Code No: RR321303 **Set No. 1**

III B.Tech II Semester Supplementary Examinations, Nov/Dec 2005
ADVANCED CONTROL SYSTEMS
(Electronics & Control Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. State the basic theorem for determining the concept of controllability of time varying system utilizing state transition matrix. Explain the same with proof. [16]

2. For the system $\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x$ find a suitable Lyapunov function V(x). Find an upper bound on time that it takes the system to get from the initial condition $x(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ to within the area defined by $x_1^2 + x_2^2 = 0.1$. [16]

3. (a) Explain the different methods used to find the state feedback gain matrix and compare them?
   (b) Consider a linear system described by the transfer function $\frac{Y(s)}{u(s)} = \frac{10}{s(s+2)(s+1)}$

   Design a feed back controller with a state feedback so that the eigen values of the closed loop system are at -2, -1 $\pm j_1$. [6+10]

4. (a) Discuss the nature of information about the plant supplied to the controller?
   (b) Write short notes on Design of optimum controllers? [8+8]

5. (a) What are the generalized boundary conditions of a Hamiltonian Method for solving optimal control problems?
   (b) Consider a system

   $$\dot{x}_1(t) = x_2(t)$$
   $$\dot{x}_2(t) = u(t)$$
   $$J = \int_0^2 \frac{1}{2} u^2 \, dt$$

   Solve optimal control problem using Hamiltonian Method. [8+8]

6. Break up the following transfer matrices into R(s) and P(s). [6+5+5]

   (a) $T(s) = R(s)P^{-1}(s)$
   (b) R(s) and P(s) are relatively right prime,
   (c) P(s) is column proper

i. $T(s) = \begin{bmatrix} \frac{s+1}{s^2} & \frac{s+2}{s^2+1} \\ \frac{2}{s} & \frac{2s+3}{s^2+1} \end{bmatrix}$

ii. $T(s) = \begin{bmatrix} \frac{(s-2)(s+1)}{s(s-1)^2} & \frac{1}{(s-1)^2} \\ -\frac{1}{s} & 0 \\ \frac{2}{s(s-1)} & \frac{1}{s-1} \end{bmatrix}$

7. Write a programme in MATLAB for drawing root locus plot for the following system whose transfer function. [16]

$G(s)H(s) = \frac{K(s+6)}{s(s+4)\,(s^2+4s+8)}$

8. Write short notes on the following.
   (a) MATLAB - search path.
   (b) Data import and export in to MATLAB [8+8]

⋆⋆⋆⋆⋆

III B.Tech II Semester Supplementary Examinations, Nov/Dec 2005
ADVANCED CONTROL SYSTEMS
(Electronics & Control Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
⋆ ⋆ ⋆ ⋆ ⋆

1. Convert the system

$$x(t) = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 1 & 1 \end{bmatrix} x(t)$$

   (a) Find, if possible, a control law, which will derive the system from $X(0) = 0 \; to \; x^1 = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ in 2 sec.

   (b) Find, if possible, the state x(0) when $y(t) = \frac{1}{2}e^{-2t} + \frac{3}{2} \; for \; u(t) = 1, \; t > 0$ [8+8]

2. (a) Define Lyapunovs stability and Instability Theorem.

   (b) Suppose you are given a linear continuous time autonomous system, how do you decide whether a system is globally asymptotically stable? [8+8]

3. (a) How will you find the transformation matrix for observability.

   (b) The state model of a system is given by

$$\dot{X} = \begin{bmatrix} 0 & 0 & 1 \\ -2 & -3 & 0 \\ 0 & 2 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix} u \; ; \; y = [1 \;\; 0 \;\; 0] \; X$$

   Convert the state model to observable phase variable form. [6+10]

4. Consider a system described by the equation $\dot{X} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \; x_1(0) = x_2(0) = 1. Choose \; the \; feedback \; law \; u = -x_1 - kx_2.$

   (a) Find the value of K so that $J = 1/2 \int\limits_0^{\alpha} (x_1^2 + x_2^2)\, dt$

   (b) Find Sensitivity of J with respect to K. [8+8]

5. (a) Find the extermal for the following functional:

$$J(x) = \int\limits_0^{t_1} \frac{\sqrt{1+\dot{x}^2}}{x} dt$$

   x(0) = 0 and $x(t_1) = t_1 - 5$

(b) Distinguish between functions and functionals. [10+6]

6. (a) Derive the transfer matrix relation from state space representation

   (b) The state space triple (A, B, C,) of a system is given by [6+10]

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

   Calculate the input and output decoupling zeros, if any. Is the matrix A cyclic? Find out the transfer matrix T(s).

7. Write the MATLAB Programme for finding the error constants for

   (a) step

   (b) ramp

   (c) parabolic inputs and steady state error of the system for all the inputs whose transfer function is given by

$G(s)H(s) = \frac{10(s+4)}{(s+1)\,(s+3)\,(s+5)}$ [4+4+4+4]

8. (a) What is MATLAB ?Explain its merits and demerits and give some its features?

   (b) Explain the following in connection with MATLAB. [8+8]

      i. Command window
      ii. Command line editing
      iii. Format command
      iv. Starting MATLAB.

⋆ ⋆ ⋆ ⋆ ⋆

III B.Tech II Semester Supplementary Examinations, Nov/Dec 2005
ADVANCED CONTROL SYSTEMS
(Electronics & Control Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. Convert the system

$$x(t) = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 1 & 1 \end{bmatrix} x(t)$$

   (a) Find, if possible, a control law, which will derive the system from $X(0) = 0 \; to \; x^1 = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ in 2 sec.

   (b) Find, if possible, the state x(0) when $y(t) = \frac{1}{2}e^{-2t} + \frac{3}{2} \; for \; u(t) = 1, \; t > 0$ [8+8]

2. For the system $\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x$ find a suitable Lyapunov function V(x). Find an upper bound on time that it takes the system to get from the initial condition $x(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ to within the area defined by $x_1^2 + x_2^2 = 0.1$. [16]

3. (a) Explain the design of full-order state observer?

   (b) Consider the system

$$with \quad A = \begin{bmatrix} 0 & 20.6 \\ 1 & 0 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \quad C = [0 \; 1]$$

   Design a full-order state observer. Assume that the desired eigen values of the observer matrix are $\mu_1 = -1.8 + i2.4, \mu_2 = -1.8 - i2.4$. [8+8]

4. Consider the system $\dot{X}_1 = X_2; \dot{X}_2 = u; y = X_1$
   Find the control law which minimizes
   $J = 1/2 \int_0^{\alpha} y^2 + u^2) \, dt$ [16]

5. Illustrate with an example the problem with terminal time t_1 and $x(t_1)$ free. [16]

6. (a) Derive the transfer matrix relation from state space representation

   (b) The state space triple (A, B, C,) of a system is given by [6+10]

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

Calculate the input and output decoupling zeros, if any. Is the matrix A cyclic? Find out the transfer matrix T(s).

7. Obtain Bode plot for the following system and write a programme in MATLAB. [16]

$G(s)H(s) = \frac{100}{s(1+0.1s)\,(1+0.05s)}$

8. (a) What menu interface to PC - MATLAB? How do you perform using MATLAB Commands Giving examples.

   (b) Explain how different functions are used in MATLAB with examples. [8+8]

⋆⋆⋆⋆⋆

Code No: RR321303

Set No. 4

III B.Tech II Semester Supplementary Examinations, Nov/Dec 2005
ADVANCED CONTROL SYSTEMS
(Electronics & Control Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
⋆ ⋆ ⋆ ⋆ ⋆

1. Convert the following state model into the Jordan canonical form and thereform comment on controllability and observability. [8+8]

$$x(t) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -2 & -4 & -3 \end{bmatrix} x(t) + \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ -1 & 1 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 0 & 1 & -1 \\ 1 & 2 & 1 \end{bmatrix}$$

2. State, prove and explain Lyapunovs stability theorm. Also explain what are the sufficient conditions of stability. [8+8]

3. (a) Given the system X = Ax + Bu where

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

   Design a linear state variable feedback such that the closed-loop poles are located at -1,-2 and -3.

   (b) Explain the concept of Stabilizability. [10+6]

4. (a) What is meant by minimum energy control law.

   (b) Explain the factors to be considered for designing of an optimum controller. [8+8]

5. Illustrate with an example the problem with terminal time t_1 fixed and $x(t_1)$ free. [16]

6. Break up the following transfer matrices into R(s) and P(s). [6+5+5]

   (a) $T(s) = R(s)P^{-1}(s)$

   (b) R(s) and P(s) are relatively right prime,

   (c) P(s) is column proper

      i. $T(s) = \begin{bmatrix} \frac{s+1}{s^2} & \frac{s+2}{s^2+1} \\ \frac{2}{s} & \frac{2s+3}{s^2+1} \end{bmatrix}$

ii. $T(s) = \begin{bmatrix} \frac{(s-2)(s+1)}{s(s-1)^2} & \frac{1}{(s-1)^2} \\ -\frac{1}{s} & 0 \\ \frac{2}{s(s-1)} & \frac{1}{s-1} \end{bmatrix}$

7. Write a program in MATLAB to find the unit step response of a second order system. Consider for

   (a) over damped

   (b) under damped

   (c) critically damped. [6+5+5]

8. (a) How do you perform the following operations using MATLAB ?

   i. To find eigen values

   ii. Matrix multiplication

   Illustrate with examples.

   (b) Write short notes on:

   i. Relational and logic operations

   ii. Matrices operations and functions using MATLAB techniques. [8+8]

⋆⋆⋆⋆⋆