Refer to the circuit shown in Fig. 8.64. Calculate:
(a) \( i_L(0^+) \), \( v_C(0^+) \), and \( v_R(0^+) \),
(b) \( di_L(0^+)/dt \), \( dv_C(0^+)/dt \), and \( dv_R(0^+)/dt \),
(c) \( i_L(\infty) \), \( v_C(\infty) \), and \( v_R(\infty) \).

![Figure 8.64](image)

For Prob. 8.3.

In the circuit of Fig. 8.65, find:
(a) \( v(0^+) \) and \( i(0^+) \),
(b) \( dv(0^+)/dt \) and \( di(0^+)/dt \),
(c) \( v(\infty) \) and \( i(\infty) \).

![Figure 8.65](image)

For Prob. 8.4.

Refer to the circuit in Fig. 8.66. Determine:
(a) \( i(0^+) \) and \( v(0^+) \),
(b) \( di(0^+)/dt \) and \( dv(0^+)/dt \),
(c) \( i(\infty) \) and \( v(\infty) \).

![Figure 8.66](image)

For Prob. 8.5.

In the circuit of Fig. 8.67, find:
(a) \( v_R(0^+) \) and \( v_L(0^+) \),
(b) \( dv_R(0^+)/dt \) and \( dv_L(0^+)/dt \),
(c) \( v_R(\infty) \) and \( v_L(\infty) \).

![Figure 8.67](image)

For Prob. 8.6.

Section 8.3 Source-Free Series RLC Circuit

8.7 A series RLC circuit has \( R = 10 \, \text{kΩ} \), \( L = 0.1 \, \text{mH} \), and \( C = 10 \, \text{μF} \). What type of damping is exhibited by the circuit?

8.8 Design a problem to help other students better understand source-free RLC circuits.

8.9 The current in an RLC circuit is described by
\[
\frac{d^2 i}{dt^2} + 10 \frac{di}{dt} + 25i = 0
\]
If \( i(0) = 2 \, \text{A} \) and \( di(0)/dt = 0 \), find \( i(t) \) for \( t > 0 \).

8.10 The differential equation that describes the voltage in an RLC network is
\[
\frac{d^2 v}{dt^2} + 5 \frac{dv}{dt} + 4v = 0
\]
Given that \( v(0) = 0 \), \( dv(0)/dt = 5 \, \text{V/s} \), obtain \( v(t) \).

8.11 The natural response of an RLC circuit is described by the differential equation
\[
\frac{d^2 v}{dt^2} + 2 \frac{dv}{dt} + v = 0
\]
for which the initial conditions are \( v(0) = 20 \, \text{V} \) and \( dv(0)/dt = 0 \). Solve for \( v(t) \).

8.12 If \( R = 20 \, \Omega \), \( L = 0.6 \, \text{H} \), what value of \( C \) will make an RLC series circuit:
(a) overdamped,
(b) critically damped,
(c) underdamped?

8.13 For the circuit in Fig. 8.68, calculate the value of \( R \) needed to have a critically damped response.

![Figure 8.68](image)

For Prob. 8.13.
8.14 The switch in Fig. 8.69 moves from position A to position B at \( t = 0 \) (please note that the switch must connect to point B before it breaks the connection at A, a make-before-break switch). Find \( v(t) \) for \( t > 0 \).

\[ 30 \Omega \quad \text{A} \quad \text{t=0} \quad 4 \text{H} \]

\[ 20 \text{V} \quad + \quad \text{v(t)} \quad - \quad 10 \Omega \]

**Figure 8.69**
For Prob. 8.14.

8.15 The responses of a series RLC circuit are

\[
v_C(t) = 30 - 10e^{-20t} + 30e^{-10t} \text{ V}
\]

\[
i_L(t) = 40e^{-20t} - 60e^{-10t} \text{ mA}
\]

where \( v_C \) and \( i_L \) are the capacitor voltage and inductor current, respectively. Determine the values of \( R, L, \) and \( C \).

8.16 Find \( i(t) \) for \( t > 0 \) in the circuit of Fig. 8.70.

\[ 10 \Omega \quad \text{t=0} \quad 60 \Omega \]

\[ 20 \text{V} \quad + \quad 40 \Omega \quad 2.5 \text{H} \]

**Figure 8.70**
For Prob. 8.16.

8.17 In the circuit of Fig. 8.71, the switch instantaneously moves from position A to B at \( t = 0 \). Find \( v(t) \) for all \( t \geq 0 \).

\[ 15 \text{A} \quad 4 \Omega \quad 10 \Omega \quad 0.25 \text{H} \]

**Figure 8.71**
For Prob. 8.17.

8.18 Find the voltage across the capacitor as a function of time for \( t > 0 \) for the circuit in Fig. 8.72. Assume steady-state conditions exist at \( t = 0^- \).

\[ 5 \Omega \quad r=0 \]

\[ 20 \text{V} \quad 1 \Omega \quad 0.25 \text{H} \quad 1 \text{F} \]

**Figure 8.72**
For Prob. 8.18.

8.19 Obtain \( v(t) \) for \( t > 0 \) in the circuit of Fig. 8.73.

\[ 10 \Omega \quad \text{t=0} \quad 1 \text{F} \]

\[ 90 \text{V} \quad + \quad 4 \text{H} \]

**Figure 8.73**
For Prob. 8.19.

8.20 The switch in the circuit of Fig. 8.74 has been closed for a long time but is opened at \( t = 0 \). Determine \( i(t) \) for \( t > 0 \).

\[ i(t) \quad \frac{1}{2} \text{H} \quad 2 \Omega \]

\[ 12 \text{V} \quad + \quad \frac{1}{4} \text{F} \]

**Figure 8.74**
For Prob. 8.20.

*8.21* Calculate \( v(t) \) for \( t > 0 \) in the circuit of Fig. 8.75.

\[ 15 \Omega \quad 12 \Omega \quad 6 \Omega \quad \frac{3}{15} \text{F} \]

\[ 24 \text{V} \quad 60 \Omega \quad + \quad \frac{1}{15} \text{F} \]

**Figure 8.75**
For Prob. 8.21.

* An asterisk indicates a challenging problem.
Section 8.4 Source-Free Parallel RLC Circuit

8.22 Assuming \( R = 2 \, \text{k}\Omega \), design a parallel RLC circuit that has the characteristic equation
\[ s^2 + 100s + 10^6 = 0. \]

8.23 For the network in Fig. 8.76, what value of \( C \) is needed to make the response underdamped with unity damping factor (\( \alpha = 1 \))?

![Figure 8.76](image)

For Prob. 8.23.

8.24 The switch in Fig. 8.77 moves from position A to position B at \( t = 0 \) (please note that the switch must connect to point B before it breaks the connection at A, a make-before-break switch). Determine \( i(t) \) for \( t > 0 \).

![Figure 8.77](image)

For Prob. 8.24.

8.25 Using Fig. 8.78, design a problem to help other students better understand source-free RLC circuits.

![Figure 8.78](image)

For Prob. 8.25.

Section 8.5 Step Response of a Series RLC Circuit

8.26 The step response of an RLC circuit is described by
\[ \frac{d^2 i}{dt^2} + 2 \frac{di}{dt} + 5i = 10 \]

Given that \( i(0) = 6 \, \text{A} \) and \( di(0)/dt = 12 \, \text{A/s} \), solve for \( i(t) \).

8.27 A branch voltage in an RLC circuit is described by
\[ \frac{d^2 v}{dt^2} + 4 \frac{dv}{dt} + 8v = 48 \]

Problems

8.28 A series RLC circuit is described by
\[ \frac{d^2 i}{dt^2} + R \frac{di}{dt} + \frac{i}{C} = 2 \]

Find the response when \( L = 0.5 \, \text{H} \), \( R = 4 \, \Omega \), and \( C = 0.2 \, \text{F} \). Let \( i(0) = 1 \), \( di(0)/dt = 0 \).

8.29 Solve the following differential equations subject to the specified initial conditions
(a) \( d^2 v/dt^2 + 4v = 12 \), \( v(0) = 0 \), \( dv(0)/dt = 2 \)
(b) \( d^2 i/dt^2 + 5 di/dt + 4i = 8 \), \( i(0) = -1 \), \( di(0)/dt = 0 \)
(c) \( d^2 v/dt^2 + 2 dv/dt + v = 3 \), \( v(0) = 5 \), \( dv(0)/dt = 1 \)
(d) \( d^2 i/dt^2 + 2 di/dt + 5i = 10 \), \( i(0) = 4 \), \( di(0)/dt = -2 \)

8.30 The step responses of a series RLC circuit are
\[ v_C(t) = 40 - 10e^{-2000t} - 10e^{-4000t} \, \text{V}, \quad t > 0 \]
\[ i_L(t) = 3e^{-2000t} + 6e^{-4000t} \, \text{mA}, \quad t > 0 \]

(a) Find \( C \). (b) Determine what type of damping is exhibited by the circuit.

8.31 Consider the circuit in Fig. 8.79. Find \( v_L(0^-) \) and \( v_C(0^-) \).

![Figure 8.79](image)

For Prob. 8.31.

8.32 For the circuit in Fig. 8.80, find \( v(t) \) for \( t > 0 \).

![Figure 8.80](image)

For Prob. 8.32.
8.33 Find \( v(t) \) for \( t > 0 \) in the circuit of Fig. 8.81.

![Figure 8.81](image)

For Prob. 8.33.

8.34 Calculate \( i(t) \) for \( t > 0 \) in the circuit of Fig. 8.82.

![Figure 8.82](image)

For Prob. 8.34.

8.35 Using Fig. 8.83, design a problem to help other students better understand the step response of series RLC circuits.

![Figure 8.83](image)

For Prob. 8.35.

8.36 Obtain \( v(t) \) and \( i(t) \) for \( t > 0 \) in the circuit of Fig. 8.84.

![Figure 8.84](image)

For Prob. 8.36.

8.37 For the network in Fig. 8.85, solve for \( i(t) \) for \( t > 0 \).

![Figure 8.85](image)

For Prob. 8.37.

8.38 Refer to the circuit in Fig. 8.86. Calculate \( i(t) \) for \( t > 0 \).

![Figure 8.86](image)

For Prob. 8.38.

8.39 Determine \( v(t) \) for \( t > 0 \) in the circuit of Fig. 8.87.

![Figure 8.87](image)

For Prob. 8.39.

8.40 The switch in the circuit of Fig. 8.88 is moved from position \( a \) to \( b \) at \( t = 0 \). Determine \( i(t) \) for \( t > 0 \).

![Figure 8.88](image)

For Prob. 8.40.
41. For the network in Fig. 8.89, find \( i(t) \) for \( t > 0 \).

![Figure 8.89](For Prob. 8.41)

42. Given the network in Fig. 8.90, find \( v(t) \) for \( t > 0 \).

![Figure 8.90](For Prob. 8.42)

43. The switch in Fig. 8.91 is opened at \( t = 0 \) after the circuit has reached steady state. Choose \( R \) and \( C \) such that \( \alpha = 8 \) Np/s and \( \omega_d = 30 \text{ rad/s} \).

![Figure 8.91](For Prob. 8.43)

44. A series \( RLC \) circuit has the following parameters: \( R = 1 \text{ k}\Omega, L = 1 \text{ H}, \) and \( C = 10 \text{ nF} \). What type of damping does this circuit exhibit?

Section 8.6 Step Response of a Parallel \( RLC \) Circuit

45. In the circuit of Fig. 8.92, find \( v(t) \) and \( i(t) \) for \( t > 0 \). Assume \( v(0) = 0 \text{ V} \) and \( i(0) = 1 \text{ A} \).

![Figure 8.92](For Prob. 8.45)

46. Using Fig. 8.93, design a problem to help other students better understand the step response of a parallel \( RLC \) circuit.

![Figure 8.93](For Prob. 8.46)

47. Find the output voltage \( v_o(t) \) in the circuit of Fig. 8.94.

![Figure 8.94](For Prob. 8.47)

48. Given the circuit in Fig. 8.95, find \( i(t) \) and \( v(t) \) for \( t > 0 \).

![Figure 8.95](For Prob. 8.48)

49. Determine \( i(t) \) for \( t > 0 \) in the circuit of Fig. 8.96.

![Figure 8.96](For Prob. 8.49)