**Code: 9A13601**

**R09**

B.Tech III Year II Semester (R09) Supplementary Examinations May/June 2017

**ADVANCED CONTROL SYSTEMS**

(Electronics & Control Engineering)

Time: 3 hours Max. Marks: 70

Answer any FIVE questions
All questions carry equal marks

*****

1 (a) Obtain the transfer function of the system:

$$X = \begin{bmatrix} -1 & 0 & -1 \\ 0 & -1 & 1 \\ 1 & -2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}$$
$$Y = [1 \quad 0 \quad 1]X$$

(b) Obtain the solution of the following state equation by obtaining the conical form,

$X = \begin{bmatrix} 1 & 0 & 2 \\ 0 & 2 & 1 \\ 0 & 0 & 3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} U$ with the initial condition $X(0) = [1 \quad 0 \quad -1]^T$.

2 (a) Test the following systems for controllability: $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$

(b) A discrete time system has state equation given by: $x(k+1) = \begin{bmatrix} 0 & 1 \\ -10 & -7 \end{bmatrix} x(k)$ use Cayley-Hamilton approach to find out its state transition matrix.

3 (a) Explain describing function analysis of nonlinear control systems.

(b) Explain Relay with Dead zone for stability of control system.

4 (a) A sample servo is described by the following equations:

Reaction torque = $\ddot{\theta}_c + 0.5\dot{\theta}_c$

Drive torque = $2 \sin n(e + 0.5e)$

$e = \theta_R - \theta_c$

$e(0) = 2$

$e = 0$

Construct the phase trajectory using the delta method.

(b) Explain construction of phase trajectories.

5 (a) Determine sufficient conditions for the stability of the system:

$x = Ax + bf(x_1)\ where\ A = \begin{bmatrix} -2 & -1 \\ 0 & -2 \end{bmatrix}, b = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$ by using Lypanov method.

(b) Explain Lyapunov instability theorems.

6 (a) Derive the necessary conditions and boundary conditions for the system with final time free and $x(t_f)$ specified.

(b) Explain the steps involved for solving nonlinear two point boundary value problems by using the method of quasilinearization.

Contd. in page 2

**Code: 9A13601** **R09**

7 (a) The system: $\dot{x}_1(t) = x_2(t)$

$$\dot{x}_2(t) = -x_1(t) + [1 - x_1^2(t)]x_2(t) + u(t)$$

Is to be controlled to minimize the performance measure

$$J = \int_0^1 \frac{1}{2}[2x_1^2(t) + x_2^2(t) + u^2(t)]\,dt$$

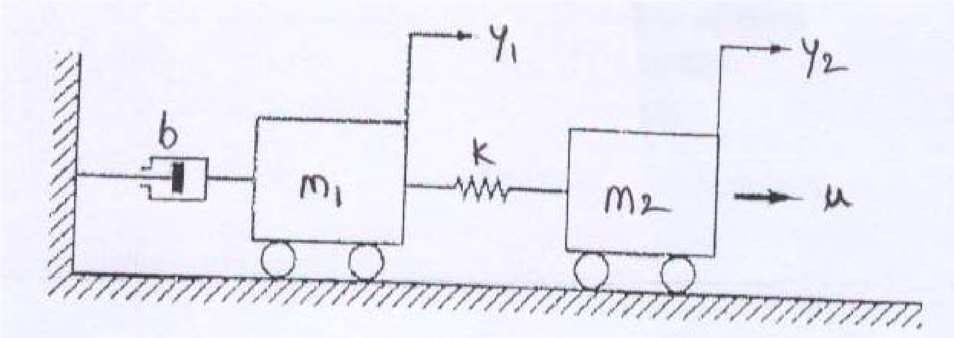
The initial and final state values are specified:

(i) Determine the costate equations for the system.

(ii) Determine the control that minimizes the Hamiltonian for u(t) not bounded, $|u(t)| \leq 1$.

(b) Determine the optimal control law for the linear regulator problems and also draw its block diagram. Derive the Riccati equation for the same.

8 (a) Determine the state model for the mechanical system shown in figure below. The displacements $y_1(t) and\ y_2(t)$ are measured from the equilibrium position of the system with no force applied.




(b) Check the linearity of the functional $J(X) = \int_{t0}^{tf} X(t)dt$

*****