College of Engineering
School of Aerospace Engineering

AE 6705: Introduction to Mechatronics

LAB3

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October 18, 2021

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Question 1

Solution:
Using a hair dryer the temperature scanner was heated up. There is a second increase in temperature in the graph since I moved the dryer closer to the sensor at around t = 50.

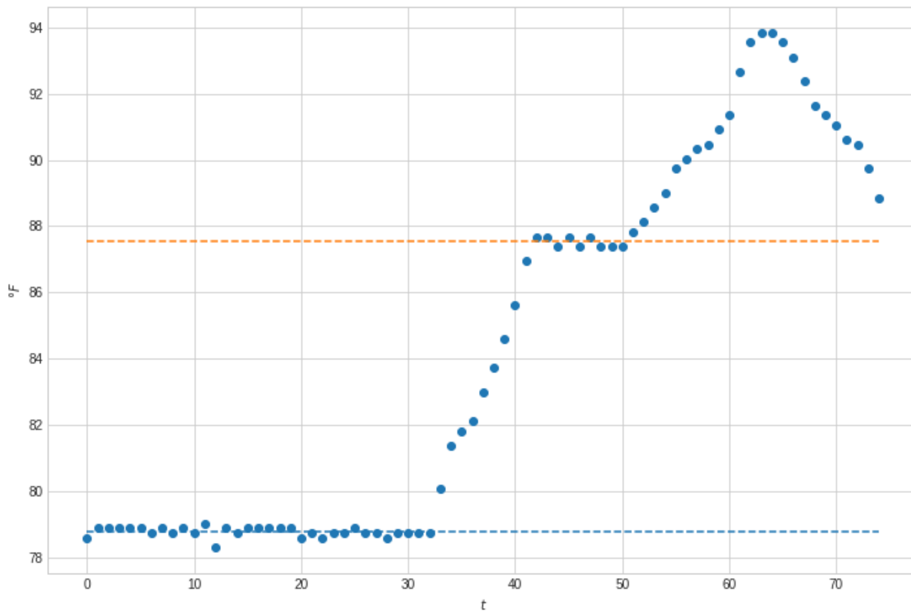

Figure 1: Sensor data of temperature over time

From the plot, we can see that the time taken to transition from one steady state to another is approximately 9 seconds in which the rise time is t = 33 and the next steady state starts from t = 42. (This is done in python. Please refer to the code in Python Code).

Question 2

Solution:
By altering the gain of the non-inverting amplifier with the op-amp to 2.2 so that the max output voltage will be $1.5V \times 2.2 = 3.3V$, we know that the maximum voltage would be 3.3

V and the minimum is 0 V. Hence, the resolution becomes

$$\boxed{\frac{3.3\text{V} - 0\text{V}}{2^{10} - 1} = 3.2258\text{mV}.}$$

and that in °F becomes

$$\boxed{3.2258\text{mV} \times 0.1\frac{^\circ\text{F}}{\text{mV}} = 0.3226^\circ\text{F}.}$$

Question 3

Solution:
The sensitivity is

$$\frac{5\text{V}}{100\text{rad/s}} = 0.05\frac{\text{V}}{\text{rad/s}}.$$

and then the input voltage becomes

$$\boxed{65\text{rad/s} \times 0.05 = 3.25\text{V}.}$$

The output becomes

$$\left\lfloor 3.25\text{V} \times \frac{2^{14}}{5.0\text{V}} \right\rfloor = \lfloor 10649.6 \rfloor = 10649,$$

hence,

$$\boxed{10649 \xrightarrow{binary} 10100110011001.}$$

Appendix

4.1 Python Code

```python
from control import step_info
import numpy as np
import matplotlib.pyplot as plt

data = np.loadtxt('temperatureData.csv')

N = len(data)
T = np.arange(N)

fig = plt.figure()
plt.rcParams['figure.figsize'] = (12, 8)
plt.plot(T, np.mean(data[0:33])*np.ones(N), '--')
plt.plot(T, np.mean(data[42:50])*np.ones(N), '--')
plt.scatter(T, data)
plt.xlabel(r'$t$')
plt.ylabel(r'$\degree F$')
plt.savefig('temperature_response.png')
sysinfo = step_info(data, T)

'''
sysinfo = {'RiseTime': 33,
 'SettlingTime': 71,
 'SettlingMin': 80.058655,
 'SettlingMax': 93.841644,
 'Overshoot': 5.610559466414027,
 'Undershoot': 88.11880637669529,
 'Peak': 93.841644,
 'PeakTime': 63,
 'SteadyStateValue': 88.856308}
'''
```