# Homework 0

## Question 1 (6 points)

Give an example of a closed loop control system. Using your example, explain the following terms associated with the control system represented by Figure 1:

a) Plant

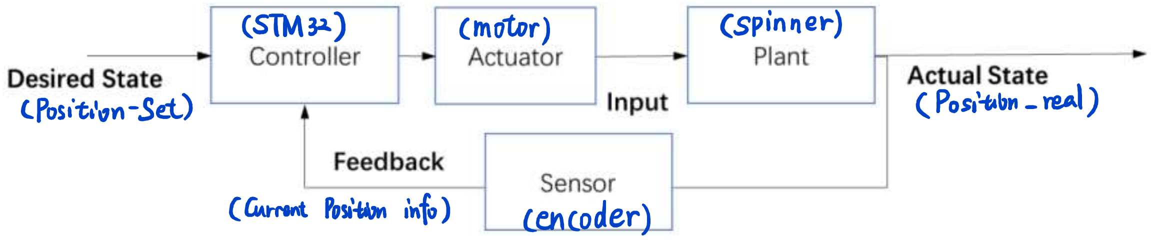
b) Sensors

c) Actuator

d) Desired State

e) Actual State

f) Feedback




(a) Plant: Spinner in the motor [The system being controlled]

(b) Sensor: Encoder in the motor for position detection

(c) Actuator: The coil in the motor for spinner control

(d) Desired State: The motor position that we set

(e) Actual State: The actual motor position that motor outputs

(f) Feedback: The current motor spinner position data that the encoder gets

## Question 2 (9 points)

Given $z = \frac{1}{j}\left(\frac{1-j}{2+2j} - \frac{1+j}{2-2j}\right)$

a) Write z in the form $\alpha + \beta j$

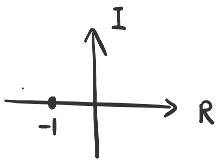
b) Sketch z in the complex plane

c) Obtain the inverse of z in polar form

d) Given $x^3 = -8$, find the complex values of $x$ that satisfy the equation.

(a). $z = \frac{1}{j}\left(\frac{1-j}{2+2j} - \frac{1+j}{2-2j}\right) = -j\left(\frac{(1-j)(2-2j)}{4+4} - \frac{(1+j)(2+2j)}{4+4}\right) = -j \cdot \frac{-4j}{4} = -1 + 0j$

(b).




(c). $\frac{1}{z} = \frac{1}{-1} = -1 = 1 \cdot e^{j\pi}$

(d) Assume $x = re^{j\theta}$

$\therefore r^3 e^{3j\theta} = 2^3 \cdot e^{j(\pi + 2k\pi)}$

$\therefore \begin{cases} r = 2 \\ \theta = \frac{\pi + 2k\pi}{3} \end{cases}$ $\therefore x = 2 \cdot e^{j \cdot \frac{\pi + 2k\pi}{3}}$ $\therefore x = -2,\ 1+\sqrt{3}j,\ 1-\sqrt{3}j$

**Question 3 (5 points)**

Consider the following differential equation:

$\ddot{x}(t) + 5\dot{x}(t) + 2x(t) = 0$. Find all values of $\lambda$ such that $x(t) = e^{\lambda t}$ satisfies the above differential equation.

$\because \lambda^2 + 5\lambda + 2 = 0$

$\therefore \left(\lambda + \frac{5}{2}\right)^2 = \frac{17}{4}$

$\therefore \lambda = -\frac{5 \pm \sqrt{17}}{2}$