Code No.: **52103**

MR 15 – 2015-16 & 2016-17 Admitted Students

MALLA REDDY ENGINEERING COLLEGE (AUTONOMOUS)

(Affiliated to JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD)

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M.TECH I SEMESTER SUPPLEMENTARY EXAMINATIONS, AUGUST-2017

SUBJECT: **MODERN CONTROL THEORY**

Branch/Specialization: **EEE/ Electrical Power Systems**

Time: **3 Hours** Max Marks: **60**

PART-A

Answer the following Questions **5 X 4 Marks=20 Marks**

1) Define State variable, State, State Trajectory and State Space.
2) Define Controllability and Observability of the system.
3) Define singular point. Discuss about different types of singular points.
4) Define State observer, Full order state observer and Reduced order state observer.
5) Explain briefly about optimal control problem.

PART-B

Answer any 5 questions **5 X 8 Marks=40 Marks**

1) Compute the solution of the following state equation d/ dt (X)= AX + BU with

$A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$ and $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ when the system is excited with unit step input. Given the initial state variable values are $x_1(0) = -1$ and $x_2(0) = 1$.

2. Determine whether the system d/ dt (X)= AX + BU with $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$ and C=[1 0 0] is Controllable and Observable or not by using Gilbert's Test.

3. a. Explain different Non-Linearities in detail. (2 M)
   b. Obtain the describing function of Dead- zone with Saturation Non-linearity (6 M)

4. a. Explain the concept of positive, negative, positive -semi, negative-semi definiteness and indefiniteness. (4 M)
   b. Consider the second order system described by d/ dt(X)= AX where $A = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix}$. The equilibrium State is the origin. Determine the stability of the system using Liapunov's second method. (4 M)

5. a) What is the procedure followed for solving optimal control problem using Hamiton – Jacob method? (2 M)

b) Obtain the Hamilton Jacobi equation for the system described by d/dt ( ) $= u(t)$, subjected to the initial condition $x\,(0) = x^0$ (6 M)

Find the control law that minimizes

$$J = \frac{1}{2}X^2\,(t_1) + \int_0^{t_1}(x^2 + u^2)\,dt,\ t_1\ specified$$

6. a) Construct a state model for a system characterized by the differential equation (4 M)

$$\frac{d^3y}{dt^3} + 6\frac{d^2y}{dt^2} + 11\frac{dy}{dt} + 6y + 4 = 0$$

Give the block diagram representation of the state model.

b) Derive the solution of Non-homogeneous state equations. (4 M)

7. Consider a linear system described by the state model d/ dt(X) = AX + BU with

A= $\begin{bmatrix} 1 & 0 & 0 \\ 1 & -2 & 0 \\ 2 & 1 & -3 \end{bmatrix}$ B= $\begin{bmatrix} 10 \\ 1 \\ 0 \end{bmatrix}$. Design a state feedback controller with a state feedback so that the closed loop poles are placed at -1+j2, -1-j2 , and -6 by using Direct –substitution method and Ackermann's formula.

8) **Write short notes any two of the following** 2X4=8M

a) Explain about Controllable Canonical Form.

b) Explain method of constructing Lyapunov functions by Krasooviski's method for non linear systems.

c) Discuss about the Jump resonance and sub-harmonic oscillations in non Linear systems.