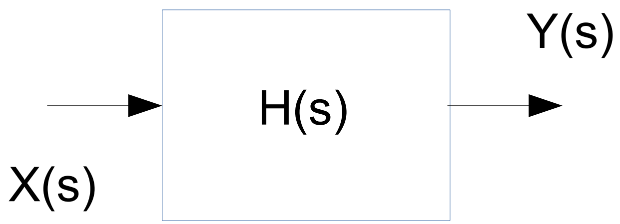
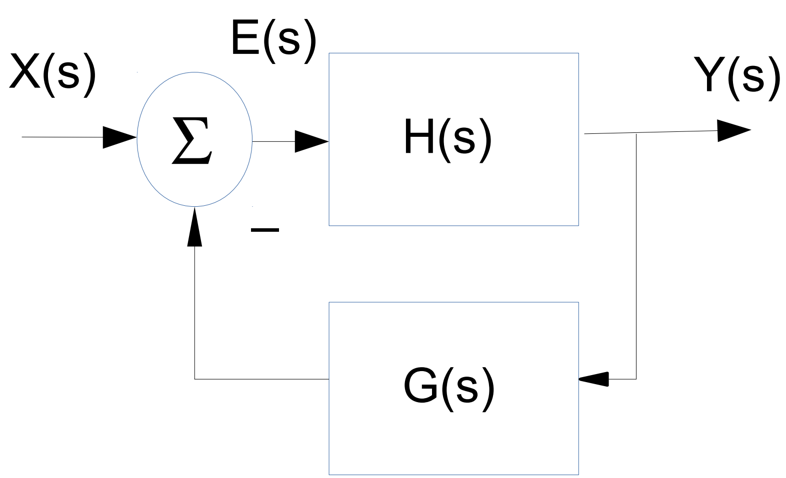
Close Loop Transfer Function



Start with open loop, where plant H(s) can be a stepper motor for example, so we have

$$Y(s) = H(s)\,X(s) \quad \ldots \quad (1)$$

Now we can add a sensor to form a feedback loop as follows



So, sensor G(s) forms a feedback loop as shown in Figure 2.

$$E(s) = X(s) - G(s)\,Y(s) \quad \ldots (2)$$

$$Y(s) = H(s)\,E(s) \quad \ldots (3)$$

From (2) we have

$$X(s) = E(s) + G(s)\,Y(s) \quad \ldots (4)$$

Substitute (3), we have

$$X(s) = E(s) + G(s)\,H(s)\,E(s)$$

Hence, the transfer function is

$$\frac{Y(s)}{X(s)} = \frac{H(s)}{1 + G(s)\,H(s)} \quad \ldots (5)$$

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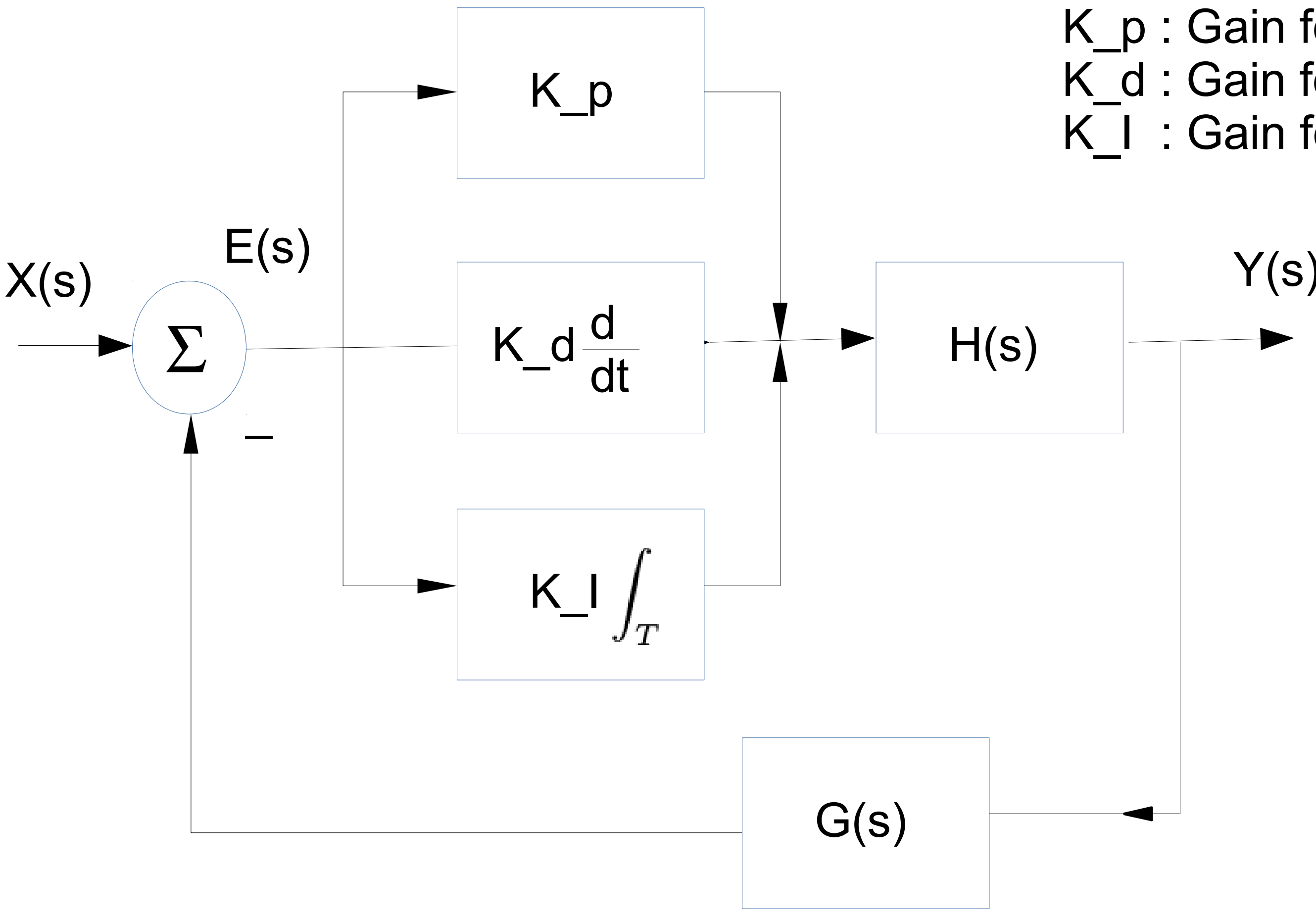
PID Control



K_p : Gain for proportional control
K_d : Gain for derivative control
K_I : Gain for integral control

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Central Difference and Its Kernel

Forward difference:

$$FD = \frac{de(t)}{dt} \approx e(t+1) - e(t)$$

Map to a kernel

t →

-1	1
t	t+1

Backward difference:

$$BD = \frac{de(t)}{dt} \approx e(t) - e(t-1)$$

Map to a kernel

t →

-1	1
t-1	t

Central differnece:

$$CD = \frac{1}{2}(FD + BD) = \frac{1}{2}[e(t+1) - e(t-1)]$$

Map to a kernel

t →

-1	0	1
t-1	t	t+1

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