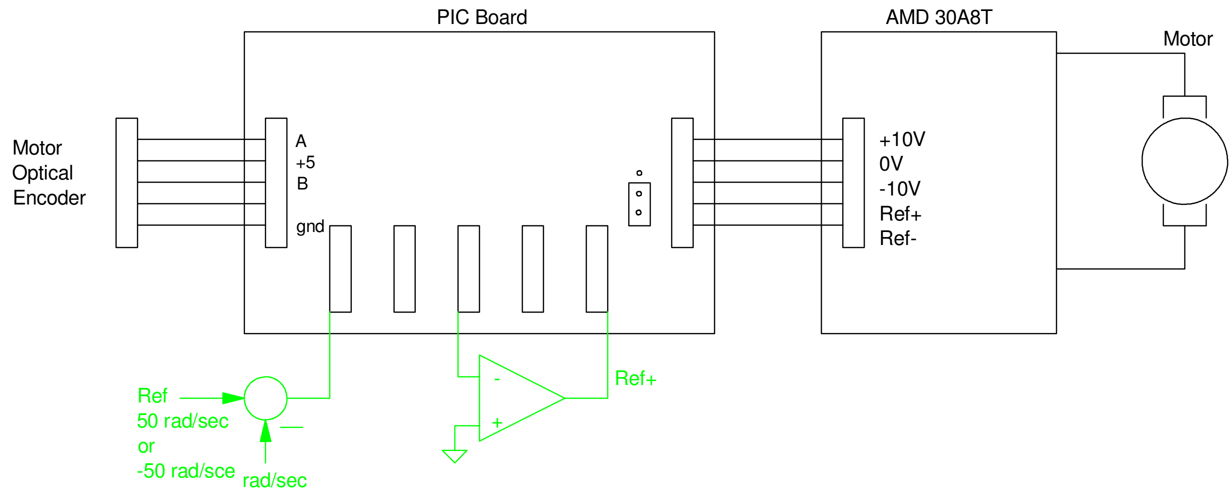
ECE 761: Homework #17: Speed Control of a DC Servo Motor

Load the program SPEED.C onto your PIC board. This program

- Measures the speed of the DC servo motor,
- Make the reference input (Ref) equal to +50 rad/sec or -50 rad/sec when you press the step button, and
- Outputs a voltage equal to 0.1*(Ref - Speed)
- With a sampling rate of 50ms.

The serial port should be set up for 9600 baud, no hand shaking.



From homework #20, the transfer function of the DC motor should be approximately

$$\omega \approx \left(\frac{40}{s+6}\right) V_a$$

With a tachometer with a gain of 0.1, the open-loop system is

$$G(s) = \left(\frac{4}{s+6}\right)$$

1) Proportional Control: Dominant Pole = -20

Open-Loop System (tachometer includes a gain of 0.1)

$$GK = \left(\frac{4k}{s+6}\right)$$

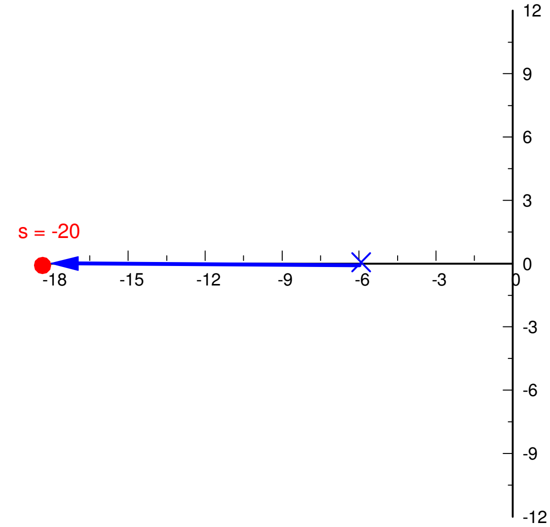
Feedback gain, k

$$\left(\frac{4k}{s+6}\right)_{s=-20} = -1$$

$$K(s) = k = 3.5$$

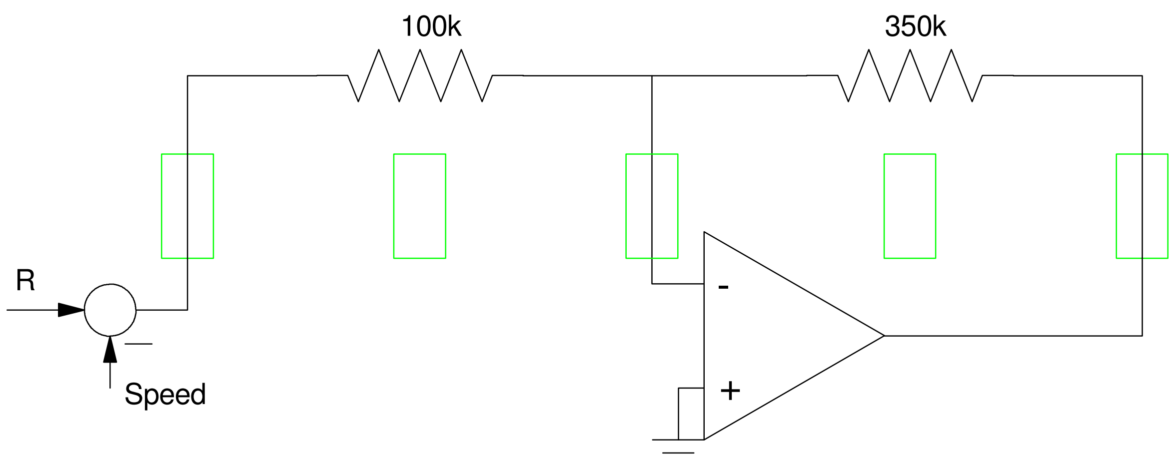
Closed-Loop System

$$\left(\frac{GK}{1+GK}\right) = \left(\frac{14}{s+20}\right)$$



- Build an op-amp circuit to implement a gain of 3.5
- Record the step respons.
- From the step response, determine the closed-loop dominant pole

DC Gain	2% Settling Time *(measured)*	Overshoot *(%)*	Dominant Pole *(measured)*



Integral Control: Dominant Pole = -3

Open-Loop Gain:

$$\left(\frac{4k}{s(s+6)}\right)_{s=-3} = -1$$

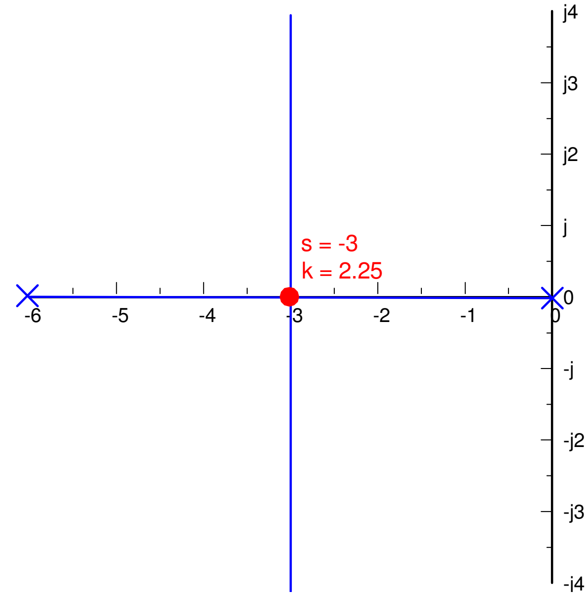
$$k = 2.25 = \frac{1}{RC}$$

$$K(s) = \left(\frac{2.25}{s}\right)$$

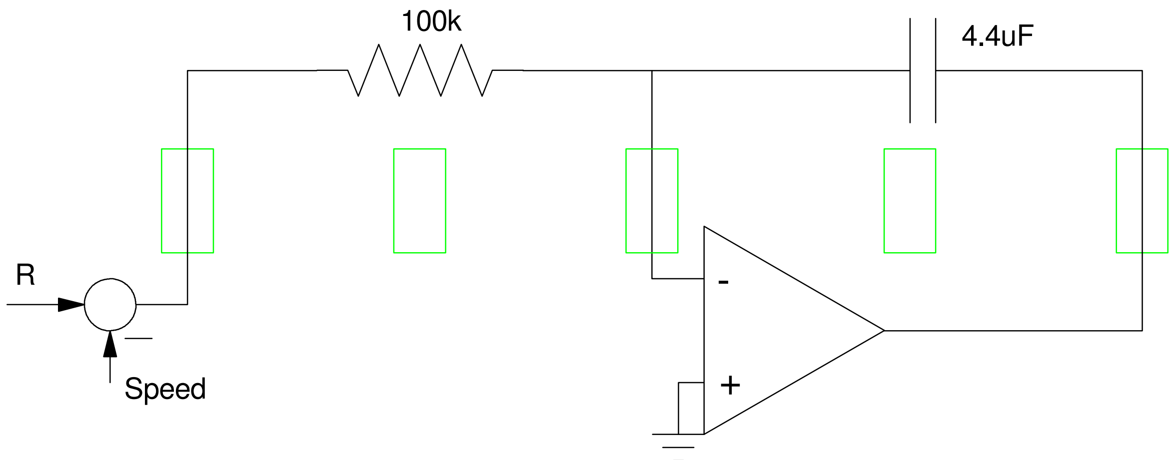
Closed-Loop System

$$\left(\frac{GK}{1+GK}\right) = \left(\frac{9}{s(s+6)+9}\right)$$

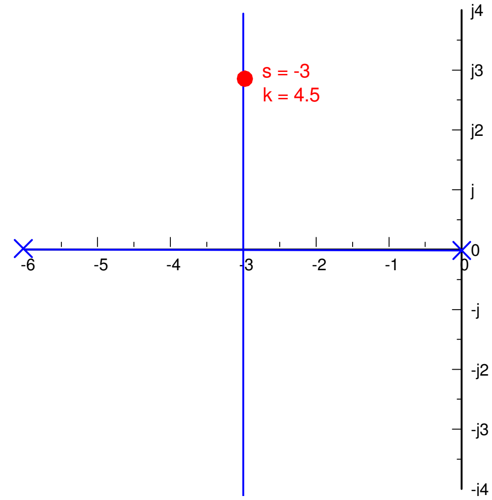
- Build an op-amp circuit to implement a gain of K(s)
- Record the step respons.
- From the step response, determine the closed-loop dominant pole



DC Gain (5 rad/sec step)	2% Settling Time *(measured)*	Overshoot *(%)*	Dominant Pole *(measured)*



Integral Control: Dominant Pole = -3 + j3



Open-Loop Gain:

$$\left(\frac{4k}{s(s+6)}\right)_{s=-3+j3} = -1$$

$$k = 4.5 = \frac{1}{RC}$$

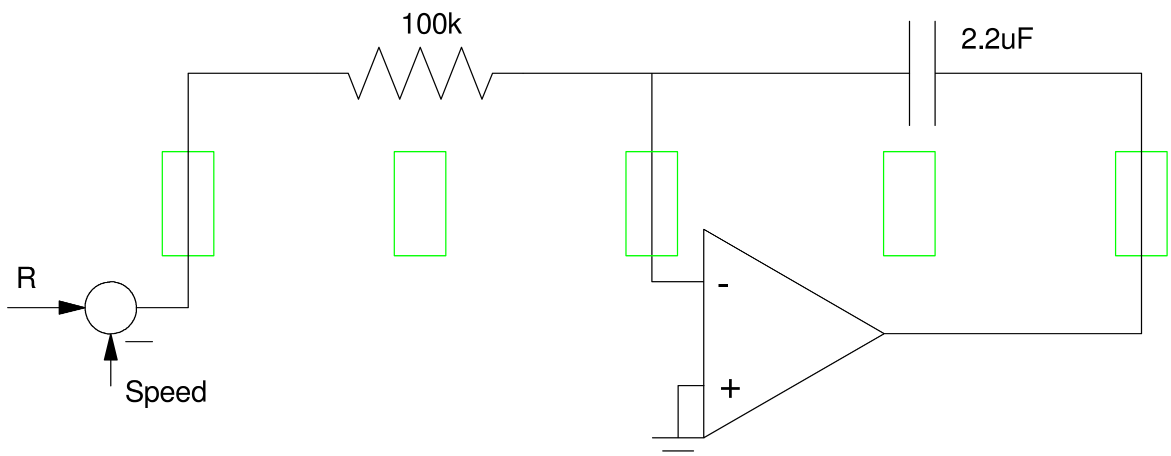
$$K(s) = \left(\frac{4.5}{s}\right)$$

Closed-Loop System

$$\left(\frac{GK}{1+GK}\right) = \left(\frac{18}{s(s+6)+18}\right)$$

- Build an op-amp circuit to implement K(s)
- Record the step respons.
- From the step response, determine the closed-loop dominant pole

DC Gain (5 rad/sec step)	2% Settling Time *(measured)*	Overshoot *(%)*	Dominant Pole *(measured)*

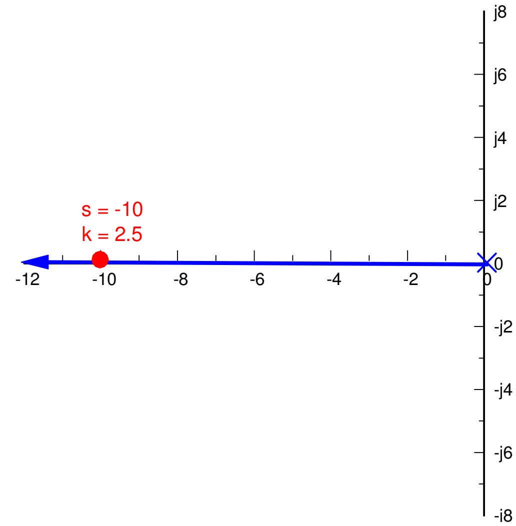


PI Control: Dominant Pole = -10

Add a PI compensator of the form

$$K(s) = k\left(\frac{s+6}{s}\right)$$

$$GK = \left(\frac{4k}{s}\right)$$



Pick 'k' to place the closed-loop dominant pole at -10

$$\left(\frac{4k}{s}\right)_{s=-10} = -1$$

$$k = 2.5$$

Closed-Loop System

$$\left(\frac{GK}{1+GK}\right) = \left(\frac{10}{s+10}\right)$$

- Build an op-amp circuit to implement K(s)
- Record the step respons.
- From the step response, determine the closed-loop dominant pole

DC Gain (5 rad/sec step)	2% Settling Time *(measured)*	Overshoot *(%)*	Dominant Pole *(measured)*