EEP1 ELogBook – Week 8

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Studio

Activity 1a:

1. Question 1
    a. Initial Current of C1:
       $((10 - V) / 80) + ((10 - V) / 100) = (V / 20) + (V / 400)$
       $V = 3$
       $I_c = I_2 - I_1 = (3 / 20) - (7 / 80) = 0.0625A$
    b. Steady state voltage of C1:
       $Vba = 10 * (100 / (100 + 400)) - 10 * (80 / (80 + 20)) = -6V$
2. Question 2
    a. Initial current of L1:
       I = 0A, open circuit
    b. Steady state voltage of L1:
       V = 0V, Short circuit
3. Warm up exercise 1:
    a. At $t = 0^+$
        i. Current: 0A
        ii. Capacitor voltage: 0V
        iii. Inductor voltage: 5V
    b. Steady state
        i. Current: 0A
        ii. Capacitor voltage: 5V
        iii. Inductor voltage: 0V
4. Warm up exercise 2:
    a. At $t = 0^+$
        i. Capacitor current: 0A
        ii. Capacitor voltage: 0V
        iii. Inductor current: 0A
        iv. Inductor voltage: 12V
    b. Steady state
        i. Capacitor current: 0A
        ii. Capacitor voltage: $R_2 / (R_1 + R_2) * V_1 = 22k\Omega / (21k\Omega + 22k\Omega) * 12 = 6.13$ V
        iii. Inductor current: $V_1 / (R_1 + R_2) = 12 / (21k\Omega + 22k\Omega) = 0.28$ mA
        iv. Inductor voltage: 0V

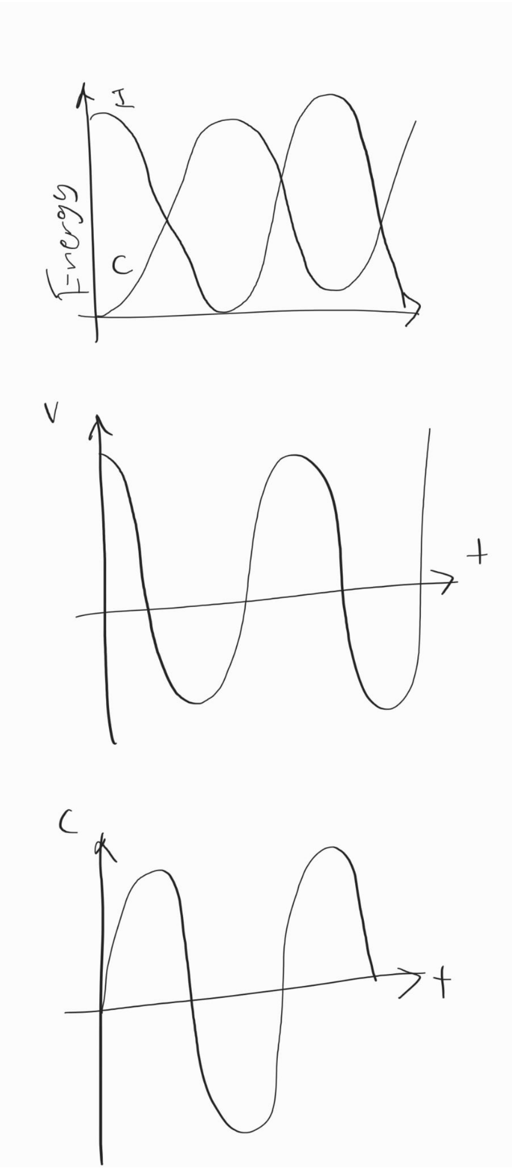
Activity 1b:

1. Capacitor:
    a. Receiving energy:
        i. The capacitor voltage will gradually increase over time, following an exponential growth curve.
        ii. The capacitor current will be initially high and decrease exponentially toward zero.
    b. Giving out energy:

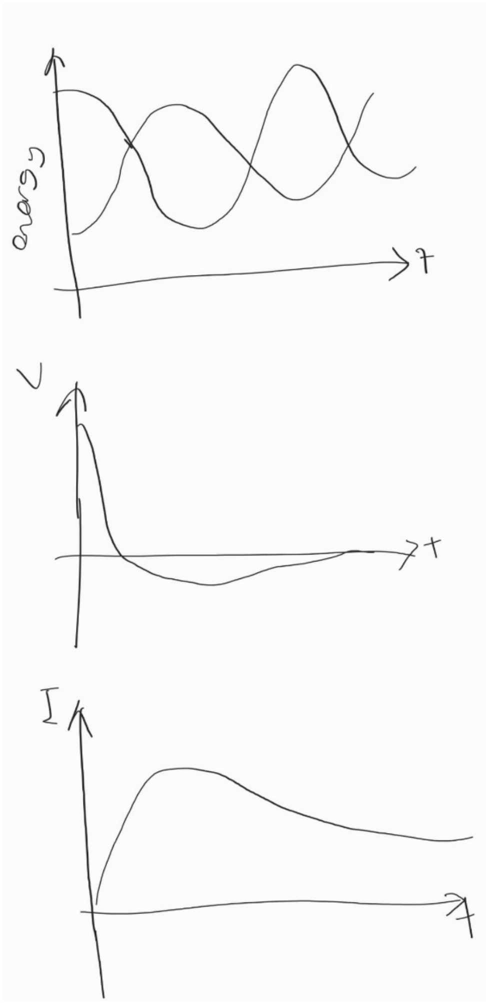
    i. The capacitor voltage will gradually increase over time, following an exponential growth curve.
    ii. The capacitor current will be initially high and decrease exponentially toward zero.

2. Inductor:
    a. Receiving energy:
        i. The capacitor voltage will gradually increase over time, following an exponential growth curve.
        ii. The capacitor current will be initially high and decrease exponentially toward zero.
    b. Giving out energy:
        i. The capacitor voltage will gradually increase over time, following an exponential growth curve.
        ii. The capacitor current will be initially high and decrease exponentially toward zero.

Activity 1c:



Once you add an extra resistor, the initial condition will change, Vc(0) = V0, while I(0) = I0.



Activity 2:

1. $\omega_n = \frac{1}{\sqrt{(1\times10^{-9})(1\times10^{-3})}} = 1 \times 10^6\ rad/s$

   $\zeta = \frac{220}{2}\sqrt{\frac{1\times10^{-9}}{1\times10^{-3}}} = 0.11$

   $\omega_d = 1 \times 10^6\ \sqrt{1 - 0.11^2} = 0.9939\ \times\ 10^6$

2. $R_{cd} = 2\sqrt{\frac{1\times10^{-3}}{1\times10^{-9}}} = 2\ \times\ 10^3\Omega$

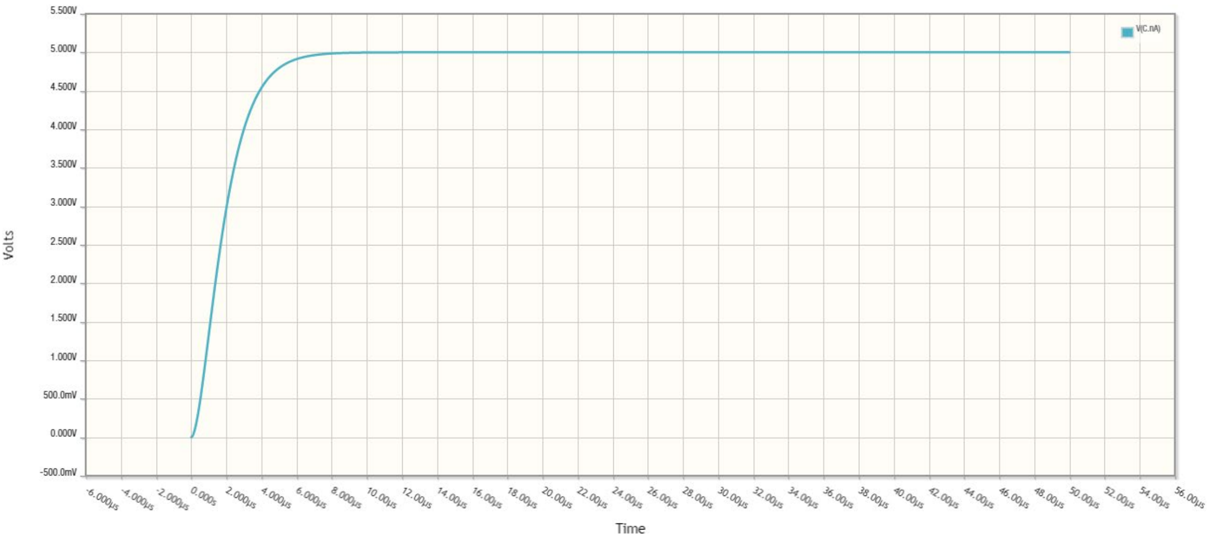
Time difference: 6.342us

2πf = 2π/T

2πf = 990726.2

f = 157679Hz = 157.7kHz

$\zeta = \frac{2000}{2}\sqrt{\frac{1\times10^{-9}}{1\times10^{-3}}} = 1$ – Critically Damped



$\zeta = \frac{3000}{2}\sqrt{\frac{1\times10^{-9}}{1\times10^{-3}}} = 1.5$ – Over Damped

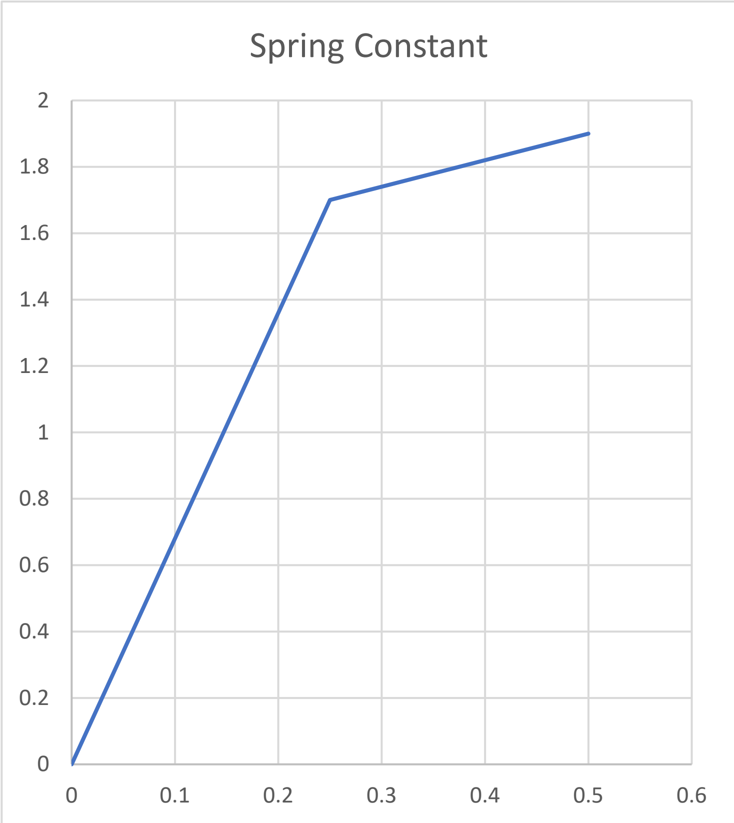
The value of damping ratio significantly influences the nature of the response in a dynamic system; a ζ of 1 indicates critical damping, resulting in a well-balanced response without oscillations, ζ > 1.5 leads to overdamping, causing sluggish and slow responses, while a low ζ of 0.11 signifies underdamping, leading to oscillatory and potentially unstable responses.

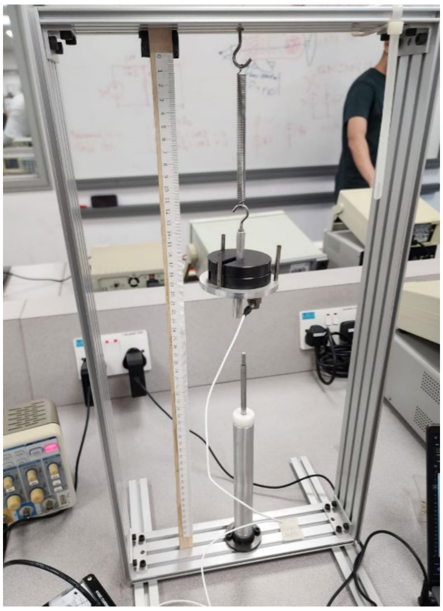
Lab

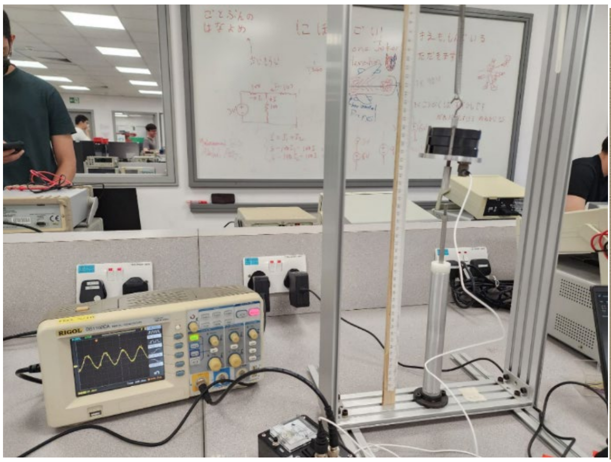
Activity 1

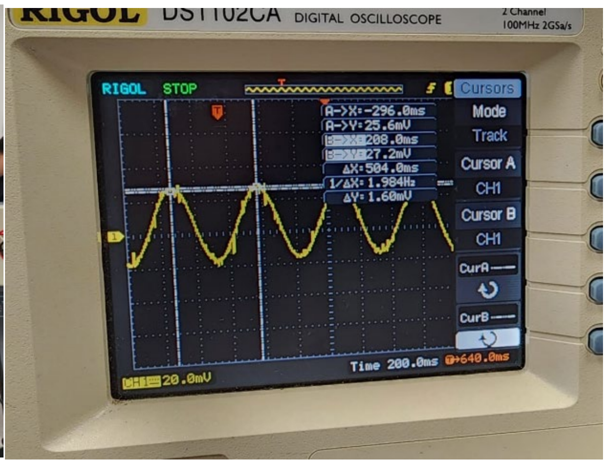
Length	Extension	Weight
6.4	0	0
8.1	1.7	0.25
10	1.9	0.5

Gradient is 3.8







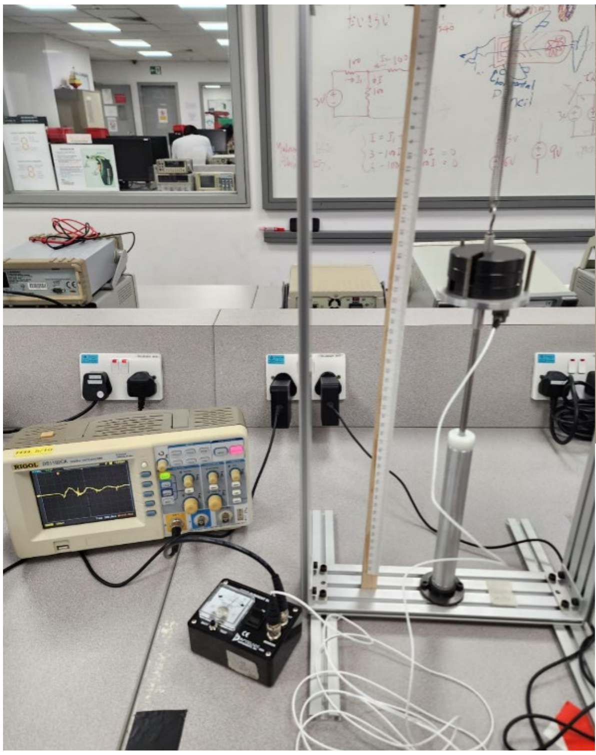


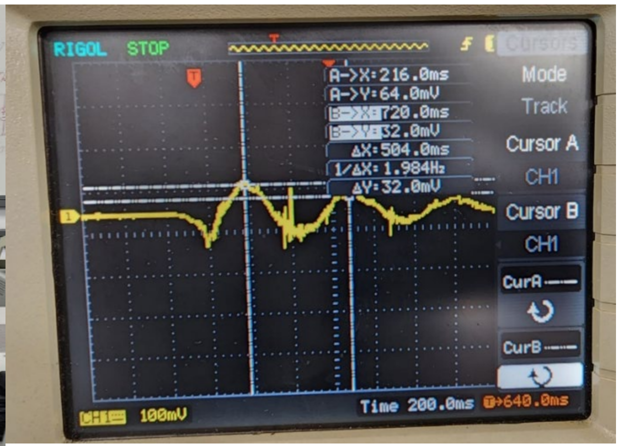
Tn = 504ms

Wn = 2π/Tn

Wn = 12.5 rad/s

Wn,th = $\sqrt{\frac{k}{m}} = \sqrt{\frac{3.8}{0.75}} = 2.25$





Td = 504ms

Wd = 2π/Td

Wd = 12.5 rad/s

Wd = $12.5\sqrt{1-\zeta^2} = 12.5$

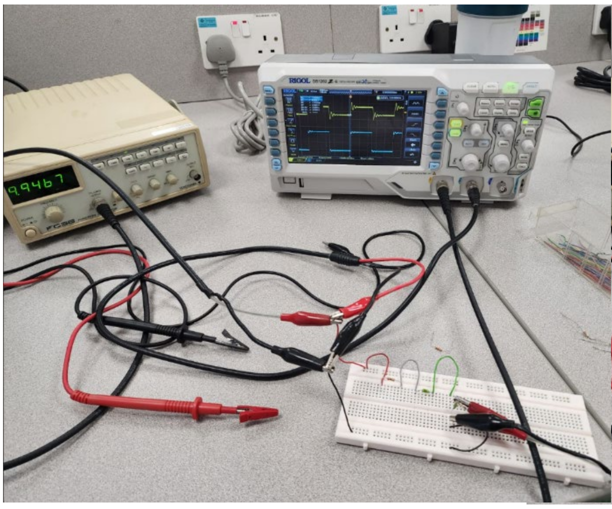
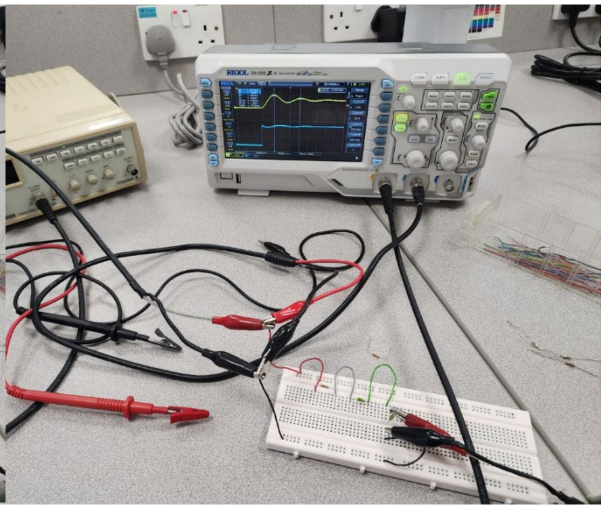
$$\zeta = 0$$

$$\zeta = \frac{c}{2\sqrt{mk}} = \frac{c}{2\sqrt{0.75 * 3.8}} = 0, c = 0$$

The machine is not working as expected, and it resulted in the damping ratio being 0, theoretically, the damping ratio should be a bit larger than 0, and not 0.

Activity 2

Resistor	Capacitor	Inductor	ζ	ωn	ωd
220	0.000000001	0.001	0.11	1000000	993931.5872
1000	0.000000001	0.001	0.5	1000000	866025.4038
2000	0.000000001	0.001	1	1000000	-
3300	0.000000001	0.001	1.65	1000000	-

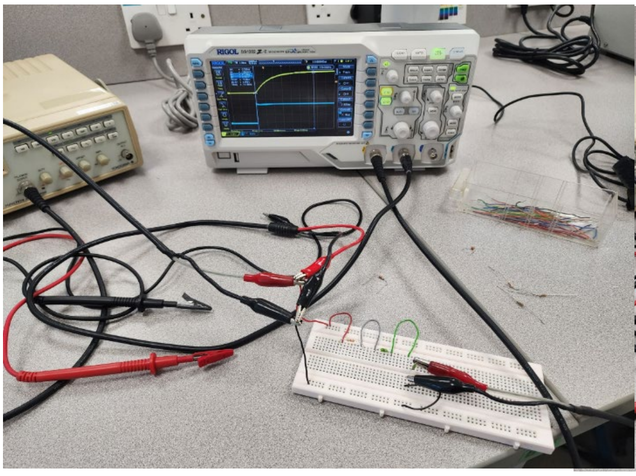
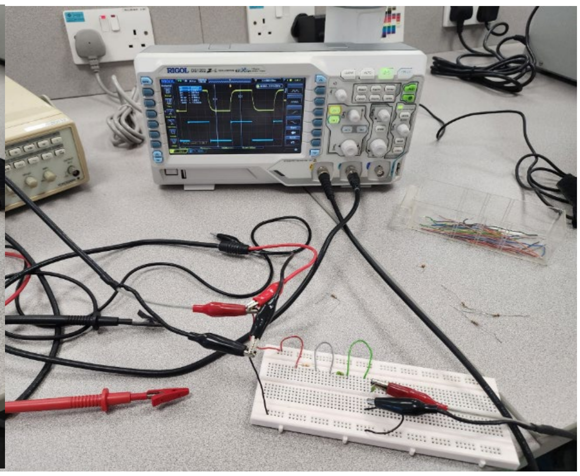



T = 5.880 us

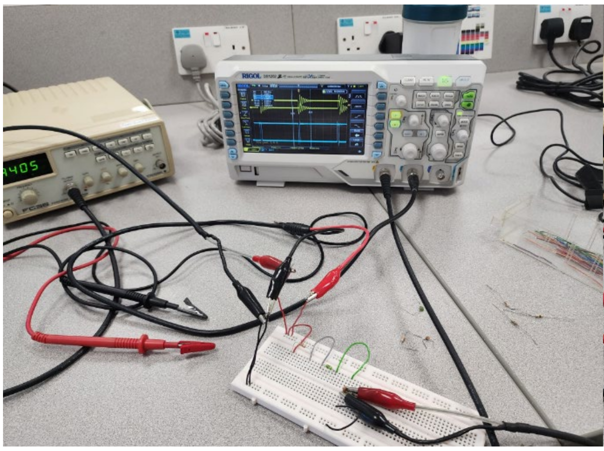
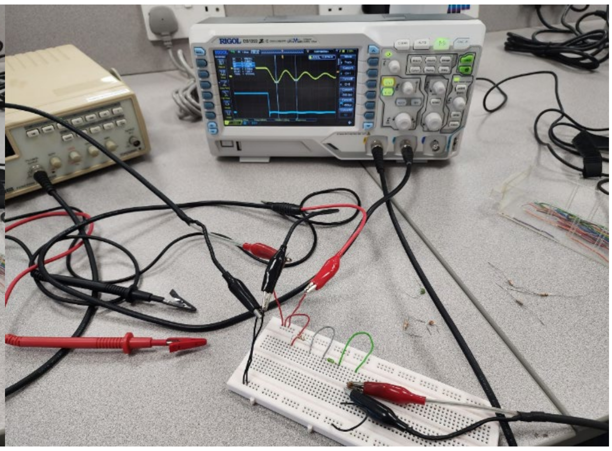
T = 2π/f

5.880*10^-6 = 2π/f

f = 1068568.9 = 1068.6 kHz

Time taken to reach steady state = 13.48 us



$T = 2.280$us

$T = 2\pi/f$

$2.280 \times 10^{-6} = 2\pi/f$

$f = 2755783$Hz = 275.6 kHz

The damping of the 220 Ohm is lowest meaning it is underdamped, while the 3300 Ohm, one shows it being overdamped. The one with the lower Capacitor, had a lower value for ζ, making it more underdamped, and had a lower frequency compared to the 1000pF one.