Lab 3 Voltage Divider Bias

Name ______________________________ **Section** ______

Purpose:

To calculate the Q point for a voltage divider bias circuit.
To plot the load line and the Q Point of this amplifier circuit
To examine the input and output signals of this amplifier and to calculate the voltage gain.
To examine the distortion created when this amplifier is not midpoint biased..

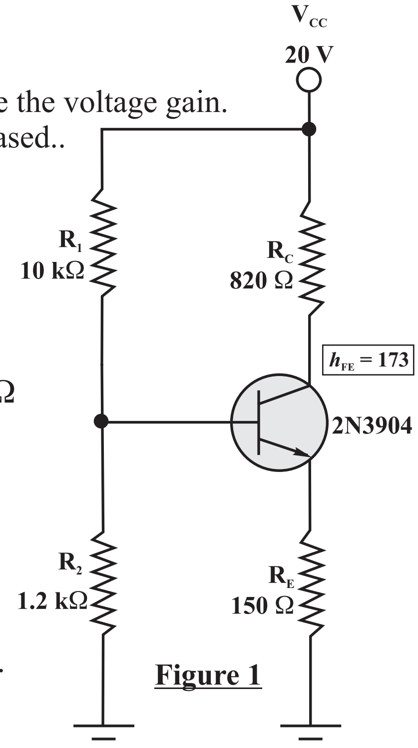

Figure 1

Equipment

1 Power Supply
1 DMM
1 dc Ammeter
7 Resistors 1 -22 kΩ, 1 -10 kΩ, 1 -1.2 kΩ, 1 -150 Ω, 2 -820 Ω, 1 -2 kΩ
3 Capacitors 1 - 100 μF, 2 - 10μF
3 2N3904 npn transistors
DMM with transistor h_{FE} measuring option

Pre-Lab:

1) Find $I_{C(sat)}$ and $V_{CE(off)}$ Plot the load line on the graph provided. ***(Fig.2)***
2) Do the circuit dc analysis and find the terminal voltages and currents.
   Show your calculations at the bottom of this page.
3) Insert these calculated values in Table 1.
4) Plot your calculated Q-point on the graph &.label it ***"Calculated Q- Point"***

Procedure: Part 1 *Do this in the Lab*

1) Construct the circuit as shown using the parts from the first year parts kit.
2) Measure and record the dc current gain for each of the 3 transistors and record it in Table 1.
   Use the DMM with the transistor h_{FE} measuring option
3) Measure and record the transistor terminal voltages and currents as indicated in Table 1.
4) Repeat steps 2 and 3 for the other transistors.
5) ***Plot the 3 Q-points for the transistors on the Figure 2 graph. Label them Q_1 Q_2 Q_3***

Table 1

	Calculated Values				
Transistor	V_B	V_E	$I_E \cong I_C$	V_{CE}	V_C
1					
2	Same as Transistor 1				
3					

Measured Values					
h_{FE}	V_B	V_E	$I_E \cong I_C$	V_{CE}	V_C

Use this area for calculations -- ***Show all of them!*** *Be sure to include R_{in} is your calculations*

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Figure 2 Plotting the Load Line and Q points

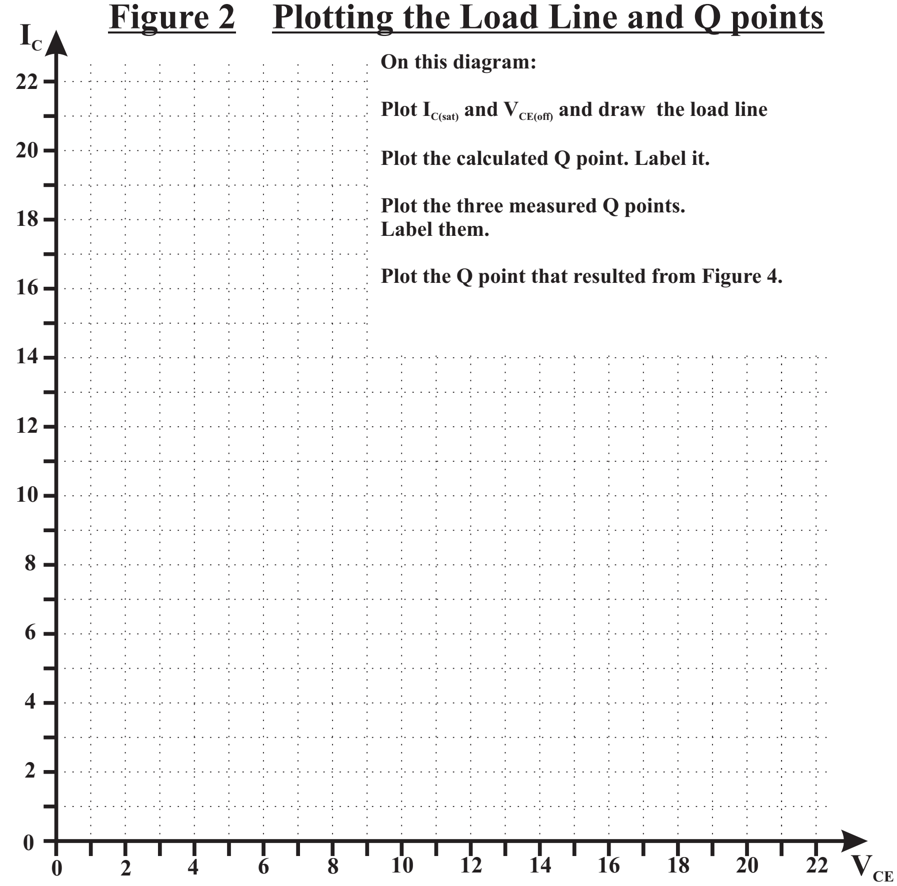
On this diagram:

Plot $I_{C(sat)}$ and $V_{CE(off)}$ and draw the load line

Plot the calculated Q point. Label it.

Plot the three measured Q points. Label them.

Plot the Q point that resulted from Figure 4.



Part 2 Using this circuit as an Amplifier

Procedure Part 2 ***Do this in the Lab***

1) Add the 3 capacitors and load resistor as shown in Figure 3. Be absolutely sure to install the capacitors properly. You must obey the polarity as shown. ***Installing these capacitors in reverse polarity can cause them to explode!!***

2) Install the function generator as shown and set it to sine wave. Connect the oscilloscope to the amplifier input at ***TP-1*** Set the generator to output ***40 mVp-p at 10 kHz .***

3) Measure and record the amplified output signal at ***TP-2***. Record the output below.

V_{out} = ________________

4) Using the formula $A_V = \frac{V_{out}}{V_{in}}$ find the ordinary gain of this amplifier

A_V = ________________

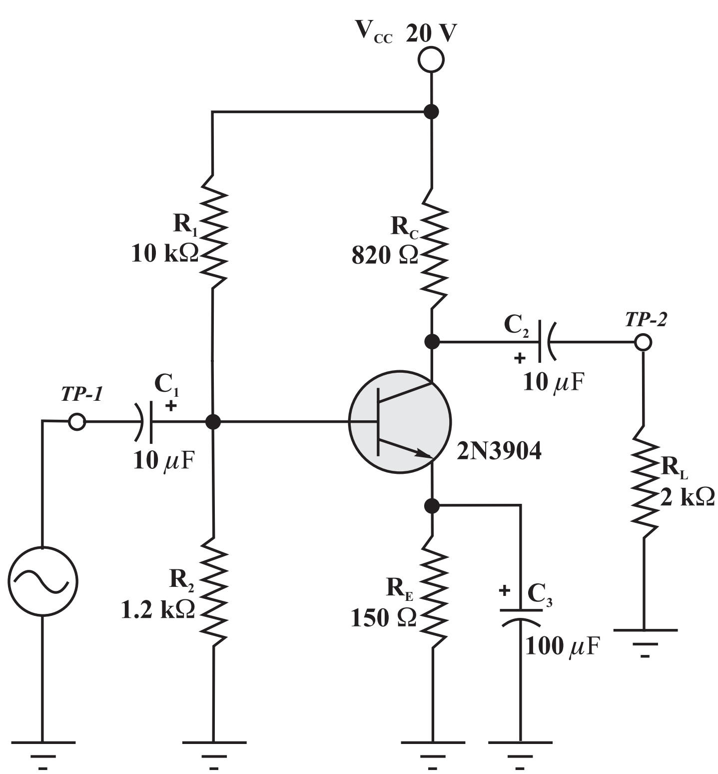


Figure 3 A Voltage amplifier

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Part 3 Examining the distorted output after purposely moving the Q-Point

Procedure Part 3 ***Do this in the Lab***

1) Remove the emitter bypass capacitor C_3.

2) Change the biasing resistors (R_1 & R_2) to the new values shown.

These new biasing resistors will bias the transistor near soft cutoff. This will move the Q-point to near the bottom end of the load line.

3) Install the function generator as shown and set it to sine wave. Connect the oscilloscope to the amplifier input at ***TP-1*** Set the generator to output 2 ***Vp-p at 10 kHz .***

3) Connect channel 2 of the oscilloscope to the output at the amplified output signal at ***TP-2***. The output should look like a half wave rectified sine wave.

4) Measure the peak to peak value of V_{out}.

V_{out} = ________________

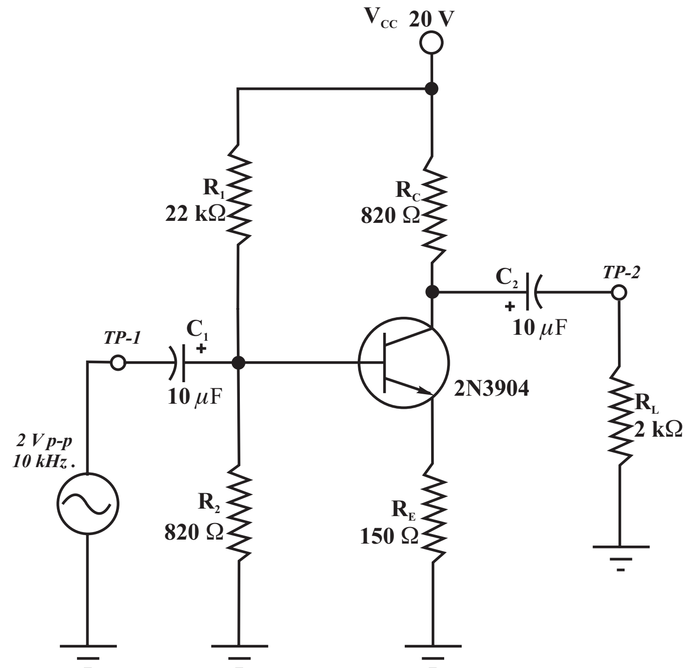


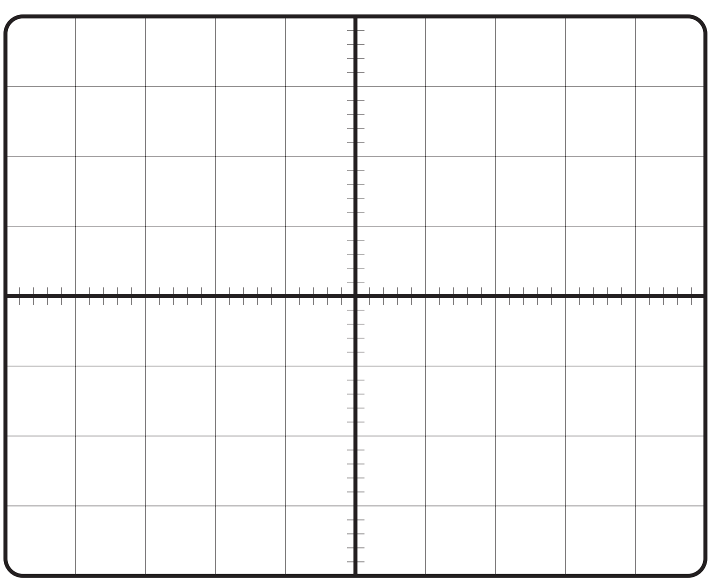
Figure 4 Examining the distortion caused by an amplifier that is not midpoint biased.

5) With V_{in} on channel 1 and V_{out} on channel 2,set up the scope to show both waveforms simultaneously. Sketch these waveforms on the graticule shown below. ***Be sure to set the vertical mode on the scope to chop.***

6) Measure and record V_{CE}. Using it, plot the Q-point for the modified amplifier on graph (Figure 2). Label the Q-point ***"Modified Q-Point"***

V_{CE} ____________

Input and output waveforms for Part 3



Channel 1 Volts/Div: ________

Channel 2 Volts/Div: ________

Time/Div: ______

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Questions

1) Perform the dc analysis for Figure 4.
Find the values listed.. ***Show all your work.***

Calculated Values for Figure 4				
V_B	V_E	$I_E \cong I_C$	V_{CE}	V_C

2) Using only a voltmeter, how can you quickly tell if this type of amplifier is midpoint biased,

3) Figure 1 is a midpoint biased amplifier. If R_2 were to go open circuit, would the amplifier still work? Why?

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