1. Analysis of the circuit shown yields the characteristic equation below. The switch has been in the top position for a long time and is switched down at time $t = 0$. Find the initial conditions and write the full expression for $i(t)$, including all the constants that you find.

\[
R_1 := 10\ \Omega \quad R_2 := 150\ \Omega \quad L := 12\ \text{mH} \quad C := 40\ \mu\text{F}
\]

\[
s^2 + \frac{1}{C\cdot R_2} + \frac{R_1}{L} \quad s + \left( \frac{R_1}{L\cdot C\cdot R_2} + \frac{1}{L\cdot C} \right) = 0
\]

\[
s^2 + 1000\ \text{sec}^2 \quad s + \frac{1}{1000\ \text{sec}^2} \quad s + \frac{2.222\times10^6}{\text{sec}^2} = 0
\]

2. What value of $R_1$ would make the above circuit critically damped?

3. Look at the circuit in HW 17, problem 2. Change $R_2$ to 50$\\Omega$ and consider the voltage across $R_1$ to be the output voltage. The transfer function would be:

\[
H(s) = \frac{V_{R1}(s)}{V_{in}(s)} = \frac{s^2 + \frac{R_2}{L} s + \frac{1}{L\cdot C}}{s^2 + \frac{R_1\cdot R_2\cdot C + L}{R_1\cdot L\cdot C} s + \frac{R_1 + R_2}{R_1\cdot L\cdot C}} = \frac{s^2 + 4.167\times10^3 s + 2.083\times10^6}{s^2 + 6.667\times10^3 s + 1.25\times10^7}
\]

a) What are the poles and zeros of this transfer function?

b) Plot these poles and zeros on the complex plane.

4. Read section 5.5 in your textbook (p.252-259)

5. Problem 5.33 in your textbook (p.267)

6. Problem 5.35 in your textbook (p.267)

   a) hint: consider the transfer function of the loop separately and don't worry about the block to the left of the summer, it will only contribute a single real pole.

   b) He wants the transfer function for the entire system, including the block to the left of the summer.

   c) In other words, find the poles. $B = 0.1$, as in part b). Note the answers below are different than his.

**Answers**

1. $i_L(0) = 75\ \text{mA} \quad v_C(0) = 11.25\ \text{V}$

   \[i_L(t) = e^{-2800 t} (37.5\ \text{cos}\left(\frac{1404}{\text{sec}} t\right) - 343\ \text{sin}\left(\frac{1404}{\text{sec}} t\right))\ \text{mA} + 37.5\ \text{mA}\]

2. $R_1 = 36.64\ \Omega$

3. a) Zeros: $(-581.02, -3.586\times10^3)$

   b) Poles: $(-3.333\times10^3 + 1.179\times10^3\cdot j, -3.333\times10^3 - 1.179\times10^3\cdot j)$

4. a) $\frac{A\cdot (s + 50)}{(s + 100)\cdot (s + 50) + 10\cdot A}$

   b) 62.5

   c) $s_1 := (-75 + 75\cdot j)\cdot \frac{1}{\text{sec}}$ \quad $s_2 := (-75 - 75\cdot j)\cdot \frac{1}{\text{sec}}$ so: underdamped

5. a) $B < 0.125$

   b) $F(s) = \frac{4\cdot(s + 2)}{(s + 1)(s + 1)(s + 2 + 0.2)}$

   c) -1, -1.28, -1.72