Departament de Disseny i Programació de Sistemes Electrònics
UNIVERSITAT POLITÈCNICA DE CATALUNYA

Pràctica 4. Circuit Dynamics

Various different responses of linear circuits.

Pere Palà
Rosa Giralt

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In this lab session we are going to investigate the dynamic behavior of linear circuits. Specifically, we will investigate an active second order circuit that exhibits different responses depending on a circuit parameter.

> ATTENTION: Please remember to work out individually those paragraphs looking as this one. This previous work has to be uploaded to the Atenea platform before 0:00 of the lab session day. You can also hand it in when you arrive at the laboratory.
> Remember also to bring all the required tools for a hardware laboratory session (protoboard, cables, etc).

1 Circuit dynamics

In this laboratory session we will investigate the circuit depicted below.

Previous Work 1. Find the transfer function $H(s) = V_O(s)/V_G(s)$ of the circuit. Indicate which values of α make the circuit stable, marginally stable and unstable.

Previous Work 2. Indicate which values of α give real, complex and purely imaginary poles of $H(s)$. Relate these results with the stability of the circuit

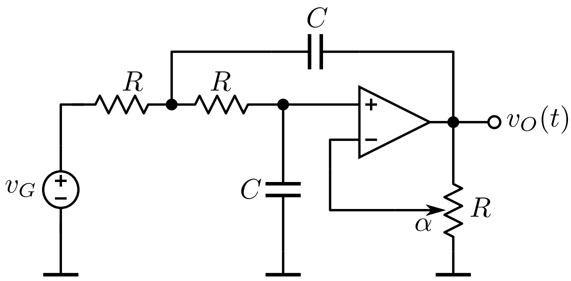

Figure 1: The circuit.

Previous Work 3. Find the step response, i.e. find $v_o(t)$ for $v_G(t) = u(t)$, when $\alpha = 1/2$. Make a sketch of the $v_o(t)$ indicating the most significant features of the waveform. Find as many ways as possible to validate the results. In particular, compute the steady-state response to a constant input in as many ways as possible.

Previous Work 4. Demonstrate that the time constant τ of an exponential waveform such as $Ae^{-t/\tau} + B$ may be found from two points of the waveform (t_1, v_1) and (t_2, v_2) and from the final value v_∞ by the expression

$$\tau = \frac{t_2 - t_1}{\ln \dfrac{v_1 - v_\infty}{v_2 - v_\infty}} \tag{1}$$

2 Laboratory work

Task 1. Build the circuit on your prototyping board with $R = 10$ kΩ and $C = 10$ nF. The input signal should be a square wave between 0 and 1 V and half-period greater than 5τ.

Task 2. Use the oscilloscope to view simultaneously the input and the output signal with different values of α that make the circuit stable. Consider specifically the case you worked out in your *previous work*.

Task 3. Experiment what happens when you lower the input frequency. Does the output signal still resemble a square wave? What happens when you change the input signal to triangular or sinusoidal?

Task 4. Make $v_i = 0$ and observe $v_o(t)$ for values of α that make the circuit unstable. Measure the oscillation frequency when α gives purely imaginary poles. Investigate what happens when you further decrease α.