GEORGIA INSTITUTE OF TECHNOLOGY
School of Electrical and Computer Engineering

Course ECE 2040

Circuit Analysis

Assigned: October 27, 2000
Due: November 3, 2000

Problem Set #10

Reading: Read the following sections from the class notes:
Chapter 7, Sections 7.2, 7.3
Chapter 8, Sections 8.1

Reading: Read the following sections from Dorf and Svoboda:
Chapter 14, Section 14.10; (System functions)
Chapter 10, Sections 10.3–10.5

Announcement: Quiz #3 will be held during the class hour on Friday, November 3, 2000. It will be a closed book test, although calculators are permitted and one 8.5in × 11in sheet of handwritten notes are permitted. It will cover problem sets 6–9.

Problem 10.1: The circuit in Figure 1 is at initial rest.

(a) Find the system function $H(s)$ that relates the output $I_{out}(s)$ to the input $V_{in}(s)$.

(b) Find the impulse response of the system $h(t)$.

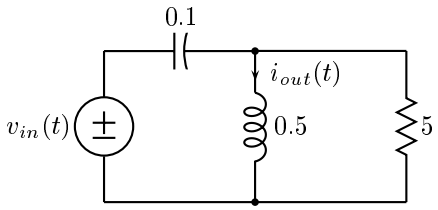

Figure 1: Circuit for Problem 10.1.

Problem 10.2: A parallel RC circuit is connected in series with an unknown circuit N excited by a current source as shown in Figure 2(a). The current source waveform is shown in Figure 2(b). The goal of the problem is to design the network N so that the voltage $v(t)$ will be that shown in Figure 2(c).

(a) Use Laplace transform methods to determine the voltage $v_2(t)$.

(b) Sketch $v_1(t)$ for $t \geq 0$.

(c) Determine the impedance $Z_1(s)$ of the circuit N.

(d) Determine the circuit N.

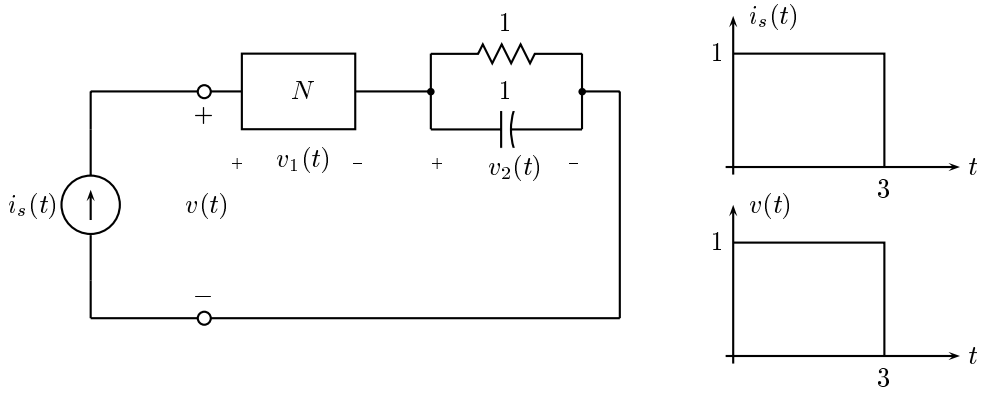

Figure 2: Circuit for Problem 10.2 with the current excitation and voltage response shown. The voltage $v_1(t)$ and the circuit N are to be determined.

Problem 10.3: An oscillator is a circuit whose system function has a pair of complex conjugate poles located $s = \pm\omega_0$, where ω_0 is the frequency of oscillation. Once started it will continue to produce a sinusoidal output $v_{out}(t)$. In the network in Figure 3 determine the value of K for which the system will oscillate and determine the frequency of oscillation.

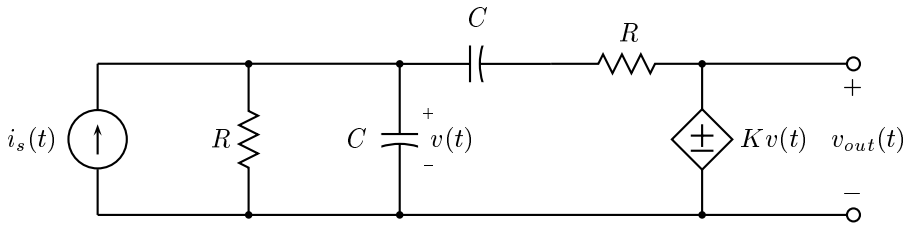

Figure 3: An oscillator circuit for Problem 10.3.

Problem 10.4: For the two-terminal pair circuit shown in Figure 4 the relation between $v(t)$ and $i(t)$ is

$$v(t) = i(t) + 3\frac{di(t)}{dt}$$

when the terminals b and b' are open-circuited and

$$v(t) = \frac{di(t)}{dt}$$

when the terminals b and b' are short-circuited. Determine a possible circuit having these properties.

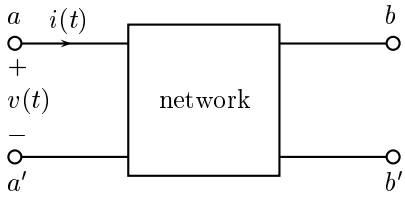

Figure 4: A two-terminal network to be designed in Problem 10.4.