer function of the system shown in the below figure, where *G(s)* is given by

$$G(s) = \frac{1-e^{-Ts}}{s}\frac{1}{s(s+1)}$$

Note that there is a sampler at the input of *G(s)*.



[05]

Q. 5. Consider the discrete-time unity-feedback control system (with sampling period T = 1 sec) whose open-loop pulse transfer function is given by

$$G(z) = \frac{K(0.3679z + 0.2642)}{(z - 0.3679)(z - 1)}$$

Determine the range of gain K for stability by use of the Jury's stability test. **[05]**

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Q. 6. Obtain the state transition matrix of the following discrete-time system:

$$x(k+1) = Gx(k) + Hu(k)$$

$$y(k) = Cx(k)$$

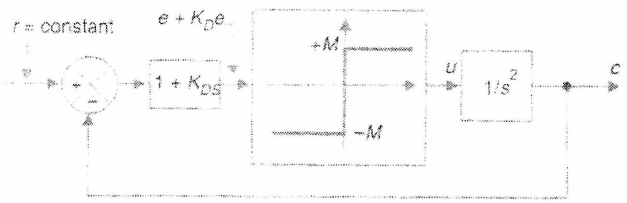
where $G = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix}, H = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, C = [1 \quad 0]$

Then obtain the state $x(k)$ and the output $y(k)$ when the input $u(k) = 1$ for $k = 0, 1, 2, \ldots$ Assume that the initial state is given by

$$x(0) = \begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix} = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$ **[05]**

Q. 7. Explain the different types of non-linearities with suitable examples in details. **[05]**

Q. 8. Consider the proportional plus derivative controller ahead of an ideal relay shown in the given below figure. Construct the Phase-trajectories of the given system by using the analytical method. **[05]**



Q. 9. Describe and explain the concept and methods of the Liapunov and Popov stability criterian with suitable examples. **[05]**

Q. 10. Describe and explain the concept and process of the Model Reference Adaptive Control with suitable examples. **[05]**

****** All the Best ******