

Islamic University of Gaza
Electrical Engineering Department
EELE 3061- Linear Control Systems Discussion

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Homework 4

Due Date: March, 29, 2016

Problem 1:

Determine state space model of the system

- | | |
|--|--------------------------------|
| a. $G(s) = \frac{s^2+8s+12}{s^2+5s+4}$ | use Parallel Method |
| b. $G(s) = \frac{s^2+8s+12}{s^2+5s+4}$ | use canonical form |
| c. $G(s) = \frac{10(s+2)}{s^2(s+1)(s+3.5)}$ | use Parallel and direct Method |
| d. $G(s) = \frac{(s+1)(s+4)}{(s+2)(s^2+2s+2)}$ | use Cascade Method |

Problem 2:

Write the state equations for the control system from the simulation diagram (flow graph) shown figure 1 and figure 2 shown below

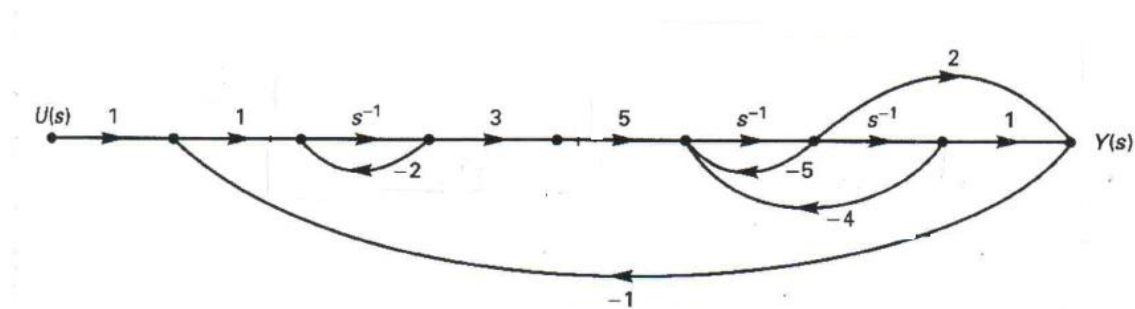


Figure 1: Flow Graph 1

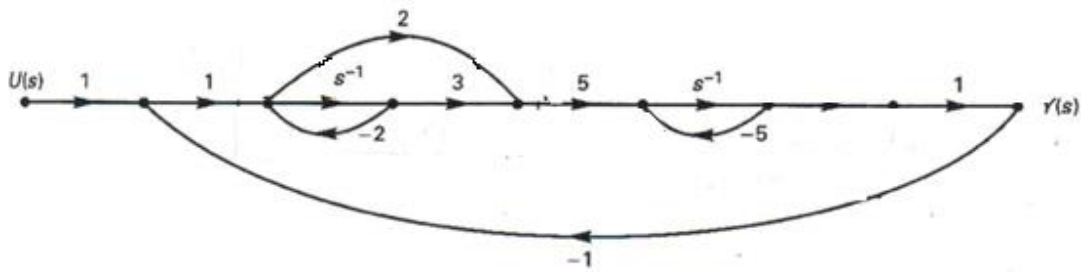


Figure 2. Flow Graph 2

Problem 3:

Given the following connection equations for the servomotor shown in figure 3, drive the equations of motion (governing equations) for the system.

Then find the state space model that describes the system. Where:

K_t = torque constant, K_m = back-emf constant, $e_m(t)$ = back emf,

$e(t)$ = system input, Θ_1' = system output, i_a = armature current

$$\tau = K_t * i_a(t), \quad e_m(t) = K_m * \Theta_1'$$

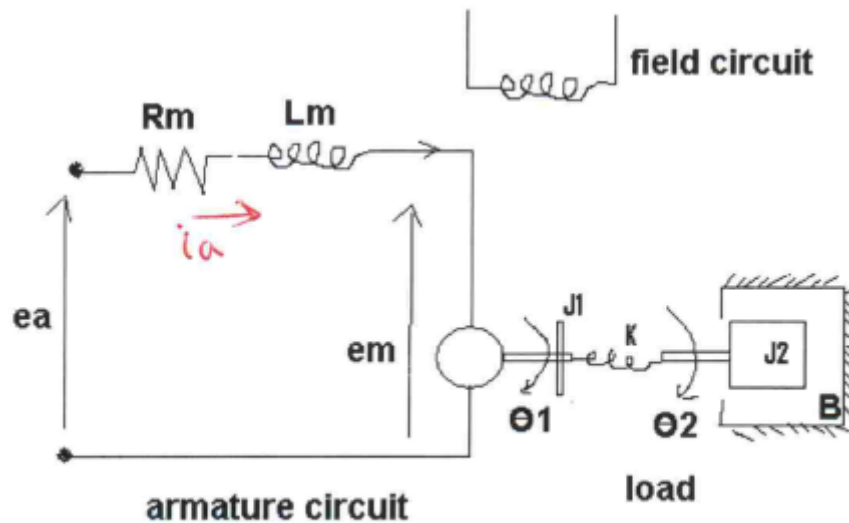


Figure 3: Servo Motor

Problem 4:

Consider the following mechanical system where $T(t)$ is applied torque; $TB1 = 10\dot{\theta} + \theta^3$ and $TB2 = 5\dot{\theta}$ are damping force; $K=20$ and $J=2$ are spring stiffness and inertia

1. Find the mechanical system differential equation
2. Linearize the a above nonlinear system at $\theta_0=0$, $\dot{\theta}_0=1$, $\ddot{\theta}_0=0$
3. Find the Linearize transfer Function
4. Will the system oscillates, given step input?
5. What is the steady state value of the output for step input
6. Evaluate the transition matrix
7. What is the response of the system due to input of unit step with amplitude of 2.5 and zero initial condition

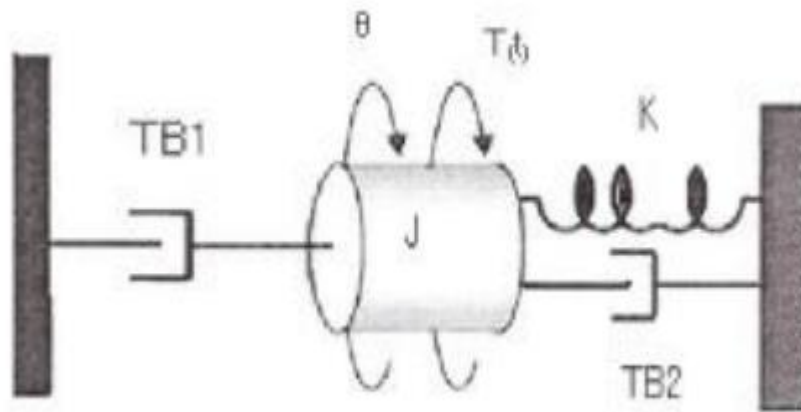


Figure 4: Rotational mechanical system

Problem 5:

A second order system settles to a final position of 5cm in a time of 2 seconds in response to a unit step input. The response of this system is oscillatory with damped frequency of 3 rad/sec. Give the transfer function for this system.

Problem 6:

Name the textbook used in this course and name the author of the textbook and the edition