1. (50 points)

After having been open for a long time, the switch is closed at \( t = 0 \).
\[ R_1 = 12.5 \Omega \quad R_2 = 12.5 \Omega \quad L = 6.25 \, \mu H \]

a. Two capacitances are available: 2 nF and 250 nF. Specify the value of \( C \) that will make \( v(t) \) overdamped.

b. Using the value of \( C \) found in (a), write a time-domain expression for \( v(t) \).

2. (50 points)

a. Determine the coefficients of the Fourier series, \( a_v, a_n, \) and \( b_n \), for the periodic waveform \( v_i(t) \). Also, use these Fourier coefficients to find the coefficients of the first five terms of the Fourier series written in terms of inverse phasors:
\[
v_i(t) = a_v + \sum_{n=1}^{\infty} A_n \cos\left(n\omega_o t + \theta_n\right)
\]
Note any symmetry properties of the waveform that you use to determine coefficients.

b. The circuit on the left is a filter with output \( v_o(t) \). Design a circuit to be placed in the box such that the filter rejects the fundamental frequency of \( v_i(t) \) and has a bandwidth of 10,000 rad/sec. Specify the component values. Show how the components are connected in the circuit.
3. (50 points)

![Circuit Diagram]

The initial energy stored in the circuit is zero.

\[ R_2 = 500 \, \Omega \quad L = 200 \, \text{mH} \]

a. Choose values of \( R_1 \) and \( C \) to accomplish the following:

1. \( v(t) \) and \( i(t) \) are decaying sinusoids 90° out of phase with each other.
2. \( 1/\alpha = T \), where \( \alpha \) is the exponential decay constant and \( T \) is the period of oscillation of the decaying sinusoid.

b. With the component values you chose in the circuit, write numerical expressions for \( v(t) \) and \( i(t) \).

4. (50 points)

![Circuit Diagram with Transformers]

\[ Z_1 = (5 - j5)\Omega \quad Z_2 = (20 + j20)\Omega \]

a. Find the input impedance, \( z_{\text{in}} = V_1/I_1 \), for the above circuit.

b. Using \( z_{\text{in}} \) from (a), find a numerical expression for \( V_{AB} \) in the circuit below.

Balanced three-phase system.

\[ V_{an} = 52 \angle 0^\circ \, \text{V} \quad V_{bn} = 52 \angle -120^\circ \, \text{V} \quad z_{\text{line}} = j12 \, \Omega \]