Laplace Transform
Laboratory III

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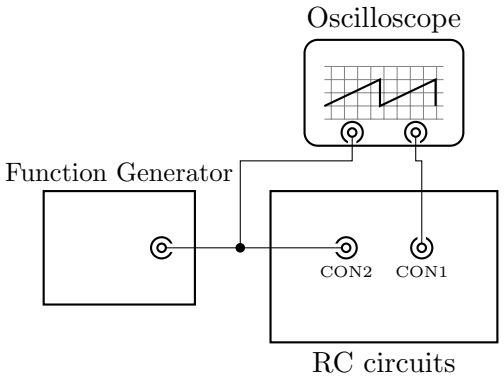
1 Goal of the exercise

2 Laplace Transform

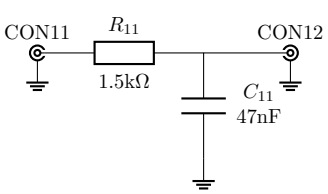
3 Course of measurements

First we tested two circuits: low-pass and high-pass configuration of RC circuit and RLC circuts. After connecting osciloscope to the wave generator and prototype board, we generated square wave with Vp2p = 1V, offset = .5V, frequency of 100Hz and duty cycle of 50%. Then we read from the osciloscope Voltage value at times 1t, 5t and 10t (where 10t is just as failsafe) and time when voltage reaches 10% and 90% of the highest value.

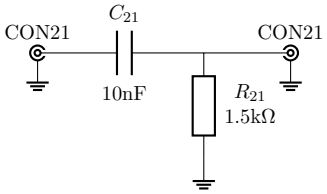
For RLC circuits we tested ho different resistances before RC circuit influence output charactristic. We measured response for 2 cases: Generator out resistance (50 Ohm) + resistance selected by jumper wire. In our case we tested jumper on 1.1k Ohm resistance path and 3.3k Ohm. After that we checked response of the circuit: if response was sinusoid with decreasing amplitude - resustance was smaller then RC if response was exp. decay if R was higher if response was aperiodic critical waveform if resistance was equal RC



(a) Measurement setup

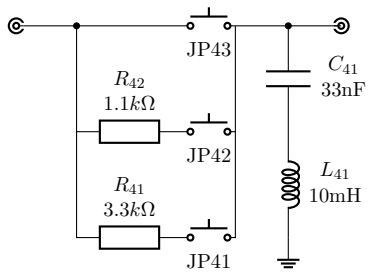


(b) Circuit A

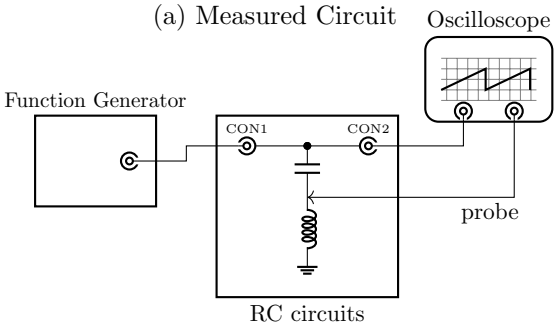


(c) Circuit B

Figure 1: RC Circuits



(a) Measured Circuit



(b) Measurements setup

Figure 2: RLC circuit

4 Theoretical calculations

For all calculations we used Matlab with Symbolic Math Toolbox. Source code can be found in Appendix. A

In all three circuit input voltage was square wave with 50% duty cycle which can be described in time domain by

$$v_{in}(t) = V_{offset}\mathbf{1}(t) + V_{pp}\mathbf{1}(t - \frac{T}{2}) - V_{pp}\mathbf{1}(t - T) \tag{1}$$

and after Laplace transform into frequency domain

$$V_{in}(s) = \mathcal{L}[v_{in}(t)] = \frac{V_{offset}}{s} + \frac{e^{-\frac{T}{2}s}}{s} - \frac{e^{-Ts}}{s} \tag{2}$$

4.1 Circuit A

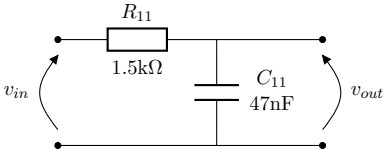


Figure 3: Circuit A schematics

v_{out} of circuit A can be described using simple voltage divider

$$v_{out}(s) = v_{in}(s)\frac{\frac{1}{sC_{11}}}{R_{11} + \frac{1}{sC_{11}}} \tag{3}$$

after applying inverse Laplace transform to $V_out(s)$ we obtain below plot.

Figure 4: Circuit A output voltage

4.2 Circuit B

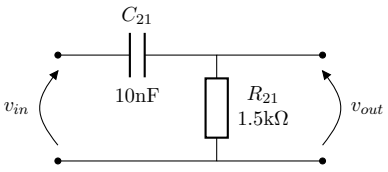
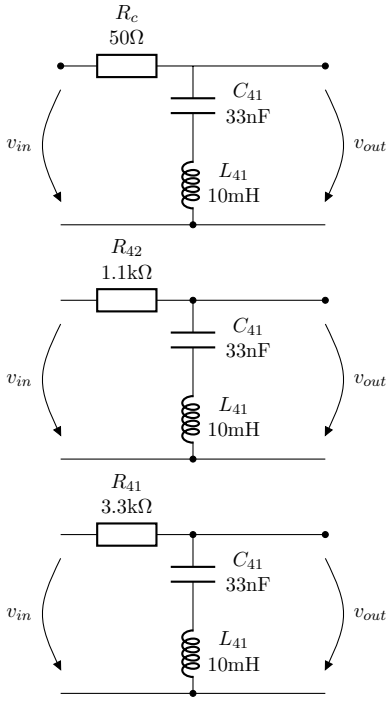


Figure 5: Circuit B schematics

4.3 Circuit C



5 Comparison

6 Conclusions

A Appendix