R09

Code No: C4903, C4303,C4210, C5410

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.TECH I SEMESTER EXAMINATIONS, APRIL/MAY-2012

MODERN CONTROL THEORY

(COMMON TO ELECTRICAL POWER ENGINEERING, POWER ELECTRONICS, POWER AND INDUSTRIAL DRIVES, POWER ELECTRONICS & ELECTRIC DRIVES)

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

Answer any five questions

All questions carry equal marks

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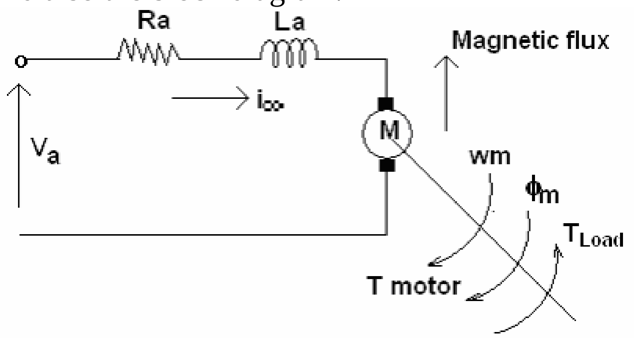
1.a) Define the following
i) Eigen values ii) Eigen vectors ii) State of a system.

b) Consider the system shown for the d.c. motor. Obtain the state space model. Obtain its state diagram and also the block diagram.



2.a) Explain the properties of state transition matrix.

b) 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.

3. Consider the system given by
$$\dot{x}(t)=\begin{bmatrix}0 & 1\\ 2 & 1\end{bmatrix}x(t)+\begin{bmatrix}1\\ 0\end{bmatrix}u(t) \qquad y(t)=\begin{bmatrix}1 & 2\end{bmatrix}x(t)$$

a) Show that the system modes are e^{-t} and e^{2t}.

b) If it is possible to find the set of initial conditions at $t = t_0$ such that the mode e^{2t} is suppressed in y(t)? If yes, find $x(t_0)$ to do this (u = 0).

c) Is it possible to chose an input $u[0\ t_0]$that transfers x(0) to $x(t_0)$? If yes find such a control.

4. A discrete-time system has the transfer function $\frac{Y(z)}{U(z)}=\frac{4z^3-12z^2+13z-7}{(z-1)^2(z-2)}$.

Determine the state model of the system in

a) Phase variable form and

b) Jordan canonical form.

5.a) What is a singular point? Draw the phase trajectory of the following singular points:
i) Stable node ii) unstable node iii) Saddle point iv) Vortex point.

b) Consider a non-linear system described by the equations:
$$\dot{x}_1=-x_1+2{x_1}^2x_2$$
$$\dot{x}_2=-x_2$$
Check the stability of the system by use of variable gradient method.

6. Consider the system with

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 3 & 2 & 0 \\ 1 & 1 & 1 \end{bmatrix}; \quad B = \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}; \quad C = \begin{bmatrix} 1 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Design a state feedback control law for this system so that the closed-loop System has poles a -1,-2,-3.

7. Formulate the two point boundary value problem which when solved, yields the optimal control $u^*(t)$ for the system

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

$$\dot{x}_3 = x_1 + (1 - x_1^{\,2})x_2 + u$$

$$X(0) = [1 \quad 0]^T; \quad J = \frac{1}{2}\int_0^2 (2x_1^2 + x_2^2 + u^2)dt$$

When (i) u(t) is not bounded (ii) $|u(t)| \le 1.0$.

8.a) Define the following

i) Stability in the sense of liapunov

ii) Asymptotic stability

iii) Asymptotic stability in the large.

b) What is a singular point? Explain different types of singular points in a non-linear control system based on the location of Eigen values of the system.

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