ELEC 341 – Graded Assignments

Assignment A1
White-Box Systems

100 Marks

Required Files

Available on Canvas

- **e341-a1.pdf** *Assignment description (this document)*
- **a1DSPlot.p** Data-Sheet curve generator
- **a1Submit.p** *Grading script (**LATEST** version)*
- **e341-APE.pdf** *Instructions for submitting graded work (for reference)*

Topics

Circuit Analysis
- matrix method

2nd Order Response
- envelope & frequency

Approximate Impulse Function
- 1st order & square

Figure 1

Parameter	Value	Physical Units		Parameter	Value	Physical Units
R_1	#A x 10	Ω		R_2	#D x 10	Ω
L_1	#B	mH		L_2	#E	mH
C_1	#C	µF		C_2	#F	µF

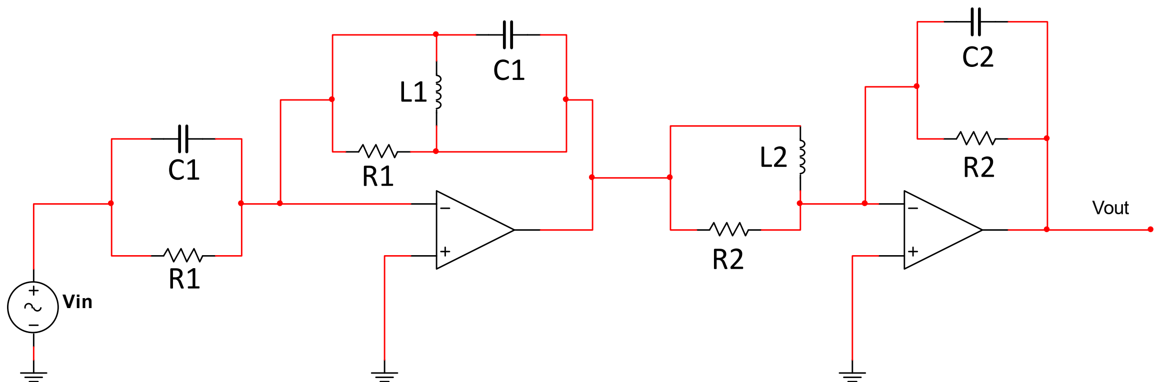


Figure 2

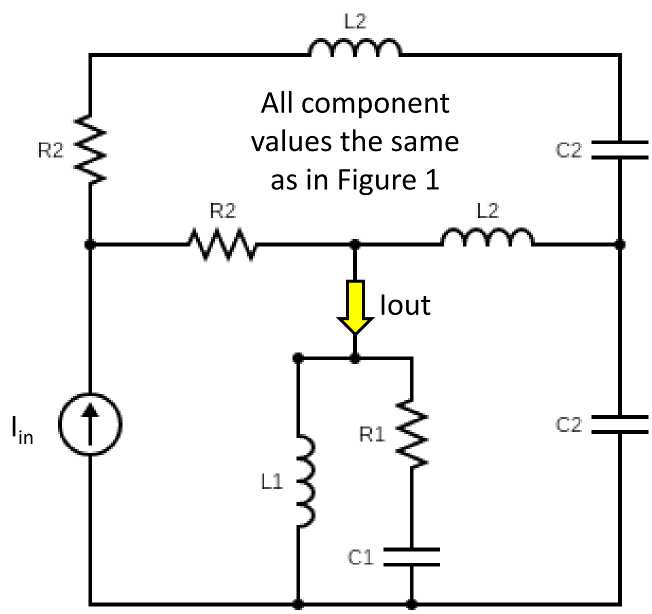
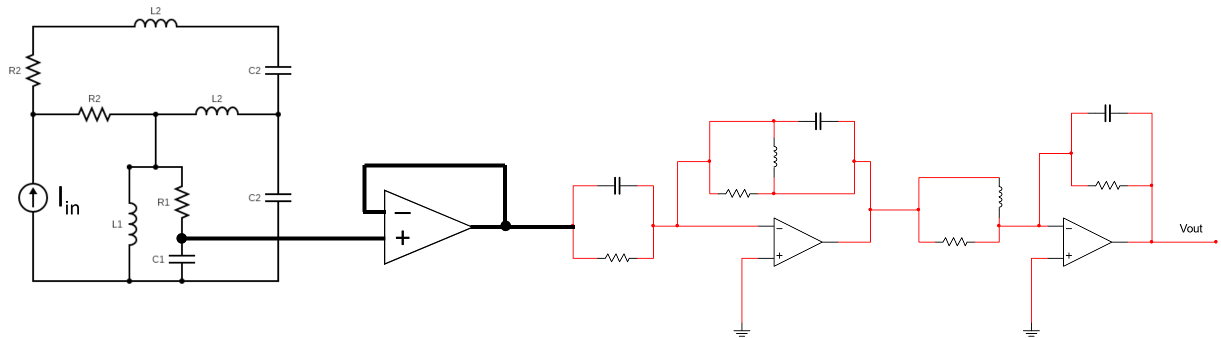


Figure 3



When you have a circuit diagram, you can model it exactly. This is a "White Box" system.
Analyze the circuit **Figure 1** using standard techniques.
Find the transfer function: **G = V_{out}/V_{in}**

1. **20 mark(s) Voltage Filter**
   - Q1.G (V/V) LTI

Use the Matrix-Method to analyze the circuit in **Figure 2**.
Find the transfer function: **G = I_{out}/I_{in}**

2. **20 mark(s) Current Filter**
   - Q2.G (A/A) LTI

Use **a1DSPlot.p** to plot an experimental step response from a data-sheet.
Estimate the envelope by manually curve-fitting it to the experimental data.
An 2nd order envelope has the form: $y = K_{dc}\, x\, (1 \pm e^{\sigma t})$ $\sigma < 0$

3. **20 mark(s) Envelope**
   - Q3.Kdc (V) Scalar
   - Q3.sigma (rad/s) Scalar

***COW**: Kdc & σ are both integers so you should be able to find them exactly.*

The transfer function **G** was used to generate the data-sheet curve.

The equation includes another parameter $\boldsymbol{\omega_n}$: $$G = K_{dc} \frac{\omega_n^2}{s^2 - 2\sigma s + \omega_n^2}$$

Find $\boldsymbol{\omega_n}$ by trial and error. It's also an integer.

Find **G** and identify the poles.

Find an approximate 1st order impulse function with the smallest possible (magnitude) non-dominant pole **p**.

Find the approximate impulse response **y** of **G**.

Use a time vector with **1ms** increments and a maximum value of **100ms**.

4. 15 mark(s) LTI Impulse

- Q4.p (rad/s) Scalar
- Q4.y (V) 1x101 Vector

COW: *Is this a reasonably good approximation of an ideal impulse ???*

Find the time constant τ (rounded to **1ms**) of a **1st order** approximate impulse,.

Find the approximate impulse response **y** of **G** using a square pulse that is τ (sec) long.

Use a time vector with **1ms** increments and a maximum time of **100ms**.

5. 15 mark(s) Square Impulse

- Q5.tau (s) Scalar
- Q5.y (V) 1x101 Vector

COW: *A pulse is obtained by subtracting a **delayed** step from a step.*
Does the pulse response resemble the LTI impulse response ???

In Fig 3, the capacitor voltage from Fig 2 is used as the input voltage in Fig 1, with a voltage buffer inserted so both circuits act independently.

Find the transfer function. $\mathbf{G = V_{out}/I_{in}}$

Run minreal() with a tolerance of **0.1** to cancel (nearly) overlapping poles and zeros.

Find the most dominant pole frequency mdp, the vector of dominant pole frequencies dp, and the vector of non-dominant pole frequencies ndp. For vectors including complex conjugate poles, repeat the pole frequency twice.

6. 10 mark(s) Dominant Pole Frequency

- Q6.mdp (rad/s) Scalar
- Q6.dp (rad/s) Vector
- Q6.ndp (rad/s) Vector