Separately Excited DC motor

$$v_a = R_a i_a + L_a \frac{di_a}{dt} + E_b \quad \dots 1$$

$$T = J\dot{\omega} + B\omega \qquad \dots 2$$

$$E_b = k_b \omega \qquad \dots 3$$

$$T = K_t i_a \qquad \dots 4$$

Simulation

From 1 & 3

$$L_a \frac{di_a}{dt} = v_a - R_a i_a - k_b \omega$$

Then

$$i_a = \frac{1}{L_a} \int (v_a - R_a i_a - k_b \omega)\, dt \qquad \text{المعادلة الكهربائية}$$

From 2 & 4

$$J\dot{\omega} = K_t i_a - B\omega$$

Then

$$\omega = \frac{1}{J} \int (K_t i_a - B\omega)\, dt \qquad \text{المعادلة الميكانيكية}$$

Motor Parameters		Value
Armature Resistance	Ra	3
Armature Inductance	La	0.1
Inertia	J	0.1
Friction	B	0.03
Back EMF constant	Kb	0.4
Torque constant	Kt	0.4

Sol:

Block	Parameters	Library
Step	Step time=0 Initial value=0 Final value=60	Math operations
Sum	List of signs=+--	Math operations
Sum1	List of signs=+-	Math operations
Gain	Gain=1/0.1	Math operations
Gain1	Gain=3	Math operations
Gain2	Gain=0.4	Math operations
Gain3	Gain=1/0.1	Math operations
Gain4	Gain=0.4	Math operations
Gain5	Gain=0.03	Math operations
Integrator	Initial condition=0	Continuous
Integrator1	Initial condition=0	Continuous
scope		Sinks
Scope1		Sinks
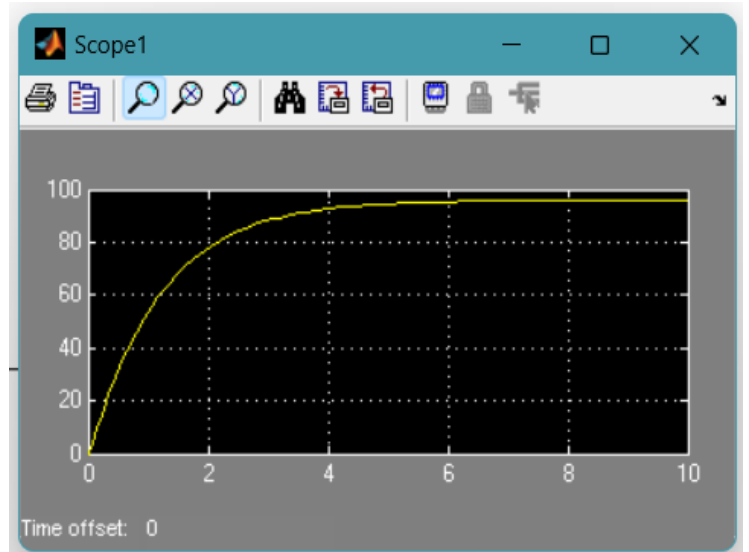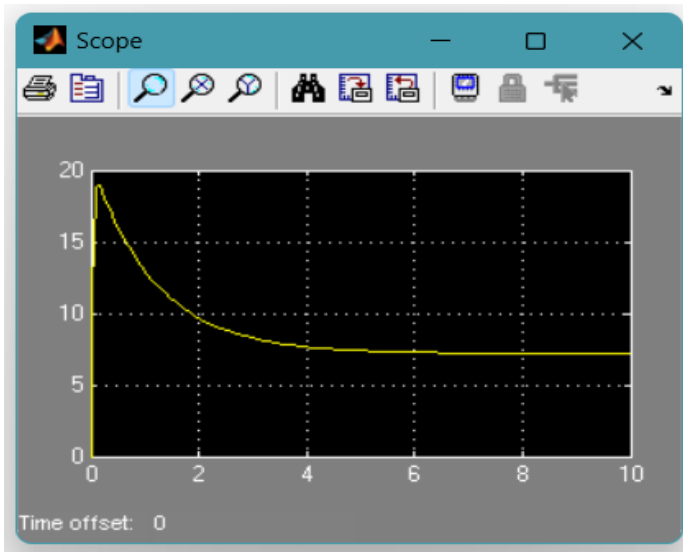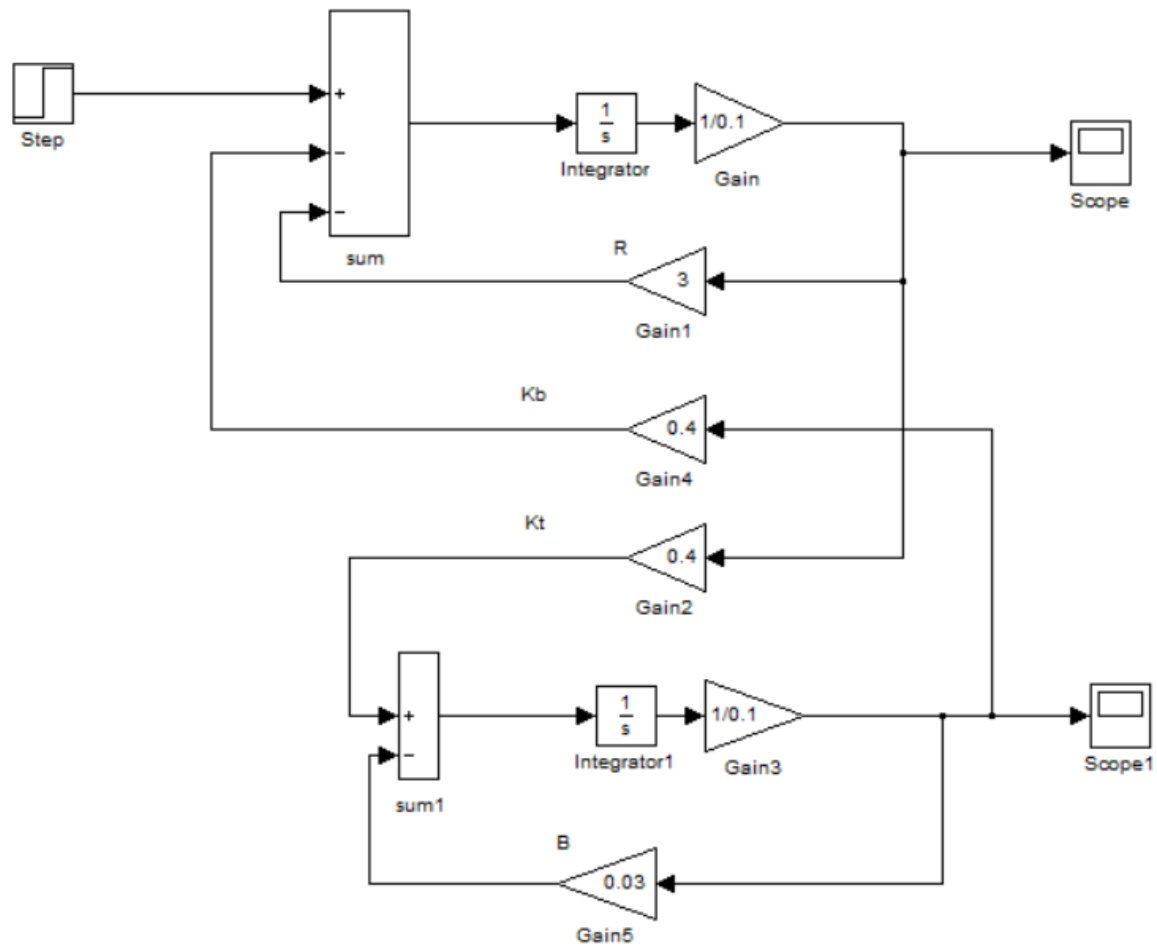
PID control

Control System

A control system is a device or set of devices, that manages, commands, directs, or regulates the behavior of other devices or systems. Industrial control systems are used in industrial production for controlling equipment or machines.

PID Controller

A PID Controller or a Proportional-Integral-Derivative controller is a control loop feedback mechanism (controller) widely used in industrial control systems.

PID control is the most common control algorithm used in industry and has been universally accepted in industrial control. The popularity of PID controllers can be attributed partly to their robust performance in a wide range of operating conditions and partly to their functional simplicity, which allows engineers to operate them in a simple, straightforward manner.

A PID controller calculates an error value as the difference between a measured process variable and a desired setpoint (desired outcome). The controller attempts to minimize the error by adjusting the process through the use of a manipulated variable.

The PID controller algorithm involves three separate constant parameters, and is accordingly sometimes called three-term control:

- Proportional (P)

- Integral (I)

- Derivative (D)
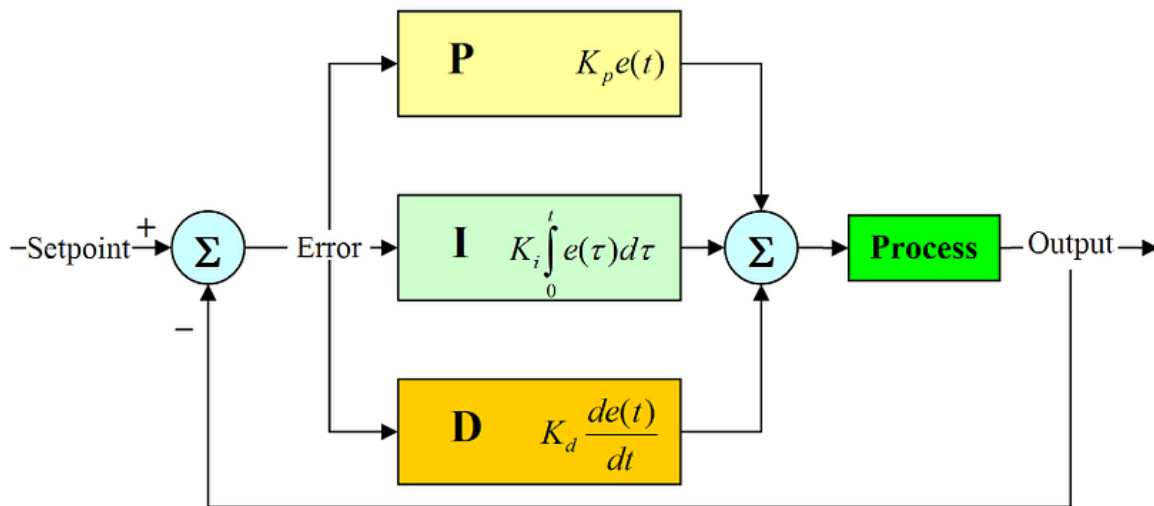
Simply put, these values can be interpreted in terms of time: 'P' depends on the *present error*, 'I' on the accumulation of *past errors*, and 'D' is a prediction of *future errors*, based on the current rate of change. The weighted sum of these three actions is used to adjust the process via a control element such as the position of a control valve, a damper, or the power supplied to a heating element.

Terminology:

The basic terminology that one would require to understand PID are:

- **Error:** The error is the amount at which a device isn't doing something right. For example, suppose the robot is located at x=5 but it should be at x=7, then the error is 2.

- **Proportional (P):** The proportional term is directly proportional to the error at present.

- **Integral (I):** The integral term depends on the cumulative error made over a period of time (t).

- **Derivative (D):** The derivative term depends on rate of change of error.

- **P-Factor (Kp):** A constant value used to increase or decrease the impact of Proportional

- **I-Factor (Ki):** A constant value used to increase or decrease the impact of Integral

- **D-Factor (Kd):** A constant value used to increase or decrease the impact of Derivative

Note- Each term (P, I, D) will need to be tweaked in the code. Hence, they are included in the code by multiplying with respective constant factors.

Block	Parameters	Library
Step	Step time=0 Initial value=0 Final value=150	Math operations
Sum	List of signs=+--	Math operations
Sum1	List of signs=+-	Math operations
Sum2	List of signs=+++	Math operations
Sum3	List of signs=+-	Math operations
Gain	Gain=1/0.1	Math operations
Gain1	Gain=3	Math operations
Gain2	Gain=0.4	Math operations
Gain3	Gain=1/0.1	Math operations
Gain4	Gain=0.4	Math operations
Gain5	Gain=0.03	Math operations
Gain6	Gain=0.08	Math operations
Gain7	Gain=0.06	Math operations
Gain8	Gain=0.04	Math operations
Integrator	Initial condition=0	Continuous
Integrator1	Initial condition=0	Continuous
Integrator2	Initial condition=0	Continuous
Derivative		Continuous
scope		Sinks
Scope1		Sinks