PROPORTIONAL CONTROL

We now consider more sophisticated control strategies that require "smart" controllers that use op-amps or a microprocessor. The first and most basic of these strategies is called proportional control. With proportional control, the actuator applies a corrective force that is proportional to the amount of error, as expressed in

$$Output_p = k_p E$$

Output = controller output due to proportional control (i.e., the corrective force)
K = proportional constant for the system called gain
E = error, the difference between where the controlled variable should be and where it is.

Consider the position control system shown in Figure 11.6. A robot arm is powered by a motor/gearhead. A potentiometer provides position information, which is fed back to a comparator. This feedback signal is called the process variable (PV). The comparator subtracts PV from the set point (SP) to determine the error (E) as expressed in:

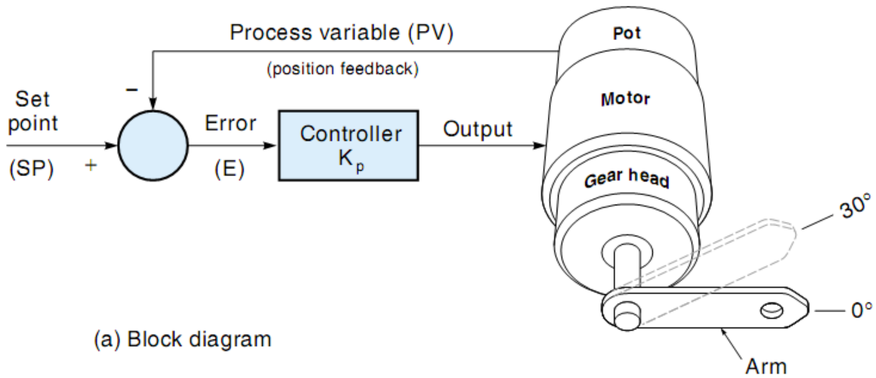
$$E = SP – PV$$

E = error
SP = set point, a desired value of the controlled variable
PV = process variable, an actual value of the controlled variable

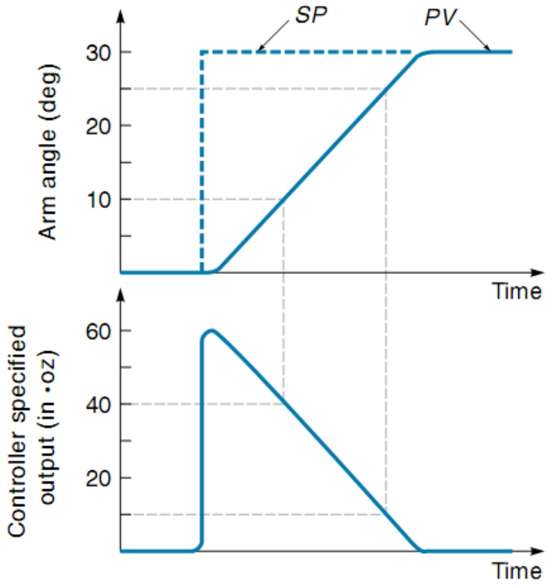
Referring to Equation 11.1, we see that the controller output is proportional to the error. This output directs the motor to move in a direction to reduce the error. As the position of the arm gets closer to the set point, the error diminishes, which causes the motor current to diminish. At some point, the error (and current) will get so small that the arm comes to a stop.

EXAMPLE 11.1 PROPORTIONAL CONTROL

Assume that a motor driven arm was originally at 0° and then was directed to move to a new position at 30°. The gain of the system is K = 2 in. · oz/deg. Describe how the controller responds to this situation.



(a) Block diagram



(b) Graphs showing response to change in set point

Using Equation 11.1, we can calculate the initial restoring torque the system would generate:

$$Output_p = k_p E$$

K = 2 in. · oz/deg

$$Output_p = (2)(30°) = 60$$