Unit 4: Laplace Transforms and their Applications

Contents

Motivating example

In Example 4.1: RC Circuit we presented the RC Circuit shown in Fig. 41

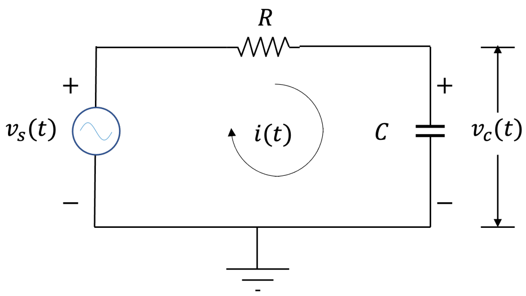

Fig. 41 An RC Circuit

We showed that voltage across the capacitor $v_c(t)$ is determined by the first-order differential equation

$$\frac{1}{RC}v_s(t) = \frac{d}{dt}v_c(t) + \frac{1}{RC}v_c(t)$$

Assuming that the input voltage is applied by operating a switch, that is $v_s(t)$ is the step function $V_s u_0(t)$ what would the output vc(t) look like?

About the Laplace Transformation

The Laplace Transformation (named after Pierre-Simon Laplace) is a useful mathematical tool that is used in many branches of engineering including signals and systems theory, control theory, communications, mechanical engineering, etc.

Its principle benefits are:

- it enables us to represent differential equations that model the behaviour of systems in the time domain as polynomials in s which facilitates their solution
- it converts time convolution (which is how we determine the time-response of a system to a given signal) into a simple multiplication in the s domain
- it allows us to model linear time-invariant (LTI) system components using transfer functions and systems by block diagrams
- block diagram analysis allows us to readily compute system responses to complex signals.

The only downside is that time t is a real value whereas the Laplace transformation operator s is a complex exponential $s = \sigma + j\omega$.

In this section of the course we will cover:

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