

GEORGIA INSTITUTE OF TECHNOLOGY  
School of Electrical and Computer Engineering

Course ECE 2040

Circuit Analysis

Assigned: November 27, 2000

Due: Friday, December 8, 2000 (last class)

### Problem Set #14

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**Reading:** Read the following sections from the class notes:

Chapter 12, Sections 12.1, 12.2, 12.4

**Reading:** Read the following sections from Dorf and Svoboda:

Chapter 16, Sections 16.3, 16.4, 16.5

Chapter 17, Sections 17.3, 17.4, 17.7

Chapter 1, Sections 1.6

Chapter 2, Sections 2.4

Chapter 5, Sections 5.7

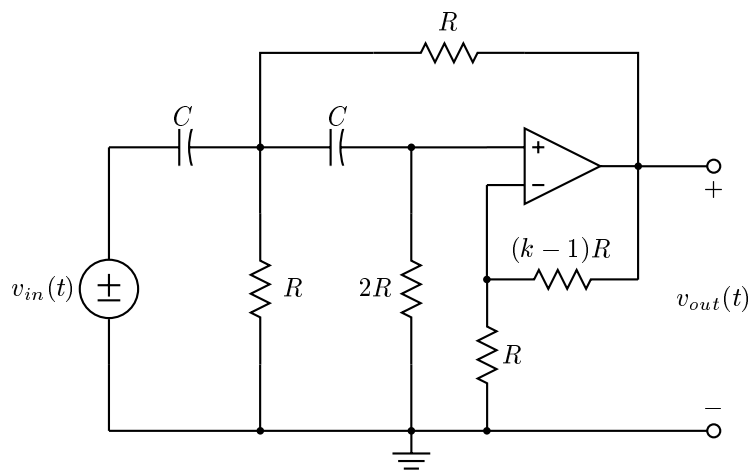
Chapter 11, Sections 11.8

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**Announcement:** The Final Exam will be held on Wednesday, December 13, 2000 from 8:00–10:50. It will be a closed book test, although calculators and one 8.5in  $\times$  11 inch sheet of handwritten notes are permitted. It will cover the entire course.

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#### Problem 14.1:



The circuit above implements a second-order highpass filter with the system function

$$H(s) = \frac{ks^2}{s^2 + \frac{3-k}{RC}s + \frac{1}{R^2C^2}}$$

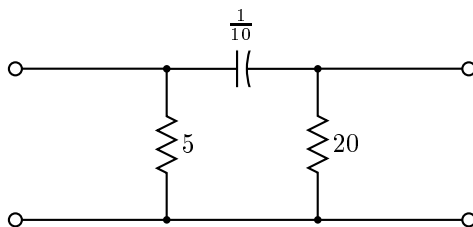
When  $k = 1.586$ , the filter is a Butterworth highpass filter.

- (a) Select values for  $R$  and  $C$  so that the cutoff frequency of the filter will be 10kHz. (The cutoff frequency is also the break frequency on the Bode plot. It is also sometimes called the half-power frequency.)
- (b) For these values of  $R$  and  $C$ , what is the high frequency gain of the filter?

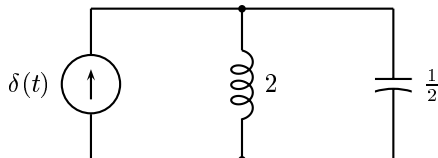
**Problem 14.2:** For a two-port network, the admittance matrix  $\mathbf{Y}$  is defined by

$$\begin{bmatrix} I_1(s) \\ I_2(s) \end{bmatrix} = \mathbf{Y} \begin{bmatrix} Y_1(s) \\ Y_2(s) \end{bmatrix}$$

Determine the admittance matrix for the two-port below.

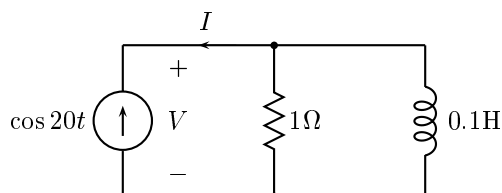


**Problem 14.3:**



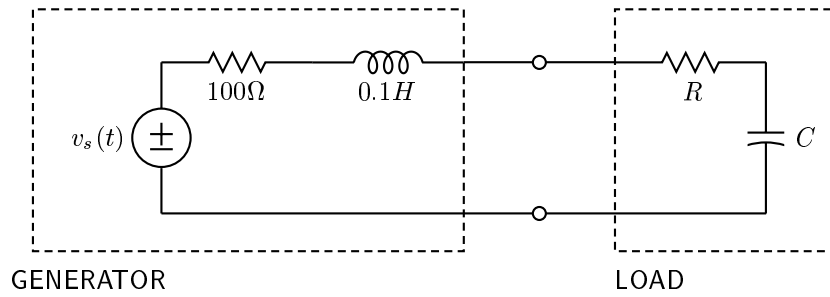
- (a) Determine the voltage drop,  $v(t)$  across all three elements as a function of time. The waveform in the current source is a unit impulse,  $\delta(t)$ .
- (b) Plot  $U(t)$ , the energy stored in the capacitor, as a function of time. (Your plot should be carefully labelled.)
- (c) Plot  $T(t)$ , the energy stored in the inductor, as a function of time.

**Problem 14.4:**



What is the average power supplied by the current source?

**Problem 14.5:**



If  $v_s(t) = V_s \cos(2\pi(60)t)$ , determine the values of  $R$  and  $C$  so that the average power delivered to the load is a maximum.