



LEVEL 4 ASSESSMENT SPECIFICATION

Student name:	Paul Miller	Student ID number:	
Programme:	HNC Electrical/Electronic Engineering		
Module:	Electronics 1		
Module code:	PSDE4004	Contribution to Overall Module Assessment (%):	25%
Lecturer:	Jason Pointer	Internal Verifier:	Steve Roberts
Assignment Title:	Diodes and Transistors	Word count (or equivalent):	1500
Submission deadline:	13/12/18	Return date of provisional marks & written feedback:	
Submission method:	All written assessments, where practical and possible, must be submitted via Turnitin unless otherwise instructed by the Lecturer. (Please DO NOT put this assessment specification into Turnitin or it will match many similarities with other students' submissions.) Alternative submission method (if applicable): Late submission of the assessment will result in a late penalty mark. Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, 0%. Only the Extenuating Circumstances Panel may approve a change to submission dates.		
Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

Module Learning Outcomes (from module syllabus)

1. Demonstrate an understanding of semi-conductor components and characteristics and their application in **analogue** and digital electronic circuits.
2. To design, simulate, build, test and evaluate **analogue** and digital electronic circuits using information gained from datasheets.

STUDENT FEEDBACK FORM

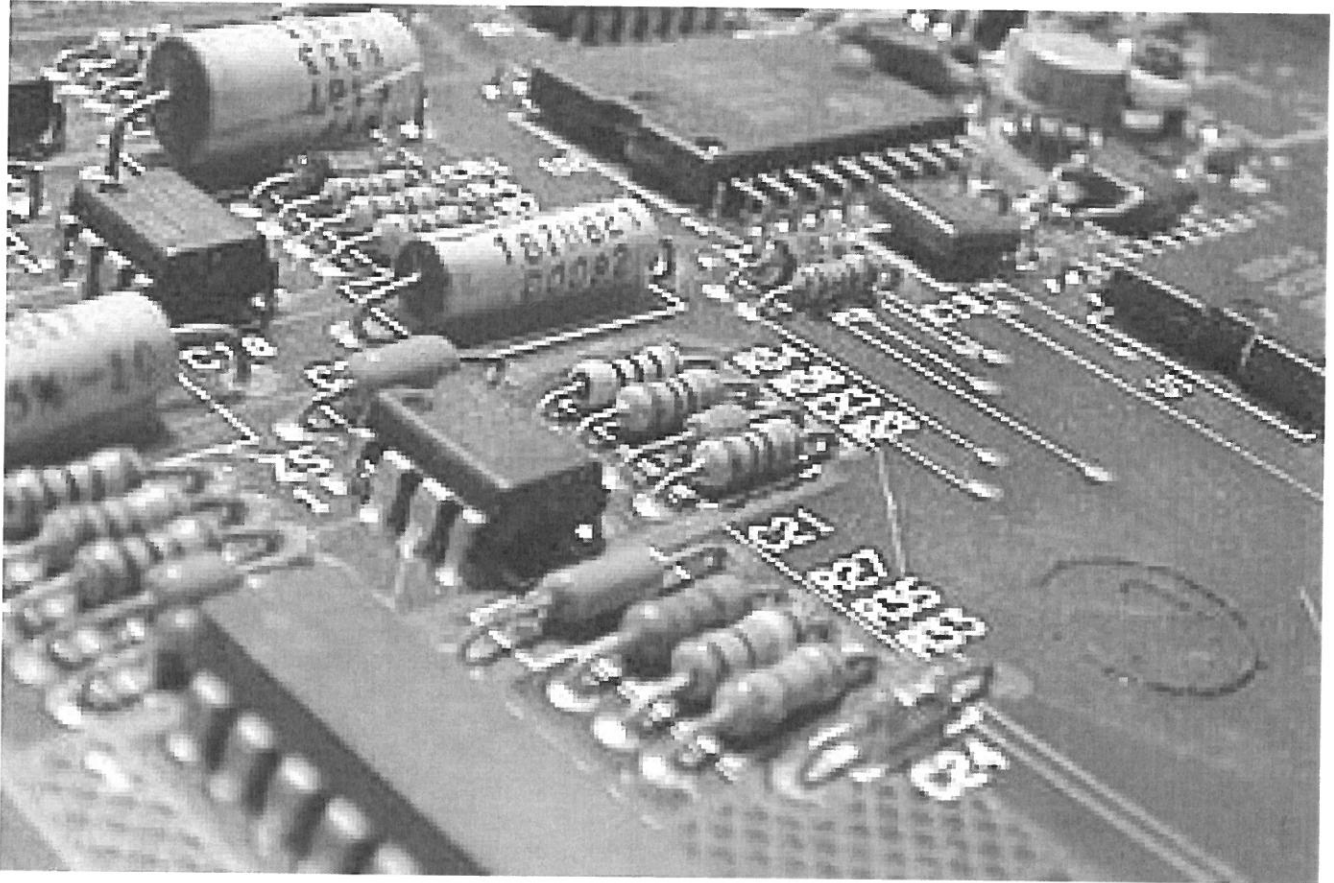
This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills	10	4.5
Engagement with a limited range of mostly relevant and credible sources but with some reliance on information gained through class contact. Have made no direct reference except for the datasheet. This is something to work on in your next assignment.		
2. Knowledge and Understanding Skills	20	11.5
Achieved for 50% for Part A. Achieved for 65% for Part B. Knowledge of the basic underlying concepts and principles is accurate with a good understanding in most areas.		
3. Cognitive and Intellectual Skills	20	9
Achieved for 50% for Part A. Achieved for 40% for Part B. Limited attempt at evaluation of the underlying concepts and principles, tending towards description. Need to make more links to relative ideas and concepts.		
4. Practical Application Skills	40	28
Achieved for 66% for Part A. Achieved for 74% for Part B. An excellent application of practical work, very good use of the test equipment to obtain all of the required results.		
5. Transferable Skills for Life and Professional Practice	10	5
Mostly coherent, organised and accurate work, in a suitable structure and is for the most part clearly expressed.		

Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)	Late Submission Penalties (tick if appropriate)		58%
	Up to 1 week late (40% Max)		
	Over 1 week late (0%)		

Electronics 1 (PSDE-4004)

Assignment 1



Student: Paul Miller (141589)

Tutor: Jason Pointer

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Introduction:

In this assignment the student must explain and understand what a semi-conductor material is and layout of how it is, the student must also understand what the uses are for semi-conductors. In Task 1 the student will investigate the characteristics of germanium and silicon diodes, they will have to produce graphs showing the characteristics of each diode and compare the results. In Task 2 the student is to construct a transistor amplifier configured in CE mode, to measure its performance, and to compare measured results against theoretical performance.



Information on Semi-Conductors:

A semi-conductor is a device which has the ability to allow current to flow through one way and not the other, semi-conductive materials are made up of a mixture of materials, for example most semi conductive materials have impurities added in which inhibits the flow of current in one direction. Materials which are good conductors of electricity have a low amount of atoms in the outer shells of their atoms, whereas semi-conductors have a slightly higher amount which is why they have the ability to resist conducting electricity. Types of semi-conductive materials consist of germanium, silicon and carbon as these materials have a slightly higher amount of electrons in their outer shells to inhibit the conductivity. An example of a semi-conductive device would be a diode, there are two main types of diodes, and these being silicon and germanium, and the characteristics are different for both of these diodes. A diode is a very useful device within electronics, they are used in a lot of electronic circuits for a number of uses such as protection for another part of the circuit to being used as a switching element.

Another example of a semi-conductive device is a transistor, there are two types of transistors, these being NPN and PNP, NPN type transistors have a leg arrangement of NPN standing for Negative, Positive, Negative, PNP type transistors have a leg arrangement of PNP, Positive, Negative, Positive. A transistor has 3 legs, one leg will be called the emitter, another leg will be called the base, and the final leg will be called the collector, these legs vary in where they are on each transistor, always checked the data sheet for the type of transistor used as the data sheet will always contain information on the leg arrange of the transistor. Transistors are commonly used as switches in electronic circuits as they are capable of switching many times within in a short space of time

Task 1:

A) Check two diodes using a DVM:

The two diodes were checked using a DVM, this was done by putting the volt meter into its diode setting, this allows the meter to show which direction the diode is passing current, this allows the diodes to be checked as if there passing current both ways this means the diode is faulty. This was done with both diodes, the silicon diode, and finally the Germainium diode.

B) Measure the resistor:

The $1\text{K}\Omega$ resistor was also checked using a DVM, the volt meter was put into the Ohm setting which allows the Ohms to be checked on the resistor, the resistor checked was within tolerance of $1\text{K}\Omega$ as it was $1.098\text{K}\Omega$ which is very close to the value needed.



Task 1:

C:

The following graphs are the graphs for both the silicon and germanium diodes, in both the forward and reverse direction.

Silicon diode tables:

Silicon Diode (Forward)

VOLTAGE	CURRENT (mA)
0	0
0.1	0.00004
0.2	0.00021
0.3	0.00144
0.4	0.01075
0.5	0.086
0.6	0.691
0.7	5.1
0.8	33.1

Figure 1, the table for the silicon diode in the **forward** bias

Silicon Diode (Reverse)

Voltage (V1)	Voltage (mV2)	Diode Voltage	Current (nA)
0	0	0	0
-1.5	-58.4	-1.4416	-5.84
-3	-65.1	-2.9349	-6.51
-4.5	-71.8	-4.4282	-7.18
-6	-78.1	-5.9219	-7.81
-7.5	-79.3	-7.4207	-7.93
-9	-84.2	-8.9158	-8.42
-10.5	-85.2	-10.4148	-8.52
-12	-85.2	-11.9148	-8.52
-13.5	-87.1	-13.4129	-8.71
-15	-88.5	-14.9115	-8.85

Figure 2, the table for the silicon diode in the **reverse** bias

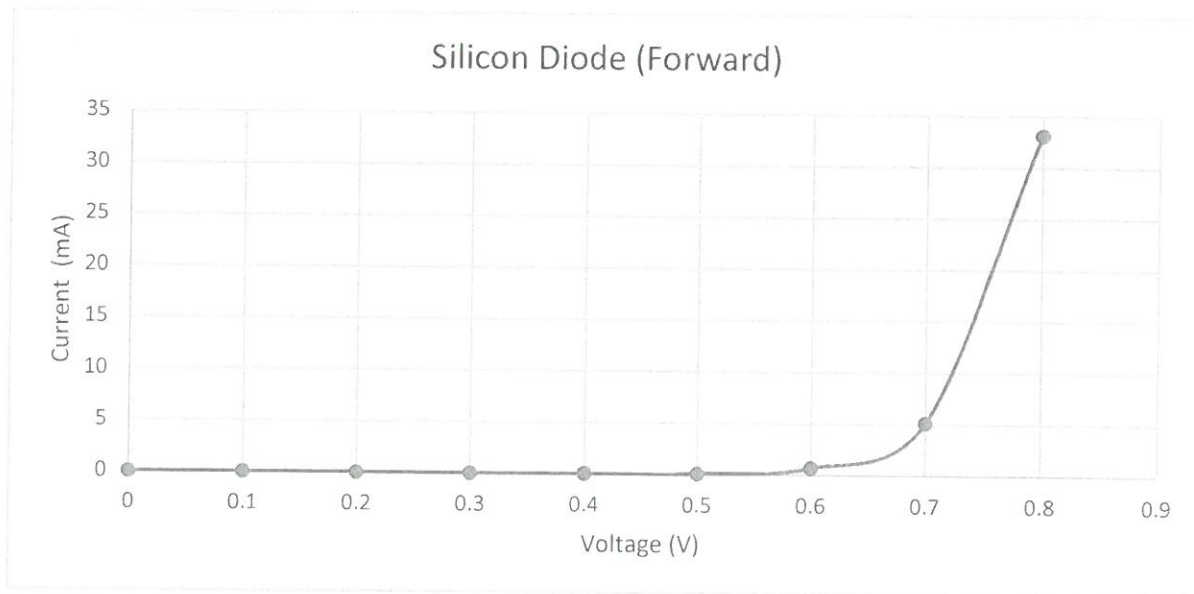


Figure 3 illustrates the graph for the silicon diode in its **forward** bias.

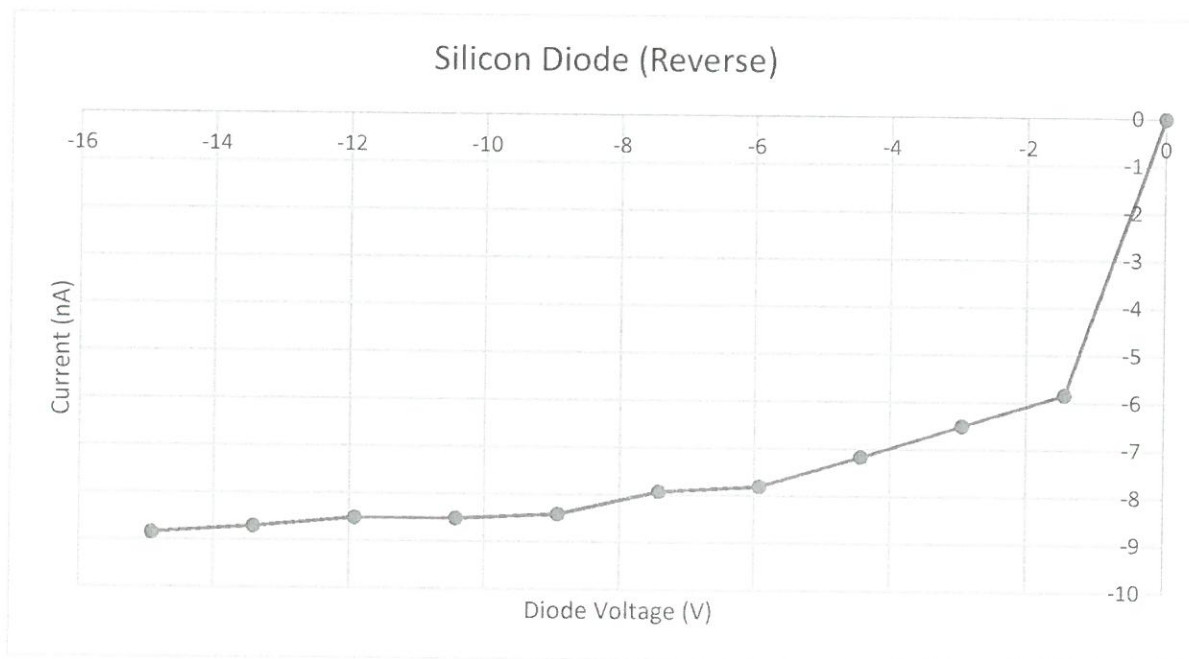


Figure 4 illustrates the graph for the silicon diode in its **reverse** bias.

Germanium Diode Table:

Germanium Diode (Forward)

VOLTAGE	CURRENT (mA)
0	0
0.1	0.014
0.2	0.166
0.3	0.596
0.4	1.236
0.5	2.01
0.6	2.91
0.7	3.89
0.8	4.94
0.9	6.07
1	7.24

Figure 5, the table for the Germanium diode in the **forward** bias

Germanium Diode (Reverse)

Voltage (V1)	Voltage (V2)	Diode Voltage	Current(μ A)
0	0	0	0
-1.5	-0.018	-1.482	-1.8
-3	-0.026	-2.974	-2.6
-4.5	-0.04	-4.46	-4
-6	-0.071	-5.929	-7.1
-7.5	-0.118	-7.382	-11.8
-9	-0.179	-8.821	-17.9
-10.5	-0.251	-10.249	-25.1
-12	-0.332	-11.668	-33.2
-13.5	-0.419	-13.081	-41.9

Figure 6, the table for the Germanium diode in the **reverse** bias

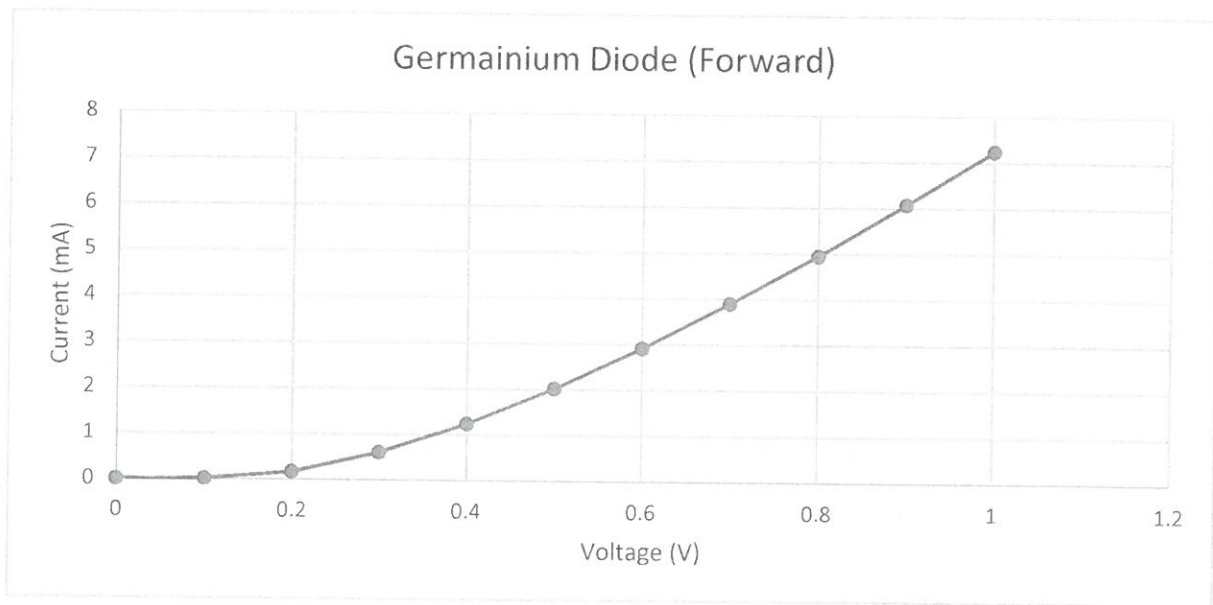


Figure 7, illustrates the graph for the Germanium diode in the **forward** bias

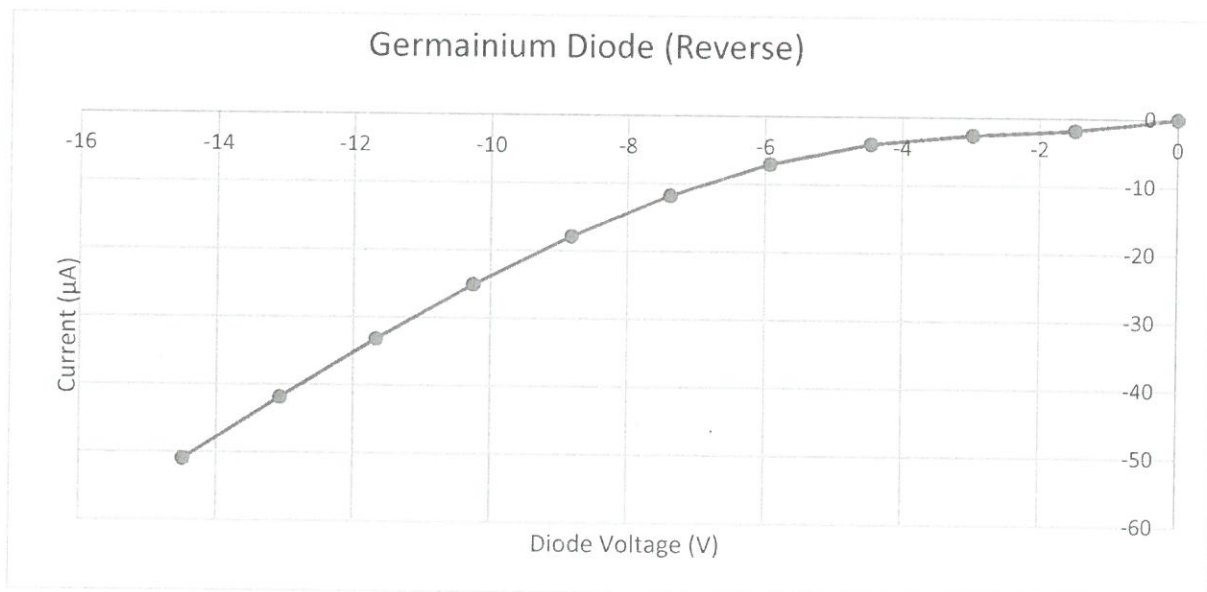


Figure 8, illustrates the graph for the Germanium diode in the **reverse** bias

Static and Dynamic Resistance:

Static resistance and dynamic for silicon diode in the forward direction

Static resistance = V/I

Silicon Diode (forward):

$$R_s = V/I = 0.7/5.1 = 137\Omega$$

Germanium Diode (Forward):

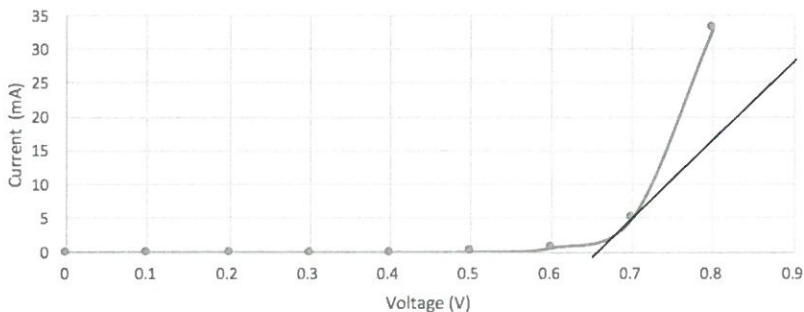
$$R_s = V/I = 0.7/3.89 = 179\Omega$$

Dynamic resistance = $R_D = \Delta V/\Delta I$

Silicon Diode (Forward):

$$R_D = \Delta 0.25 / \Delta 28 \times 10^{-3} = 8.92\Omega$$

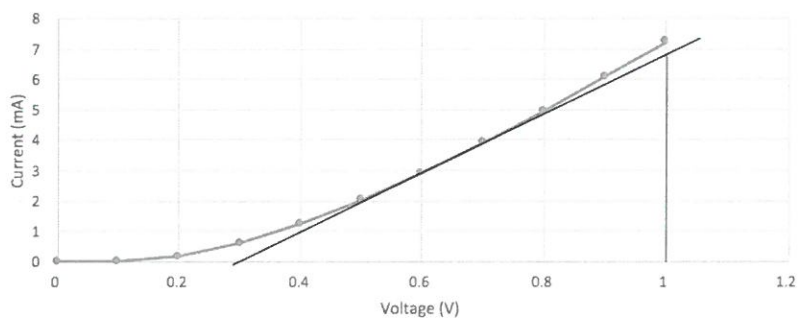
Silicon Diode (Forward)



Germanium Diode (Forward):

$$R_D = \Delta 0.7 / \Delta 6.8 \times 10^{-3} = 102.9\Omega$$

Germanium Diode (Forward)



Static Resistance = V/I

Silicon Diode (Reverse):

$$R_s = V/I = -9/-8.42 = 1.07\Omega \quad \times$$

*You not included
the prefix values
for the currents.*

Germanium Diode (Reverse):

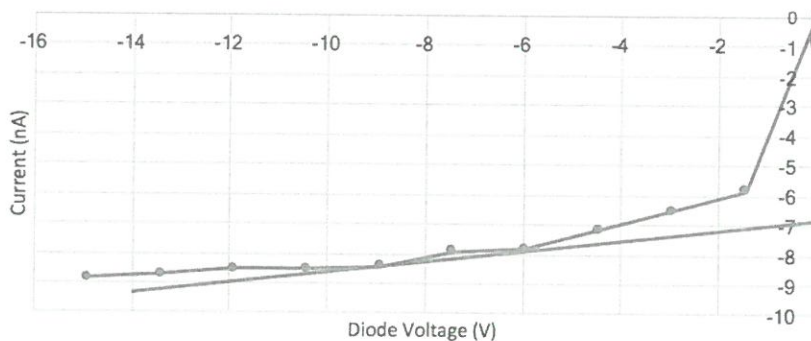
$$R_s = V/I = -9/-17.9 = 502\text{m}\Omega \quad \times$$

Dynamic resistance = $R_D = \Delta V/\Delta I$

Silicon Diode (Reverse):

$$R_D = \Delta V/\Delta I = 14/2.2 \times 10^{-9} = 6.36\text{G}\Omega$$

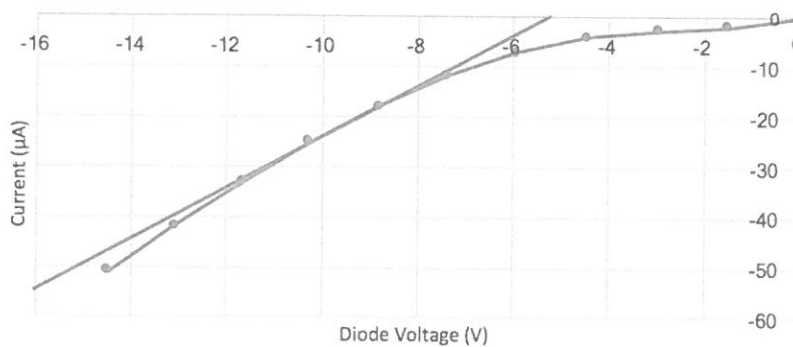
Silicon Diode (Reverse)



Germanium Diode (Reverse):

$$R_D = \Delta V/\Delta I = 11/55 \times 10^{-6} = 200\text{K}\Omega$$

Germanium Diode (Reverse)



Comparing Results:

The difference in the forward bias for both diodes represents the point at where they start conducting, as the graphs show, the silicon diode starts conduction a lot later compared to the Germanium, the silicon starts conduction around 0.6/0.7, whereas the Germanium starts around 0.2, this allows for both diodes to have slightly different uses, for a more accurate uses with slightly smaller amperages a Germanium Diode can be used, for uses which don't have to be as accurate, a silicon diode can be used.

The difference in the forward bias for both diodes show at which they both reach the breakdown limit and allow current to pass through. As the graphs show, the silicon diode has a higher resistance than that of the Germanium diode, this also means it has less leakage, it is capable of hold back more current before reaching its breakdown limit and allowing current to pass through, the Germanium diode has a resistance of $200\text{K}\Omega$ which is a lot lower compared to the $6.36\text{G}\Omega$ of the silicon diode. This means has a lower breakdown limit compared to the silicon diode, it also has more of a leakage current compared to the silicon.

Task 2:

Task 2 - Transistor Amplifier Design and Performance Measurement

To construct a transistor amplifier configured in CE mode, to measure its performance, and to compare measured results against theoretical performance.

Experimental Procedure

- Design a common emitter amplifier using a suitable transistor that has a h_{fe} value between 100 to 500 (value to be checked using datasheets and multimeter). The circuit will have a 10V supply, the decoupling capacitor will be $100\mu\text{F}$ and coupling capacitors will be $10\mu\text{F}$.
- Build the circuit and produce a record of test results under dc and ac conditions.
- Use Multisim to simulate the test performed in part b. and compare the results.
- Analyse the performance of the circuit, commenting upon any variations in the results and the overall performance of the amplifier.

Write in past tense.

A) Designing a common emitter amplifier:

In order to design a common emitter amplifier there must be known values which are used to find other components so,

- $V_{CC}=10\text{V}$
- Measure $H_{FE} = 280$ (BC 184)
- Let $I_C=1\text{mA}$
- $R_C = V_{CC}/2 \times I_C = 10/2 \times 1 \times 10^{-3} = 5000 = 5\text{k}\Omega = \text{nearest value} = 4.7\text{k}\Omega$
- Assume $I_E=I_C$, $V_E = 10\% \text{ OF } V_{CC} = 1\text{V}$
- So $R_E = V_E/I_E = 1\text{V}/1 \times 10^{-3} = 1\text{k}\Omega$
- $I_B = I_C/H_{FE} = 1 \times 10^{-3}/280 = 3.57\mu\text{A}$
- $V_B = V_E + V_{BE} = 1\text{V} + 0.7\text{V} = 1.7\text{V}$
- Assume I_2 is 10x greater than I_B
 $R_2 = V_B/10 \times I_B = 1.7/10 \times 3.57 \times 10^{-6} = 47.6\text{k}\Omega = \text{nearest resistor} = 47\text{k}\Omega$
- Determine R_1
 $V_1 = V_{CC} - V_B$
 $R_1 = V_1/I_1 = V_{CC} - V_B / I_B = 211.36\text{k}\Omega = \text{Nearest resistor} = 220\text{k}\Omega$

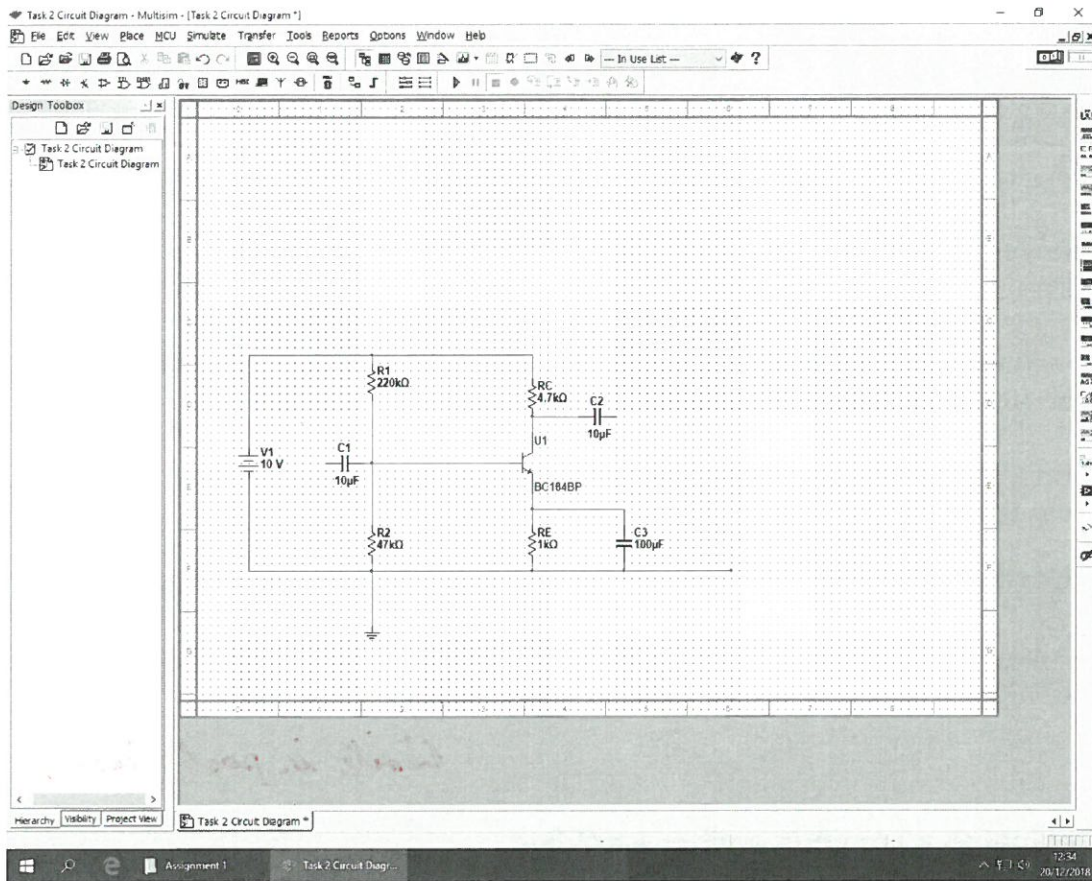


Figure 9 is the circuit which was designed, using the measurements required, parts of the circuit are left unconnected, this is so the circuit is ready for the multimeter to be added so values can be measured while simulating the circuit working.

B) Build the circuit and measure and test DC and AC conditions

The Measurements taken for DC conditions were:

$$V_{RC}=4.33V$$

$$V_C=5.59V$$

$$V_E=0.97V$$

$$V_{BE}=0.62V$$

$$V_B=1.54V$$

$$I_C= 0.94mA$$

These measurements were taken by using a multimeter to measure each component needed and recorded each value.

The measurements taken for AC conditions were:

$$\text{Output Voltage (Vout)} = 5.78V$$

$$\text{Voltage in (Vin)} = 40mV$$

$$\text{Gain} = 5.78/0.04 = 144.5$$

The measurements were taken by adding a function generator into the circuit, then by adding an oscilloscope to be able to see the waveforms produced by the circuit, from these waveforms the values above were taken.

C) The circuit was built in multisim and then measured the values under DC conditions first. The diagram below is the circuit produced to measure DC conditions, the variables measured here were (V_{RC} , V_C , V_E , V_{BE} , V_B), these values were measured using the multimeter tool within the multisim software, these are labelled as XMM1-XMM5:

V_{RC} (XMM1) = 4.617V
 V_C (XMM2) = 5.383V
 V_E (XMM3) = 985.8mV
 V_{BE} (XMM4) = 637.4mV
 V_B (XMM5) = 1.62V

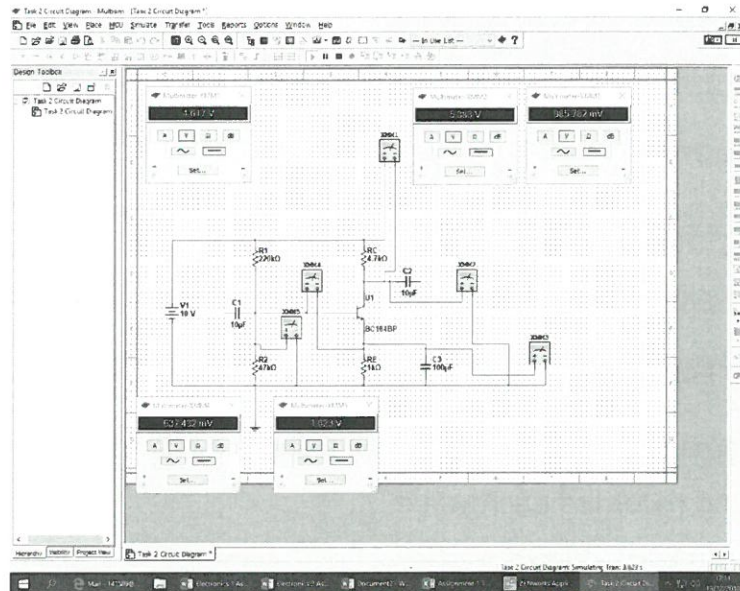


Figure 10, is an illustration of the diagram once all the meters have been added, it shows the simulated readings.

The results from the simulation compare very closely to those from the calculations, the measured values are shown below:

V_{RC} = 4.33V
 V_C = 5.59V
 V_E = 0.97V
 V_{BE} = 0.62V
 V_B = 1.54V

from the actual circuit, which shows that the design was correct and all components were correct, however there are small discrepancies, these can either be put down due to the calibration of the equipment used, it could have been slightly out which would give slightly different readings, human error when rounding numbers up or down, this could also give different values, also the settings within multisim could have been changed slightly by another user of the software which also could change the results slightly.

The next test was to check the current running through the whole circuit, this was done by connecting a multimeter to the supply leg of the circuit, and connecting it the R_c resistor. The current which was measured on the actual circuit was 0.94mA, so the current measured in the simulation running through the circuit is 0.98mA which is very close to that which was measured on the actual circuit.

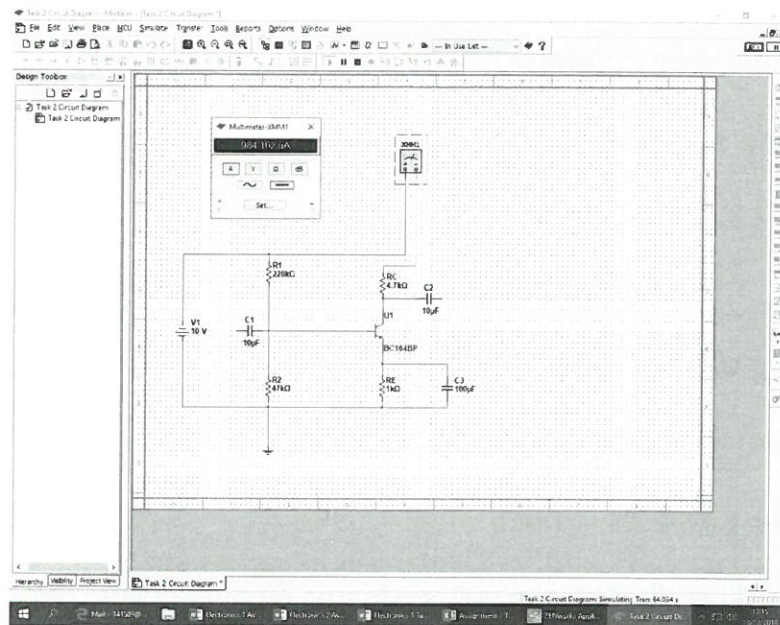


Figure 11 illustrates where the meter was added to measure the current of the whole circuit, it shows the simulated value.

The next test to conduct tests under AC conditions, the simulation circuit was set up using the function generator in multisim, we then used the oscilloscope tool within multisim to measure values, the values which were measured were output voltage (V_{out}), Voltage in (V_{in}) and the gain which is V_{out}/V_{in} . The values measured on the simulation were:

Output Voltage (V_{out}) = 8.120V

Voltage in (V_{in}) = 40mV

Gain = $8.120/0.04 = 203$

The measurements which were taken from the actual circuit were:

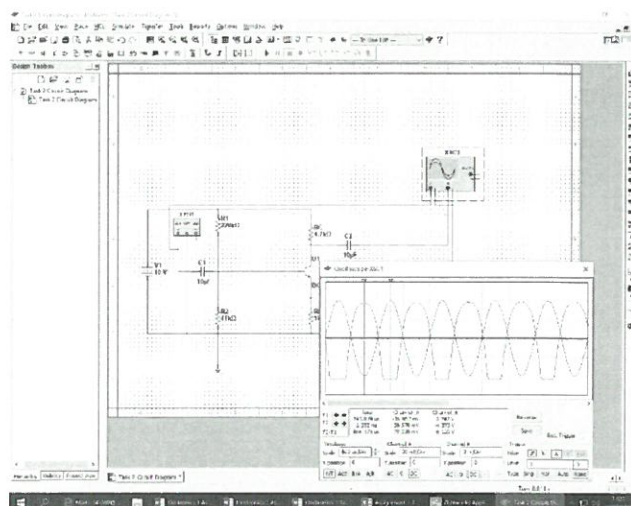
Output Voltage (V_{out}) = 5.78V

Voltage in (V_{in}) = 40mV

Gain = $5.78/0.04 = 144.5$

The difference in voltage in can be put down to the use of different components such as different resistors and other components, also human error has when rounding can be another factor, also the equipment used to measure the actual circuit may be set up differently compared to that of the multisim software.

Figure 12 illustrates the test under AC conditions on the circuit, it shows the function generator which has been added, it also shows the oscilloscope which allows the waveforms to be monitored and obtain measurements.



The final test on AC conditions was to find the frequency response, this was measured by connecting a bode plotter into the circuit on the multisim software, this gave the frequency response graph, this can be used to find the peak performance of the circuit, the lower frequency and higher frequency was measure off multisim and they were:

Lower simulated Freq = 55.8Hz

Higher simulated Freq = 16.7MHz

The measured values were taken off of the graph produced:

Lower measured Freq = 50Hz

Higher measured Freq = 17MHz

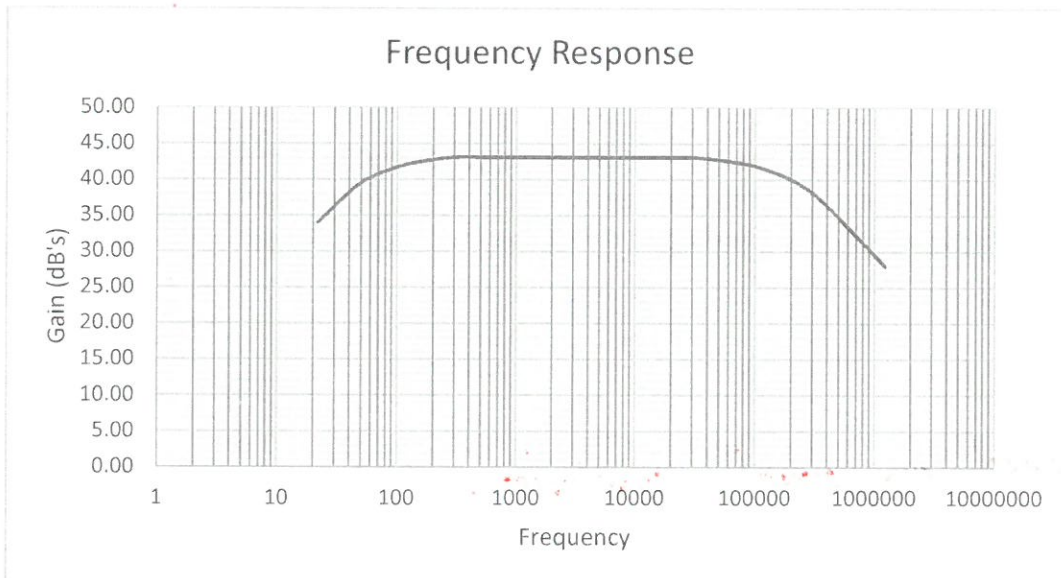


Figure 13, is the graph produced using the measured values, it shows the where it starts to gain and it also shows the bandwidth, finally it shows where it starts to drop off, this allows for the maximum operating range to be found.

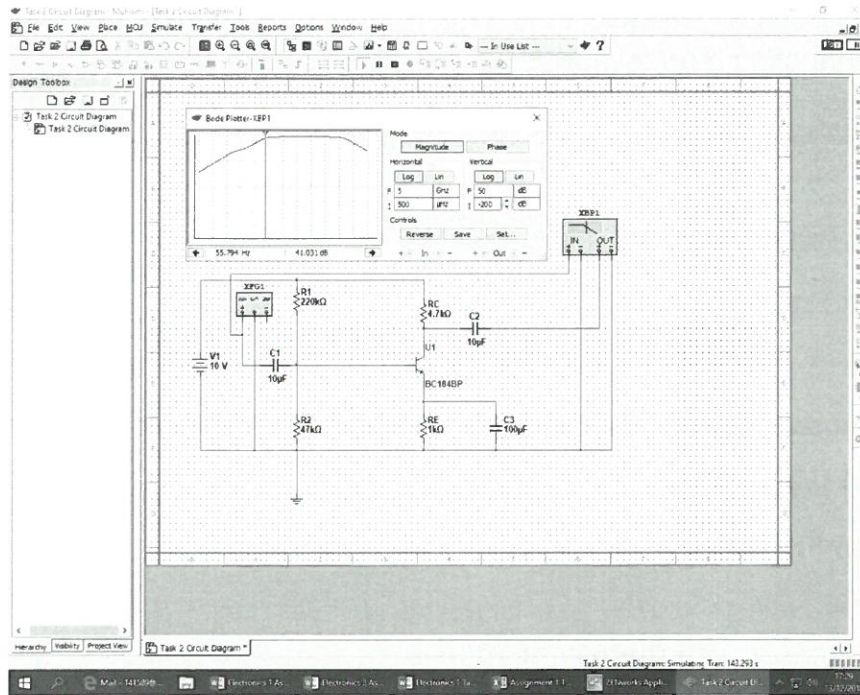


Figure 14, illustrates the circuit being simulated on multisim, it shows the graph being produced on a bode plotter, which is a tool in multisim, this graph is very close the graph which was produced using the measured values.

You need an overall conclusion.

✓

Appendix:

- Relevant information from Data sheet for BC184



September 2007

BC184 Silicon NPN Small Signal Transistor

- $BV_{CEO} = 30V$ (Min.)
- $h_{FE} = 130$ (Min.) @ $V_{CE} = 5.0V$, $I_C = 100mA$



Absolute Maximum Ratings $T_C = 25^\circ C$ unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	30	V
V_{CBO}	Collector-Base Voltage	45	V
V_{EBO}	Emitter-Base Voltage	5	V
I_C	Collector Current (DC)	100	mA
T_J, T_{STG}	Operating and Storage Junction Temperature Range	-55 ~ +150	$^\circ C$

* These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:

- These ratings are based on a maximum junction temperature of 150 degrees C.
- These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics $T_a = 25^\circ C$ unless otherwise noted

Symbol	Parameter	Max.	Units
P_D	Total Device Dissipation Derate above $25^\circ C$	350 2.8	mW mW/ $^\circ C$
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125	$^\circ C/W$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	$^\circ C/W$

* Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06"

Electrical Characteristics $T_C = 25^\circ C$ unless otherwise noted

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Units
BV_{CBO}	Collector-Base Voltage	$I_C = 10\mu A$	45			V
BV_{CEO}	Collector-Emitter Voltage	$I_C = 2mA$	30			V
BV_{EBO}	Emitter-Base Voltage	$I_E = 10\mu A$	5			V
I_{EBO}	Emitter Cut-off Current	$V_{EB} = 4V$			15	nA
I_{CBO}	Collector Cut-off Current	$V_{CB} = 30V$			15	nA
h_{FE}	DC Current Gain	$V_{CE} = 5V, I_C = 10\mu A$ $V_{CE} = 5V, I_C = 100mA$	100 130			
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10mA, I_B = 0.5mA$ $I_C = 100mA, I_B = 5mA$			0.25 0.6	V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 100mA, I_B = 5mA$			1.2	V
$V_{BE(on)}$	Base-Emitter On Voltage	$V_{CE} = 5V, I_C = 2mA$	0.55		0.7	V
C_{ob}	Output Capacitance	$V_{CE} = 10V, f = 1MHz$			5	pF
f_T	Current gain Bandwidth Product	$V_{CE} = 5V, I_C = 10mA, f = 100MHz$	150			MHz

Notes:

- These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.
- These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
- These ratings are based on a maximum junction temperature of 150degrees C.

