Registration No. :

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B. Tech
PEEC 5414

Seventh Semester (Special) Examination – 2013

ADVANCED CONTROL SYSTEMS

BRANCH : AEIE, EC, EEE, ELECTRICAL, ETC

QUESTION CODE : D 412

Full Marks – 70

Time : 3 Hours

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

1. Answer the following questions : 2×10

   (a) Why is Laplace transform technique not applicable to nonlinear ordinary differential equations ?

   (b) Distinguish between phase plane trajectory and phase plane portrait.

   (c) What is the mapping function used to shift from S-plane to Z-plane ?

   (d) Is the assessment of stability by direct method of Lyapunovs for linear systems conservative ? Justify your answer.

   (e) What is Similarity transformation ? Show the differences among the state variable representation of

      (i) Physical Variable form

      (ii) Phase variable form

      (iii) Jordan canonical form.

   (f) Briefly describe the state feedback based control algorithm like pole placement and Ackermann state feedback control.

   (g) Illustrate how prediction of limit cycles is done with the use of Describing function.

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(h) What do you mean by ZOH equivalence method of discretization ?

(i) Illustrate any one method of construction of phase trajectory.

(j) Is there any fundamental difference between differential equation and difference equation ?

2. (a) Explain the effect of pole-zero cancellation on controllability and observability of the system 3

(b) A system described by 7

$$\frac{dX}{dt} = \begin{bmatrix} 2 & 1 & 2 \\ 3 & 2 & 1 \\ 2 & 3 & 2 \end{bmatrix} X \; ; \; y = \begin{bmatrix} 3 & 0 & 2 \\ 3 & 2 & 1 \end{bmatrix} X$$

Test the observability of the system.

3. (a) Compare Describing function method and phase plane method for the analysis of nonlinear control system. 5

(b) For the Nonlinear systems $\frac{d^2X}{dt^2} + 4\frac{dX}{dt} + X^2 = 0$ and $\frac{d^2X}{dt^2} + 2\frac{dX}{dt} + X = 0$, find out the nature of the phase plane and also determine the isocline equation for both the systems. 5

4. A regulator system has the plant described by

$$\frac{dX}{dt} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} X \; ; \; y = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} X$$

Design a state variable feedback controller which will place the closed loop poles at $-2 \pm j3.464$ and -5. 10

5. (a) A linear time-invariant system described by 5

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

(i) Comment on the stability of the system.

(ii) It is desired to locate the eigen-values at -1 and at -2, using state feedback decide the feedback gain matrix. 5

(b) For the system described by

$$\frac{dX}{dt} = \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix} X + \begin{bmatrix} b1 \\ b2 \end{bmatrix} U \text{ and } y = \begin{bmatrix} c1 & c2 \end{bmatrix} X.$$

What conditions should be on *b1, b2, c1* and *c2* so that the system should be observable as well as controllable ? 5

6. (a) Find the Z transform of $G(s) = \dfrac{s(2s+3)}{(s+1)^2(s+2)}$. 5

(b) Check the stability of following sampled data control system : 5

$f(z) = z^4 - 1.7z^3 + 1.04z^2 - 0.26z + 0.024 = 0$

7. (a) Find the Jordan canonical form (Diagonal matrix) of the matrix: 5

$$\begin{bmatrix} 4 & 1 & -2 \\ 1 & 0 & 2 \\ 1 & -1 & 3 \end{bmatrix}$$

(b) Define

(i) Stable system,

(ii) Asymptotically stable system, and

(iii) Globally asymptotically stable system in reference to phase plane analysis of nonlinear systems. 5

8. Write short notes on any **two** of the following : 5×2

(a) Caley Hamilton theorem in context of evaluation of state transition matrix

(b) Lyapunovs stability criteria

(c) Phase lead and phase lag controllers

(d) Delta method of construction of phase trajectory.