Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B. TECH (EE)/SEM-6/EE-603/2012

2012
CONTROL SYSTEM-II

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following:

$10 \times 1 = 10$

i) The given matrix is $\begin{bmatrix} 4 & -4 & 2 \\ -4 & 5 & -2 \\ 2 & -2 & 1 \end{bmatrix}$

a) Positive semi-definite b) Negative semi-definite

c) Positive definite d) Negative definite.

ii) Lyapunov's stability criterion can be used for determination of

a) Linear system b) Non-linear system

c) Both (a) & (b) d) None of these.

iii) If $A = \begin{bmatrix} -0\cdot5 & 0 \\ 0 & -2 \end{bmatrix}$ and $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ the

a) system is controllable

b) system is uncontrollable

c) system is undefined

d) none of these.

iv) Jump resonance characteristic can be found in

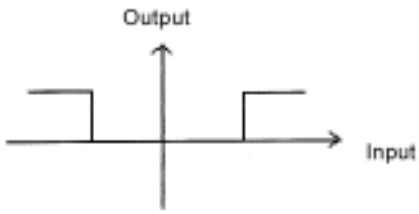
a) chaotic system

b) second order non-linear system

c) higher order non-linear system

d) linear time varying system.

v) The input-output characteristics of the following nonlinearity is



a) backlash non-linearity

b) relay with pure hysteresis

c) relay with dead-zone and hysteresis

d) relay with dead-zone.

vi) In order to design a linear system by pole placement technique, the first step to be carried out is

a) find the location of the poles of the system

b) check the damping and natural frequency

c) carry out the controllability test

d) check the observability.

vii) If the Eigenvalues of a second order system are complex conjugate with negative real parts, then the singularity point is termed as

a) the stable nodal point

b) the unstable nodal point

c) the stable focus point

d) the vortex point.

viii) Jury's stability test is carried out to check the stability of a

a) discrete time system

b) linear time invariant system

c) linear time varying system

d) non-linear system.

ix) For the given LTI system $x' = \begin{bmatrix} 3 & -2 \\ -1 & 2 \end{bmatrix} x$, diagonalization matrix is

a) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ b) $\begin{bmatrix} 0 & 4 \\ 1 & 0 \end{bmatrix}$

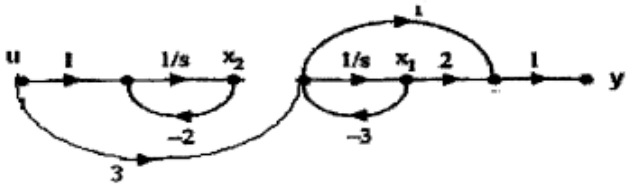
c) $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ d) $\begin{bmatrix} 1 & 0 \\ 0 & 4 \end{bmatrix}$.

x) The second order system $X = AX$ when $A = \begin{bmatrix} -1 & -1 \\ 1 & 0 \end{bmatrix}$; system is

a) Underdamped b) Undamped

c) Overdamped d) Critically damped.

xi) The state diagram of a system is shown in the given figure :



The system is

a) controllable and observable

b) controllable but not observable

c) observable but not controllable

d) neither controllable nor observable.

xii) The faithful reconstruction of a signal on account of sampling is obtained by

a) $\omega_s = \omega_m$ b) $\omega_s \geq 2\omega_m$

c) $\omega_s \leq \omega_m$ d) $\omega_s \leq 2\omega_m$.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Find out the describing function for Dead-zone with saturation.

3. A system is described by

$x_1' = -x_1 + x_2 + x_1 (x_1^2 + x_2^2)$

$x_2' = -x_1 - x_2 + x_1 (x_1^2 + x_2^2)$

Determine the asymptotic stability using Lyapunov's second method.

4. For the discrete time system

$x(k+2) + 5x(k+1) + 6x(k) = u(k),\ x(0) = x(1) = 0$

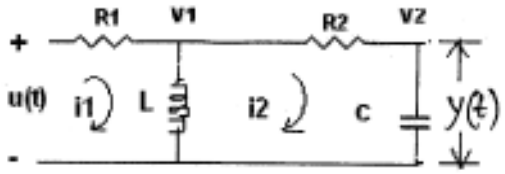
Find the state transition matrix.

5. Check the controllability and observability of the system :

$$X'(t) = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix} X(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

$y(t) = [1\ 0]\ X(t)$

6. Derive the state space representation of the network :



GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. A system is characterized by the following state equation

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

a) Find the transfer function of the system.

b) Draw the block diagram of the above transfer function.

c) Compute the state transition matrix.

d) Obtain the solution to the state equation for a unit step input under zero initial conditions. 4 + 3 + 4 + 4

8. a) Define Lyapunov's first theorem.

b) Consider a non-linear system described by the equations

$$\dot{x}_1 = -x_1 + 2x_1^2 + x_2$$

$$\dot{x}_2 = -x_2$$

Find the region in the state plane for which the equilibrium state of the system is asymptotically stable.

5 + 10

9. a) Consider the system defined by $\dot{X} = AX + BU$, where

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -30 & -11 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

By using feedback control $U = -Kx$, it is desired to have closed loop poles at $S = -2, -5$ and -6. Determine the state feedback gain matrix K. 5

b) Test the sign definiteness of the following quadratic scalar function :

$$V(X) = x_1^2 + 4x_2^2 + x_3^2 + 2x_1 x_2 - 6x_2 x_3 - 2x_1 x_3$$ 3

c) Consider the following non-linear differential equation :

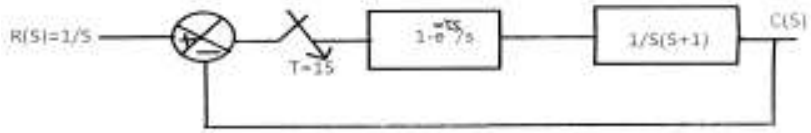
$$d^2x/dt^2 + x^2 + (dx/dt)^2 - 2x + dx/dt = 0$$

Determine the points of equilibrium points. 3

d) In continuous time, a system is given by the transfer function

$G(S) = K/S + a$, find the Z-transfer function $G(Z)$ 4

10. a) Find the time response of system shown in figure : 10



b) Given $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$, Determine $\varphi(k) = A^k$, using Cayley-Hamilton method. 5

11. Write short notes on any three of the following : 3×5

a) Anti-aliasing filters

b) Limit cycle

c) Pole placement

d) Digital control

e) Harmonic linearization.