Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/B.Tech(EE-NEW)/SEM-6/EE-603/2010

2010

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) Liapunov function must be

a) a scalar and negative definite function

b) a scalar and positive definite function

c) a positive semi-definite function

d) all of these.

ii) If both the eigenvalues of a second order system are real and negative, then it is termed as

a) the saddle point

b) the nodal point

c) the focus point

d) the unstable focus point.

iii) Hysteresis in a mechanical transmission is termed as

a) damping b) backlash

c) dead zone d) drift.

iv) For SISO : $Y(s) = G(s)U(s)$

a) $G(s)$ is a scalar

b) $G(s)$ is a transfer function

c) $G(s)$ is $m \infty r$ dimensional matrix

d) both (a) and (b).

v) The transfer function for the state variable representation is given by

a) $D + C(SI - A)^{-1} B$

b) $B + C(SI - A)^{-1} D$

c) $C + B(SI - A)^{-1} D$

d) $A + C(SI - B)^{-1} D$.

vi) The inverse Z transform of the function $\dfrac{TZ}{(Z-l)^2}$ is

a) kT b) $(kT)^2$

c) e^{-kT} d) 1.

vii) For the difference equation

$x(k+2) + 4x(k+1) + 5x(k) = 0$, the initial conditions are $x(0) = 0$ and $x(1) = 1$. The value of $x(2)$ is

a) 4 b) – 4

c) – 9 d) 0.

viii) For analysis of non-linear system by describing function

a) the structure of non-linear system must be reduced to linear $[G_L(jW)]$ and non-linear $[N(R)]$ parts

b) the structure of non-linear system must be reduced to non-linear $[N(R)]$ part only

c) the structure of whole system must be reduced to linear $[G_L(jW)]$ part only

d) the linear part must have characteristics of a high-pass filter.

ix) In a series $R - L - C$ circuit, the number of state variables is

a) 3 b) 2

c) 1 d) 0.

x) For all x in the state plane, $V(x) = x_1^2 + x_2^2$ is

a) positive definite b) positive semi-definite

c) negative definite d) indefinite.

xi) The device which converts as continuous signal into a sequence of pulses is termed as

a) synchro b) amplifier

c) sampler d) integrator.

xii) The phase plane analysis method is restricted to

a) second order systems

b) n order systems

c) 4th order system

d) none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. For the circuit shown, choose $V_1(t)$, $i_2(t)$ and $V_3(t)$ on state variables, the output $Y(t) = V_3(t)$ and hence obtain state equation representation.

Dia.

3. Give $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$, determine $\phi(k) = A^k$ using Cayley-Hamilton method.

4. Solve the difference equation

   $x(n+2) = 3x(n+1) + 2x(n) = u(n)$. The initial conditions are $x(0) = 0$ and $x(1) = 1$.

5. Use the second method of Liapunov to show that the following system is stable for all positive values of k.

$$\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & -1 & 1 \\ -k & (-1-k/2) & -k/2 \end{bmatrix} X$$

6. 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.

GROUP – C

(Long Answer Type Questions)

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

7. a) Determine the describing function of the non-linear element shown in the figure having a dead zone followed by linear characteristics.

Dia.

b) Using describing function analysis, determine the amplitude and frequency of the limit cycle when $k = 4$.

Dia.

8 + 7

8. a) Define phase plane, phase trajectory and phase portrait.

b) Plot the phase trajectory of the system shown with initial conditions $e(0) = 2$ and $e(0) = 0$.

Dia.

3 + 12

9. a) Determine the controllability and observability of the system

$$\dot{X} = \begin{bmatrix} -1 & 0 & 0 \\ 0 & -2 & 0 \\ 0 & 0 & -3 \end{bmatrix} X + \begin{bmatrix} 1 & 0 \\ 0 & 2 \\ 2 & 1 \end{bmatrix} u$$

$$Y = \begin{bmatrix} 1 & 1 & 2 \\ 3 & 1 & 0 \end{bmatrix} X$$

b) Obtain the solution of the state equation for $u(t) = 1$ for $t \geq 0$

$$\dot{X} = \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix} X + \begin{bmatrix} 0 \\ 2 \end{bmatrix} u$$

$$X(0) = \begin{bmatrix} 0 \\ 1 \end{bmatrix}, \; Y(t) = \begin{bmatrix} 1 & 1 \end{bmatrix} X(1).$$ 8 + 7

10. a) State Shanon's sampling theorem.

b) For the sampled data control system shown below, find the output (k) for $r(t)$ = unit step.

Dia.

3 + 12

11. a) Show that the arbitrary pole placement of a liner state feedback system is possible if the system is completely controllable.

b) Determine the state feedback gain matrix so that the closed loop poles of the following system are located at $(-2+j4)$, $(-2-j4)$, -10

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 0 \\ -1 & -5 & -6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

7 + 8

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

a) Harmonic linearization

b) Global asymptotic stability

c) Digital compensator

d) Anti-aliasing filters.