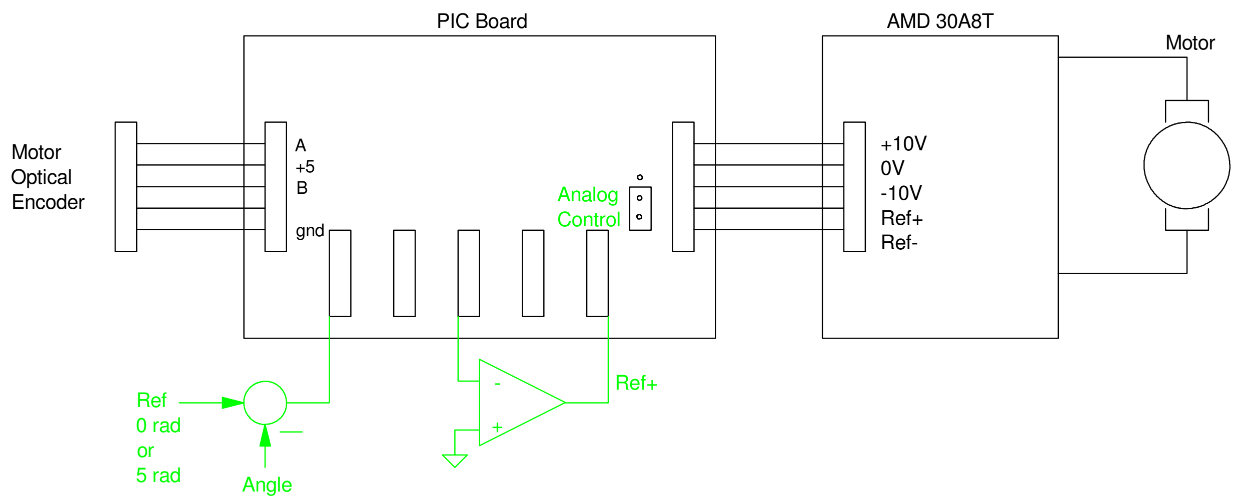
ECE 761: Homework #16: Angle Control of a DC Servo Motor

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

- Measures the angle of the DC servo motor,
- Make the reference input (Ref) equal to -5 radians or 0 radians when you press the step button, and
- Outputs a voltage equal to Ref - Angle
- 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

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

or

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

Proportional Feedback:

$$U = k(R - \theta)$$

Op-Amp Circuit

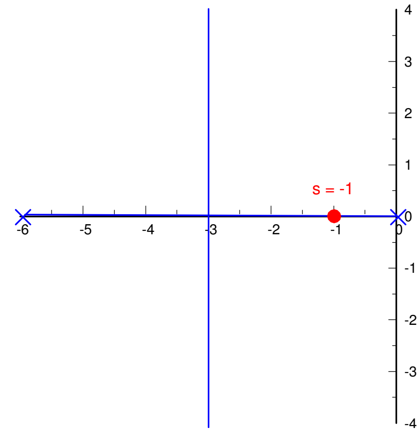
Root Locus

$$\left(\frac{Gk}{1+Gk}\right) = \left(\frac{40k}{s(s+6)+40k}\right)$$

1) Proportional Feedback: Dominant Pole = -1

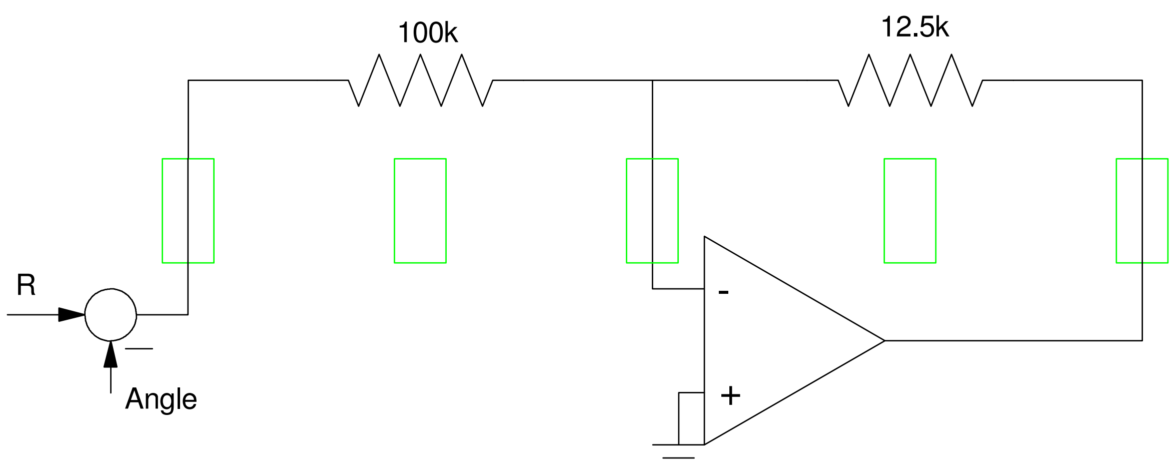
$$\left(\frac{40}{s(s+6)}\right)_{s=-1} \cdot k = -1$$

$$k = 0.125$$



- Build an op-amp circuit to implement a gain of 0.125.
- Record the step response.
- From the step response, determine the closed-loop dominant pole (it should be -1)

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

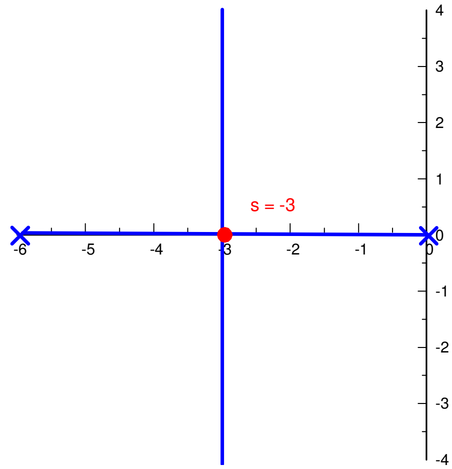


2) Proportional Feedback: Dominant Pole = -3

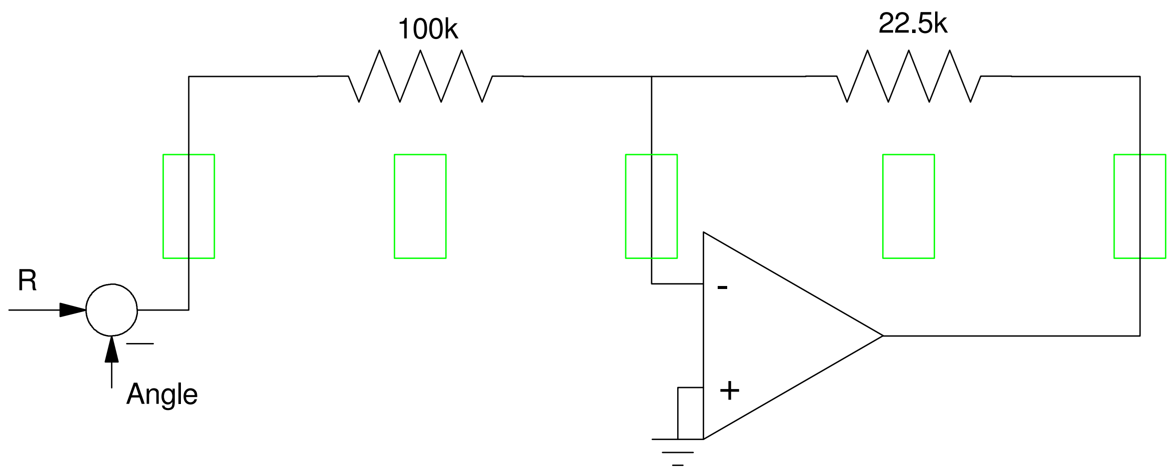
$$\left(\frac{40}{s(s+6)}\right)_{s=-3} \cdot k = -1$$

$$k = 0.225$$

- Build an op-amp circuit to implement a gain of 0.225.
- 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)*

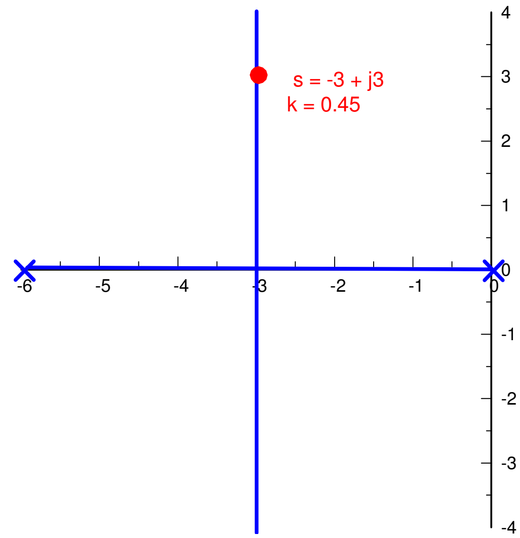


3) Proportional Feedback: Dominant Pole = -3 + j3

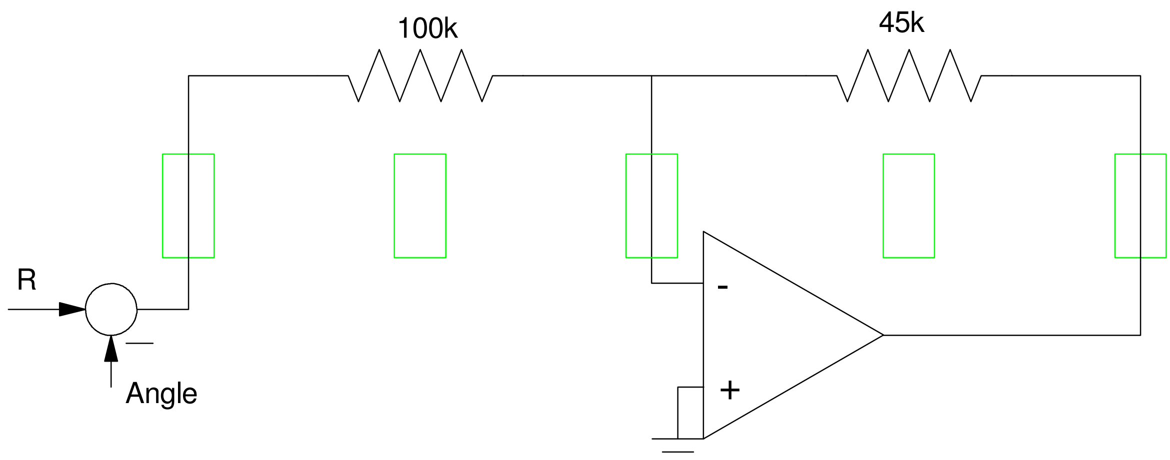
$$\left(\frac{40}{s(s+6)}\right)_{s=-3+j3} \cdot k = -1$$

$$k = 0.45$$

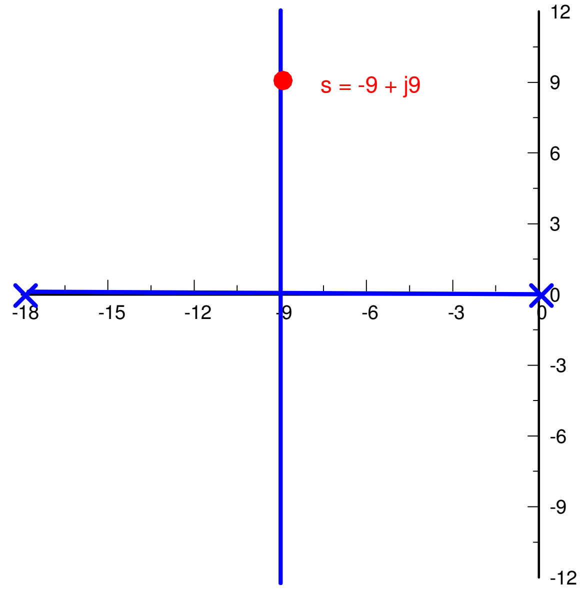
- Build an op-amp circuit to implement a gain of 0.45
- Record the step respons.
- From the step response, determine the closed-loop dominant pole



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



4) Lead Compensation: Dominant Pole = -9 + j9



Add a lead compensator of the form

$$K(s) = 3k\left(\frac{s+6}{s+18}\right)$$

This results in the open-loop system being

$$GK = \left(\frac{120k}{s(s+18)}\right)$$

Pick 'k' to place the closed-loop dominant pole at -9 + j9

$$\left(\frac{120k}{s(s+18)}\right)_{s=-9+j9} = -1$$

$$k = 1.35$$

- Build an op-amp circuit to implement a gain of 0.45
- 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)*