Code.No: 52120/ MT **NR**

M.Tech. I-Semester Regular Examinations, March-2008.

MODERN CONTROL THEORY
(Common to Power Electronics, Electrical Power Engineering and Power Engineering & Energy Systems)

Time: 3 hours **Max. Marks: 60**

Answer any FIVE questions
All questions carry equal marks.

1.a) What are the advantages and disadvantages of state space analysis.
b) Develop the state model of linear system and draw the block diagram of state model.

2.a) Construct a state model for a system characterized by the differential equation

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

Give the block diagram representation of the state model.
b) Derive the solution of Non-homogeneous state equations.

3.a) State and explain the observability theorem.
b) The state model of a system is given by

$$\dot{x} = Ax+Bu,\ y=Cx$$

where $A=\begin{bmatrix}0 & 0 & 1\\ -2 & -3 & 0\\ 0 & 2 & -3\end{bmatrix}, B=\begin{bmatrix}0\\ 2\\ 0\end{bmatrix}, C=\begin{bmatrix}1 & 0 & 0\end{bmatrix}$

Convert the state model to controllable phase variable form.

4.a) Explain the following nonlinearties
i) Saturation and ii) Dead-zone.
b) Discuss the describing function analysis of non linear systems.

5.a) Explain the singular points in non linear systems.
b) Construct phase trajectory for the system described by the equation.

$\frac{dx_2}{dx_1}=\frac{4x_1+3x_2}{x_1+x_2}$. Comment on the stability of the system.

Contd...2

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

b) Check the stability of the system described by

$$\dot{x}_1 = x_2$$

$$\dot{x}_2 = -x_1 - b_1 x_2 - b_2 x_2^3;\ b_1, b_2 > 0$$

7.a) Explain the Linear system with full order state observer with neat block diagram.

b) Consider the system with

$$A = \begin{bmatrix} 0 & 20.6 \\ 1 & 0 \end{bmatrix},\ B = \begin{bmatrix} 0 \\ 1 \end{bmatrix},\ C = \begin{bmatrix} 0 & 1 \end{bmatrix}$$

Design a full order state observer. Assume that the desired eigen values of the observer matrix are

$$\mu_1 = -1.8 + J\,2.4,\ \mu_2 = -1.8 - J\,2.4$$

8.a) State and explain the principle of optimality.

b) Obtain the Hamilton Jacobi equation for the system described by $\dot{x} = u(t)$, subjected to the initial condition $x(0) = X^0$

Find the control law that minimizes

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

###