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.

http://qpaper.wbut.ac.in

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 $\frac{TZ}{(Z-l)^2}$ 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.

http://qpaper.wbut.ac.in

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. $3 \times 5 = 15$

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.

http://qpaper.wbut.ac.in

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.

http://qpaperwbut.ac.in

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

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

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

http://qpaper.wbut.ac.in

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

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

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

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.

http://qpaper.wbut.ac.in

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.

http://qpaper.wbut.ac.in