Registration no:

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M .TECH
EIPC201

Second Semester Examination 2013
CONTROL SYSTEM DESIGN

Time: 3 Hours

Max marks: 70

Answer Question No.1 which is compulsory and any five from the rest.
The figures in the right hand margin indicate marks.

Q1 Answer the following questions: (2 x 10)

(a) Discuss advantages and disadvantages of feedback control system .

(b) Using Routh –Hurwitz stability criterion determine the stability of the following :

(i) $S^2 - 3S + 1 = 0$

(ii) $S^3 + 3S^2 - 6S + 10 = 0$

(c) Derive the relation to convert state space model into transfer function ?

(d) What does it mean to say that a system is uncontrollable ? Justify your explanation using mathematical formulation ?

(e) What is usefulness of Caley Hamiltons theorem in computing state transition matrix of a system ?

(f) What are the Eigen Vectors ? How these are useful in diagonalsing a system matrix ?

(g) What are the general characteristics of a proportional controller ? Give its limitations and also give time domain equation of a PID controller ?

(h) State both the tuning rules of ziegler and Nichols method ?

(i) Draw the frequency response characteristics of a zero –order hold device ?

(j) State the shanon's sampling theorem ? What is its importance ?

Q 2 (a) Design a suitable lag compensating network for $G(S) = \frac{K}{S(S+2)(S+20)}$. Keep $Kv = 20, PM \geq 35 degrees$. (5)

b) Construct the state model for a system characterized by the differential equation

$$\frac{d^3y}{dt^3} + 6\frac{d^2y}{dt^2} + 11\frac{dy}{dt} + 6y = u$$

Give the block diagram representation of the state model. (5)

Q3(a) Consider a unity feedback system with open loop transfer function ,

$$G(s) = \frac{2}{S(S-1)(S-2)},$$

Draw the polar plot . Determine the GM and PM and comment upon the closed system stability . (5)

b)Sketch a Nyquist plot for a system with the open loop transfer function :

$$\frac{K(1+0.5S)(1+S)}{(1+10S)(S-1)}$$

Determine the range of values of K for which the system is stable ? (5)

Q 4) Consider the type 1 servo system described by :

$$\frac{dX}{dt} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -5 & -6 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} U$$

And output $y = [1 \quad 0 \quad 0]X$

Determine the feedback gain constants K1 ,K2 , K3 such that the closed loop poles at $s = -2 \pm j4 and\ s = -10$. Obtain the unit step response . (10)

Q 5(a) The dynamics of a system is represented by : (5)

$$\frac{dx}{dt} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u\ and\ y = [2 \quad 0]X$$

With the initial condition $X(0) = \begin{bmatrix} 0.5 \\ 0 \end{bmatrix}$

It is desired to design a state observer so that the new pole placement will be at -10 , -10 .

b) Consider the system : (5)

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

And output $y = [1 \quad 1 \quad 0]X$

Transform the system into (a) Controllable canonical form (b) Observer canonical form .

Q 6(a) Show how the disadvantages of $P, I and\ D$ control action are overcome in composite mode ? (5)

b) Discuss about controller setting using Ziegler –Nichols continuous cycling method and write its limitations ? (5)

Q 7(a) Without solving for the roots determine whether or not the following characteristics equation represents a stable discrete time system: $10Z^2 + 5Z + 1 = 0$ (5)

b) For the system : $G(z) = \dfrac{K(Z + 0.9)}{(Z - 1)(z - 0.7)}$ (5)

Determine the range of $'K'$ for stability by

(a) Bilinear transformation .

(b) Jury's stability test .

Q 8 Answer any two Questions (5x2)

(a) Resolvent Matrix

(b) Kalman's controllability

(c) Ackerman Controller .