University of Toronto
Faculty of Applied Science and Engineering

ECE 360F - Introductory Electronics

Final Examination

December 2001

Examiner: Professor S. Zukotynski

Name: _____

Student no: _____

Q	Max	Mark
1	25	
2	25	
3	25	
4	25	
Bonus	5	
Total	105	

Aid sheet allowed

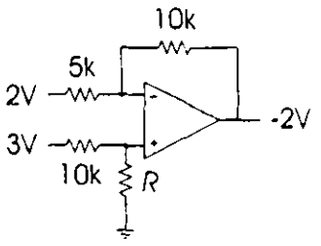
Non-programmable calculator allowed

ALL WORK TO BE MARKED IS TO BE DONE ON THESE SHEETS

There are two spare pages at the back

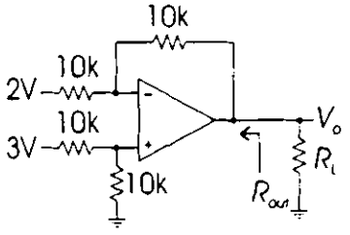
QUESTION 1 - OP-AMPS

Part A: The op-amp is ideal. Find R and the current in the feedback resistor. Show the current polarity on the figure.



R=
I=

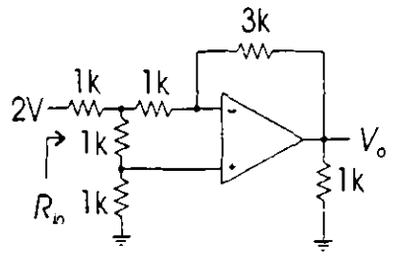
Part B: The op-amp is ideal, except the open loop gain is 80dB and the output resistance is 75Ω. Find the output resistance of the amplifier circuit.



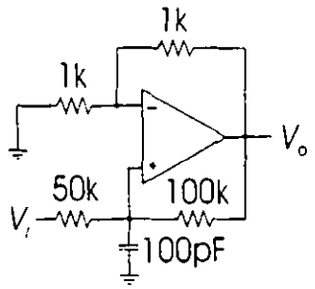
R_{out}=

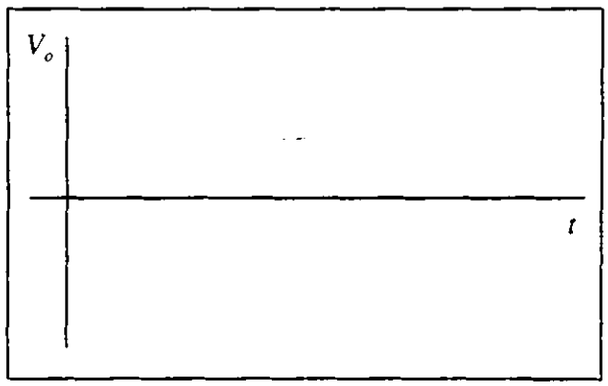
Part C: The op-amp is ideal . Find R_{in} and V_o

R_{in}=
V_o=



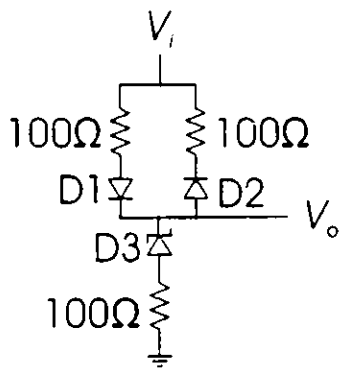
Bonus: The op-amp is ideal. V_i is a square wave 2V peak-to-peak with a period of 2ms. Sketch one period of V_o. Clearly indicate the critical points, give their coordinates and give analytical expressions for the curves. Assume that negative feedback dominates positive feedback.

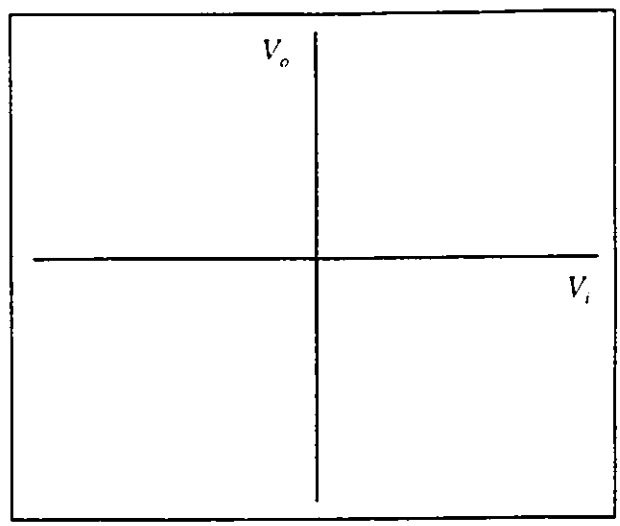




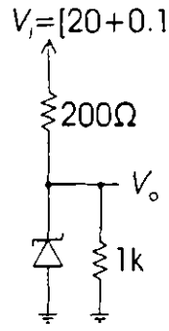
QUESTION 2 - DIODES

Part A: All three diodes are ideal and V_Z=5V for D3. Sketch V_o for -10V ≤ V_i ≤ 10V. Indicate characteristic points and give their coordinates. Give the slope of the linear segments.





Part B: The zener diodes has V_{ZT}=10V at I_{ZT}=100mA and r_z=4Ω. Find V_o and the load and line regulation in the circuit.

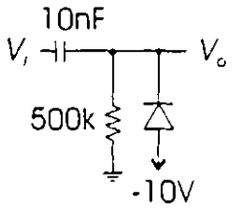


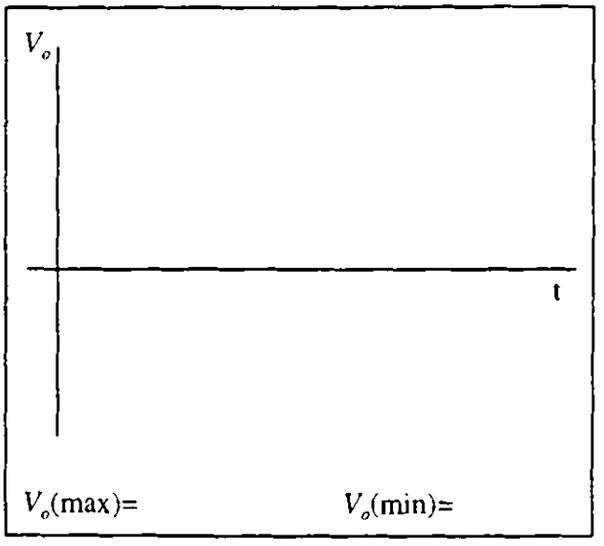
V_o=

Load regulation=

Line regulation=

Part C: The diode is ideal. The square input voltage is 20V peak-to-peak with a period of 20ms. Sketch one period of V_o. Label the graph and give expressions for the curves (on the graph) and all of the critical values of V_o.

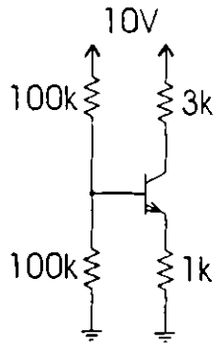




QUESTION 3 - BJTs

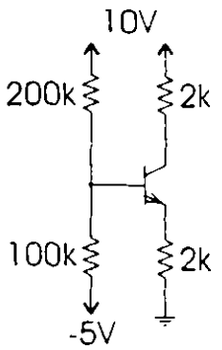
Part A: For the three BJTs below, β=99. Find the emitter current and the voltages at the collector, base and emitter. Verify the mode of operation. Assume $V_{CE}(sat)$=0.2V.

i)



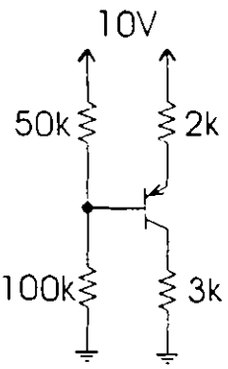
Mode of operation=saturation
I_E=
V_C=
V_B=
V_E=
Confirm mode of operation

ii)



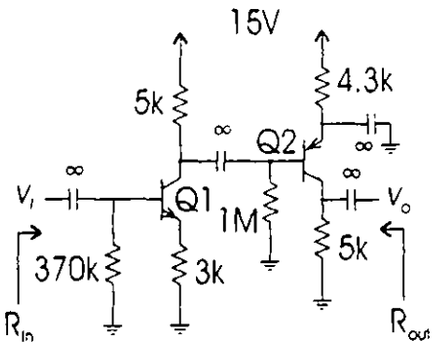
Mode of operation=cut off
I_E=
V_C=
V_B=
V_E=
Confirm mode of operation

iii)



Mode of operation=active
I_E=
V_C=
V_B=
V_E=
Confirm mode of operation

Part B: Both BJTs have β=99 and V_A=∞. The dc emitter current of both transistors is 1mA. Replace Q1 with the T model and Q2 with the hybrid-π model and sketch the equivalent amplifier circuit. Find the small signal R_{in}, R_{out} and open circuit voltage gain A_{V0}. Assume V_T=25mV.

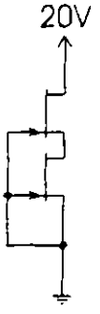


Equivalent small signal circuit

R_{in}=
R_{out}=
A_V=

QUESTION 4 - FETs

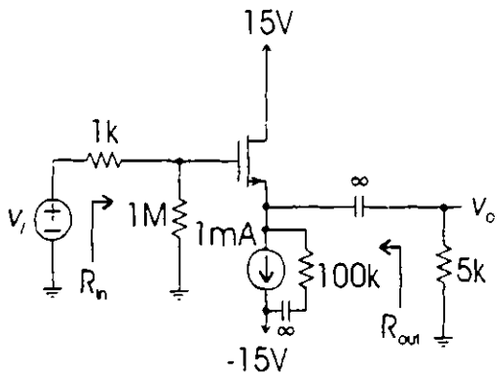
Part A: The two JFET are identical with I_{DSS}=5mA and V_P=−2V. Assume λ=0. Find I_D.



I_D=

Part B: For the FET you have k=1mA/V^2, V_t=2V and λ=1/100V. Assume V_i is small.

i) Show that the FET is in saturation.



The FET is in saturation because:

ii) Calculate g_m, replace the transistor with its small signal model, sketch the amplifier circuit and give the value of all components.

g_m=

b) Find R_{in}, R_{out} and the small signal voltage gain V_o/V_i.

R_{in}=
R_{out}=
V_o/V_i =