B.E. / B.Tech. (Full Time) DEGREE AND END SEMESTER EXAMINATION. APR/ MAY 2013

ELECTRICAL AND ELECTRONICS ENGINEERING

FIFITH SEMESTER

EE 9048– ADVANCED CONTROL SYSTEMS

(REGULATION 2008)

Time : 3 hr Max Mark: 100

Answer ALL Questions

PART – A (10 x 2 = 20 Mark)

1. Explain how PI controller improves the steady state performance.
2. State the Zeigler-Nichol's tuning rules based on the FODT model.
3. State conditions for controllability in linear time invariant systems.
4. Distinguish the terms observability and detectability.
5. Why should the state weighting matrix be positive definite in an LQR problem?
6. State the difficulties involved in solving the matrix Ricatti equation.
7. Derive the relationship between continuous and discrete poles using backward difference approximation.
8. State the relationship between continuous and discrete poles as the function of sampling interval.
9. Name one distinguishing factor between parametric and non-parametric models used for system identification.
10. State the equations used for estimation of a first parametric model in the least square sense.

PART – B (5 x 16 = 80 Mark)

11. Consider a system whose state equation is given by

$$\dot{x} = \begin{bmatrix} -1 & 1 \\ 0 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$$

Check the controllability and observability of the system and design a suitable state feedback controller to place the closed loop poles at -5 and -6.

12.(a) Design a lead compensator using Bode's plot for the system whose open loop transfer function is given by G(s)=k/[s(s+1)(s+5)] to meet the following specifications. Velocity error constant to be greater than 5/s, Phase margin >= 60 deg and Band width to be less than 10 rad/s.

(OR)

12.(b) Design a suitable controller using Zeigler Nichols approach for the system whose open loop transfer function is given by G(s)=k/[s(s+1)(s+5)] to meet the following specifications. Velocity error constant to be greater than 5/s, Phase margin >= 60 deg and Band width to be less than 10 rad/s.

13.(a) State and derive the solution of the linear quadratic infinite time regulator problem. Show that the solution is a constant gain state feedback.

(OR)

13.(b) Consider the optimal control problem of minimizing J subject to the state constraints with,

$$J = \frac{1}{2}\int_0^\infty (x^2 + u^2)\,dt$$

$$x = 2x + u$$

Determine the optimum control law.

14.(a) Derive the relationship between continuous and discrete state equations when the output is sampled at periodic intervals T and input is driven through ZOH. Also, derive conditions for observability of discrete time systems.

(OR)

14(b) Consider the system whose state equation is given by

$$x_{k+1} = \begin{bmatrix} 1 & -0.02 \\ 0.1 & -0.3 \end{bmatrix} x_k + \begin{bmatrix} 0.1 \\ 1 \end{bmatrix} u_k$$

$$y_k = \begin{bmatrix} 0 & 1 \end{bmatrix} x_k$$

Obtain the pulse transfer function and discuss the effect of controlling the system through a suitable discrete PI controller.

15. (a) Illustrate the use of Kalman's equations for state estimation in the presence of noise for discrete shift invariant system

(OR)

15.(a) Consider the ARMAX model of a first order system with input disturbance. Derive expression to estimate the state coefficients in the least square sense.