LAB 1 Oral Presentation Contents

Each student must make one oral presentation in lab during the semester.

Each presentation will last **five minutes** and will be made in the order listed at the beginning of the lab session. The presentations will describe work performed the previous week in lab by way of review. Practice your talk and be succinct. Stick to the five-minute time frame.

Week 2 of lab:
Presentation 1.1: Launcher circuit overview

a) Explain that your presentation will describe the qualitative behavior of the launcher circuit.
b) Draw Fig. 2 from Lab 1 on the board. Point out that the L and R_S in the circuit are for the coil that you will wind that actually launches the paper clip.
c) Show the students what a would coil looks like, and make the observation that we want to charge the coil quickly to draw the paper clip into the coil and then discharge it quickly so the accelerated paper clip will continue moving instead of being drawn back into the coil after it passes the center point.
d) Draw a plot showing the general shape of the current versus time that we want to have. (This plot will start at zero, rise like an RC charging curve that rises steeply, then rolls over to horizontal, then starts to roll down, then looks like an exponential decay toward zero at time approaching infinity.
e) With the plot of current versus time on the board, comment on the initial conditions and behavior of the circuit: C is charged to 30 V, $i_L = 0$ A immediately before and after the switch moves, and the voltage on the capacitor will start to push current through the L from left to right as time increases.
f) Conclude by observing that having the current rise and fall only once and stay positive is more efficient than having the having the current passing through zero many times, as it would if the current oscillated positive and negative as it died out. On the other hand, overdamping would slow the fall time. So critical damping is the best solution.

Presentation 1.2: Launcher circuit differential equation

a) Explain that your presentation will discuss the differential equation for the circuit used in Lab 1.
b) Draw Fig. 2 from Lab 1 on the board.
c) Write the component equations for R, L, and C on the board:

$$v_R = iR \qquad v_L = L\frac{di_L(t)}{dt} \qquad i_C(t) = C\frac{dv_C(t)}{dt}$$

d) Show how to derive the differential equation for the circuit by summing the voltages around the loop and expressing each voltage as a function of the same current, *i*.
e) Conclude by writing the differential equation and noting that the solutions are of form Ae^{st} where *s* may be real or complex. (You may also wish to note that for critical damping we also get a solution of form tAe^{st}.)

Presentation 1.3: Waveforms for C = 2000 nF and C = 2000 μF

a) Explain that your presentation will describe the waveforms for the launcher circuit with C = 2000 nF and C = 2000 μF.
b) Write down the equations for α and ω_o in terms of R, L, and C for a series RLC circuit.
c) Comment on why C only affects ω_o.
d) Write down the formula for the characteristic roots in terms of α and ω_o, and comment on whether a larger C or a smaller C causes overdamping.
e) By analyzing $\alpha^2 - \omega_o^2$, show why a larger value of L moves the circuit behavior toward an underdamped solution.
f) Conclude your presentation by noting that C = 2000 nF and C = 2000 μF should give under- and over-damped solutions for the values of L and R_s that are typical for the coil.

Week 3 of lab:

Presentation 1.4: Overview of third-order circuit

a) Explain that your presentation will describe the qualitative behavior of the third-order circuit in Fig. 3 of Lab 1.
b) Draw the circuit in Fig. 3 of Lab 1 on the board but switch the positions of R_2 and C_2. (R_2 and C_2 will still be in parallel and connected to the top and bottom wires.)
c) Point out that one may replace v_g, R_2, and R_3 with a Thevenin equivalent. Draw the resulting circuit on the board. ($V_{Thev} = v_g \cdot R_2/(R_2 + R_3)$ and $R_{Thev} = R_2 || R_3$.)
d) Observe that without R_1, L, and C_1, the circuit would be just an RC circuit, with C_2 charging up exponentially to V_{Thev}. Follow this idea up by pointing out that, even with the other components in the circuit, C_2 will ultimately charge up to V_{Thev}. Thus, we expect to see something vaguely like an RC charging curve for v_2.
e) Analyze the right side of the circuit consisting of R_1, L, and C_1 as a series resonant circuit. By calculating $\alpha^2 - \omega_o^2$, show that you get an underdamped solution. Point out that the current this part of the circuit draws away from the charging of C_2 would tend to oscillate and be seen as ripples superimposed on the charging curve for C_2.
f) Conclude your presentation by drawing an RC charging curve with some extra up and down ripples occurring during the charging process. Comment that, from the preceding analysis, this waveform is similar to what we might expect to see for v_2.

Presentation 1.5: State-variable equations for third-order circuit

a) Explain that your presentation will show the derivation of the state-variable equations for the third-order circuit in Fig 3 of Lab 1.
b) Draw the circuit in Fig. 3 of Lab 1 on the board.
c) State that state variables are always the variables used to calculate energy stored in C's and L's: v_c's and i_L's.
d) Explain that the rules for writing state-variable equations require the left sides of equations to be the first derivatives of state variables (and nothing else) and the right sides of equations to be expressions containing only state variables (no derivatives), component values, and source values.
e) Show how to translate the derivative of a state variable into a non-derivative by employing the component equations: $dv_c/dt = i_C/C$ or $di_L/dt = v_L/L$.
f) Write down the state variable equations for the third-order circuit and explain how you derived them from circuit laws by referring to the circuit diagram and using current summations at nodes or voltages around loops.
f) Conclude your presentation by noting that the format of the state-variable equations allows for either a matrix differential equation solution as studied in Math 2250 or a numerical solution as used in Lab 1.

Presentation 1.6: Practical considerations for building and testing third-order circuit

a) Explain that your presentation will give a step-by-step procedure for building and testing the third-order circuit in Fig. 3 of Lab 1.
b) Draw the circuit in Fig. 3 of Lab 1 on the board.
c) Start a new drawing next to the complete circuit that shows just v_g, R_3 and C_2. Suggest that this is the first circuit the students should build. Observe that this first circuit would be just an RC circuit, with C_2 charging up exponentially to v_g. Draw the expected waveform for v_2, using the time constant $R_3C_2 = 52\ \mu s$.
d) Now add R_2 to the circuit and suggest that this is the second circuit the students should build. Comment that using the Thevenin equivalent of v_g, R_2, and R_3 reduces the circuit once again to an RC circuit. Draw the expected exponential charging waveform for v_2 using the new time constant $R_{Thev}C_2$ where $R_{Thev} = R_2 || R_3$.
e) Now draw the complete circuit with L and C_1 replaced by wires and suggest that this is the third circuit the students should build. Observe that this circuit will also give an RC charging curve for v_2. The time constant of charging will now be $R_1 || R_2 || R_3 \cdot C_2$. Sketch this charging curve.
f) Conclude your presentation by commenting that adding L and C_1 to complete the circuit should be easy to do after the preceding steps and that the suggested procedure provides a way of verifying the circuit as it is built. This allows mistakes to be quickly found and corrected.