Total No. of Pages 2 *Roll No. .....*

M.Tech III *SEMESTER(C&I)FT*

SUPPLEMENTARY EXAMINATION *(Feb.–2019)*

EE-7122 ADVANCED CONTROL SYSTEM DESIGN

Time: 3:00Hours *Maximum Marks : 100*

Note : Answer any **FIVE** questions.
Assume suitable missing data, if any.

1[a] Prove that if system is completely state controllable then there exit a matrix k that will place the closed loop poles at the desired location. **10**

[b] Prove that in dead beat control, any non zero error vector will be driven to origin in at most n sampling period if magnitude of scalar control u(k) is unbounded. **10**

2[a] Discuss a more general approach to determine the observer feedback gain matrix K. **10**

[b] Consider the system defind by

$$x(k+1)=\begin{vmatrix} 0 & 1 \\ -0.16 & -1 \end{vmatrix} x(k)+\begin{vmatrix} 0 \\ 0 \end{vmatrix} u(k)$$

$$y(k)=|1\ 0|\ x(k) \quad \text{and} \quad u(k)= K_0 r(k)-Kx(k)$$

Design a state feedback control system with refrence input such that desired characteristic equation are at $z=0.5 \pm j0.5$ **10**

3[a] Discuss the designing of sliding mode controller for single input plant. **10**

[b] Prove that for sliding in multi-input system, behavior of the system in sliding can be described as $\dot{X} = (I_n - B(SB)^{-1}S)AX$, $SX=0$ **10**

4[a] By considering linear quadratic regulator problem derive expression for Algebraic Riccati Equation. **10**

[b] Consider the following model of dynamical system

$$\dot{X} = \begin{vmatrix} 0 & 1 \\ 2 & -1 \end{vmatrix} X + \begin{vmatrix} 0 \\ 1 \end{vmatrix} U$$

which is to be controlled to minimise the performance index

$J=\int_0^\infty [X_1^2 + \frac{1}{2}X_2^2 + \frac{1}{4}U^2]dt$

Find (i) the solution to the ARE corresponding to the linear state Feedback optimal controller.

(ii) the optimal control law

(iii) the value of performance index J for the optimal closed loop system. **10**

5 The approximate difference equation representation for a continuous operating system is $x(k+1)=x(k)+u(k)$; $k=0,1$ where $u(0)$ and $u(1)$ are to be selected to minimize the performance measure $J=x^2(2)+2u^2(0)+2u^2(1)$ subjected to constraints

$0.0 \leq x(k) \leq 1.5$; $k=0,1,2$

And $-1.0 \leq u(k) \leq 1.0$; $k=0,1$

Quantize the state and control input values in to the step of 0.5 Find the optimal control values and the minimum cost for each point on state grid. What is the optimal control sequence if $x(0)=1.5$? **20**

6[a] Find the extremal of the functional

$J(x)=\int_0^{\pi/4}(x_1^2+\dot{x}_2^2 + \dot{x}_1\dot{x}_2)dt$

The boundary conditions are

$x_1(0)=0$, $x_1(\frac{\pi}{4})=1$, $x_2(0)=0$, $x_2(\frac{\pi}{4})= -1$ **10**

[b] Explain the method of solving Optimal control problem using Hamiltonian Formulation of Variational Calculus and hence derive the control equation , Co-state equation and state equation. **10**

7[a] Using principle of calculation of variation find the extremal for the following functional

$J(x) =\int_1^{t_1}(2x + \frac{1}{2}\dot{x}^2)dt$, $x(1)=2$, $x(t_1) =2$, $t_1>1$ **10**

[b] Using principle of calculation of variation derive the equation for transversality condition. **10**

8 Write short notes on any two of the following

[a] Designing H_2 controller

[b] Tuning of PID controller

10,10