

Jacobs University Bremen

Introduction to Robotics and Intelligent Systems Lab

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Lab 3

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1-Introduction:

In this final lab, we are perfecting our skills and experiences with the Arduino, working with different codes and equipment to solve the tasks we are given. This report is mainly constituted of pictures and explanations of what we did, the problems we faced, and how we solved them.

2-Lab Tasks:

Task 3.1:

The command `rotateX()` makes a rotation around the x-axis with the argument the angle of rotation, for `rotateY()`, it does the same except the rotation occurs on the y-axis.

Task 3.2:

3.2.1:

The signs of XYZ are negative or positive depending on their axis respectively (the ones printed on the accelerometer), so Yes, the values are as we expected.

3.2.2:

COM5						
X:	Y:	Z:	X:	Y:	Z:	
-0.01	-8.88	3.71				m/s^2
Portrait Up Front						
2	-3796	1408				
-0.02	-9.08	3.38				m/s^2
Portrait Up Front						
-2	-3750	1524				
0.02	-8.99	3.66				m/s^2
Portrait Up Front						
8	-3820	1344				
0.02	-9.14	3.17				m/s^2
Portrait Up Front						
10	-3826	1338				
0.03	-9.12	3.24				m/s^2
Portrait Up Front						
-4	-3812	1278				
-0.03	-9.17	3.03				m/s^2
Portrait Up Front						
-6	-3882	1222				
-0.04	-9.27	2.94				m/s^2
Portrait Up Front						
-20	-3856	1202				
-0.05	-9.22	2.83				m/s^2
Portrait Up Front						
-8	-3868	1180				
-0.01	-9.27	2.81				m/s^2
Portrait Up Front						
-14	-3888	1164				
-0.03	-9.31	2.74				m/s^2
Portrait Up Front						
-14	-3892	1130				
-0.00	-9.31	2.69				m/s^2
Portrait Up Front						

Portrait Up Front

COM5						
X:	Y:	Z:	X:	Y:	Z:	
0.27	9.95	3.47				m/s^2
Portrait Down Front						
12	4082	950				
-0.01	9.79	2.26				m/s^2
Portrait Down Front						
56	4192	952				
0.17	10.16	2.29				m/s^2
Portrait Down Front						
-28	4076	978				
-0.03	9.76	2.33				m/s^2
Portrait Down Front						
-16	4082	1024				
-0.02	9.82	2.40				m/s^2
Portrait Down Front						
-24	4070	1026				
-0.08	9.70	2.47				m/s^2
Portrait Down Front						
-14	4128	956				
-0.02	9.84	2.32				m/s^2
Portrait Down Front						
-12	4090	960				
-0.02	9.80	2.31				m/s^2
Portrait Down Front						
-24	4092	1006				
-0.05	9.78	2.36				m/s^2
Portrait Down Front						
-36	4080	980				
-0.08	9.78	2.36				m/s^2
Portrait Down Front						
-26	4092	1012				
-0.08	9.81	2.44				m/s^2
Portrait Down Front						

Portrait Down Front

COM5

X:	4000	Y:	0	Z:	370	
X:	9.70	Y:	-0.20	Z:	0.89	m/s^2
Landscape Right Front						
X:	4052	Y:	-76	Z:	350	
X:	9.70	Y:	-0.17	Z:	0.93	m/s^2
Landscape Right Front						
X:	4064	Y:	-72	Z:	342	
X:	9.71	Y:	-0.18	Z:	0.88	m/s^2
Landscape Right Front						
X:	4068	Y:	-78	Z:	362	
X:	9.74	Y:	-0.17	Z:	0.84	m/s^2
Landscape Right Front						
X:	4046	Y:	-60	Z:	300	
X:	9.70	Y:	-0.11	Z:	0.72	m/s^2
Landscape Right Front						
X:	4056	Y:	66	Z:	300	
X:	9.68	Y:	0.12	Z:	0.72	m/s^2
Landscape Right Front						
X:	4038	Y:	26	Z:	266	
X:	9.68	Y:	0.04	Z:	0.69	m/s^2
Landscape Right Front						
X:	4028	Y:	8	Z:	336	
X:	9.67	Y:	0.02	Z:	0.79	m/s^2
Landscape Right Front						
X:	4030	Y:	24	Z:	360	
X:	9.62	Y:	0.05	Z:	0.81	m/s^2
Landscape Right Front						
X:	4024	Y:	52	Z:	326	
X:	9.65	Y:	0.12	Z:	0.81	m/s^2
Landscape Right Front						
X:	4028	Y:	28	Z:	348	
X:	9.66	Y:	0.07	Z:	0.83	m/s^2
Landscape Right Front						

Landscape Right Front

COM5

X:	2130	Y:	70	Z:	3321	
X:	-5.81	Y:	-0.15	Z:	7.98	m/s^2
Landscape Left Front						
X:	-3456	Y:	200	Z:	1800	
X:	-8.14	Y:	0.25	Z:	3.99	m/s^2
Landscape Left Front						
X:	-4408	Y:	318	Z:	364	
X:	-10.54	Y:	1.01	Z:	1.05	m/s^2
Landscape Left Front						
X:	-4074	Y:	88	Z:	174	
X:	-9.76	Y:	0.28	Z:	0.54	m/s^2
Landscape Left Front						
X:	-4092	Y:	300	Z:	728	
X:	-9.80	Y:	0.65	Z:	1.77	m/s^2
Landscape Left Front						
X:	-4028	Y:	240	Z:	804	
X:	-9.66	Y:	0.59	Z:	1.93	m/s^2
Landscape Left Front						
X:	-4010	Y:	220	Z:	782	
X:	-9.54	Y:	0.61	Z:	1.96	m/s^2
Landscape Left Front						
X:	-4052	Y:	196	Z:	794	
X:	-9.73	Y:	0.46	Z:	1.90	m/s^2
Landscape Left Front						
X:	-4016	Y:	138	Z:	836	
X:	-9.62	Y:	0.30	Z:	1.93	m/s^2
Landscape Left Front						
X:	-4012	Y:	176	Z:	784	
X:	-9.60	Y:	0.43	Z:	1.83	m/s^2
Landscape Left Front						
X:	-4014	Y:	182	Z:	798	
X:	-9.62	Y:	0.43	Z:	1.91	m/s^2
Landscape Left Front						

Landscape Left Front

COM5

X:	Y:	Z:	
0.29	-2.40	-8.16	m/s ²
Portrait Up Back			
562	206	-3724	
1.43	0.34	-8.87	m/s ²
Portrait Up Back			
2212	244	-3504	
5.37	0.66	-8.44	m/s ²
Landscape Right Back			
2142	-12	-3680	
5.17	-0.01	-8.78	m/s ²
Landscape Right Back			
2158	260	-3404	
5.15	0.69	-8.15	m/s ²
Landscape Right Back			
2328	332	-3386	
5.57	0.83	-8.08	m/s ²
Landscape Right Back			
2352	284	-3416	
5.62	0.65	-8.15	m/s ²
Landscape Right Back			
2258	474	-3240	
5.32	1.09	-7.73	m/s ²
Landscape Right Back			
2428	424	-3282	
5.78	1.01	-7.85	m/s ²
Landscape Right Back			
2384	442	-3220	
5.71	1.04	-7.78	m/s ²
Landscape Right Back			
2430	362	-3276	
5.78	0.91	-7.92	m/s ²
Landscape Right Back			

Landscape Right Back

COM5

X:	Y:	Z:	
-4.06	-0.90	-8.35	m/s ²
Landscape Left Back			
-1944	-258	-3426	
-4.67	-0.63	-8.17	m/s ²
Landscape Left Back			
-1950	-258	-3502	
-4.67	-0.67	-8.41	m/s ²
Landscape Left Back			
-2028	-252	-3436	
-4.79	-0.60	-8.19	m/s ²
Landscape Left Back			
-2044	-246	-3562	
-4.87	-0.60	-8.56	m/s ²
Landscape Left Back			
-1992	-170	-3452	
-4.81	-0.44	-8.30	m/s ²
Landscape Left Back			
-2018	-214	-3474	
-4.77	-0.51	-8.32	m/s ²
Landscape Left Back			
-1972	-176	-3486	
-4.71	-0.46	-8.29	m/s ²
Landscape Left Back			
-1998	-206	-3498	
-4.75	-0.48	-8.32	m/s ²
Landscape Left Back			
-1976	-186	-3484	
-4.72	-0.43	-8.38	m/s ²
Landscape Left Back			
-2040	-228	-3500	
-4.84	-0.56	-8.34	m/s ²
Landscape Left Back			

Landscape Left Back

COM5

X	Y	Z	Unit
X: -1.37	Y: -4.09	Z: -8.40	m/s ²
Portrait Up Back			
X: -252	Y: -3026	Z: -2540	
X: -0.59	Y: -7.24	Z: -6.06	m/s ²
Portrait Up Back			
X: -270	Y: -3070	Z: -2598	
X: -0.62	Y: -7.31	Z: -6.22	m/s ²
Portrait Up Back			
X: -234	Y: -3014	Z: -2608	
X: -0.62	Y: -7.25	Z: -6.25	m/s ²
Portrait Up Back			
X: -274	Y: -3034	Z: -2568	
X: -0.64	Y: -7.28	Z: -6.14	m/s ²
Portrait Up Back			
X: -226	Y: -3050	Z: -2554	
X: -0.60	Y: -7.30	Z: -6.14	m/s ²
Portrait Up Back			
X: -256	Y: -3050	Z: -2518	
X: -0.60	Y: -7.29	Z: -6.02	m/s ²
Portrait Up Back			
X: -244	Y: -3092	Z: -2550	
X: -0.59	Y: -7.37	Z: -6.11	m/s ²
Portrait Up Back			
X: -210	Y: -3098	Z: -2562	
X: -0.51	Y: -7.42	Z: -6.05	m/s ²
Portrait Up Back			
X: -260	Y: -3054	Z: -2512	
X: -0.62	Y: -7.33	Z: -6.05	m/s ²
Portrait Up Back			
X: -264	Y: -3030	Z: -2526	
X: -0.64	Y: -7.25	Z: -6.12	m/s ²
Portrait Up Back			
X: -250			

Portrait Up Back

COM5

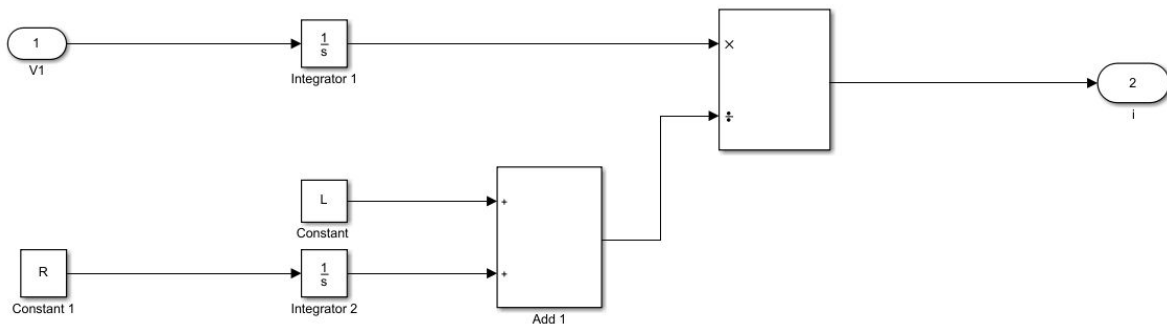
X	Y	Z	Unit
X: 0.94	Y: 6.31	Z: -7.01	m/s ²
Portrait Down Back			
X: 348	Y: 3282	Z: -2622	
X: 0.82	Y: 7.78	Z: -6.23	m/s ²
Portrait Down Back			
X: 380	Y: 3202	Z: -2554	
X: 0.91	Y: 7.70	Z: -6.12	m/s ²
Portrait Down Back			
X: 362	Y: 3250	Z: -2552	
X: 0.87	Y: 7.78	Z: -6.06	m/s ²
Portrait Down Back			
X: 360	Y: 3184	Z: -2596	
X: 0.88	Y: 7.58	Z: -6.19	m/s ²
Portrait Down Back			
X: 396	Y: 3178	Z: -2584	
X: 0.92	Y: 7.58	Z: -6.23	m/s ²
Portrait Down Back			
X: 368	Y: 3184	Z: -2580	
X: 0.90	Y: 7.58	Z: -6.20	m/s ²
Portrait Down Back			
X: 412	Y: 3282	Z: -2632	
X: 1.02	Y: 7.86	Z: -6.29	m/s ²
Portrait Down Back			
X: 416	Y: 3232	Z: -2638	
X: 1.00	Y: 7.72	Z: -6.24	m/s ²
Portrait Down Back			
X: 402	Y: 3160	Z: -2598	
X: 0.94	Y: 7.56	Z: -6.17	m/s ²
Portrait Down Back			
X: 404	Y: 3188	Z: -2634	
X: 0.96	Y: 7.62	Z: -6.32	m/s ²
Portrait Down Back			

Portrait Down Back**3.2.3:**

The unit of the Acceleration is m/s², so yes it is really in m/s² (we are working on the accelerometer).

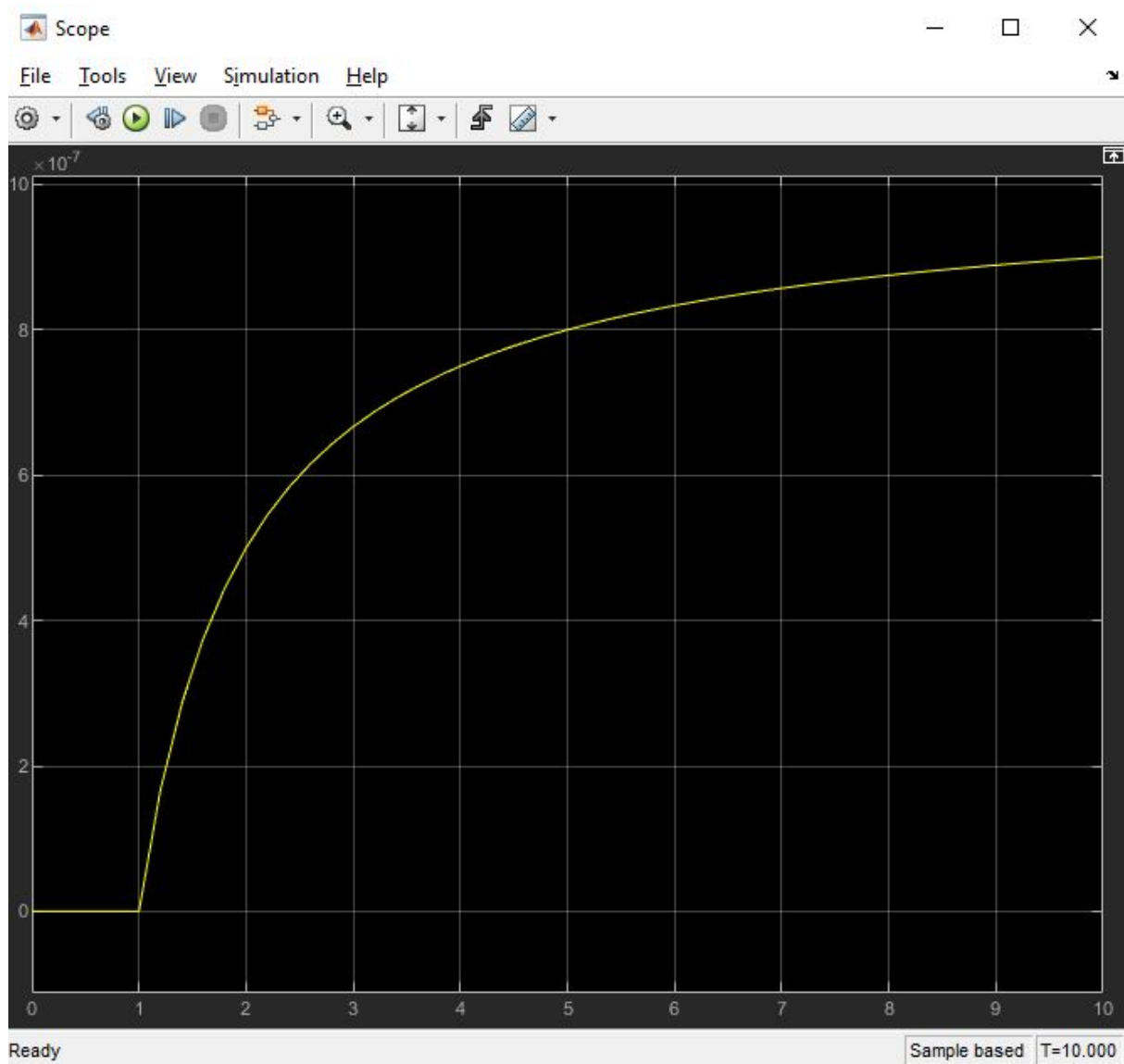
Task 3.4:

We know that $i(t)R = V1(t) - (Ldi/dt)$, using the Laplace transform we find $I(S)R = V1(S) - SLI(S)$ so the transform function is $H(S) = 1/(SL + R)$ or $H(S) = (1/S)/(L + R/S)$ this function helps us design the circuit in Matlab and it's equivalent to our RL circuit after the transform function.



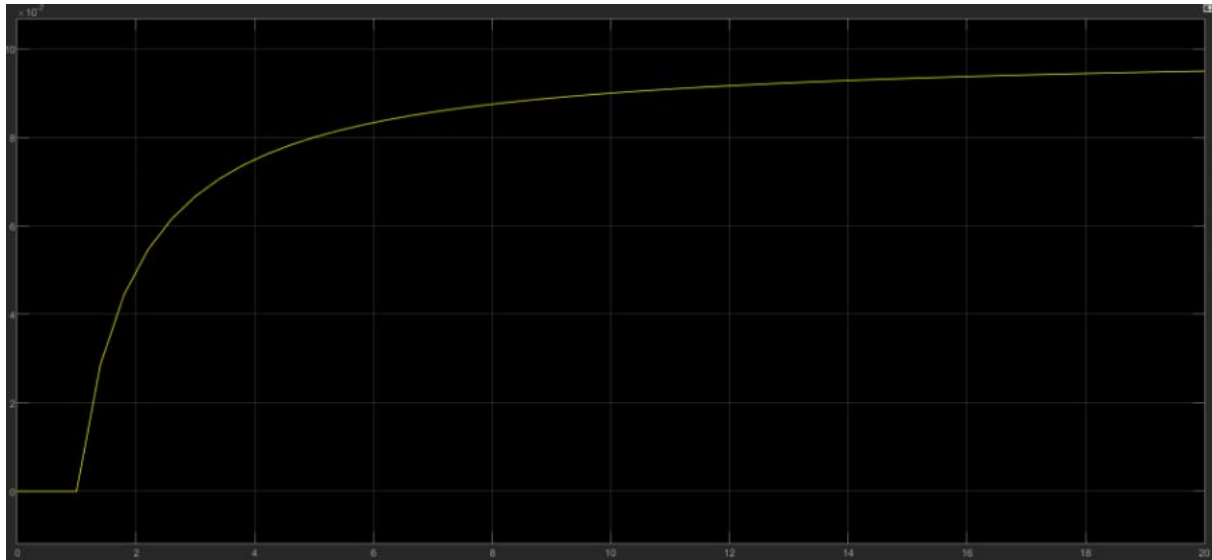
the circuit that we created in Matlab Simulink

Task 3.5:



After running the program for 10 discrete time, we obtain the preceding graph, in which we can observe the graph being stagnant then gradually increasing from an initial value which starts at 0 to a more stable state at a final value of 9×10^{-7} .

Task 3.6



Similarly to the first graph, we can observe the same phenomenon occurring once again, as the graph is stable for the first few values and then starts to gradually increase to a final value in which the graph becomes more stable.