UCLA

Electrical and Computer Department

ECE 100

Second Midterm

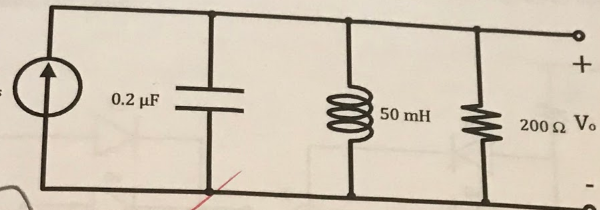
Last Name: Roberts

First Name: Grant

UID: 405 150 937

Problems	Points
1	17 /20
2	9 /14
3	17 /20
4	0 /6
5	12 /20
6	20 /20
Total	75 /100

1. ***For the circuit shown below, find and plot magnitude and phase of $\frac{v_o}{i_s}$. Specify the resonance frequency, −3 dB frequencies and also the BW.***



Resonance frequency

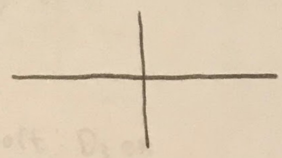
$\omega_0 = \frac{1}{\sqrt{LC}}$

$= \frac{1}{\sqrt{50mH \cdot 0.2\mu F}}$

$f_0 = \frac{1}{2\pi\sqrt{50\times10^{-3}\cdot(0.2\times10^{-6})}} = 1591.5\ Hz$

$Z_{eq} = \frac{1}{\frac{1}{R} + j(\omega C + \frac{1}{\omega L})}$ $V_o = I_S \cdot Z_{eq}$

$\left|\frac{V_o}{I_S}\right| = \frac{1}{\sqrt{\frac{1}{R^2} + (\omega C + \frac{1}{\omega L})^2}}$ → −1

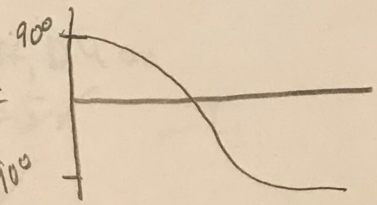


$\angle\frac{V_o}{I_S} = \angle num - \angle den$

$= 0 - \angle den$

$= -\arctan(\frac{im}{Real})$

$= -\arctan(\frac{\omega C - \frac{1}{\omega L}}{\frac{1}{R}})$ →



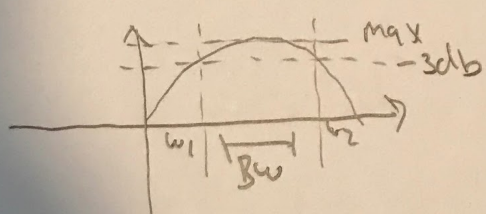
−3db frequencies = halfway cutoff

$|H\omega| = \frac{1}{\sqrt{2}}\cdot max$

$\omega_{1,2} = \pm\frac{1}{2RC} + \sqrt{(\frac{1}{2RC})^2 + \frac{1}{\omega_0^2}}$

−2

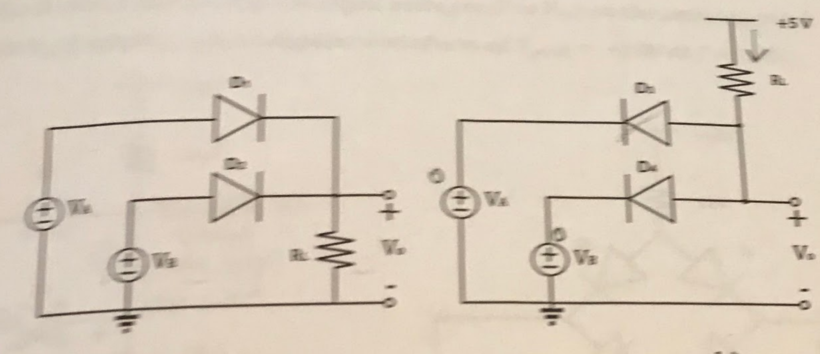
max $= \frac{1}{R}$



$Q = 2\pi f_0 CR$

$Bw = \frac{f_0}{Q}$ $Bw = \frac{1}{2\pi CR} = \frac{1}{2\pi(0.2\times10^{-6})(200)}$

2. The circuits shown below is a kind of logic circuit. V_A and V_B independently can be 0 or +5V. There are 4 possible combinations: 1) $V_A = 0V, V_B = 0V$; 2) $V_A = 0V, V_B = +5V$; 3) $V_A = +5V, V_B = 0V$; 4) $V_A = +5V, V_B = +5V$. Show the output voltages for each case, assuming diodes are ideal.



a) b)

$V_A = 0, V_B = 0$

$= 0$, by [illegible]

$0, V_B = +5$

5V

5V, D_1 on

5V

on

① V_0 0

② D_4 off : D_3 on

$V_0 = 5V$

③ D_3 off, D_4 on

$V_0 = 5V$ −5

④ 5V

3) Assuming ideal diodes:

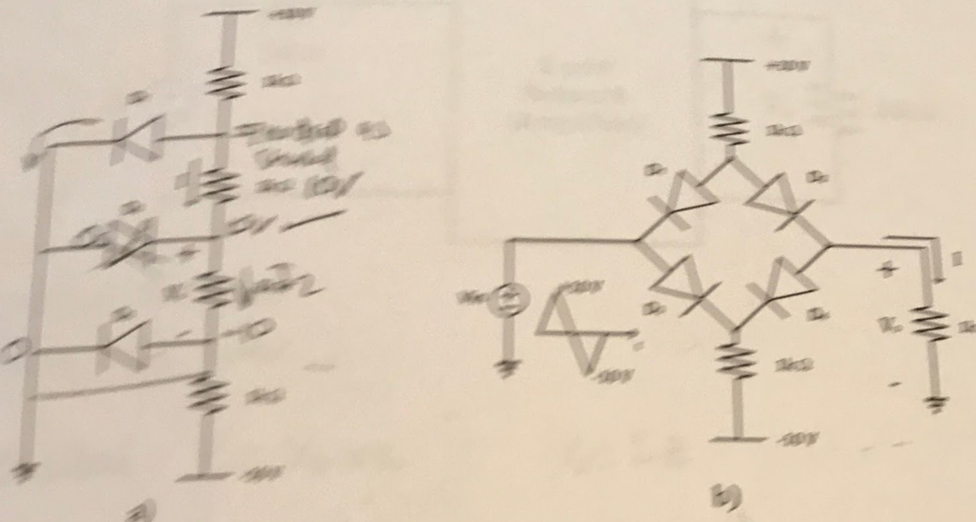
a) find the value of I and V_o for circuit a).

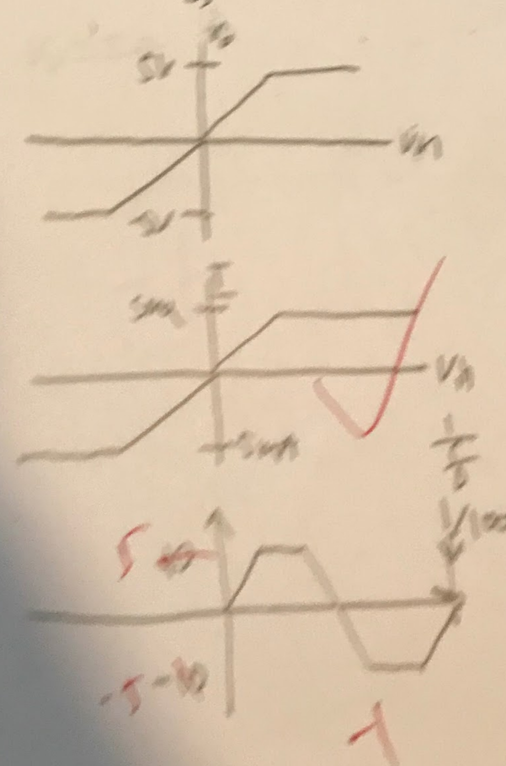
b) for circuit b):

1) sketch the output voltage vs input voltages (V_o vs V_{in}) on the same xy plane.

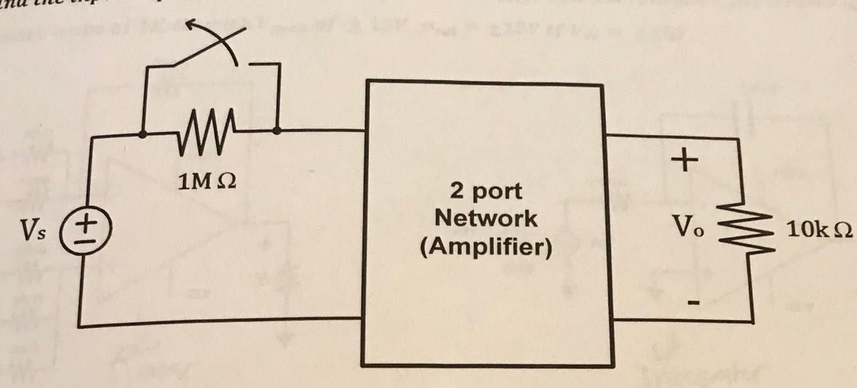
2) sketch the output current I vs input voltages (I vs V_{in}) on the same xy plane.

3) plot $V_o(t)$ with V_{in} as a triangular waveform of $V_{peak} = +10V$ at $f = 1kHz$.





4. ***The output voltage of the two port network with the switch closed is 100mV. If we open the switch, the output drops to 50mV. (A way they measure the input resistance of an amplifer). Find the input impedance of the network.***



Switch closed: $V_o = 100mV$

Open switch : $V_o = 50mV$

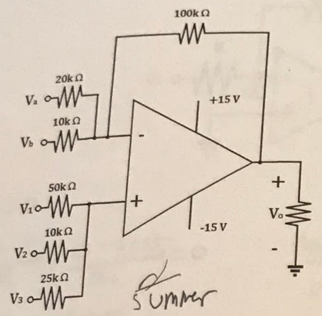
Switch closed: $V_o = V_s 10K$ $\quad$ $V_o = IZ$

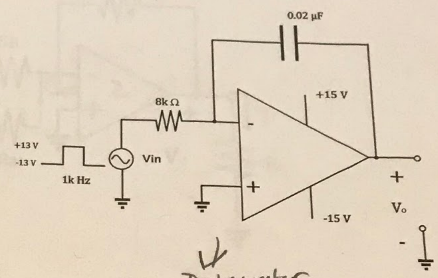
Switch open: $I =$ $\quad$ $V_o = IZ$

-6

5. a) *Find the output voltages with respect to the input voltage* $v_o(v_a, v_b, v_1, v_2, v_3)$ *for amplifier a).*

b) *For b), find the expression of* $V_o(t)$ *interms of* $V_{in}(t)$ *and also sketch* $V_o(t)$ *when* $V_{in}(t)$ *is a square wave of 1K Hz with* V_{peak} *of* $\pm 13V$. $v_{sat} = \pm 13V$ *if* $V_{cc} = \pm 15V$.





$V_- = V_+$

V_+: $\frac{V_+ - V_1}{50K} + \frac{V_+ - V_2}{10K} + \frac{V_+ - V_3}{25K} = 0$

V_+ ①: $\frac{-V_1}{50K} + \frac{V_2}{10K} + \frac{V_3}{25K} = \frac{V_+}{50K} + \frac{V_+}{10K} + \frac{V_+}{25K}$

$= V_1 + 5V_2 + 2V_3 = V_+ + 5V_+ + 2V_+ = \boxed{8V_+}$

V_-: $\frac{V_+ - V_a}{20K} + \frac{V_+ - V_b}{10K} + \frac{V_+ - V_o}{100K} = 0$

$\frac{V_+ - V_a}{20K} + \frac{V_+ - V_b}{10K} + \frac{V_+}{100K} = \frac{V_o}{100K}$

$5(V_+ - V_a) + 10(V_+ - V_b) + V_+ = V_o$

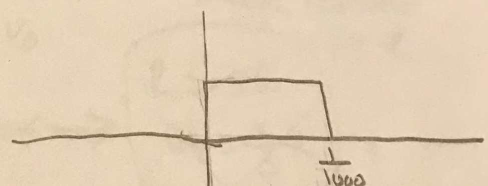
Plug

Ran out of time to Plug in and get final value

−2

$V_o(t) = -\frac{1}{RC}\int^t V_{in}(t)\,dt$

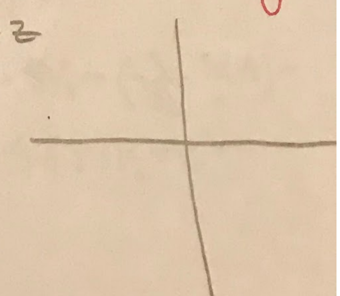
$= -\frac{1}{(8\times10^{3})(0.02\times10^{-6})}\int^t V_{in}(t)\,dt$



−6

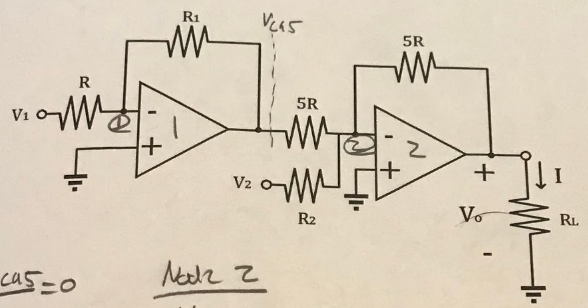
$f = 1K\ Hz$

$T = \frac{1}{f}$



6. *a) Find R_1 and R_2 in terms of R if we want to have $V_O = 3V_2 - 5V_1$.*

b) If $V_1 = 2\,V, V_2 = 1\,V$ and $R_L = 1k\,\Omega$, find the current I if R_1 and R_2 equal to the values found in a).



① $V_- = V_+ = 0$

Node ①: $\frac{0-V_1}{R} + \frac{0-V_{cas}}{R_1} = 0$

$-\frac{V_1}{R} - \frac{V_{cas}}{R_1} = 0$

$-\frac{V_1}{R} = \frac{V_{cas}}{R_1}$

$-\left(\frac{R_1}{R}\right)V_1 = V_{cas}$

Node 2

$V_- = V_+ = 0$

$\frac{0-V_{cas}}{5R} + \frac{0-V_2}{R_2} + \frac{0-V_o}{5R} = 0$

$\frac{-V_{cas}}{5R} - \frac{V_2}{R_2} = \frac{V_o}{5R}$

$-V_{cas} - \frac{5RV_2}{R_2} = V_o$

$\frac{R_1}{R}V_1 - \frac{5RV_2}{R_2} = V_o \rightarrow$ $R_1 = -5R$, $R_2 = -\frac{5}{3}R$

Think I may have got directions mixed up resulting in negative resistance for R

$-\frac{5R}{R}V_R$

$= -5V_1 - \left(-\frac{3}{5R} \cdot 5RV_2\right) -$

$= -5V_1 + 3V_2 = V_o$

② b)

$I = \frac{V_o}{R_L}$

$V_2 = 1\,V$

$V_1 = 2V$

$R_L = K$

$I = \frac{(3(1) - 5(2))}{1000}$

$= \frac{3-10}{1000} = \frac{-7}{1000} = -7mA$