Quiz 4

Graded

Student

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Total Points

25 / 30 pts

Question 1

General ADC Use **9** / 10 pts

1.1 **(no title)** **3** / 3 pts

✔ **+ 3 pts** $2^{12}\frac{1.1V-0V}{3.0V-0V} = 1501.9 \rightarrow 1501$

+ 1.5 pts 1501.9 or 1510

+ 0 pts Incorrect/Blank

1.2 **(no title)** **2** / 3 pts

+ 3 pts $3.5V > 3.0V \rightarrow$ Saturation.
Therefore, output max value of ADC: $2^{12} - 1 = 4095$

✔ **+ 2 pts** 4096: Saturation but didn't subtract 1.

+ 1 pt $2^{12}\frac{3.5V-0V}{3.0V-0V} = 4778.7 \rightarrow 4778$
Rounded or unrounded acceptable for partial

+ 0 pts Incorrect/Blank

1.3 **(no title)** **4** / 4 pts

✔ **+ 2 pts** Minimum: $\hat{V}_{in} \geq \frac{854}{2^{10}}3.0V \geq 2.502V$

✔ **+ 2 pts** Maximum: $\hat{V}_{in} < \frac{854+1}{2^{10}}3.0V < 2.5049V$

+ 0 pts Incorrect/Blank

Question 2

ADC Control Applications **3** / 5 pts

2.1 (no title) **0** / 2 pts

+ 2 pts $R_{bot} = 6.0k\Omega$ therefore $R_{top} = 4.0k\Omega$

$$V_{out} = 2.5V\frac{R_{bot}}{R_{top}+R_{bot}} = 1.5V$$

+ 1 pt Did voltage divider upside-down:

$$V_{out} = 2.5V\frac{R_{top}}{R_{top}+R_{bot}} = 1.0V$$

✔ **+ 0 pts** Incorrect/Blank

2.2 (no title) **3** / 3 pts

✔ **+ 3 pts** `angle = NADC / 1024.0 * (45-10) + 10`

+ 1.5 pts Partial

+ 0.5 pts Several errors

+ 0 pts Incorrect or blank

Question 3

System Responses and Control 1 **6** / 8 pts

3.1 (no title) **2** / 2 pts

✔ **+ 2 pts** 0.82 m (0.8 to 0.85 acceptable)

+ 0 pts Incorrect/Blank

3.2 (no title) **0** / 2 pts

+ 2 pts $1s - 0.25s \approx 0.75s$ (0.7 to 0.8 accepetable)

✔ **+ 0 pts** Incorrect/Blank

3.3 (no title) **2** / 2 pts

✔ **+ 2 pts** $1.19m - 0.82m \approx 0.37m$ (0.35 - 0.4 acceptable)

+ 1 pt $1.19m - 1m \approx 0.19m$

+ 0 pts Incorrect/Blank

3.4 (no title) **2** / 2 pts

+ 0 pts Incorrect

✔ **+ 2 pts** Underdamped

Question 4

System Responses and Control A **7** / 7 pts

4.1 (no title) **1** / 1 pt

✔ **+ 1 pt** Response 3

+ 0 pts Incorrect

4.2 (no title) **2** / 2 pts

✔ **+ 2 pts** Response 3

+ 0 pts Incorrect

4.3 (no title) **2** / 2 pts

✔ **+ 2 pts** Response 2

+ 0 pts Incorrect

4.4 (no title) **2** / 2 pts

✔ **+ 2 pts** Response 1

+ 0 pts Incorrect

Q1 General ADC Use
10 Points

Q1.1
3 Points

The MSP432P401R ADC14 is configured as single ended. With the parameters below, what is the output of the ADC?

$$V_{in} = 1.1V$$
$$\text{ADC bits} = 12$$
$$V_{ref}^{+} = 3.0V$$
$$V_{ref}^{-} = 0V$$

1501

Q1.2
3 Points

Repeat the previous question except with: $V_{in} = 3.5V$

$$V_{in} = 3.5V$$
$$\text{ADC bits} = 12$$
$$V_{ref}^{+} = 3.0V$$
$$V_{ref}^{-} = 0V$$

4096

Q1.3
4 Points

An ADC returned the `uint16_t` value 854 with the configuration listed below. What are the minimum and maximum input voltages that this number might represent?

$$\text{ADC bits} = 10$$
$$V_{ref}^{+} = 3.0V$$
$$V_{ref}^{-} = 0V$$

minimum:

Min Voltage: 2.502V

maximum:

Max Voltage: 2.505V

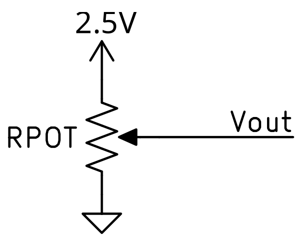
Q2 ADC Control Applications

5 Points

Q2.1

2 Points

A potentiometer is used to create a system input, where one leg is wired to 2.5 V, another to 0V, and the wiper is connected to an ADC input.



If the potentiometer resistance is 10 kΩ and the resistance between 0 V (ground) leg and the wiper is 6.0 kΩ, what is the voltage applied to the ADC input?

Vout = Vin(R1/(R1 + R2)) = 2.5(10/(10+16)) = 1.5625
1.5625V

Q2.2

3 Points

The potentiometer is intended to control the maximum tilt angle of a drone. When the potentiometer is turned all the way one way (ADC input is 0 V), the max tilt angle should be set to 10 degrees. If turned all the way the other way the max tilt angle should be set to 45 degrees.

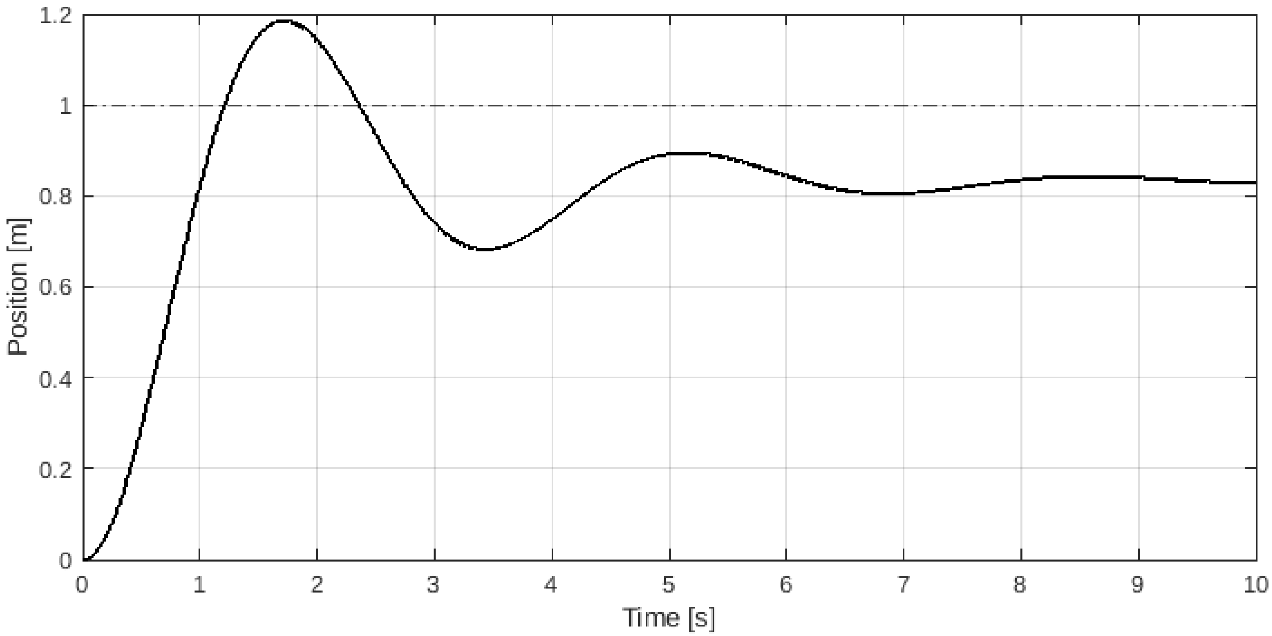
Derive an equation that will produce the **desired maximum drone tilt angle**, `angle`, from the **ADC conversion value**, `NADC`, of the POT. Assume the ADC is set to 10 bits and the reference voltages are 2.5 V and 0 V, matching the potentiometer legs.

30/(2^10) * Nadc + 10

Q3 System Responses and Control 1

8 Points

A second-order system responds to a step change in desired position (desired: 1m) as shown in the figure below. Answer the subquestions below considering these responses. Answers to numeric questions are expected to be *approximate*.



Q3.1

2 Points

What is the steady state value of the response?

0.83

Q3.2

2 Points

What is the system rise time?

1.7 seconds

Q3.3
2 Points

How far does the system overshoot (in meters)?

1.2 - 0.83 = 0.37
The system overshot by 0.37 m.

Q3.4
2 Points

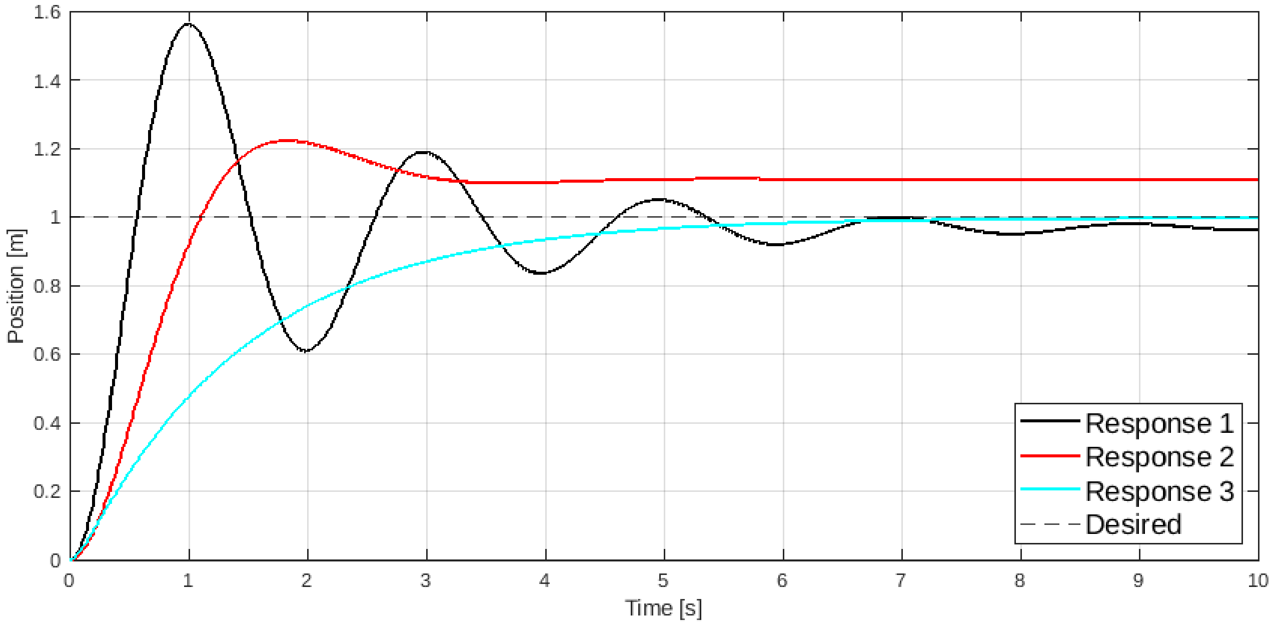
What word(s) best describes this response?

- (●) Underdamped
- ( ) Overdamped
- ( ) Critically-damped
- ( ) Unstable

Q4 System Responses and Control A

7 Points

Three second-order system responses are shown to a step input change in desired heading. Answer the subquestions below considering these responses. It is recommended to open this image in a new tab or window for quick reference.



Q4.1

1 Point

Which response most resembles a first-order response?

- Response 1
- Response 2
- Response 3 (selected)

Q4.2
2 Points

Assuming PID is being used to control the system, Which response would benefit most from an **increased proportional gain constant**, assuming no other changes?

- ( ) Response 1
- ( ) Response 2
- (x) Response 3

Q4.3
2 Points

Assuming PID is being used to control the system, Which response would benefit most from an **increased integral gain constant**, assuming no other changes?

- ( ) Response 1
- (x) Response 2
- ( ) Response 3

Q4.4
2 Points

Assuming PID is being used to control the system, Which response would benefit most from an **increased derivative gain constant**, assuming no other changes?

- (x) Response 1
- ( ) Response 2
- ( ) Response 3