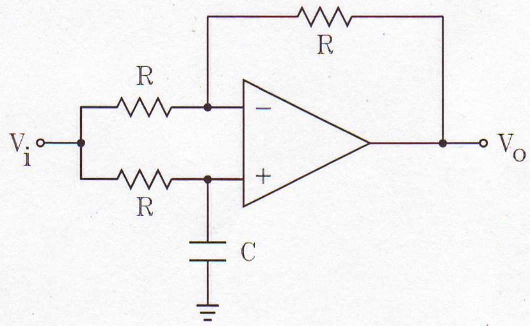
ECE 3042 Lecture Exam No. 2 Spring 2013

FRIDAY, MARCH 15, 4-5 PM AD LOGON ____________

Name ~~Key~~

Closed Book and Note. Calculator Permitted. Four Equally Weighted Problems. All Work Must Be Shown for Credit. Box All Answers.

1. The component values for the filter shown below are $R = 8\,\mathrm{k\Omega}$, $C = 5\,\mathrm{nF}$, and the op amp may be considered to be ideal.



2 What is the order of the filter? 1, One, Unity

2 What type of filter is it? All Pass

2 What is the linear dc gain? 1

2 What is the linear infinite frequency gain? −1 (Accept +1)

2 What is the gain in dB when $f = 7.3\,\mathrm{kHz}$? 0

2 What is the phase shift in degrees when $f = 7.3\,\mathrm{kHz}$? −123°

Derive the complex transfer function $T(s) = V_o(s)/V_i(s)$. Express the answer in terms of the symbols s, R, and C (not the numerical values).

5 $$V_o = -\frac{R}{R}V_i + \frac{\frac{1}{sC}}{R + \frac{1}{sC}}\left[1 + \frac{R}{R}\right]V_i$$

$$\frac{V_o}{V_i} = -1 + \frac{2}{1 + sRC} = \frac{1 - sRC}{1 + sRC}$$

8 try

42F7

2. A certain filter has the complex transfer function

$$T(s) = K\frac{\left(\frac{s}{\omega_o}\right)^2 - \frac{1}{Q}\frac{s}{\omega_o} + 1}{\left(\frac{s}{\omega_o}\right)^2 + \frac{1}{Q}\frac{s}{\omega_o} + 1}$$

where $K = 8$, $f_o = 73\,\text{kHz}$, and $Q = 10$.

3 What is the order of the filter? 2, Two, Second

3 What type of filter is it? All Pass

3 What is the dc phase shift? $0°$

3 What is the linear dc gain? 8

3 What is the linear infinite frequency gain? 8

3 What is the gain in dB when $f = 43\,\text{kHz}$? 18.1 dB

3 What is the phase shift in degrees when $f = 43\,\text{kHz}$? $-10.3°$

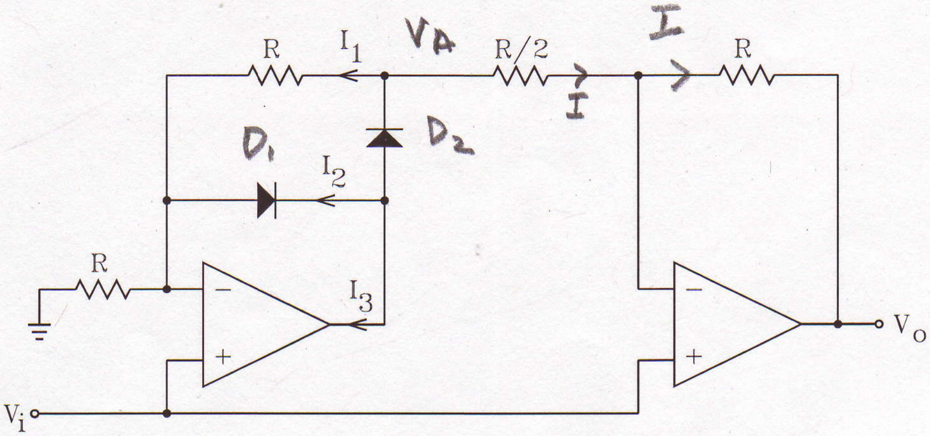
$$T(43k) = 8\,\frac{\left(j\frac{43}{73}\right)^2 - \frac{1}{10}\left(j\frac{43}{73}\right) + 1}{\left(j\frac{43}{73}\right)^2 + \frac{1}{10}\left(j\frac{43}{73}\right) + 1} =$$

$8 \angle -10.308°$

4 try

42 F4

3. In the circuit shown below the op amps may be considered ideal excepts that they have an upper and lower saturation voltage of ±15 V. The resistor value is $R = 2\,\mathrm{k}\Omega$. The diodes are semiconductor diodes with an on voltage of 0.65 V. Complete the table.



V_i	I_1	I_2	I_3	V_o
−3 V	0	−1.5 m	1.5 m	−3
0 V	0	0	0	0
3 V	1.5 m	0	−4.5 m	−3

2 each

$V_i < 0$ D_1 on D_2 off

$I_1 = 0$ $V_o = V_i$ $I_2 = -\frac{3}{2}$ mA

$I_3 = -I_2 = \frac{3}{2}$ mA

$V_i > 0$ D_1 off D_2 on

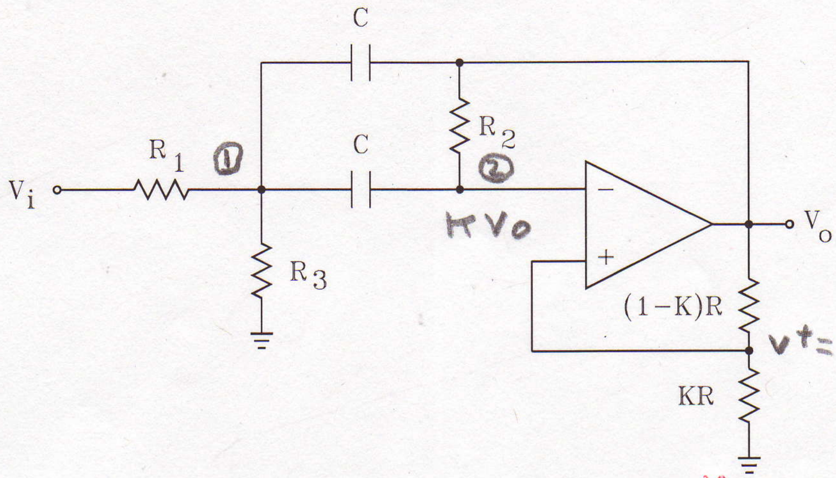
$I_1 = \frac{3}{2}$ mA $V_o = V_i$ $V_A = 2V_i$

$I = \frac{2V_i - V_i}{R/2} = \frac{6-3}{1} = 3$ mA $V_o = V_i - RI = 3 - 2 \cdot 3 = -3$ V

$I_3 = -(I_1 + I) = -(1.5 + 3) = -4.5$ mA

1 try

4. The op amp in the filter circuit shown below may be considered to be ideal.



$v^+ = v^- = \frac{KR}{(1-K)R + KR} KV_o$ $V_o =$

What is the order of the filter? 2, Two, Second   4

What type of filter is it? Band Pass   4

What is the linear dc gain? 0   4

What is the linear infinite frequency gain? 0   4

Derive the complex transfer function $T(s) = V_o(s)/V_i(s)$. Express the answer in terms of the symbols s, R_1, R_2, R_3, C,and the parameter K. (K is just a parameter that varies from 0 to 1,viz. the load resistor is a pot)

KCL @ node 1   5

$$\frac{V_i - V_1}{R_1} + sC[V_o - V_1] + sC[KV_o - V_1] - \frac{V_1}{R_3} = 0$$

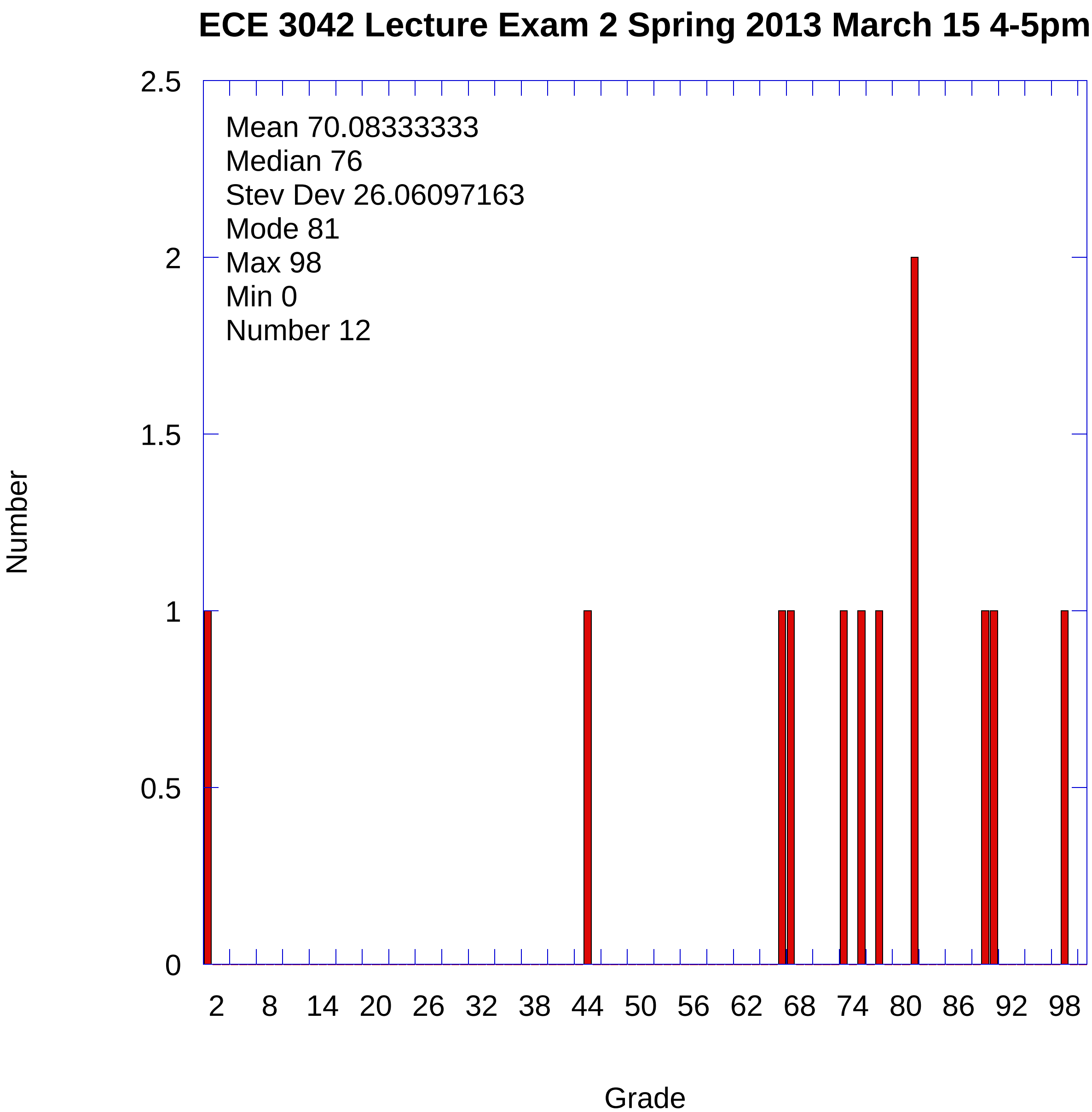
KCL @ node 2 $\quad sC[V_1 - KV_o] = [KV_o - V_o]/R_2$

simultaneous solution ⇒

$$T(s) = K_o \frac{\frac{1}{Q}\frac{s}{\omega_o}}{\left(\frac{s}{\omega_o}\right)^2 + \frac{1}{Q}\frac{s}{\omega_o} + 1} \qquad \omega_o = \frac{\sqrt{1 + \frac{R_1}{R_3}}}{C\sqrt{R_1 R_2}}$$

$$Q = \frac{\sqrt{1 + \frac{R_1}{R_3}}}{2\sqrt{\frac{R_1}{R_2}} - \frac{K}{1-K}\sqrt{\frac{R_2}{R_1}}\left[1 + \frac{R_1}{R_3}\right]}$$

$$K_o = \frac{1}{K\left[1 + \frac{R_1}{R_3}\right] - 2\frac{R_1}{R_2}(1-K)}$$


ECE 3042 Lecture Exam 2 Spring 2013 March 15 4-5pm
Mean 70.08333333
Median 76
Stev Dev 26.06097163
Mode 81
Max 98
Min 0
Number 12
Number
Grade
2.5
2
1.5
1
0.5
0
2
8
14
20
26
32
38
44
50
56
62
68
74
80
86
92
98