Lab 2 Report

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Modeling of P-controller based d.c. motor in Simulink using state space model (using differential equations) and transfer functions based model.

This experiment will illustrate about the modeling and design of separately excited d.c. motor using state space model and transfer function block diagram. Thereafter, a P-controller will be designed to control the speed of the motor.

This can be achieved using two methods as follows:

1. Voltage Control Method: By varying the input voltage, the speed of the separately excited d.c. motor can be controlled as expressed in relation given below. (Flux/pole) is kept constant in this method.
2. Field Current Control Method: By decreasing/ increasing the flux, the speed can be increased or decreased and vice versa. Input voltage is kept constant while flux is varied.

The DC motor model can be made using the following relations:

Electro-mechanical torque, $T = K_t i$

Back-emf, $e = K_e \frac{d\theta}{dt}$

Motor shaft angular position, $\iint \frac{d^2\theta}{dt^2} = \int \frac{d\theta}{dt} = \omega$

Armature current, $\int \frac{di}{dt} = i$

$$\frac{d\omega}{dt} = \frac{1}{J}(K_t i - \omega)$$

$$\frac{di}{dt} = \frac{1}{L}(-Ri + V - K_e\omega)$$

$$\frac{d\theta}{dt} = \omega$$

1 Open loop circuit

Design of DC motor without controller or feedback:

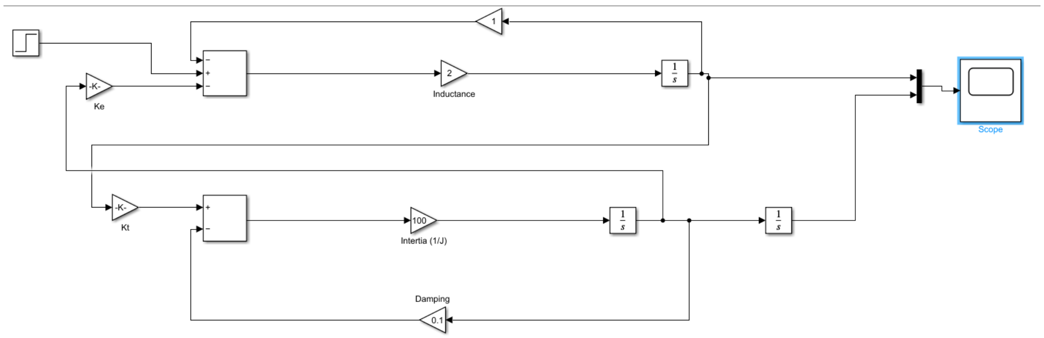

Figure 1: DC motor without controller or feedback

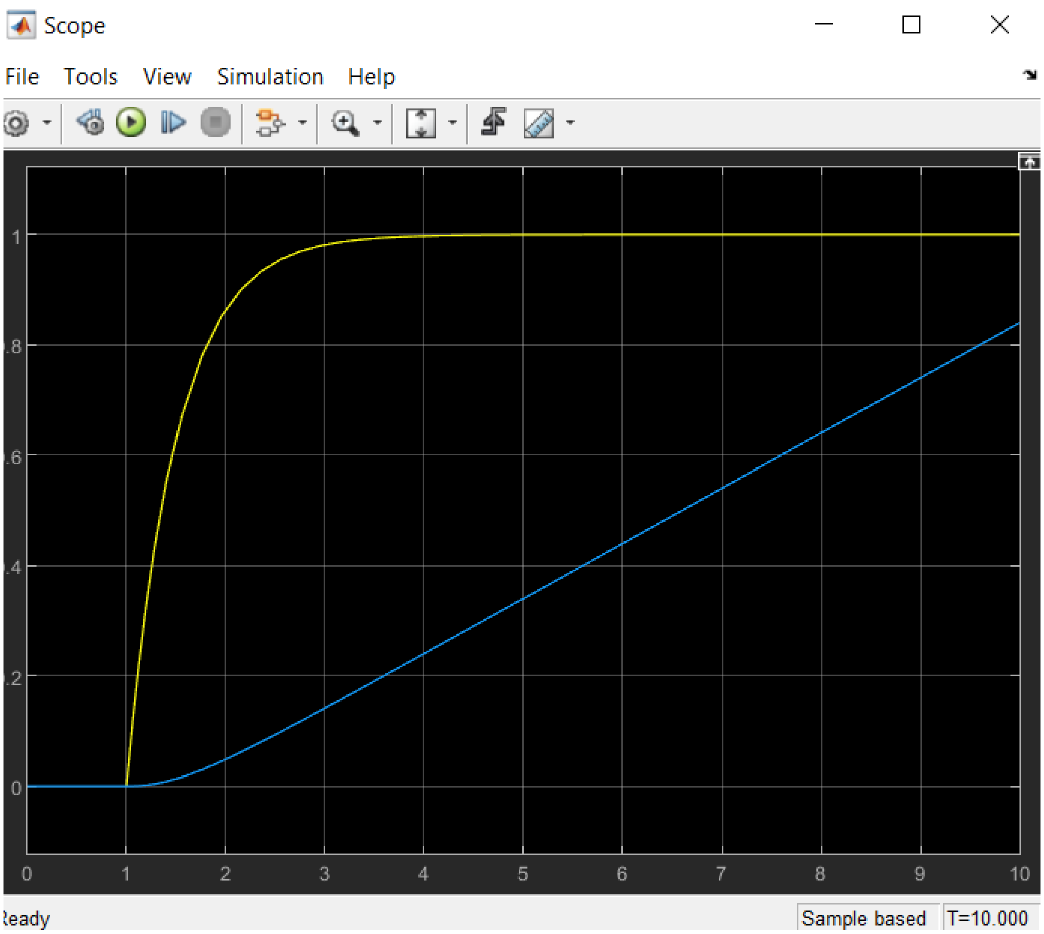

Figure 2: Obtained Output

2 Control Loop Circuit

In these circuits, the output produced is fed back to controller. The controller takes the difference between the desired signal and output signal, and produces appropriate signal to minimize this difference. In a P controller(Proportional Controller), the difference is multiplied by a appropriate constant K_p and fed back to the system. For a PI system, the sum of Proportional Difference as well as the K_p(Integral Constant) times the integral of the error signal is fed as input signal.

Circuit diagram for control loop circuit

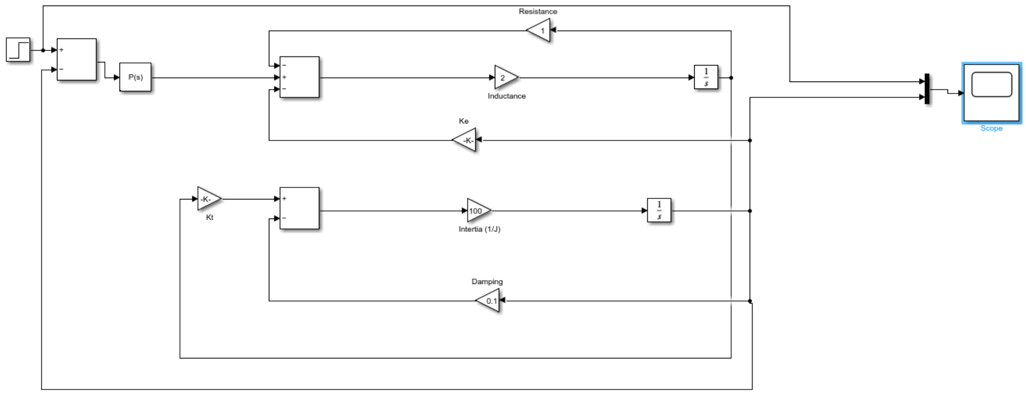

Figure 3: Circuit for control loop circuit

Output for desired speed v/s obtained speed:

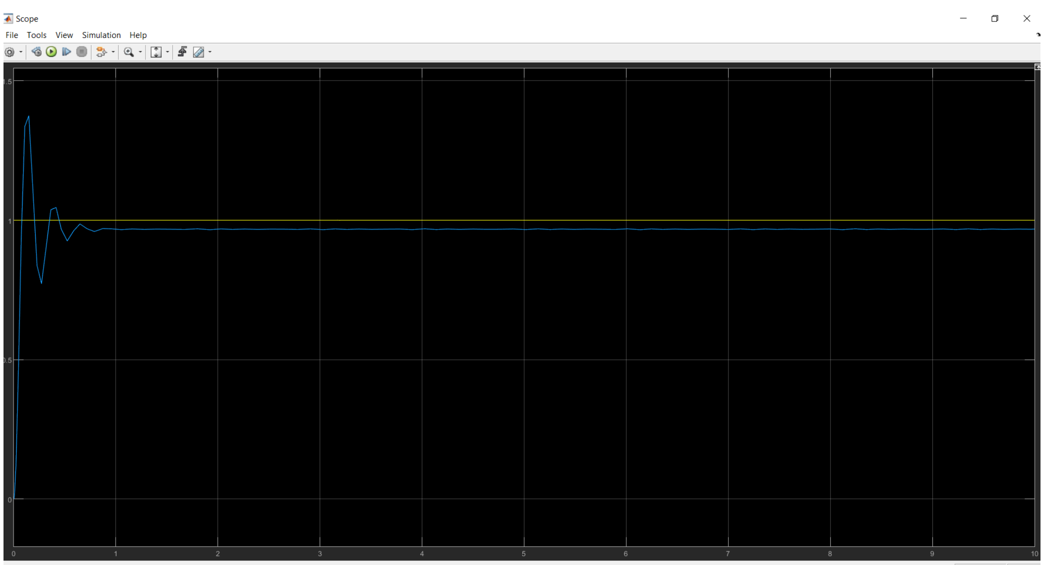

Figure 4: Output for P controller with optimum value of K

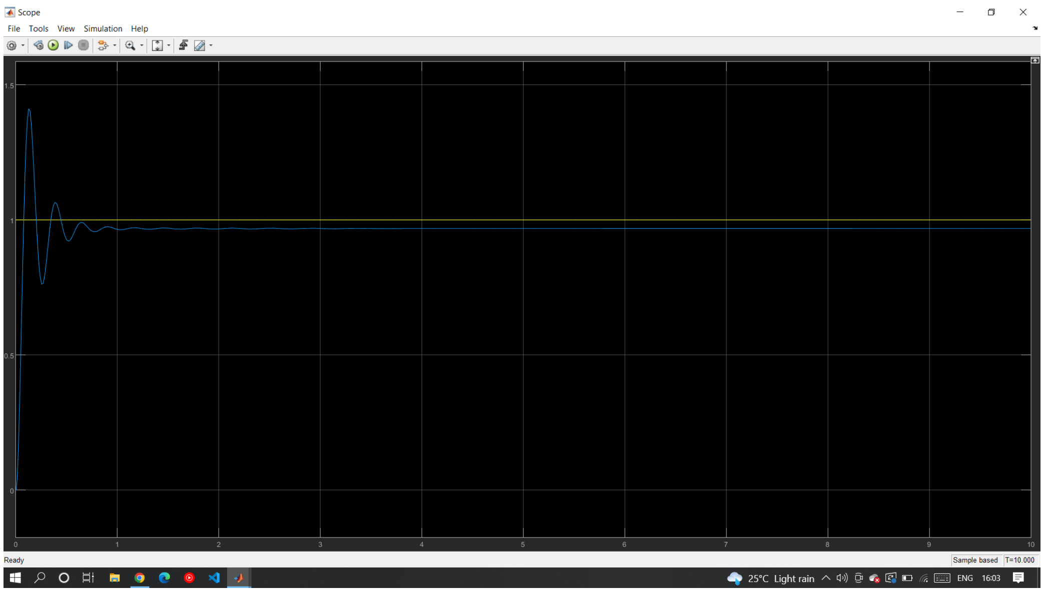

Figure 5: Output for PI controller with optimum value of K

Parameters	P Controller	PI Controller
Settling Time of speed	0.9	1
Value of the K_p	100	300
Value of the K_i	-	100
Error between desired and actual speed	0.011	0.004
Is there any speed overshoot or undershoot?	Yes	Yes