Total No. of printed pages = 2

EI 1815PE11

Roll No. of candidate | | | | | | | | | | |

1/3/22 2021

B.Tech. 5th Semester End-Term Examination

IE

ADVANCED CONTROL SYSTEM

(New Regulation & New Syllabus)

Full Marks – 70 Time – Three hours

The figures in the margin indicate full marks
for the questions.

Answer *all* questions.

1. Answer any *five* : $(5 \times 2 = 10)$

   (a) Define observability.

   (b) A system is described by the following state model

   $$\dot{x}_1 = -3x_1 + x_2 + 2u$$
   $$\dot{x}_2 = -2x_2 + u$$
   $$y = x$$

   What will be system transfer function?

   (c) What is Singular point?

   (d) What is positive definiteness of a matrix?

   (e) Find the Eigen values of $A = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix}$.

   (f) Write down the properties of state transition matrix.

[Turn over

2. Answer any *two* : (2×10=20)

(a) Obtain the time response y(t), of the system given below using Laplace transformation.

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix}=\begin{bmatrix}-1 & 0 & 1\\ 1 & -2 & 0\\ 0 & 0 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}+\begin{bmatrix}0\\ 0\\ 1\end{bmatrix}u;\ y=[1\ 1\ 0]\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}$$

u is a unit step function and $x(0)=[0\ 0\ 2]^T$.

(b) A system is described by $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix}=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ 0 & -6 & -5\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}+\begin{bmatrix}0\\ 0\\ 1\end{bmatrix}u$. Design a state feedback controller such that the desired closed loop poles are at $(-1\pm j2)$, (-5).

(c) Derive Riccatti Equation.

3. Answer any *two* : (2×10=20)

(a) Derive the describing function of Saturation type nonlinearity.

(b) Consider a nonlinear system described by the equations

$$\dot{x}_1=-3x_1+x_2$$

$$\dot{x}_2=-x_1-x_2-x_2^3$$

Using the Krasovskii method for constructing the Lyapunov function with P as identity matrix, investigate the stability of the equilibrium state.

(c) Check for stability of the samples data control systems represented by the following characteristic equation (by Jury's test)

$$z^4-1.2z^3+1.04z^2-0.28z+0.02=0$$

4. Find the control law which minimizes the performance index. (20)

$$J=\int_0^\infty\left(x_2^2+u^2\right)\ \text{for the system}\ \begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ 0 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\ 1\end{bmatrix}u.$$