THE UNIVERSITY OF BRITISH COLUMBIA
Department of Electrical and Computer Engineering
EECE356 Quiz 2 – October 7, 2011

Time: 20min.
This examination consists of 2 pages. Please check that you have a complete copy. You may use both sides of each sheet if needed.

READ THIS

Surname First

Student Number

Page #	MAX	GRADE
1	100	
TOTAL	100	

IMPORTANT NOTE: The announcement "stop writing" will be made at the end of the examination. Anyone writing after this announcement will receive a score of 0. No exceptions, no excuses.

All writings must be on this booklet. The blank sides on the reverse of each page may also be used.

Each candidate should be prepared to produce, upon request, his/her Library/AMS card.

Read and observe the following ***rules****:*
Candidates are not permitted to ask questions of the invigilators, except in cases of supposed errors or ambiguities in examination-questions.

Caution *- Candidates guilty of any of the following, or similar, dishonest practices shall be immediately dismissed from the examination and shall be liable to disciplinary action:*

- *Making use of any books, papers or memoranda, calculators, audio or visual cassette players or other memory aid devices, other than as authorized by the examiners.*
- *Speaking or communicating with other candidates.*
- *Purposely exposing written papers to the view of other candidates.*

The plea of accident or forgetfulness shall not be received.
NOTE: NO CALCULATORS, NO CELLPHONES, NO OTHER ELECTRONIC AIDS, NO NOTES, NO FORMULA SHEET and NO BOOKS ARE PERMITTED.

100p

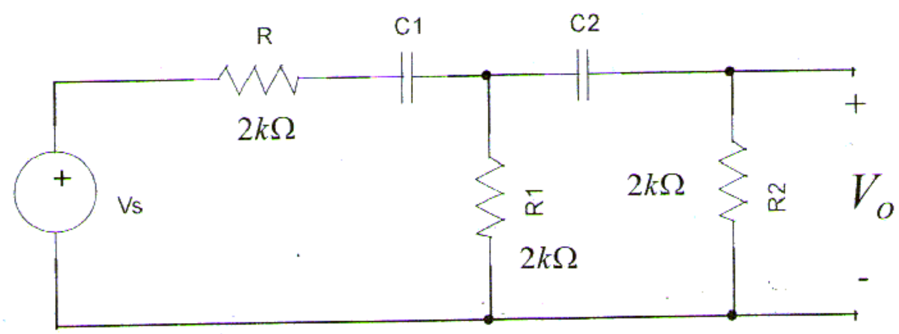
1. The transfer function for the circuit shown below is given by:

$$\frac{V_o(s)}{V_i(s)} = A_0 \frac{s}{s+20}\frac{s}{s+200}$$

Here A_0 is a constant value.

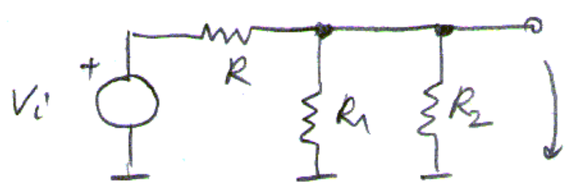
a. Determine the value of A_0

b. Use the method of open-circuit/short-circuit time constants to estimate the values of C_1 and C_2, assuming $C_1 > C_2$



a) A_0 can be calculated from the value of the transfer function when $\omega \to \infty$ $\quad H(j\omega) = \frac{V_o(j\omega)}{V_i(j\omega)} \xrightarrow{\omega \to \infty} A_0$

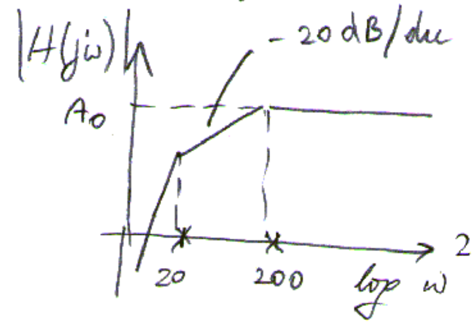
For $\omega \to \infty$, the circuit becomes:



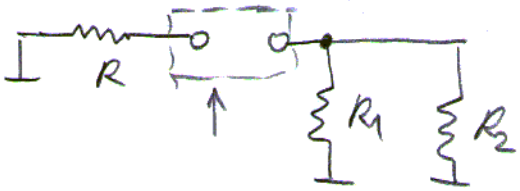
$V_o = \frac{R_1 \| R_2}{R + R_1 \| R_2} \cdot V_i \Rightarrow$

$$\Rightarrow \left.\frac{V_o}{V_i}\right|_{\omega \to \infty} = \frac{1\,k\Omega}{2\,k\Omega + 1\,k\Omega} = \frac{1}{3} = 0.33 \Rightarrow \boxed{A_0 = 0.33}$$ (20p)

b.) The circuit is a high-pass filter, with 2 zeros and 2 poles. The poles are 1 decade apart, so we can apply the method of SC time ct to approximate ω_{L3dB} (the highest pole)

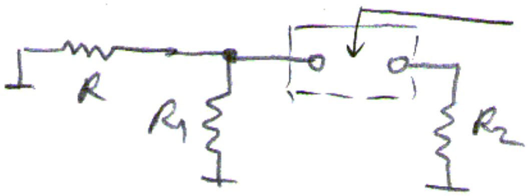


- Determine the SC time constant for C_1



$R_{1sc} = R + R_1 \parallel R_2 = 2k\Omega + 1k\Omega$
$= 3k\Omega$
$\Downarrow$
$\tau_{1sc} = R_{1sc} C_1 = 3 \cdot 10^3 \cdot C_1$

- The SC time constant for C_2



$R_{2sc} = R_2 + R \parallel R_1 = 2k\Omega + 1k\Omega = 3k\Omega$

$\tau_{2sc} = R_{2sc} C_2 = 3 \cdot 10^3 C_2$

$$\omega_{L3dB} = 200 = \frac{1}{\tau_{1sc}} + \frac{1}{\tau_{2sc}} = \frac{1}{3 \cdot 10^3 C_1} + \frac{1}{3 \cdot 10^3 C_2}$$

$$C_1 > C_2 \Rightarrow \omega_{L3dB} \approx \frac{1}{\tau_{2sc}} = \frac{1}{3 \cdot 10^3 C_2} \Rightarrow C_2 \cong \frac{1}{3 \cdot 10^3 \cdot 200}$$

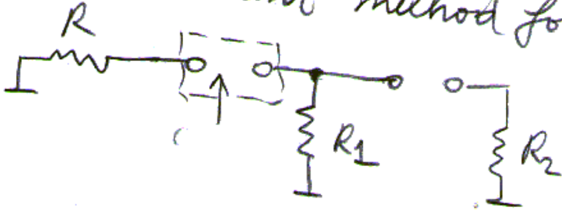
$$\boxed{C_2 \simeq \frac{10^{-5}}{6} F = 1.67 \mu F}$$ (+50p)

To determine C_1, we separate in the transfer function the part given by C_2:

$$H(s) = \frac{V_o(s)}{V_i(s)} = A_0 \frac{s}{s+20} \cdot \frac{s}{s+200}$$

LF ← → HF

As C_2 is now a HF component relative to the pole at $\omega = 20$, it will appear as open-circuit when we apply again the SC time constant method for C_1



$R_{1sc}' = R_1 + R = 4k\Omega$

$\tau_{1sc}' = R_{1sc}' \cdot C_1 = 4 \cdot 10^3 C_1 \Rightarrow$

$$\Rightarrow 20 \approx \frac{1}{\tau_{1sc}'} = \frac{1}{4 \cdot 10^3 C_1} \Rightarrow C_1 = \frac{1}{8 \cdot 10^4} = \frac{100}{8} \mu F$$

$$\boxed{C_1 = 12.5 \mu F}$$ (+30p)

Marking scheme:

- computation of $A_0 = 0.33 \rightarrow +20p$
- apply sc time ct method to get $C_2 = 1.67\mu F \rightarrow +50p$
- apply sc (with C_2 open circuited) to get $C_1 = 12.5\mu F \rightarrow +30p$

100p