My grades for **F2023.ECE484 Lab 1 Report**

Q1

0 / 0

Include the **signed Declaration of Authorship** found on the Lab Manual. An actual signature must be included; *a typed name is not an acceptable signature substitute*.

Graded by Ilyas Farhat (ilyas.farhat@uwaterloo.ca)

Q1

1. Station# not included in the report (-1)
2. Statement of originality/Authorship Declaration missing (-2)
3. Code of the formula node not included in the report (-1)
4. Missing references (-2)

We acknowledge and promise that:

(a) We are the sole authors of this lab report and associated simulation files/code.

(b) This work represents our original work.

(c) We have not shared detailed analysis or detailed design results, computer code, or Simulink diagrams with any other student.

(d) We have not obtained or looked at lab reports from any other current or former student of ECE 481/484, and we have not let any other student access any part of our lab work.

(e) We have completely and unambiguously acknowledged and referenced all persons and aids used to help us with our work.

Student 1 Name: Clayton Haight

Student 1 Signature*: Clayton Haight

Student 2 Name: Ethan Childerhose

Student 2 Signature*: EC

Group #: 97

Station #: 7

(*) We require an actual signature: a typed name is not an acceptable substitute.

Q2

4 / 10

Provide here the report portion pertaining to **Lab 1, paragraphs (c) and (d)**.

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c) Determine the gain K and the theta offset

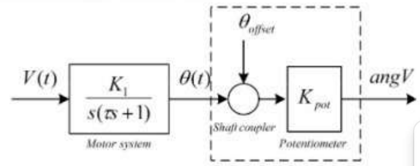


FIGURE 9: Nonlinearity introduced by servo-angle potentiometer

The offset was determined to be 4.212 with a gain error of 1.3576 creating this as the ServoAng /
ServoAng = 1.3576*(angV – 4.212);

d) Determine stiction:

CW: 0.476V

CCW: -0.476V

We incrementally increased the voltage until the gears started moving. This stiction is ... ical, the offset is 0.476V in either direction.

how? nothing is explained or discussed -6

Q2.c Gear angle scaling from V to rad

1. measurements correct (out of 2)
2. correct slope sign implementation (out of 2)
3. correct offset (out of 2)

(out of 6)

Q2.d Motor stiction

1. procedure explained (out of 2)
2. correct values (out of 2)

(out of 4)

Q3

2 / 23

Provide here the report portion pertaining to **Lab 1 paragraphs (e) and (f)**.

e) Sdf

The motor model is as follows:

$$\frac{K_1}{s(\tau s+1)}$$

We increased the C gain to 100 to get an overshoot while keeping motor voltage under 6V, which is its max. The response peaks at 0.137s after the step and overshoots by 7.5%.
The transfer function of the system would then be:

$$\frac{\frac{100K_1}{\tau s^2+s}}{1+\frac{100K_1}{\tau s^2+s}} = \frac{\frac{100K_1}{\tau s^2+s}}{\frac{100K_1+\tau s^2+s}{\tau s^2+s}} = \frac{100K_1}{\tau s^2+s}\frac{\tau s^2+s}{100K_1+\tau s^2+s} = \frac{100K_1}{\tau s^2+s+100K_1} = \frac{\frac{100K_1}{\tau}}{s^2+\frac{1}{\tau}s+\frac{100K_1}{\tau}}$$

1. $\omega_n = \sqrt{\frac{100K_1}{\tau}}$ 2. $\omega_n = \frac{1}{2\tau\zeta}$ 3. $T_p = \frac{\pi}{w_n\sqrt{1-\zeta^2}}$ 4. $\%OS = e^{\frac{-\zeta\pi}{\sqrt{1-\zeta^2}}} \cdot 100$

$\zeta = 0.63615$ $\omega_n = 29.72$ $\tau = 0.0264$ $K_1 = 0.2335$

1. Plugging in 7.5% for %OS allows us to solve damping ratio as 0.6362
2. Plug damping into 3 with Tp which is 1.37s gives a natural frequency of 29.72
3. This then allows us to solve tau which is 0.0264 rad/(Vs)
4. Finally we solve for K1 which comes out to 0.2332

f) A simple if statement shall do the trick:

```
if (ref > 0.7)
{ref = 0.7;}
else if (ref < -0.7)
{ref = -0.7;}
```

what C?

For lab 2, you may use the average of your station.

Station 7

K1 =-2.0513 rad/(Vs)

tau = 0.0203 s

check the comment in Q4 code block.

Cannot give any point here for your work as you don't show any plots or discussion of what you have done!

or answers.

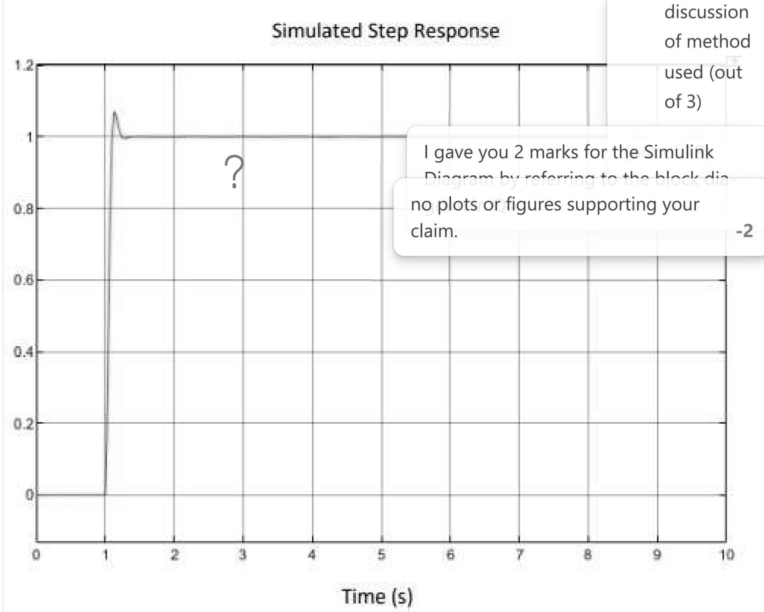
You have an idea about 2nd order systems but not about your system here.

-19

Q3.e Motor modeling

1. explanation of how cl stabilized (out of 2)
2. sampling rate stated (out of 1)
3. sample calculations included (out of 3)
4. valid choices of test parameters (out of 3)
5. results for K1 and tau correct (out of 3)
6. experimental plots, including motor voltage to show it did not saturate (out of 2)
7. several sets of measurements with different parameters taken (out of 2)
8. explanations and

2. Simulink plot showing saturation in a meaningful way (out of 1)
3. relevant experimental plot testing the gear angle coercion (out of 1)



discussion of method used (out of 3)

I gave you 2 marks for the Simulink Diagram by referring to the block dia

no plots or figures supporting your claim. -2

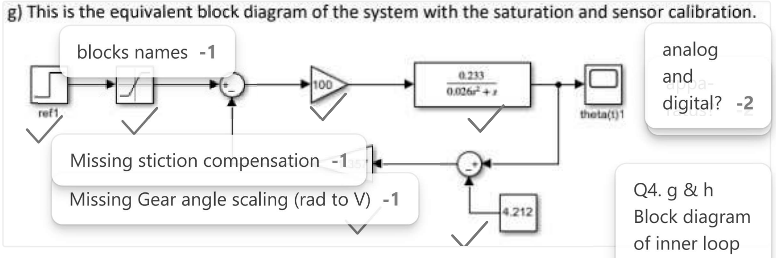
Q4

9.5 / 17

Provide here the report portion pertaining to **Lab 1 paragraphs (g) and (h)**.

Provide here, at the end of this Question, any **References** you used for the preparation of this report.

g) This is the equivalent block diagram of the system with the saturation and sensor calibration.



blocks names -1

analog and digital? -2

Missing stiction compensation -1

Missing Gear angle scaling (rad to V) -1

Q4. g & h Block diagram of inner loop

1. all blocks present; nonlinear effects included (out of 7)
2. shows variable names used in the formula node and their units; signs consistent with those used in the formula node (out of 1)
3. apparatus components identified (out of 2)
4. analog and digital signals identified (out of 2)

(out of 12)

```
/* ======== USER INTERFACE TEMPLATE ============= */
/*  Insert below the code for your scaling, saturation block, and controllers.*/

/*  Variables may be declared on the box border, as shown for the input
"Tms" and the output "BallPosn". Variables can also be declared inline as was done for "Temp1". */

float Temp1;
float eGearAng;

/*  Shift registers permit previous values of variables to be saved.
The output variable "e" is wired to a shift register input on the For Loop border.
The inputs "e1" and "e2"are wired  to the corresponding shift register outputs.
"e1" holds the value of "e" from the previous iteration and "e2" holds the value of "e1" from  the
previous iteration. */

/* Place your sensor SCALING here */
/* NO scaling is provided for the demo */
BallPosn = posV ;  /* V to V */
ServoAng = 1.3576*(angV - 4.212); /* V to V */
/* SCALING end */


if (Loop  < 3) /* all shift registers cleared after 3rd iteration; this statement initializes the shift registers
*/
  {u = e = ThRef = posV= angV =ServoAng= BallPosn= 0;}
else
{
if (Manual)   /*manual motor voltage control*/
  {  u = MotV;}
   else    /*control algorithm*/
  {

/* CAUTION: DO NOT load the output of a nonlinear block (e.g., saturator, offset) into a SHIFT REGISTER,
to avoid introducing a nonlinearity into your controller loop. Create separate variables to hold nonlinear
values.*/

/* Place your outer loop BALL POSITION CONTROLLER below */
BallPosn = 0; // REMOVE this line when the ball is being used on the beam

/* Place your gear angle SATURATOR below */
/*
if (ref > 0.7)
{ref = 0.7;}
else if (ref < -0.7)
{ref = -0.7;}
*/
/* Place your inner loop GEAR
  u = 100*(ref - ServoAng);

  }
}

/* ThRef, ThRef1, e, e1 are present, but not used in this demo.
However, they will be necessary (at a minimum) when the controllers will be implemented. */
```

no, you don't change the output specified from the ref. generator. You generate another signal, call it Theta_sat or something, and that can be saturated. You don't change your input signal values as this might result in 'inconsistencies' in real-life when working on a project with other engineers. **-0.5**

References provided by email