Homework 9

1 Problem

For circuit A in the appendix:

- Determine the current profile $i(t)$ in response to a step-input of V_0 volts using the impedance method. (Hint: find the impedance of the total circuit Z_{circuit}, solve for $I(s)$ assuming $V(s)$ is the desired step input, and use the inverse Laplace transform.)
- Determine the voltage profile $v_{\text{cap}}(t)$ across the capacitor in response to a step-input of V_0 volts using the impedance method. (Hint: use the ratio of Z_{circuit} to Z_{cap} to find the desired transfer function, as described in the notes.)
- If $R = 10$ ohm and $C = 15\mu$F how long does it take the capacitor's voltage to reach ≈ 2 % of V_0? (Hint: determine the time constant first)

2 Problem

For circuit B in the appendix:

- Determine the current profile $i(t)$ in response to a step-input of V_0 volts using the impedance method.
- Determine the voltage profile $v_{\text{ind}}(t)$ across the inductor in response to a step-input of V_0 volts using the impedance method.

3 Problem

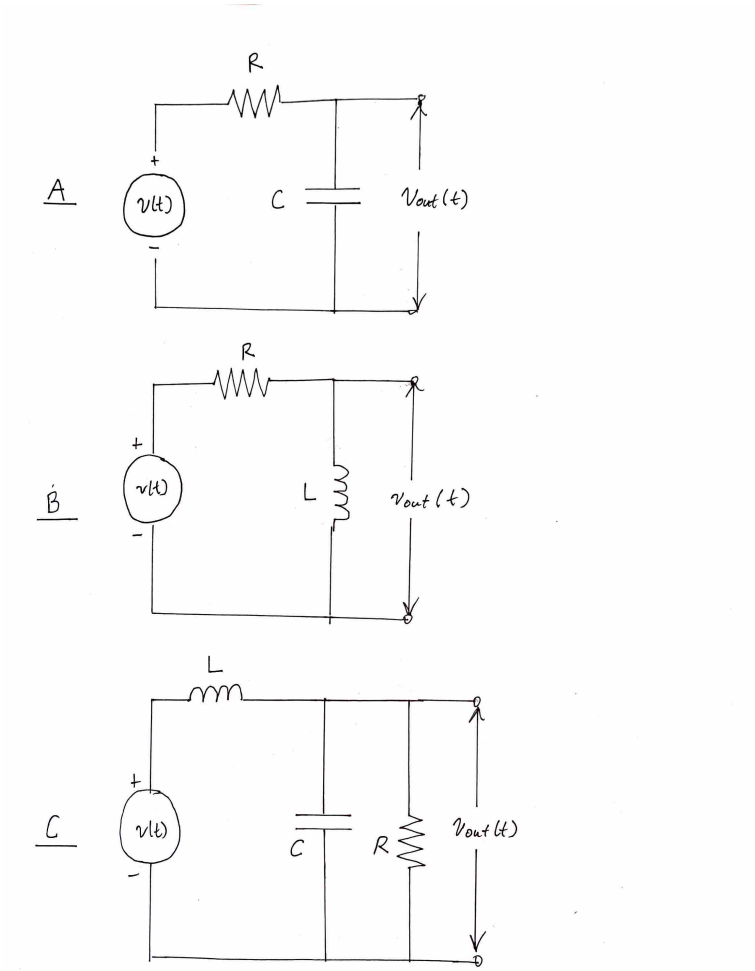
For circuit C in the appendix:

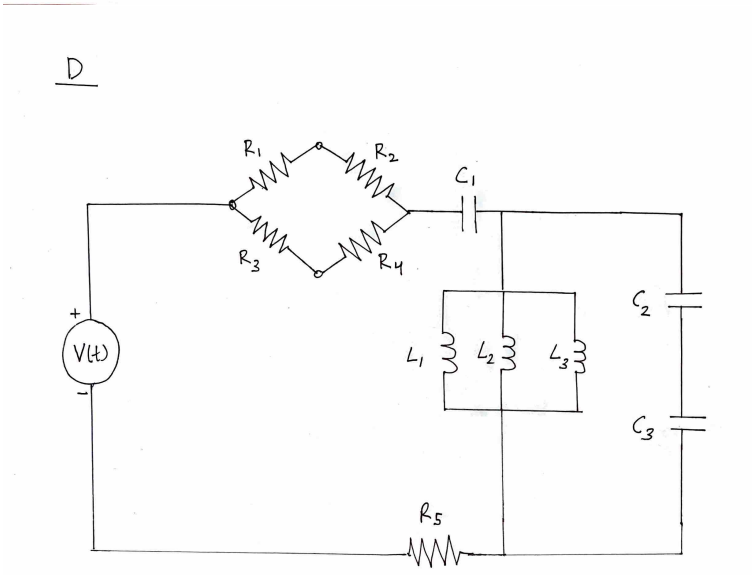
- Derive the transfer function
$$G_{V \to V_{\text{output}}} = \frac{V_{\text{out}}(s)}{V(s)}$$
from input voltage $V(s)$ to output voltage $V_{\text{out}}(s)$ (across the parallel RC connection)
- State the natural frequency and damping ratio of the circuit in terms of R, C, and L.
- Given C = 10E-6 Farads and L = 1E-3 Henries select R (units of ohms) so the circuit is critically damped and state the natural frequency of the circuit in Hz.

4 Problem

For circuit D in the appendix. Assume that all resistors, capacitors, and inductors have the same value R, C, and L, respectively. Find the total equivalent impedance of the circuit, Z_{circuit}. (Hint: simplify the circuit step-by-step, similar to this example [Link])

Appendix


A
R
v(t)
C
$v_{out}(t)$
B
R
v(t)
L
$v_{out}(t)$
C
L
v(t)
C
R
$v_{out}(t)$


D
R_1
R_2
C_1
R_3
R_4
V(t)
L_1
L_2
L_3
C_2
C_3
R_5