ECE2100
Exam 1

This is a closed book, and notes exam. You may have one page of notes(front and back), pencil(s), pen(s), eraser(s) and a calculator.

NAME:_____

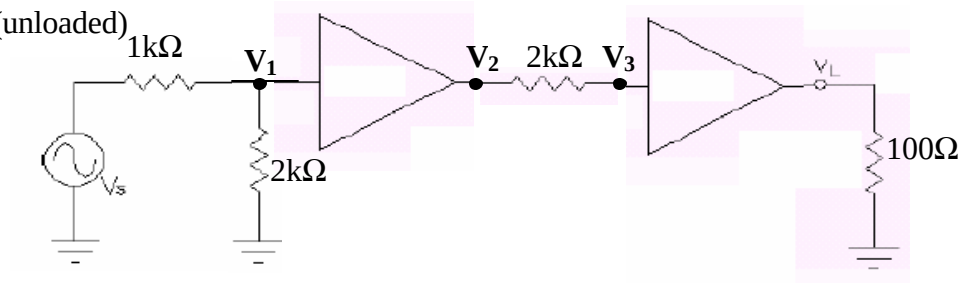
I certify that the work below is my own.

Signature:_____

Problem 1 – (43 points)

- Both amplifiers have the following characteristics:
  A_{vo}=40 R_i=2kΩ R_o=4kΩ Clipping levels: L=$\pm$12V

(unloaded)

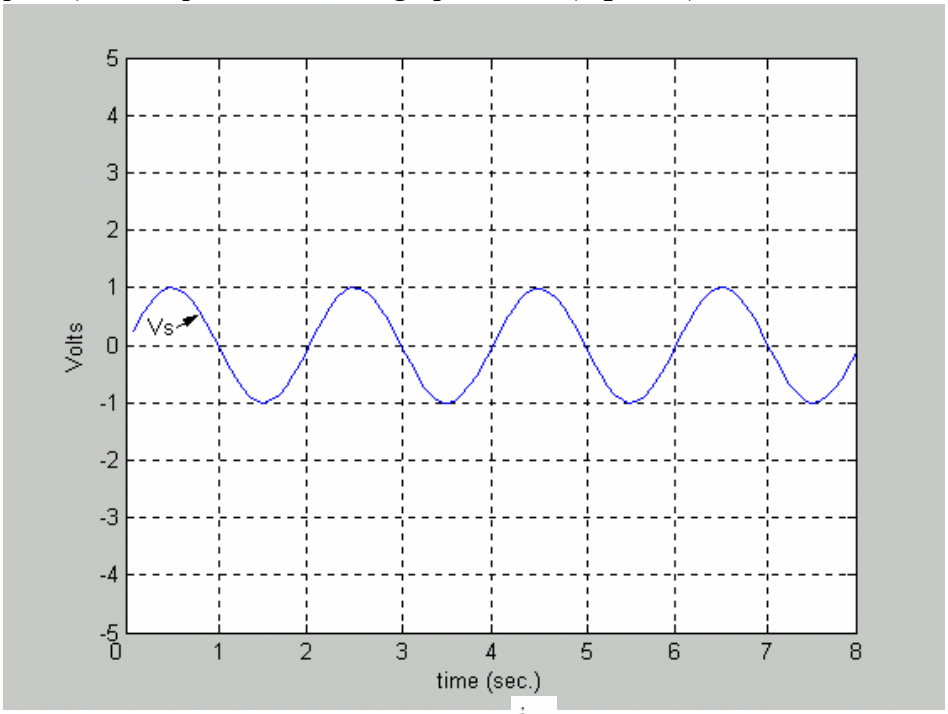


(a) Redraw this 2 stage amplifier using the amplifier model. Make sure to label V_1, V_2, V_3, and V_L on the schematic. **(15 points)**

1. (cont.)

(b) Find $A_v = \frac{v_L}{V_s}$. Express your answer as a ratio(V/V) and in dB. [Round the answer to a whole number] **(10 points)**

(c) For the input V_S as shown, sketch (make the peaks exact and estimate between the peaks) the output at V_L on the graph below. **(8 points)**



(d) Evaluate the overall current gain. ($\frac{i_o}{i_s}$) [round to the nearest whole number and express as A/A]. **(10 points)**

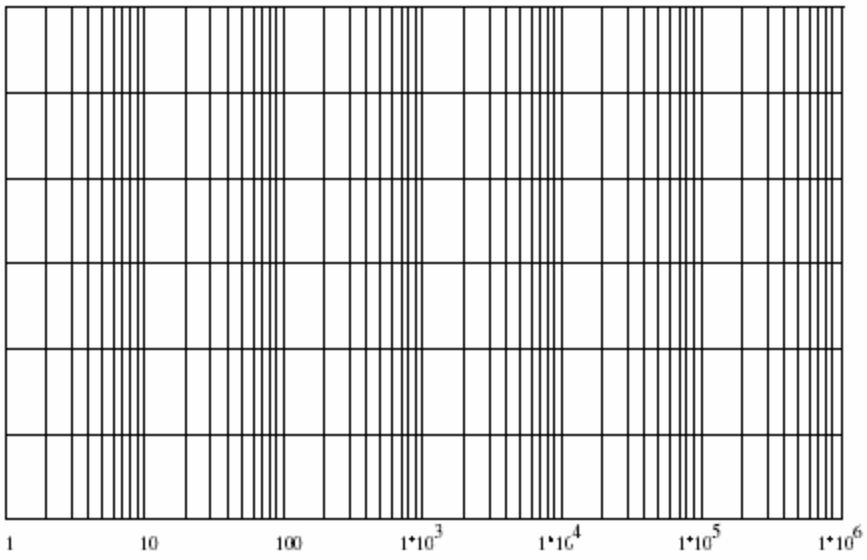
Problem 2 – (20 points)

Sketch the straight-line approximation of the Bode (both magnitude & phase) plot for: (make sure to label all your y values)

$$H(s)= \frac{(s + 100)\cdot(s + 1k)}{(s + 10)\cdot(s + 10k)}$$

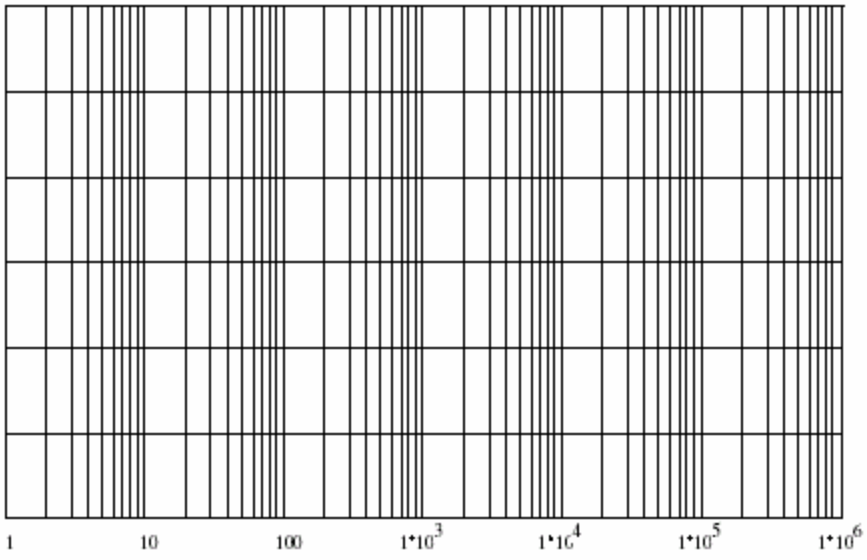
dB

|H(s)|



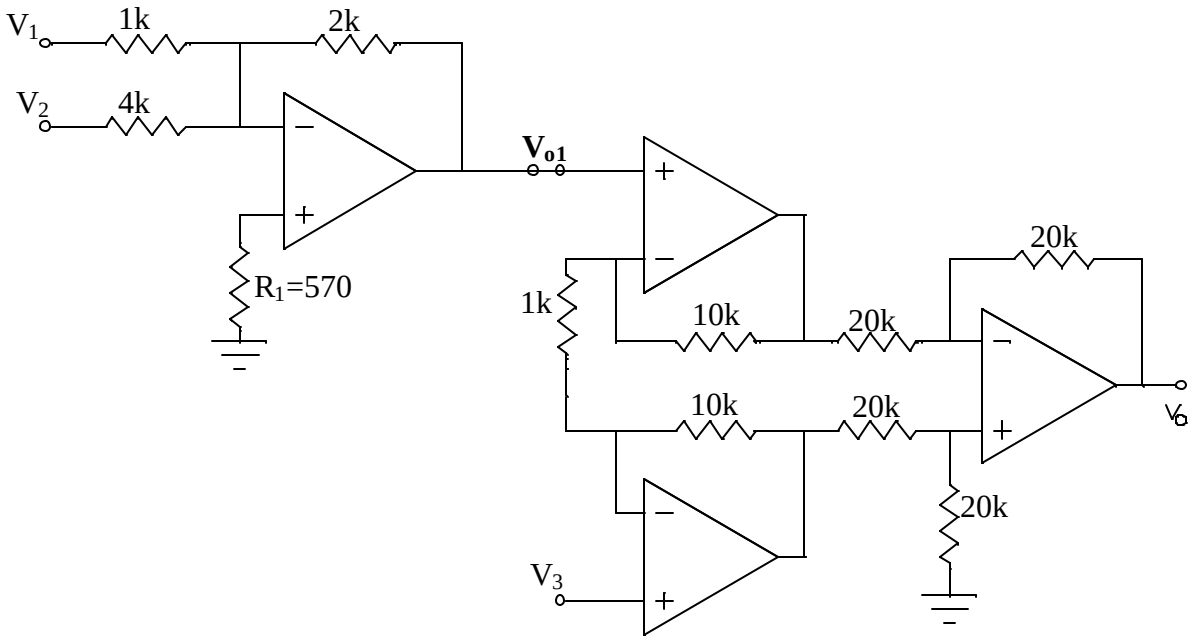
(rad/sec.)

degree



(rad/sec.)

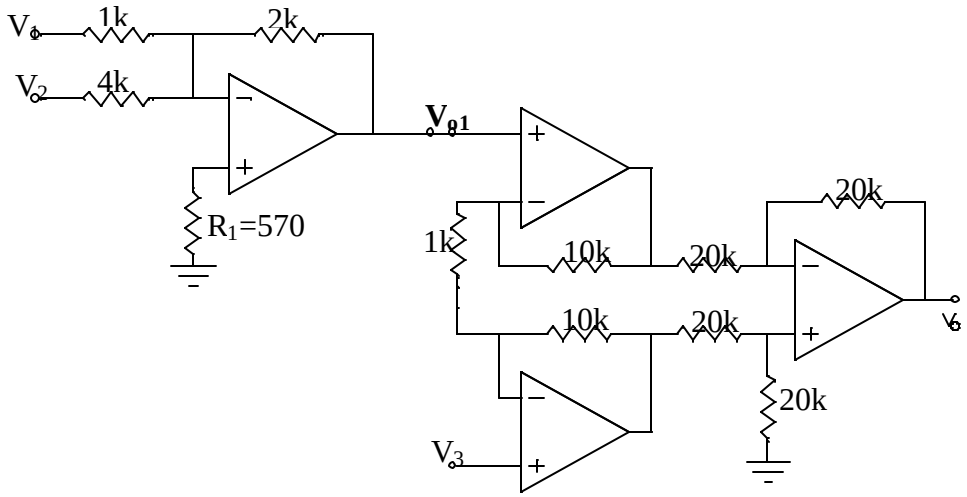
Problem 3 – (37 points)



(a) Assume all operational amplifiers are ideal
V_1=10mVpp, V_2=20mVpp, V_3=50mVpp

(i) What is the voltage value at V_{o1}(express as Vpp)? **(10 points)**

(ii) What is the voltage value at Vo (express as Vpp)? **(10 points)**



(b) All operational amplifiers are NOT ideal and have the following characteristics:

Input offset voltage:	V_{ios}=2.0mV
Input offset current:	I_{os}=100nA
Input bias current:	I_{iB}=500nA
Input resistance:	R_i=2MΩ
Output resistance:	R_o=75Ω
Open-loop gain:	A_{o1}=100dB
Unity-gain bandwidth:	f_T=4MHz
Output swing limits:	L=$\pm$12V
Slew rate:	SR=2V/μs

(i) Explain the purpose of the R_1 resistor? **(5 points)**

(ii) When V_1=V_2=V_3=0 calculate the voltage that will be observed at $\mathbf{V_{o1}}$. **(12 points) {Hint: there are two effects}**

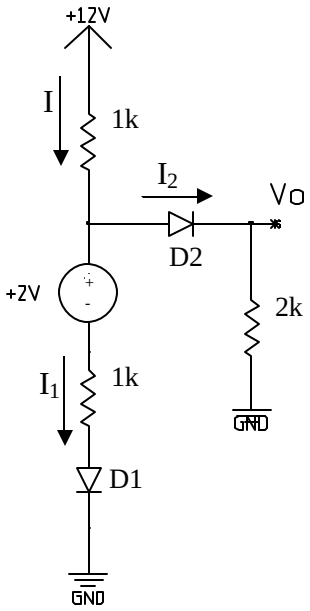
Problem 1 – (25 points)

Assume both diodes are identical and ideal. Verify that your assumption for the diode operation(i.e. on or off) are correct.

a) 9 points – The current I_1

b) 9 points – The current I_2

c) 7 points – The voltage Vo



Problem 2 – (25 points)

Referring to the pn junction diode, determine the following: (5 points each)

1) For p-type material:
   a) The majority carrier(holes or electrons) is_____
   b) As the temperature DECREASES, what happens to the number of MAJORITY carriers in this p-type material?

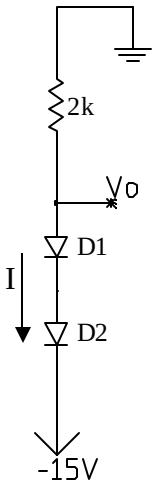
2) For p-type material:
   a) The minority carrier is_____
   b) As the temperature DECREASES, what happens to the number of MINORITY carriers in this p-type material?

3) As the temperature INCREASES, what happens to the number of unbound holes in the n-type material?

4) As the temperature INCREASES, what happens to the reverse saturation current I_S?

5) Explain how the diffusion current, I_D, is created.

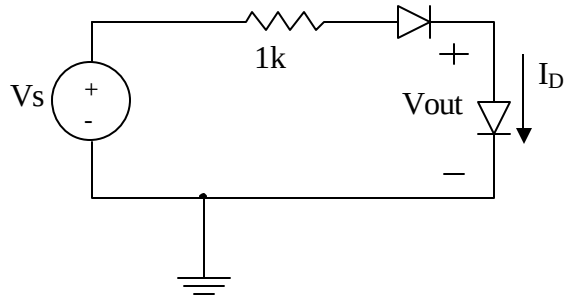
Problem 3 – (10 points)



a) Use the constant voltage drop diode model with V_{D0}=0.7
   i) 2.5 points – Solve the circuit for I
   ii) 2.5 points – Solve the circuit for Vo

b) Use the piecewise linear diode model with V_{D0}=0.7 and r_D=20Ω
   iii) 2.5 points – Solve the circuit for I
   iv) 2.5 points – Solve the circuit for Vo

Problem 4 – (15 points)



Given Vs=15 + 3sin(ωt) V
Assume V_D=0.7V, n=2, and V_T=25mV
Assume identical diodes
Use the constant voltage drop method when appropriate

c) 3 points – Determine the **DC** component of the diode current, I_D.

d) 3 points - Determine the **DC** component at the output, V_{out}.

e) 3 points – Determine the **AC** component of the diode current, i_d.

f) 3 points - Determine the **AC** component at the output, V_{out}.

g) 3 points – What is the total output for Vout.

ECE2100
Exam 1

This is an open book, and notes exam. You may use a calculator.

NAME:_____

Alias to be used to post grades outside my door (leave blank if you would not like it posted: (do not use any part of your SSN or uID number)

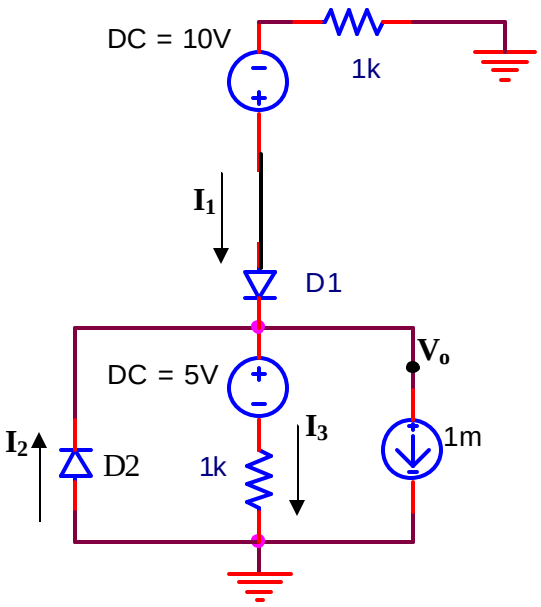
_____

I certify that the work below is my own.

Signature:_____

Problem 1 – (30 points)

Assume all diodes are identical and have V_{DO}=0.7V. Use the constant voltage drop method. Verify that your assumption for the diode operation(i.e. on or off) are correct. Find the following making sure you find the correct operation of the diodes.



a) State your assumptions (diode is on/off):

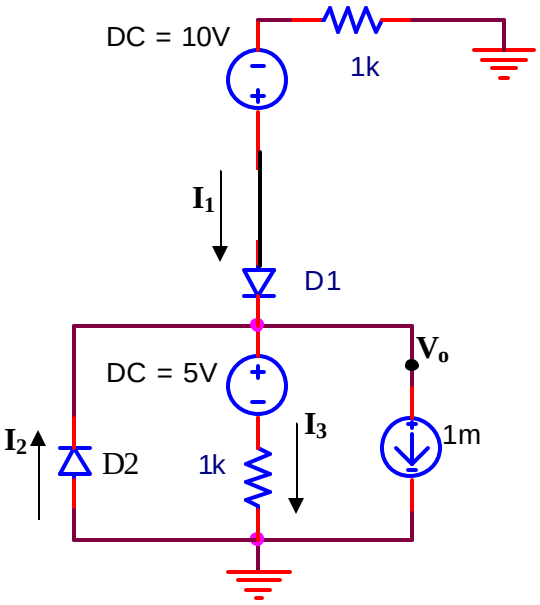
b) The current I_1

c) The current I_2

d) The current I_3

e) The voltage Vo

f) Your verification:


DC = 10V
1k
I1
D1
DC = 5V
Vo
I3
1m
I2
D2
1k

Problem 2 – (25 points)

a) Sketch the Bode (both magnitude & phase) plot for: {label your axis and show all your work}

$$H(s) = \frac{(100)(s+100)(s+10)}{(s^2)(s+10{,}000)}$$

b) What is the estimated magnitude value at ω=1 rad/sec:

c) For the magnitude plot, what is the slope of the line going through ω=1 rad/sec:

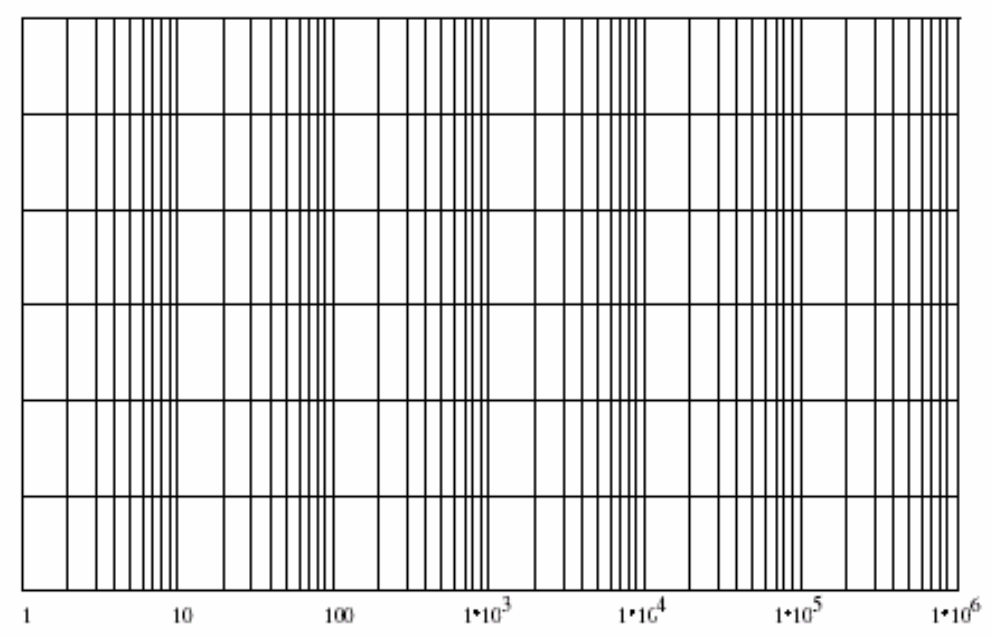
d) What is the estimated phase value at ω =1 rad/sec:

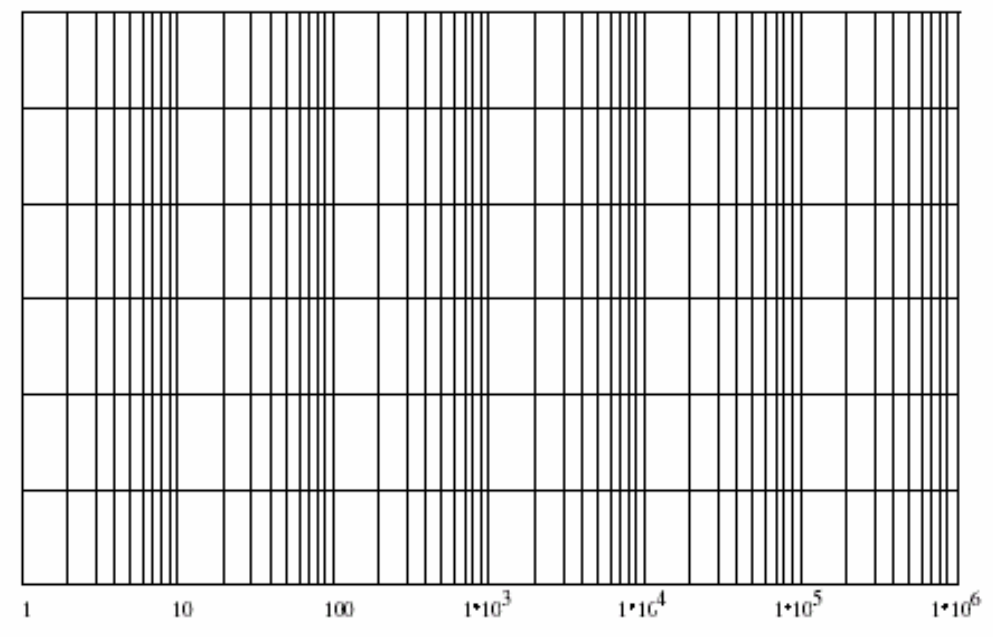
e) For the phase plot, what is the slope of the line to the left of ω =1 rad/sec:

f) For the phase plot, what is the slope of the line to the right of ω =1 rad/sec:

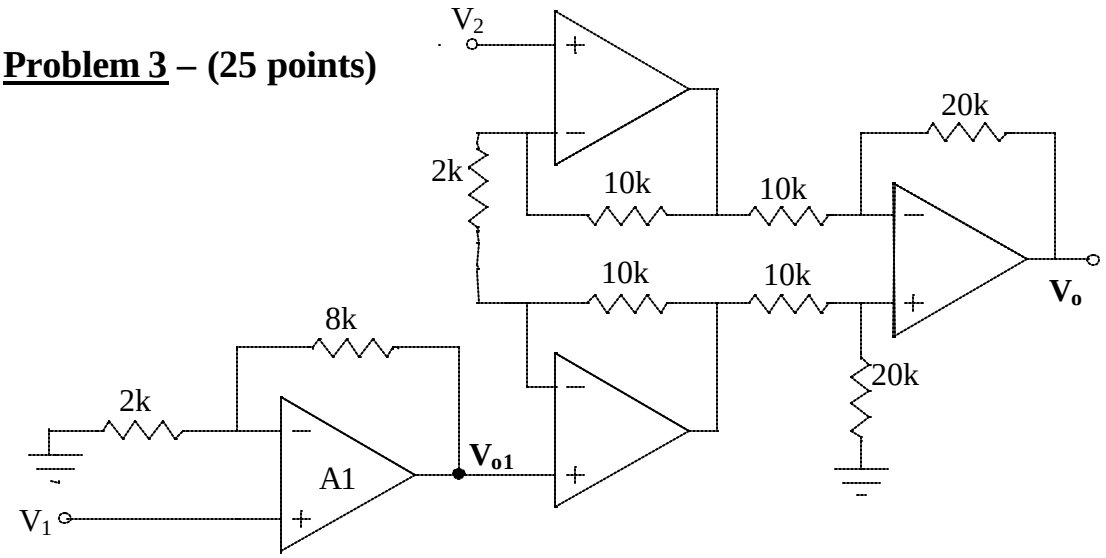
g) List the three frequencies other than 0 where the bode plots will have a change in slope (or value):

$$H(s) = \frac{(100)(s+100)(s+10)}{(s^2)(s+10{,}000)}$$

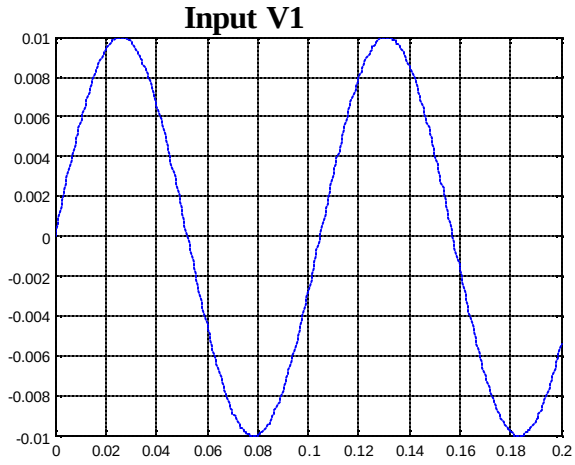


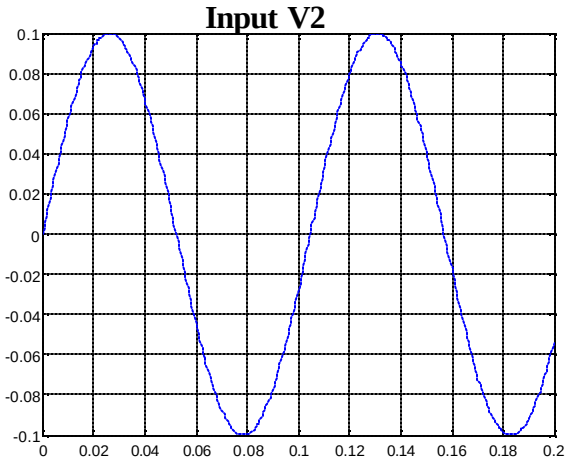


Problem 3 – (25 points)



(a) For the circuit above, assume all operational amplifiers are ideal





(i) What is the voltage value at $\mathbf{V_{o1}}$(express as Vpp)?

(ii) What is the voltage value at **Vo** (express as Vpp)?

Electrical Characteristics (Note 3)

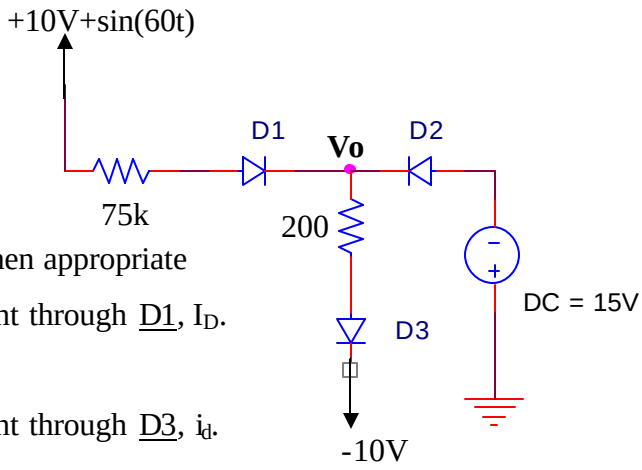
Parameter	Conditions	LM107/LM207			LM307			Units
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	$T_A = 25°C$, $R_S \leq 50\ k\Omega$		0.7	2.0		2.0	7.5	mV
Input Offset Current	$T_A = 25°C$		1.5	10		3.0	50	nA
Input Bias Current	$T_A = 25°C$		30	75		70	250	nA
Input Resistance	$T_A = 25°C$	1.5	4.0		0.5	2.0		MΩ
Supply Current	$T_A = 25°C$ $V_S = \pm 20V$ $V_S = \pm 15V$		1.8	3.0		 1.8	 3.0	 mA mA
Large Signal Voltage Gain	$T_A = 25°C$, $V_S = \pm 15V$ $V_{OUT} = \pm 10V$, $R_L \geq 2\ k\Omega$	50	160		25	160		V/mV

(b) Assume all operational amplifiers are ideal EXCEPT amplifier **A1** which is LM307. Use the attached datasheet to determine the following:

(i) Assume that you have no Slew Rate distortion on your output signal. Neglecting the input bias current, calculate the voltage that will be the maximum value observed at $\mathbf{V_o}$ (NOT V_{o1}) when $V_1=V_2=0V$ at room temperature.

(ii) Explain in detail, by giving exact values and drawing any schematics, the technique used to reduce the input bias current for amp A1.

Problem 4 – (20 points)



Given Assume V_{DO}=**0.6V**, n=1, and V_T=25mV
Assume identical diodes
Use the constant voltage drop method when appropriate

a) Determine the **DC** component of the diode current through D1, I_D.

b) Determine the **DC** component at the output, V_o.

c) Determine the **AC** component of the diode current through D3, i_d.

d) Determine the **AC** component at the output, V_o.

e) What is the **total** output for V_o.

ECE 2100 Midterm #1

Name_____

Scores:

Prob 1 _____of a possible 30pts

Prob 2 _____of a possible 25pts

Prob 3 _____of a possible 25pts

Prob 4 _____of a possible 20pts

Total _____of a possible 100 pts