Carleton University

Dept. of Systems and Computer Engineering

Systems and Simulations—SYSC 3600 Fall 2014

Homework #9

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1. Second-order response: In the RLC circuit shown in Figure 1, let $E = 1$ volt, $L = 1$ Henry and $C = 0.5$ Farad. The switch was open for a long time and was closed at $t = 0$. Assume zero initial conditions.

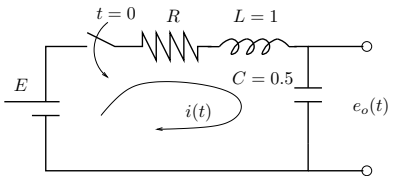

Figure 1: Second order electrical system

   (a) Derive an expression for the Laplace transform of the voltage across the capacitor for arbitrary R.

   (b) Is the system underdamped or overdamped with $R = 1$ Ohm?

   (c) What is the steady-state value of $e_o(t)$? Sketch $e_o(t)$ versus t.

   (d) What is the natural frequency of the system, ω_n? What is the damping ratio, ζ?

   (e) What is the value of R for which the system is critically damped?

2. Consider the system in Figure 2. Assume zero initial conditions and let $b = 4$ Nt.s/m and $m = 1$ Kg.

   (a) Obtain the differential equation that describes the displacement y when the input force is $p(t) = u(t)$ and k is arbitrary.

   (b) Suppose that $k = 2$. Is the system underdamped, critically damped or over damped?

   (c) What is the natural frequency of the system, ω_n? What is the damping ratio, ζ?

   (d) What is the value of k for which the system is critically damped?

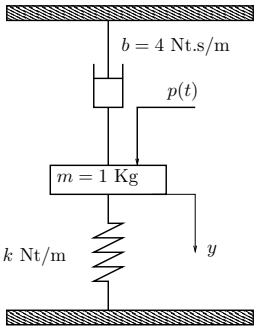

Figure 2: Second order mechanical system