

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Regular/ Backlog), April-May 2018

B. Tech/ M. Tech (as applicable) in Electrical.....Engineering, Semester ...VI...

Roll No.....

COURSE CODE: EE604

Time: 3 hours

Max. Marks: 100

COURSE TITLE: Advanced Control System

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

Q.1A Objective type multiple choice questions (10 questions @ 1 mark)

10

- i. A control system represented by $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$

and $y = \begin{bmatrix} 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$ the transfer function is

(a) $\frac{s}{s+1}$

(b) $\frac{1}{s+3}$

(c) $\frac{1}{s+1}$

(d) $\frac{s}{s^2+4s+3}$

- ii. The state model is given as $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$. If the input is unit step, the time response is

(a) undamped

(b) under damped

(c) critically damped

(d) over damped

- iii. An autonomous state equation is $\dot{x} = [A]x$ where, $[A] = \begin{bmatrix} 0 & 2 \\ 8 & 0 \end{bmatrix}$. the poles are located at

(a) $j4, -j4$

(b) $-4, 2$

(c) $j2, -j2$

(d) $-8, 4$

- iv. The characteristic equation for a system having state equation

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 4 \\ -2 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$$

(a) $s^2 + 5s + 8 = 0$

(b) $s^2 + 4s + 3 = 0$

(c) $s^2 + 4s + 5 = 0$

(d) $s^2 + 4s + 2 = 0$

- v. For the system $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 2 & 0 \\ 0 & 4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} r(t)$ and $y = \begin{bmatrix} 4 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$

Where $r(t)$ is a unit impulse function. Having initial conditions as nil, the output y is determined as...

(a) $y(t) = 2e^{2t}$

(b) $y(t) = 4e^{2t}$

(c) $y(t) = 2e^{4t}$

(d) $y(t) = 4e^{4t}$

- vi. In z-plane the unit circle corresponds to

(a) Imaginary axis of s-plane

(b) + real axis of s-plane

- (c) - real axis of s-plane
 (d) Origin of s-plane
- vii. The faithful reconstruction of a signal on account of sampling is obtained if
 (a) $w_s = w_1$ (b) $w_s \geq 2w_1$ (c) $w_s \leq w_1$ (d) $w_s \leq 2w_1$
- viii. For second order system with an initial condition of $\begin{bmatrix} 1 \\ 2 \end{bmatrix}$ without any external input, the state transition matrix for the system is given below:

$$\phi(t) = \begin{bmatrix} e^{-2t} & 0 \\ 0 & e^{-t} \end{bmatrix}$$

The state of the system at the end of one second is

- (a) $\begin{bmatrix} 0.135 \\ 0.735 \end{bmatrix}$ (b) $\begin{bmatrix} 0.135 \\ 0.368 \end{bmatrix}$ (c) $\begin{bmatrix} 0.271 \\ 0.735 \end{bmatrix}$ (d) $\begin{bmatrix} 0.135 \\ 1.47 \end{bmatrix}$
- ix. With reference to state space representation of the equation,

$$\frac{d^2 y(t)}{dt^2} + \frac{2dy(t)}{dt} + 3y(t) = u(t). \text{ The matrices A}$$

and B are,

(a) $A = \begin{bmatrix} 0 & 1 \\ -3 & -2 \end{bmatrix}; B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$

(b) $A = \begin{bmatrix} -2 & -3 \\ 0 & 1 \end{bmatrix}; B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$

(c) $A = \begin{bmatrix} 0 & -2 \\ 1 & -3 \end{bmatrix}; B = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

(d) $A = \begin{bmatrix} -2 & 0 \\ 1 & -3 \end{bmatrix}; B = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

- x. In z-plane the unit circle corresponds to
 (e) Imaginary axis of s-plane
 (f) + real axis of s-plane
 (g) - real axis of s-plane
 (h) Origin of s-plane

Q.2 Short answer type questions (4 questions @ 2.5 marks)

10

- Define positive definiteness, negative definiteness and positive and negative semi definiteness of scalar functions.
- Explain and illustrate the phenomenon of jump resonance.
- Explain the back-lash nonlinearity with an example.
- What is sylvester's criterion? Where it is used?

Q.3A What is do you mean by sampler and ideal sampler? Explain the working of sampler.

05

Q.3B A system is described by the following equations

05

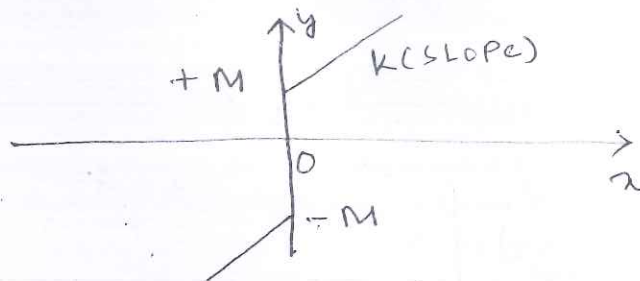
$$\dot{x}(t) = \begin{bmatrix} -1 & 1 \\ 0 & -2 \end{bmatrix} x(t) + \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 1 & 2 \\ 1 & 0 \\ 1 & 1 \end{bmatrix} x(t)$$

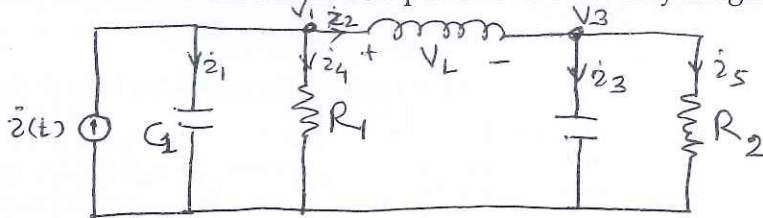
find the transfer function of the system.

Q.4A Determine the describing function for the following non-linearity.

05



- Q.4B Write the state-variable formulation of the network shown below and construct the state model. Where all the components are of unity magnitude. 05



choose charges and fluxes as state variables.

- Q.5A Determine the equilibrium points and investigate the stability for the following systems using Liapunov function. 05

(a) $\dot{x}_1 = -x_1 + x_2^2$
 $\dot{x}_2 = -x_2$

(b) $\dot{x}_1 = -x_1 + x_1^2 x_2$
 $\dot{x}_2 = -x_2 + x_1$

- Q.5B Determine the stability of the system using sylvester's Theorem. 05

$$\dot{x} = Ax$$

Where $A = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix}$

- Q.6A Find the state transition matrix e^{At} for $A = \begin{bmatrix} 1 & 4 \\ -2 & -5 \end{bmatrix}$ using inverse Laplace transform method. 05

- Q.6B The transfer function is given by 05

$$\frac{Y(s)}{U(s)} = \frac{(s+3)}{(s+1)(s+2)}$$

Obtain the state model in the canonical form using parallel decomposition method.

OR

- Q.6B Obtain the state equations for the differential equation 05

$$\frac{d^2 y}{dt^2} + \frac{3dy}{dt} + 4y = \frac{du}{dt} + 3u$$

- Q.7A Verify the controllability. given that : 05

$$\dot{x}_1 = x_2 + u_1$$

$$\dot{x}_2 = x_3$$

$$\dot{x}_3 = -2x_2 - 3x_3 + U_1 + U_2$$

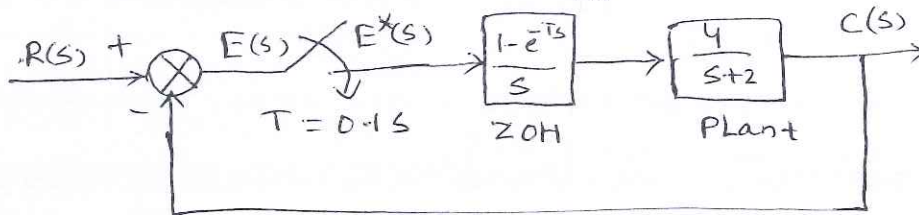
Q.7B Write a short note on sampling theorem. 05

OR

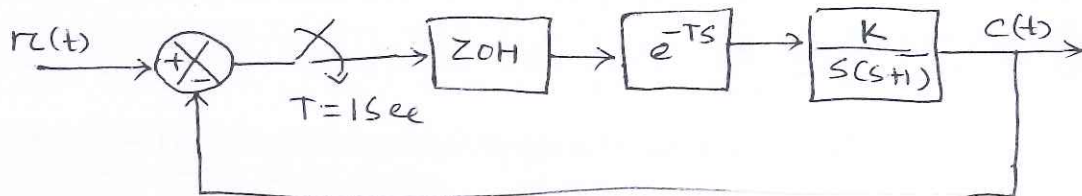
Q.7B Solve the following difference equation by z-Transform method. 05

$$C(k+2) - 5c(k+1) + 6c(k) = u(k)$$

Q.8A Find the unit-step response for the first-order system shown in the figure below 10
having the plant transfer function as $G(s) = \frac{4}{s+2}$



Q.9A Find the range of K for the system shown in the figure below to be stable. 10

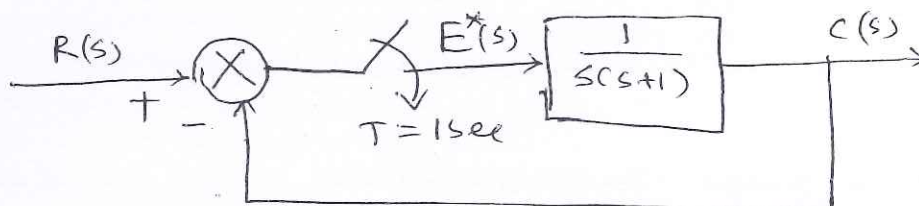


Q.9B Find the inverse z-Transform in number sequence form for the function 10

$$F(Z) = \frac{Z}{Z^2 - Z + 0.5}$$

OR

Q.9B Determine the pulse transfer function for the system shown below. 10



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All the best!!