

# **BENG 186B Winter 2013**

## **Quiz 1**

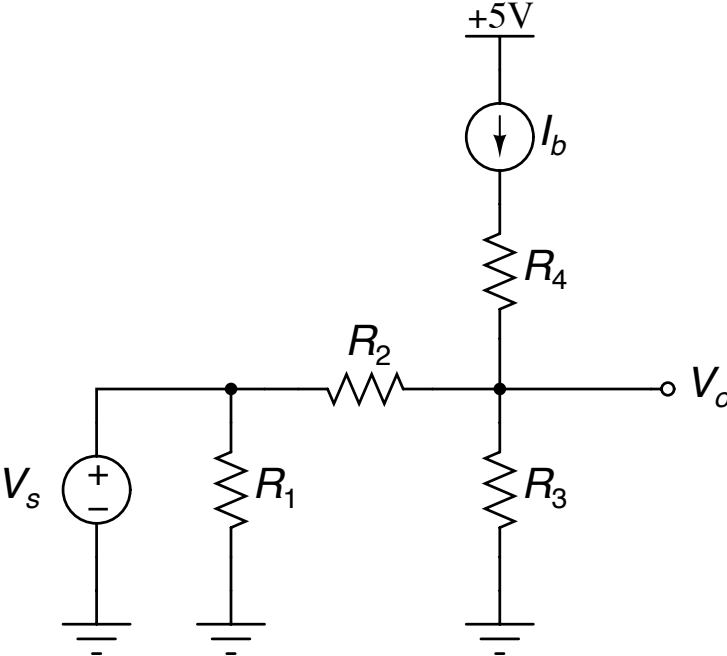
January 25, 2013

**NAME (Last, First)** \_\_\_\_\_

- This quiz is closed book, closed notes, you may use a calculator for algebra.
- Circle your final answers and show your work on the pages provided.
- Do not attach separate sheets. If you need more space, use the back of the pages.
- Points for each problem are given in [brackets], 100 points total. The quiz is 50 minutes long.

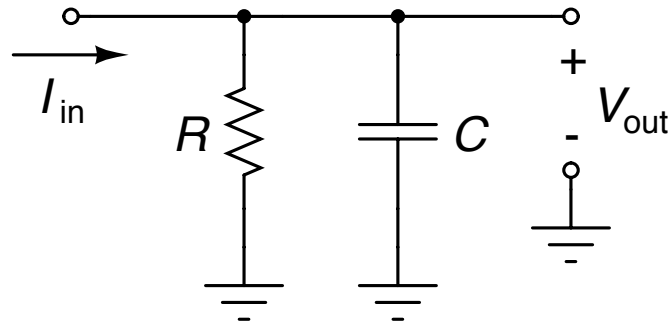
1	/25
2	/35
3	/20
4	/20
Total	/100

1. [25 pts] Find the Thévenin equivalent at  $V_o$  for the following circuit:



(1. continued)

2. [35 pts] For the following current-in, voltage-out filter circuit:



a. Find the input impedance  $Z_{in}$ .

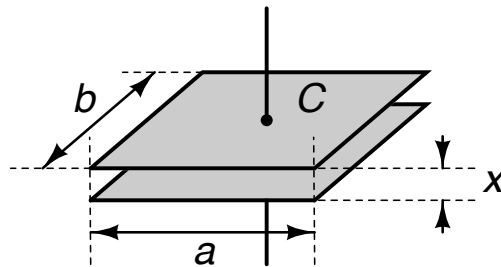
(2. continued)

b. Find the output impedance  $Z_{out}$ .

c. Find the transfer function  $H(j\omega) = \frac{V_{out}(j\omega)}{I_{in}(j\omega)}$ .

(2. continued)

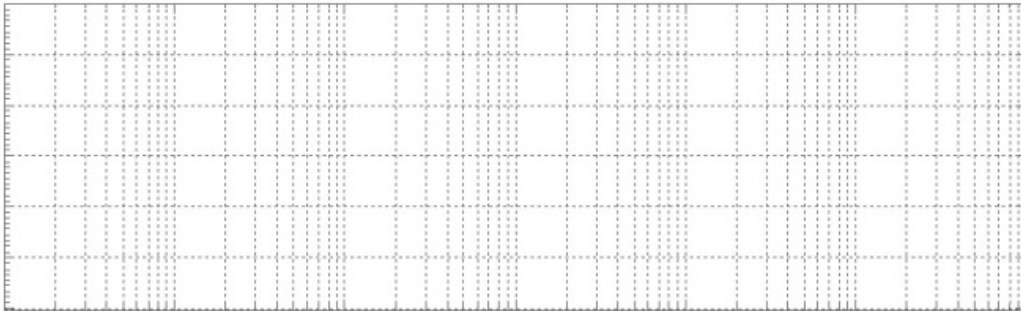
- d. A variable capacitance  $C$ , with adjustable transversal distance  $x$  between conductor plates illustrated below, is used to tune the cut-off frequency of the above filter circuit, while the resistance  $R$  is kept at  $100 \text{ k}\Omega$ . At a distance  $x = 10 \text{ }\mu\text{m}$  the capacitance  $C$  is measured to be  $10 \text{ nF}$ . Find the radial cut-off frequency of the circuit for  $x = 1 \text{ }\mu\text{m}$ , and for  $x = 100 \text{ }\mu\text{m}$ .



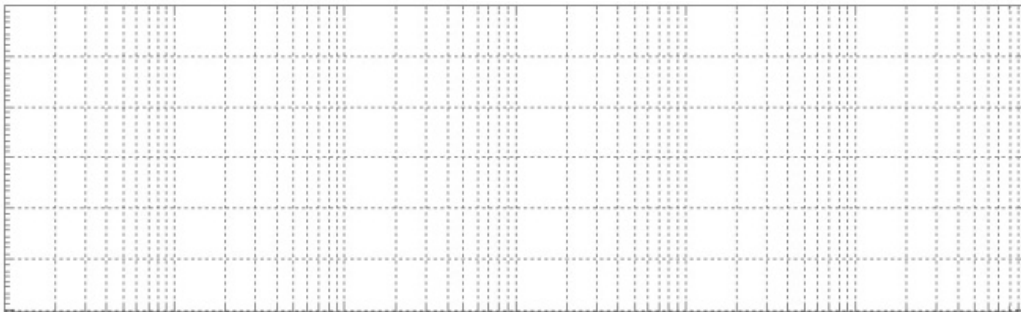
(2. continued)

- e. Sketch the Bode plots, with magnitude and phase, of the transfer function  $H(j\omega)$  for  $R = 100 \text{ k}\Omega$  and  $x = 100 \text{ }\mu\text{m}$ . Be sure to label all axes with units.

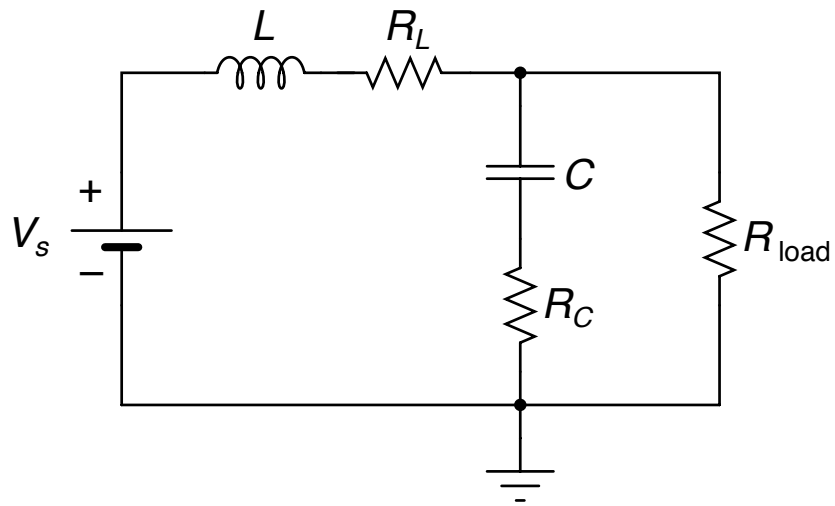
$H(j\omega)$  Magnitude



$H(j\omega)$  Phase



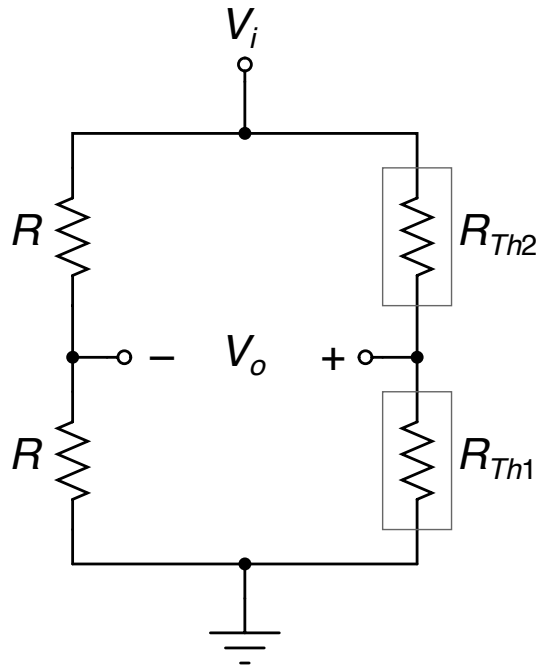
3. [20 pts] For the circuit below, calculate the power efficiency  $\eta$  at steady state. The power efficiency is defined as the ratio of power delivered to the load  $R_{\text{load}}$ , over power delivered by the source  $V_s$ .





(3. continued)

4. [20 pts] Consider the temperature transducer below, with a constant voltage supply  $V_i = 1$  V, two constant resistors each with resistance  $R$ , and two thermistors with temperature dependence  $R_{Th1} = R (1 + k_1 T)$  and  $R_{Th2} = R (1 + k_2 T)$  respectively, where  $T$  is the ambient temperature. Find values of the temperature coefficients  $k_1$  and  $k_2$  for which the transducer is linear with constant sensitivity  $dV_o / dT = 0.002$  V/°C.



(4. continued)