Registration No.:						
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Total number of printed pages - 3

B. Tech PEEC5414

## 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.

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 partrait.
- (c) What is the mapping function used to shift from plane to Z plane?
- (d) Is the assessment of stability by direct method of the property of 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.

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

   A system described by

  7
  - (b) A system described by

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

Test the observability of the system.

- 3. (a) Compare Describing function method and phase plane method for the analysis of nonlinear control system.
  - (b) For the Nonlinear systems  $\frac{d^2X}{dt^2} + 4\frac{dX}{dt} + X = 0$  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.
- 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.

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

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

- (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.

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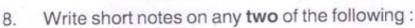
(b) For the system described by

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

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

- 6. (a) Find the Z transform of G(s) =  $\frac{s(2s+3)}{(s+1)^2(s+2)}$ .
  - (b) Check the stability of following sampled data control system:  $f(z) = z^4 1.7z^3 + 1.04z^2 0.26z + 0.024 = 0$
- 7. (a) Find the Jordan canonical form (Diagonal matrix) of the matrix: 5

- (b) Define
  - (i) Stable system,
  - (ii) Asymptotically stable system, and
  - (iii) Globally asymptotically stable system in exerence to phase plane analysis of nonlinear systems.



- (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.

