LAB 3 Oral Presentation Contents

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

Presentations will last **five minutes** and will be given at the beginning of the lab session. The presentations will describe work performed the previous or current 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 3.1: Overview of x-y plots on oscilloscope

a) Explain that your presentation will discuss what types of figures you get on an oscilloscope in x-y mode as a prelude to the patterns produced on the oscilloscope in Lab 3.

b) Draw the following x(t) and y(t) waveforms versus time and then as they would appear on an oscilloscope in x-y mode. (Explain why they produce the corresponding patterns.)
   - i) x(t) = y(t) = sin(2πt)
   - ii) x(t) = sin(2πt), y(t) = cos(2πt)
   - iii) x(t) = square wave, y(t) = x(t) but shifted by one-quarter cycle
   - iv) x(t) = triangle wave, y(t) = x(t) but shifted by one-quarter cycle

c) Summarize your results.

Presentation 3.2: Dual spiral plots on oscilloscope

a) Explain that your presentation will discuss the spiral patterns produced on the oscilloscope in Lab 3.

b) Draw the following x(t) and y(t) waveforms versus time and then as they would appear on an oscilloscope in x-y mode. (Explain why they produce the corresponding patterns.)
   - i) x(t) = sin(2πt), y(t) = cos(2πt) [to connect with previous talk]
   - ii) x(t) = $ae^{-\alpha t}\sin(\beta t)$, y(t) = $be^{-\alpha t}\cos(\beta t)$
   - iii) x(t) = $ae^{-\alpha t}\sin(\beta t)$, y(t) = $be^{-\alpha t}\cos(\beta t) + c$
   - iv) x(t) and y(t) as in (iii) until spiral dies out, followed by x(t) = $-ae^{-\alpha t}\sin(\beta t)$, y(t) = $-be^{-\alpha t}\cos(\beta t) - c$ (i.e., negative of previous x and y)

c) Summarize your results and point out that (iv) is what we get in Lab 3.

Presentation 3.3: RLC circuit response

a) Explain that your presentation will describe the current that flows in the left half side of the circuit for Lab 3. (v_o is proportional to this current)
b) Redraw the left side of the Lab 3 circuit on the board. Do not draw the op-amp and R3. Instead, connect the right side of R2 to reference.
c) Discuss what waveform you expect to get for the current in the circuit when the input voltage steps from 0 to 1V at time zero. (This will be a decaying sinusoid, but will it be a decaying cos() or will it be a decaying sin()?) Consider the current flow at time t=0+. Assume initial conditions are zero.
d) Summarize your talk by plotting the shape expected for the current.

Presentation 3.4: Role of op-amp in Lab 3 circuit

a) Explain that your presentation will cover the role of the op-amp in Lab 3.
b) Draw the circuit for Lab 3 on the board.
c) Explain the behavior of an ideal op-amp with negative feedback: the voltages at the inputs are equal, and no current flows into the op-amp.
d) Explain that we solve op-amp problems by calculating the current i flowing toward the -input from the left if the right side of R2 is connected to reference (since we will have 0 volts at the + and - inputs). The same current then flows through R3. Thus, $v_o = R3*i$.
e) Point out that the op-amp turns i into a voltage v_o and has adjustable gain determined by R3.
f) Summarize your results and point out that given your results we need only calculate i on the left assuming R2 is connected to reference. v_o will follow from i.

Presentation 3.5: Initial conditions for Lab 3 circuit

a) Explain that your presentation will discuss initial conditions for the circuit of Lab 3.
b) Draw the circuit for Lab 3 on the board. Use only the left side and connect the right side of R2 to reference.
c) Note that although we have a square wave input, we will assume it is a negative DC value forever before it steps to a positive DC value forever. The idea is that the square is so slow that the circuit settles to its final state between transitions on the input.
d) Derive the initial conditions for L, C1, and C2. Use the argument that the same current flows in C1 and C2 so Q = CV is the same for both C1 and C2. Also, the sum of the capacitor voltages must equal the negative DC input voltage before time zero. Give the resulting values for v_{c1} and v_{c2} at t=0-.
e) Summarize your results by listing all the initial conditions for L, C1, and C2.

Presentation 3.6: Laplace domain model for current in RLC for Lab 3

a) Explain that your presentation will discuss the Laplace-domain model for the left side of the circuit in Lab 3.
b) Draw the s-domain model for the left side of the circuit for Lab 3 (with the right side of R2 connected to reference) including sources for initial conditions.
c) Draw a more compact model that will suffice for finding the current. That is, combine R1 and R2 into Req, and C1 and C2 into Ceq.
d) Summarize your talk by writing down the formulas you get for current, I(s), and voltage $V_1(s)$.

Presentation 3.7: Laplace forms for decaying sinusoids in Lab 3

a) Explain that your presentation will use Laplace transforms to explain the need for split capacitors, C_1 and C_2, in order to generate sinusoids that are 90° out of phase.

b) Draw the Lab 3 circuit to the left of the op-amp, and write the formula for $\mathbf{I}(s)$, the Laplace transform of the current flowing toward the "–" input of the op-amp. Note that $\mathbf{V}_o(s) = \mathbf{I}(s)R_3$ has the form of the Laplace transform of a decaying sine wave.

c) Write the Laplace transforms you would get if you measured $\mathbf{V}_1(s)$ at different points (versus reference) in the circuit, for example: between R_1 and L, between L and C_1, or between C_2 and R_2. Explain why none of these is equal to the Laplace transform of a decaying cosinusoid plus a DC offset.

d) Summarize your talk by noting that splitting the capacitance into C_1 and C_2 is necessary if we are to obtain the Laplace transform of a decaying cosinusoid plus a DC offset, as the *next* talk will explain.

Presentation 3.8: Solution of Lab 3 to obtain signals 90° out of phase.

a) Explain that your presentation will discuss the equations that must be satisfied for $\mathbf{V}_1(s)$ to be a decaying cosinusoid.

b) Write down the Laplace transform for $\mathbf{V}_1(s)$ in terms of component impedances, the C_2 initial conditions, and the Laplace transform of $\mathbf{V}_i(s)$.

c) Write down the Laplace transform for a decaying cosinusoid plus a DC offset.

d) Derive the constraints that cause $\mathbf{V}_1(s)$ to be a decaying cosinusoid plus a DC offset.

e) Summarize your talk by pinpointing the aspects of $\mathbf{V}_1(s)$ that allow it to be equated to a decaying cosinusoid plus a DC offset.

Presentation 3.9: How to transfer x-y oscilloscope plot to Matlab™

a) Explain that your presentation will discuss the advantages and disadvantages of several ways of capturing an x-y plot from the oscilloscope screen.

b) Explain how to capture a bitmap of the x-y display on the oscilloscope, and note the disadvantage that you cannot easily superimpose predicted values from Matlab™ on the bitmap image. (There are registration and scale issues.) You will probably want to demonstrate the method on the lab equipment. You may hook up two function generators to create the x and y waveforms.

c) Explain how to capture the x and y waveforms (i.e., $v_o(t)$ and $v_1(t)$) in the usual fashion as waveforms plotted versus time on the oscilloscope. Then explain how to make an x-y plot from the data in Matlab™. Also, explain how to superimpose predicted waveforms from Matlab™ on the oscilloscope data. (Use, for example plot(xdata, ydata, xpredicted, ypredicted). Explain the syntax of the plot command.)

d) Summarize your talk by briefly reviewing the steps involved in transferring waveforms from the oscilloscope to Matlab™ for an x-y plot.

Presentation 3.10: How to measure a, b, and c from plots

a) Explain that your presentation will discuss issues in the measurement of the amplitudes, a and b, and the DC offset, c, of the decaying sinusoids in the x-y spiral plots.
b) Sketch $v_o(t)$ and $v_1(t)$ on the board (versus time rather than as an x-y plot).
c) Point out that the DC offset (i.e., value of c) for $v_1(t)$ decays away over time because a scope probe attached to measure $v_1(t)$ acts like a resistor from the junction between C_1 and C_2 to reference. Treat L as a wire and the C's as opens to determine the final values for the voltages on C_1 and C_2.
d) Suggest a procedure for determining the value of c from the oscilloscope plot given the long-term droop of $v_1(t)$.
e) Suggest a procedure for determining the value of b. (Easy) Also, suggest a procedure for determining the value of "a" by extrapolating back to $t = 0$ from the first peak of the $v_0(t)$ waveform using the value of decay constant α. (This will lead in to the next talk.)
f) Summarize your talk by noting that the problem of measuring a, b, and c involves many subtleties that can affect accuracy, and that the methods you have described are only a starting point.

Presentation 3.11: How to measure α and β from plots

a) Explain that your presentation will discuss issues in the measurement of the decay rate, α, and the frequency, β, of the decaying sinusoids in the x-y spiral plots.
b) Sketch $v_o(t)$ and $v_1(t)$ on the board (versus time rather than as an x-y plot).
c) Suggest a procedure for measuring the frequency, β. Note that using zero crossings is better than using peaks, since peaks actually move slightly because of the exponential decay. Also, the zero crossings are more accurate for $v_o(t)$ than for $v_1(t)$ owing to the lack of a DC offset in $v_o(t)$.
d) Summarize your talk by noting that the problem of measuring α and β involves many subtleties that can affect accuracy, (such as determining exactly where $t = 0$ is, for example), and that the methods you have described are only a starting point.

Presentation 3.12: Recap Lab 3

a) Explain that your presentation will recap the derivations of the Lab 3 circuit.
b) Draw the Lab 3 circuit on the board.
c) Explain that the RLC produces decaying sinusoids for spirals
d) Explain that the op-amp turns current through R2 into v_o but with adjustable gain determined by R3.
e) Explain that the capacitance is split into two pieces to enable us to have v_o and v_1 90° out of phase.
f) Point out any aspects of the circuit design that you feel are instructive.
g) Summarize your talk by noting that Lab 3 was a challenging exercise in using Laplace transforms.