Helpful readings for this homework: Chapter 12

**Exercise 9-1:** Using one 3-nF capacitor and two resistors, construct a network that has the following zero-state response (ZSR) to a 1-V step input. Provide a diagram of the network, and specify the values of the two resistors.

![Network Diagram]

Exercise 9-2: Exercise 12.4, Chapter 12, page 695.

Exercise 9-3: Consider a linear time-invariant system. Suppose its ZSR to a unit step applied at \( t = 0 \) is \( A(1 - e^{-t/\tau}) \). What would be its ZSR to the input \( S + Mt \), applied at \( t = 0 \), where \( S \) and \( M \) are constants?


Problem 9.2: Problem 12.6, Chapter 12, page 698.

Problem 9.3: In the network shown below, the inductor and capacitor have zero states prior to \( t = 0 \). At \( t = 0 \), a step in voltage from 0 to \( V_o \) is applied by the voltage source as shown.

a) Find \( v_c \), \( v_l \), \( i \), and \( \frac{di}{dt} \) at \( t = 0^+ \).

b) Argue that at \( t = \infty \), \( i = 0 \) so that \( i(t) \) has no constant component.
c) Find a second-order differential equation which describes the behavior of \( i(t) \) for \( t \geq 0 \).

d) Following part (b), the current \( i(t) \) takes the form \( i(t) = I e^{-\alpha t} \sin(\omega t + \phi) \). Find \( I \), \( \omega \), \( \phi \), and \( \alpha \).

e) Suppose that the input is a voltage impulse with area \( \Lambda_o \) in Volt-seconds where \( \Lambda_o = \tau V_o \), the voltage \( V_o \) is the amplitude of the voltage step shown below, and \( \tau \) is a given time constant. Find the response of the network to the impulse.

Save a copy of your answers to this problem. They will be useful during the pre-lab exercises for Lab 3.

**Problem 9.4:** Problem 12.7, Chapter 12, page 699 with the following parts.

a) Explicitly set up the characteristic equation for the circuit.

For parts (b) and (c) use the values \( R_n = 25 \Omega \), \( L_1 = 10 \mu m \), \( W_1 = 1 \mu m \), and \( C_p = 1 nF \). Use intuitive analysis to find the form of the responses. Solve for the frequency, initial and final values, time constants, and decay envelopes. You don’t have to solve for the maximum amplitude.

b) Sketch \( v_P \) for the underdamped case. Use \( R_1 = 4.75k\Omega \) and \( L_p = 4 mH \).

c) Sketch \( v_P \) for the overdamped case. Use \( R_1 = 750 \Omega \) and \( L_p = 6.25 mH \).

d) Compare the results from parts (b) and (c) with that for the inductor acting alone as shown in Figure 10.107 on page 582.