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CS/M.TECH (EE)/SEM-1/PEM-101/2011-12

2011
ADVANCED CONTROL SYSTEMS

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) Eigenvalues of a system are

      a) poles of the system

      b) zeros of the system

      c) both poles and zeros of the system

      d) only zeros which lie in left half of the s-plane.

   ii) Kalman's test is carried out to check

      a) the stability of the system

      b) the controllability & observability of the system

      c) type of singularity of the origin

      d) state transition matrix at $t = \infty$.

iii) Voltage drop across a resistor cannot be taken as a state variable because

a) resistor is not an energy storing element

b) it is a passive element

c) resistor has a tolerance band

d) all of these.

iv) The analysis of multiple inputs multiple outputs system is conveniently studied by

a) State space approach

b) Root locus approach

c) Characteristics equation approach

d) Nichols chart.

v) Existence of a limit cycle in a system depends upon

a) type of forcing function applied

b) the way forcing function is applied

c) the magnitude of forcing function

d) all of these.

vi) The state model of a linear continuous time system is the

a) state equation of the system

b) output equation of the system

c) state equation & output of the system

d) none of these.

vii) For single input, 4 state and 2 output system, the dimension of C matrix is

a) 4×4 b) 2×4

c) 4×2 d) 4×1.

viii) The second order system $\dot{x} = Ax$ has $A = \begin{matrix} -1 & -1 \\ 1 & 0 \end{matrix}$

The values of the damping & frequency are respectively

a) 1 & 1 b) 0.5 & 1

c) 0.707 & 2 d) 1 & 2.

ix) For state transition matrix $\phi\ t$, which statement is incorrect ?

a) $\phi\ (t_1 + t_2) = \phi\ (t_1) + \phi\ (t_2)$

b) $[\ \phi\ (t\ )\ ]^n = \phi\ (nt\ )$

c) $\phi^{-1}\ (t\ )\ ] = \phi\ (-\ t\ )$

d) $\phi\ (0) = I$.

x) One n-order system is fully observable when the observable matrix has rank

a) $(n-1)$ b) n

c) 2 d) None of these.

xi) The transfer function of a network is $\frac{1+0.3s}{2+s}$. It represents a

a) lag network

b) lead network

c) lag-lead network

d) proportional controller.

xii) For eliminating the steady state error, the control action required is

a) proportional control

b) proportional plus derivative control

c) proportional plus integral control

d) none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.

$3 \times 5 = 15$

2. A system is described by the differential equation $\frac{d^3y}{dt^3} + 6\frac{d^2y}{dt^2} + 11\frac{dy}{dt} + 10y = 8u(t)$, Where y is the output and u is the input to the system. Obtain the state space representation of the system.

3. Check whether the system represented by the following state equation is controllable or not :

$$\dot{x} = \begin{bmatrix} -5 & 2 & 1 \\ 0 & 0 & 1 \\ -1 & -4 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u \ , \ y = [\ 1 \quad 0 \quad 0\ ]\ x$$

4. A system is described by $\dot{x} = Ax + Bu$ and $y = Cx$ where the matrices are

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad C = \begin{bmatrix} 1 & 2 & 0 \end{bmatrix}$$

Determine the transfer function of the system.

5. Find out the controllable canonical form of the following system :

$$H(s) = (s + 1) \ / \ (s^2 + 5s + 3)$$

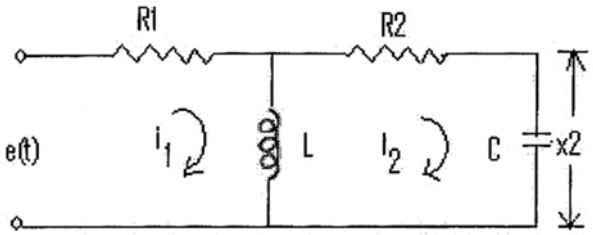
GROUP – C

(Long Answer Type Questions)

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

6. a) Write down the properties associated with state transition matrix.

b) Determine the state model for the following electrical system.



7. The state equation of a linear invariant system is given below :

$$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} -2 & 0 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

find out

i) state transition matrix

ii) the complete solution $x(t)$ of the state equation at $t > 0$ due to application of a step input under zero initial conditions.

iii) controllability of the system.

8. a) Digitalize the following system :

$$X = \begin{bmatrix} 0 & 1 & 0 \\ 3 & 0 & 2 \\ -12 & -7 & -6 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \\ 2 \end{bmatrix} u$$

b) Find out the controllable canonical realization of the following system :

$$H(s) = (s + 6) / (s^2 + 2s + 5)$$

9. a) Derive the transfer function of an armature controlled DC motor.

   b) A PI controller offsets steady state error. Explain.

   c) Why a derivative controller is not used alone ?