EXERCISE 9

COMPARISON OF REAL TIME AND MODELING OF QUBE SERVO DC MOTOR

Date: ***Reg. No. :***

LAB PREREQUISITES:

Exercise 1 to 3

PREREQUISITE KNOWLEDGE:

Fundamentals of MATLAB programming and Simulink.

OBJECTIVES:

The objective of this exercise is to compare the speed of the Qube Servo for both real time and modeling systems.

QUBE SERVO DC MOTOR MODELING AND SPECIFICATIONS:

The Quanser QUBE-Servo 2 is a direct-drive rotary servo system. Its motor armature circuit schematic is shown in Figure 1. and the electrical and mechanical parameters are given in Table 1. The DC motor shaft is connected to the *load hub*. The hub is a metal disk used to mount the disk or rotary pendulum and has a moment of inertia of J_h. A disk load is attached to the output shaft with a moment of inertia of J_d.

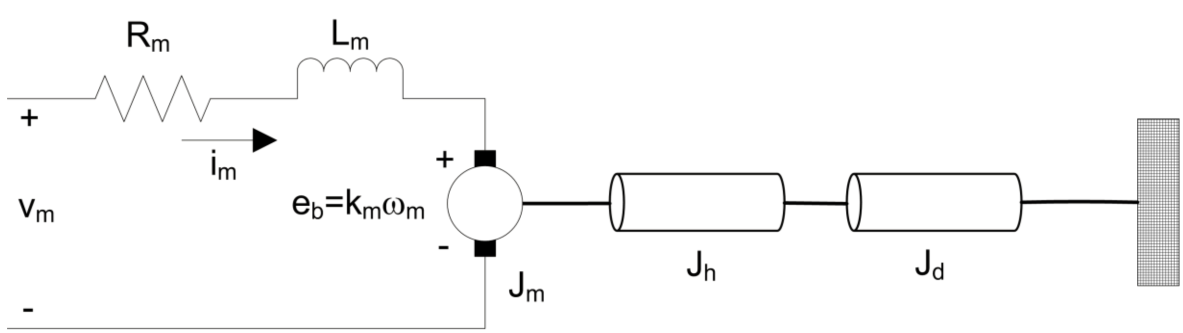

Figure.1. Qube servo DC motor with load

The back-emf (electromotive) voltage $e_b(t)$ depends on the speed of the motor shaft, w_m, and the back-emf constant of the motor, k_m. It opposes the current flow. The back emf voltage is given by:

$$e_b(t) = k_m \omega_m(t)$$

Table 1. Qube servo 2 system parameters

Symbol	Description	Value
DC Motor		
R_m	Terminal resistance	8.4Ω
k_t	Torque constant	0.042 N.m/A
k_m	Motor back-emf constant	0.042 V/(rad/s)
J_m	Rotor inertia	4.0×10^{-6} kg.m^2
L_m	Rotor inductance	1.16 mH
m_h	Load hub mass	0.0106 kg
r_h	Load hub mass	0.0111 m
J_h	Load hub inertia	0.6×10^{-6} kg.m^2
Load Disk		
m_d	Mass of disk load	0.053 kg
r_d	Radius of disk load	0.0248 m

Using Kirchoff's Voltage Law, we can write the following equation

$$v_m(t) - R_m i_m(t) - L_m \frac{di_m(t)}{dt} - k_m \omega_m(t) = 0.$$

Since the motor inductance L_m is much less than its resistance, it can be ignored. Then, the equation becomes

$$v_m(t) - R_m i_m(t) - k_m \omega_m(t) = 0.$$

Solving for $i_m(t)$, the motor current can be found as:

$$i_m(t) = \frac{v_m(t) - k_m \omega_m(t)}{R_m}.$$

The motor shaft equation is expressed as

$$J_{eq} \dot{\omega}_m(t) = \tau_m(t),$$

Where, J_{eq} is total moment of inertia acting on the motor shaft and τ_m is the applied torque from the DC motor. Based on the current applied, the torque is

$$\tau_m = k_m i_m(t)$$

The moment of inertia of a disk about its pivot, with mass *m* and radius *r*, is

$$J = \frac{1}{2}mr^2.$$

PROGRAMS, OBSERVATIONS AND INFERENCES

1. **Draw the modelling of the Qube servo 2.0 DC motor by assuming the inputs and output are the voltage and speed.**
2. **Compare the modelling results with real time output of the Qube servo 2.0 DC motor.**

PROGRAM

RESULTS & INFERENCES:

Evaluation Component	**Maximum Marks**	**Marks Obtained**
Pre-lab Tasks	10	
In-Lab Tasks	20	
Post-lab Tasks	10	
Bonus Tasks	10	
Signature of Faculty with Date		

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