

LEVEL 5 ASSESSMENT SPECIFICATION

Student name:	Dan Chick	Student ID number:	
Programme:	HND/HNC Electrical/Electronic Engineering, HNC Instrumentation Engineering & HNC Power System Engineering		
Module:	Electrical Principles, Methods and Simulation		
Module code:	PSDE5009	Contribution to Overall Module Assessment (%):	50%
Lecturer:	Jason Pointer	Internal Verifier:	Steve Roberts
Assignment Title:	Analogue Systems	Word count (or equivalent):	2000
Submission deadline:	07/02/19	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. Analyse and **evaluate electrical circuits, electronic systems** and control systems.
2. Simulate standard **electrical circuits, electronic systems** and control systems.

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	0	0
2. Knowledge and Understanding Skills	20	13.8
Achieved 80% for Task 1. Achieved 65% for Task 2. Achieved 50% for Task 3. Achieved 85% for Task 4. Achieved 65% for Task 5. Knowledge is reasonably extensive and accurate in most parts. Show a very good understanding of most concepts and principles covered by this assignment but not all of the elements were covered for some of the tasks.		
3. Cognitive and Intellectual Skills	20	9.7
Achieved 55% for Task 1. Achieved 50% for Task 3. Achieved 40% for Task 5. For the tasks that asked for comments there was limited attempt at critical evaluation and analysis of concepts and principles, tending towards description.		
4. Practical Application Skills	50	36.5
Achieved 85% for Task 1. Achieved 65% for Task 2. Achieved 75% for Task 3. Achieved 85% for Task 4. Achieved 45% for Task 5. Achieved 83% for Task 6. A very good application of established methods in the use of Matlab, Multisim and practical work but in places not all of the required work was produced.		
5. Transferable Skills for Life and Professional Practice	10	6
Work is accurate, coherent, fluent, well-structured and organised.		

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)

Up to 1 week late (40% Max)
Over 1 week late (0%)

66%

Daniel Chick
Instrumentation Engineering
Electronic Principles, Methods
and Simulation
Assignment 1: Analogue
Systems
PSDE 5009

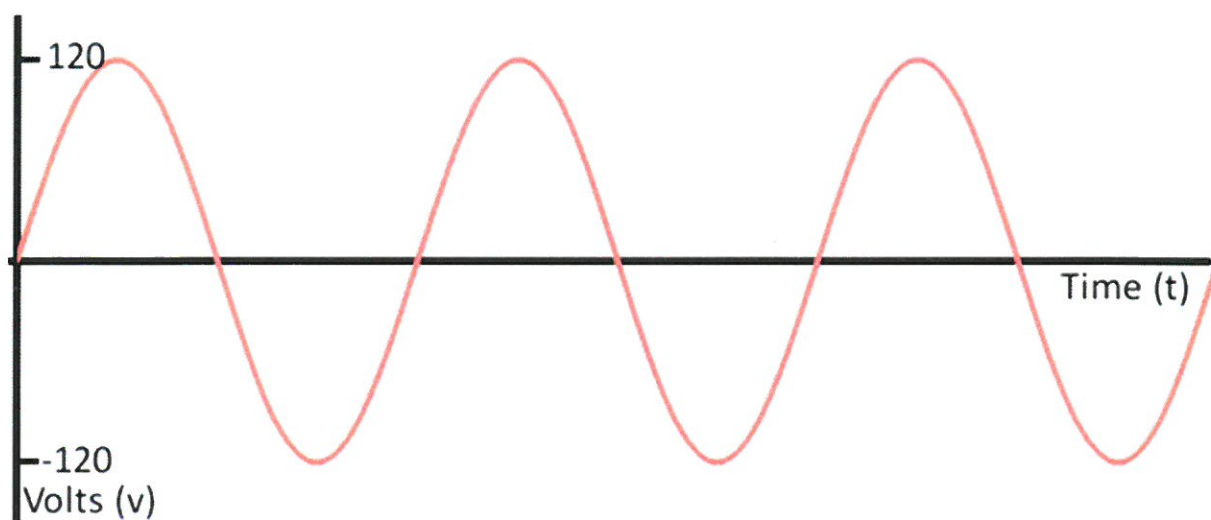


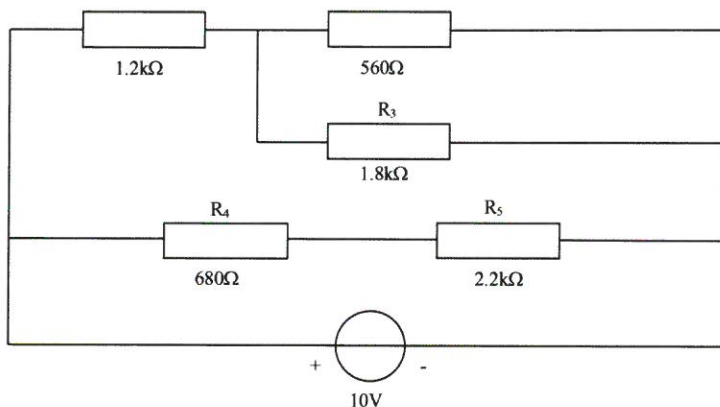
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Task 1 – Combinational Circuit

The circuit below was required to be constructed on breadboard and the voltage measurements of each resistor was to be measured and recorded using a Digital Multimeter. The results from the physical build were then to be compared with calculated measurements which would demonstrate the difference between a real world scenario and an ideal calculation outcome. Both results are shown below:

Breadboard Measurements with Multimeter.

Resistor	Value (Ohms)	Voltage (V)
R1	1200	7.36
R2	560	2.64
R3	1800	2.64
R4	680	2.35
R5	2200	7.64

Calculated Measurements

$$R4 + R5 = 2.88k$$

$$I1 = 10 / 2.88k = 3.47mA$$

$$V4 = I1 * R4 = 2.35V$$

$$V5 = I1 * R5 = 7.634V$$

$$R23 = (1 / (1 / 560) + (1 / 1.8k)) = 427ohm$$

$$R123 = 1.2k + 427 = 1627 ohms$$

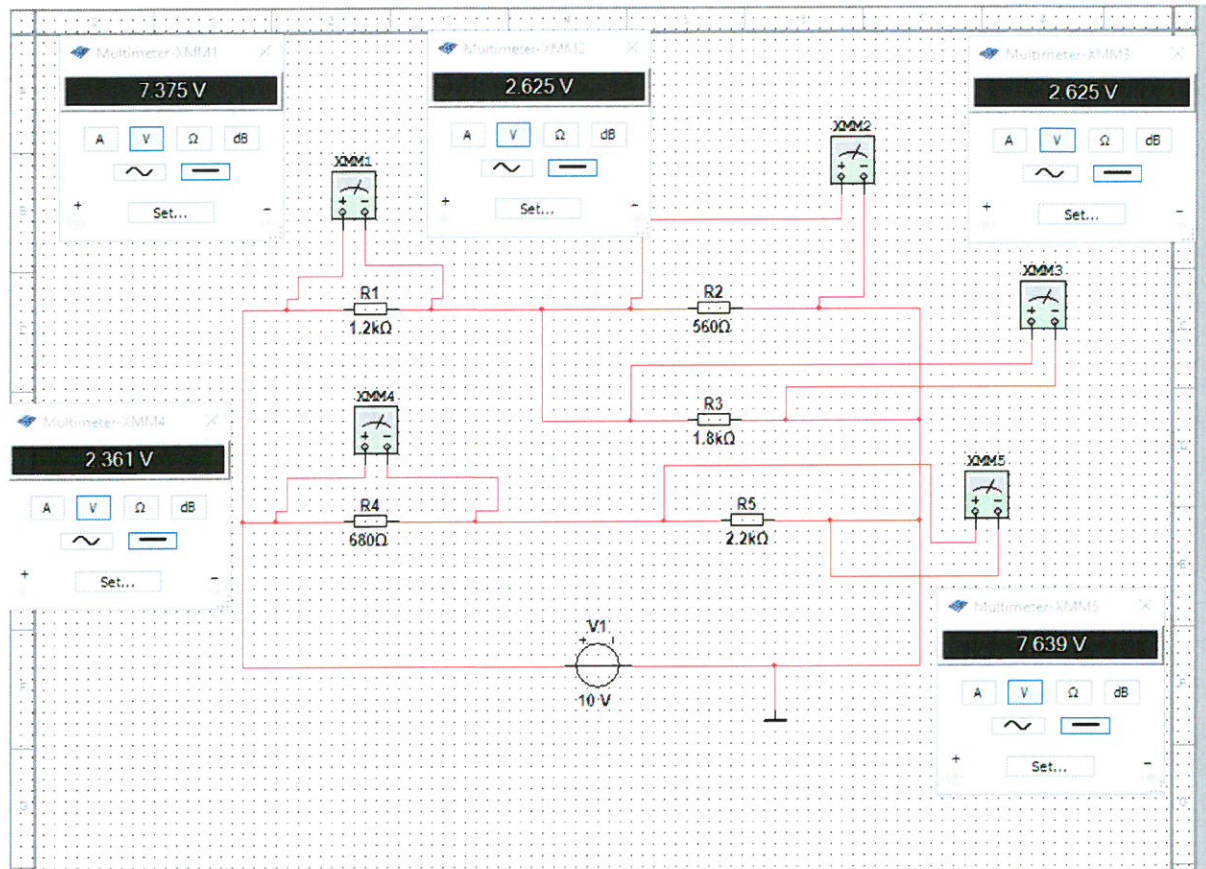
$$I2 = 10 / 1627 = 6.15mA$$

$$V1 = 6.15mA * 1200 = 7.38V$$

$$V2 = V_s - V1 = 10 - 7.38 = 2.62V$$

After the calculated results, the task was then to build the circuit using simulation software (Multisim), and compared to the previous physical build and the calculated results.

Multisim Measurements



From the measured results and the calculated results, there is a slight difference in the outcomes; this could be because of the tolerances from the physical resistors, where the actual resistance could be up to $\pm 5\%$ of the stated resistance, Whereas the calculated measures uses the stated figure of resistance which would affect the voltage readings.

With the calculated voltages, error could occur within the calculations themselves which could lead to a false figure, or a rounding 'error' could be present where figures have been rounding up to a certain number of decimal places that could change the outcome of the voltages by a small margin. With the Simulation readings, all the inputted data is the exact figure that is inputted without any tolerance error, and all calculations are exact without rounding error, this creates an ideal scenario where every measurement is perfect.

A MatLab program was then to be constructed that would perform the calculations itself while only be given the resistor values and the input source voltage. The result are shown below and are proven against a Multisim simulation of the same values.

Matlab Results

Code:

```

% Daniel Chick - 11/10/18
% Assignemnt 1 Task 1 - DC Circuits, Combination Circuits

- V=input('Enter the supply voltage: '); %Supply Voltage Value
- R1=input('Enter the resistance value for R1: '); %Resistor Value for R1
- R2=input('Enter the resistance value for R2: '); %Resistor Value for R2
- R3=input('Enter the resistance value for R3: '); %Resistor Value for R3
- R4=input('Enter the resistance value for R4: '); %Resistor Value for R4
- R5=input('Enter the resistance value for R5: '); %Resistor Value for R5

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

%Calculate V4 and V5
- I1=V/(R4+R5); %Calculates the Current through R4 and R5 (I1)
- V4=I1*R4; %Calculates the Voltage across R4
- V5=I1*R5; %Calculates the Voltage across R5

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

%Calculate V1, V2 and V3
- R23=R2*R3/(R2+R3); %Calculates the total resistance of R2 and R3 (R23)
- I2=V/(R1+R23); %Calculates the Current through R1 and R23 (I2)
- V1=I2*R1; %Calculates the Voltage across R1 (V1)
- V2=V-V1; %Calculates the Voltage across R23 (V2)

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

%Display the Results
- disp('The Volatge across R1: '); %Displays the Voltage across the R1 Resistor
- disp(V1);

- disp('The Volatge across R2: '); %Displays the Voltage across the R1 Resistor
- disp(V2);

- disp('The Volatge across R3: '); %Displays the Voltage across the R1 Resistor
- disp(V2);

- disp('The Volatge across R4: '); %Displays the Voltage across the R1 Resistor
- disp(V4);

- disp('The Volatge across R5: '); %Displays the Voltage across the R1 Resistor
- disp(V5);

- disp('The Current Value Through R4 and R5: '); %Displays the Current through R4 and R5
- disp(I1);

- disp('The Current Value Through R1, R2, and R3: '); %Displays the Current through R1, R2 and R3
- disp(I2);

- disp('The Resistance of the R2 and R3 parallel resistors: '); %Displays the total resistance or R2 and R3
- disp(R23);

```

Very good presentation

Results:

Enter the supply voltage: 10
Enter the resistance value for R1: 1200
Enter the resistance value for R2: 560
Enter the resistance value for R3: 1800
Enter the resistance value for R4: 680
Enter the resistance value for R5: 2200
The Volatge across R1:
7.3750

The Volatge across R2:
2.6250

The Volatge across R3:
2.6250

The Volatge across R4:
2.3611

The Volatge across R5:
7.6389

The Current Value Through R4 and R5:
0.0035

The Current Value Through R1, R2, and R3:
0.0061

The Resistance of the R2 and R3 parallel resistors:
427.1186

6. ~ ~ I

Check Results

New Values

Supply Voltage: 12V

R1: 2.2k

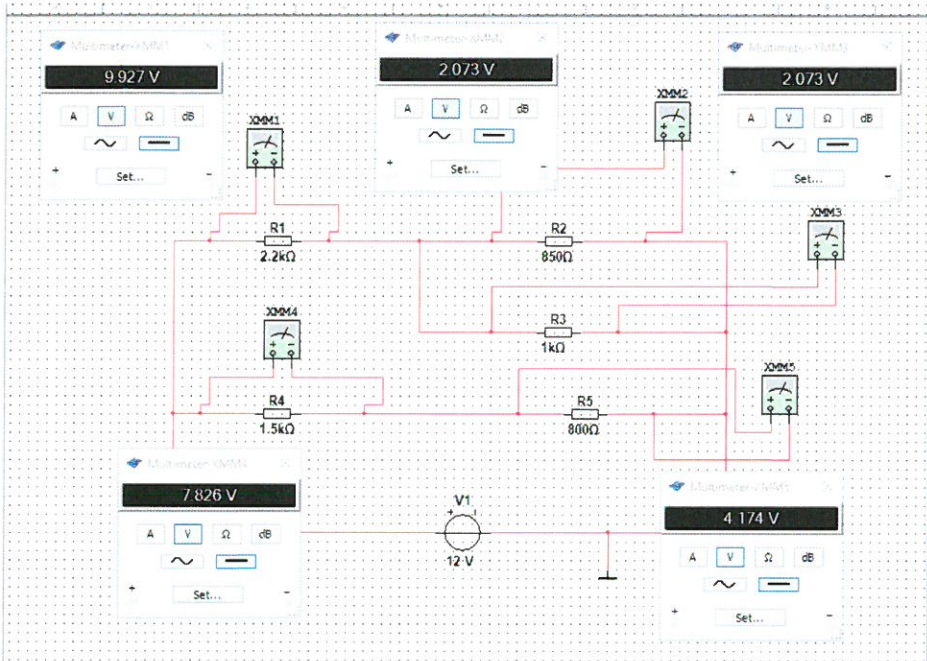
R2: 850

R3: 1k

R4: 1.5k

R5: 800

Multisim:



Matlab:

Enter the supply voltage: 12
 Enter the resistance value for R1: 2200
 Enter the resistance value for R2: 850
 Enter the resistance value for R3: 1000
 Enter the resistance value for R4: 1500
 Enter the resistance value for R5: 800
 The Voltage across R1:
 9.9268

 The Voltage across R2:
 2.0732

 The Voltage across R3:
 2.0732

 The Voltage across R4:
 7.8261

 The Voltage across R5:
 4.1739

 The Current Value Through R4 and R5:
 0.0052

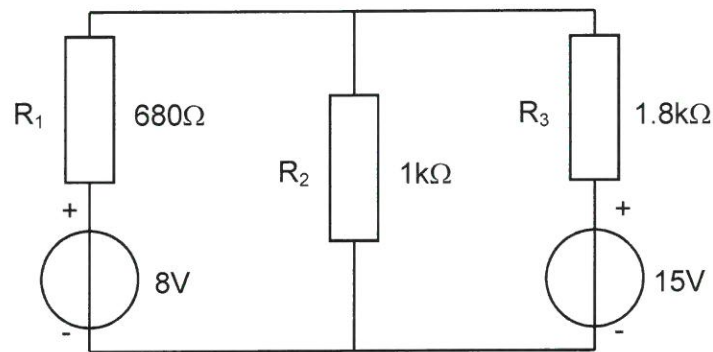
 The Current Value Through R1, R2, and R3:
 0.0045

 The Resistance of the R2 and R3 parallel resistors:
 459.4595

As seen from above, the calculations from each scenario are close, with the only major differences are the rounding errors on the programs.

Task 2 Circuit Theorem

This task was to calculate the current flowing through the R2 resistor using a variety of methods.

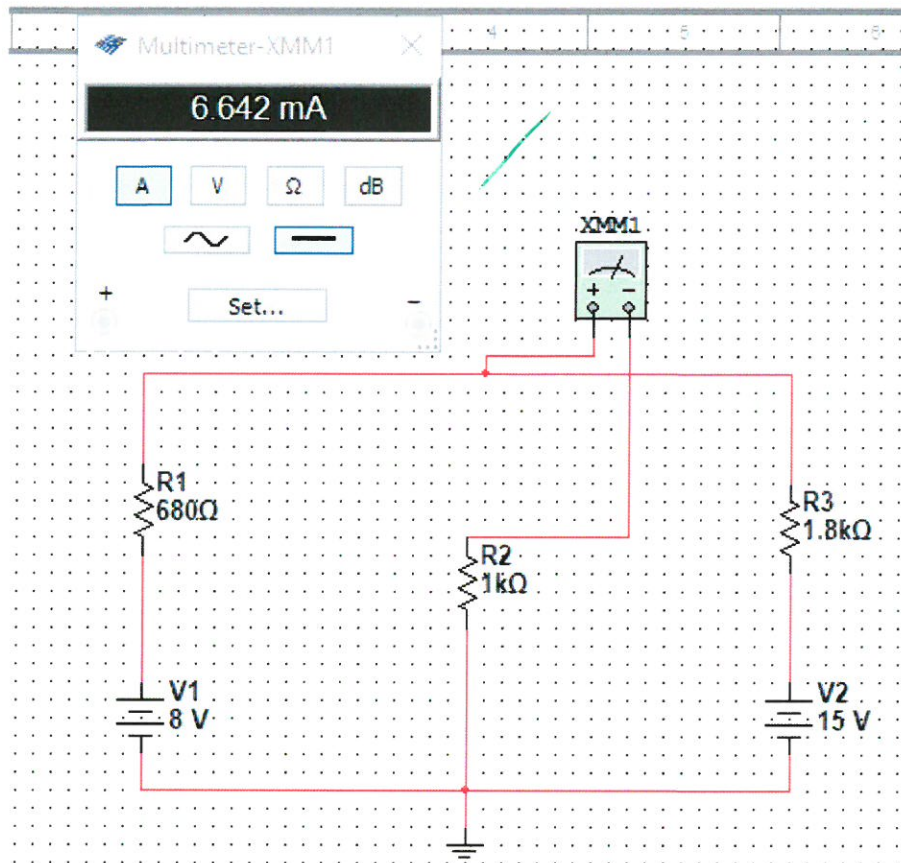
Nortons Calculation For Current

$$I_{sc} = I_1 + I_2 = (8/680) + (15/1800) = 0.02A$$

$$R = ((680 * 1800) / (680 + 1800)) = 493.55\Omega$$

$$(493.55 / (493.55 + 1000)) * 0.02 = 6.6mA$$

This calculation was then checked using the Multisim software and a Digital multimeter option over the R2 resistor



The results of the simulation are shown in the image above which match the calculated results, A Matlab program was then to be created to perform the same calculations, by using both Thevenins and Norton's Theorem

Matlab Program

```

% Daniel Chick - 11/10/18
% Assigment 1 Task 2 - Thevenins and Nortons

V1=input(' Enter the voltage value, V1: ');           %Supply Voltage Value
V2=input(' Enter the voltage value, V2: ');           %Supply Voltage Value
R1=input('Enter the resistance value for R1: ');       %Resistor Value for R1
R2=input('Enter the resistance value for R2: ');       %Resistor Value for R2
R3=input('Enter the resistance value for R3: ');       %Resistor Value for R3

#####
%Thevenins%
#####

I1=(V2-V1)/(R1+R3);           %calculate The current I1
E1=V1+(I1*R1);               %Calculate V1 and V2 Voltage
E2=V2-(I1*R3);
r=((R1*R3)/(R1+R3));         %Calculate the Equivalent Resistance
I=E1/(R2+r);                 %calculate the Equivalent Current
P=(I^2)*r;                   %Power Dissapated

#####
%Nortons%
#####

In1=V1/R1;
In2=V2/R3;
Isc=In1+In2;
rN=((R1*R3)/(R1+R3));
IN=(rN/(rN+R2))*Isc;         %Nortons Equivalent
VN1=In1*R1;                  %Voltage across R1
VN2=In2*R3;                  %Voltage Across R3

#####

disp('Thevanin: The Current I1: ')
disp('Thevanin: The Equivalent resistance r: ')
disp('Thevanin: The equivalent current I: ')
disp('Thevanin: The Power dissapated P: ')
disp('Thevanin: The Voltage Across V1 : ')
disp('Thevanin: The Voltage Across V2 : ')
disp('Norton: The Current I1: ')
disp('Norton: The Current I2: ')
disp('Norton: The Supply Current Isc: ')
disp('Norton: The equivalent resistance r: ')
disp('Norton: The equivalent Current IN: ')

disp(I1); %Display the Results
disp(r);
disp(I);
disp(P);
disp(VN1);
disp(VN2);
disp(In1);
disp(In2);
disp(Isc);
disp(rN);
disp(IN);

```

Matlab Results

```
Enter the voltage value, V1: 8
Enter the voltage value, V2: 15
Enter the resistance value for R1: 680
Enter the resistance value for R2: 1000
Enter the resistance value for R3: 1800
Thevanin: The Current I1:
    0.0028
```

```
Thevanin: The Equivalent resistance r:
    493.5484
```

```
Thevanin: The equivalent current I:
    0.0066
```

```
Thevanin: The Power dissipated P:
    0.0218
```

```
Thevanin: The Voltage Across V1 :
    8
```

```
Thevanin: The Voltage Across V2 :
    15
```

```
Norton: The Current I1:
    0.0118
```

```
Norton: The Current I2:
    0.0083
```

```
Norton: The Supply Current Isc:
    0.0201
```

```
Norton: The equivalent resistance r:
    493.5484
```

```
Norton: The equivalent Current IN:
    0.0066
```

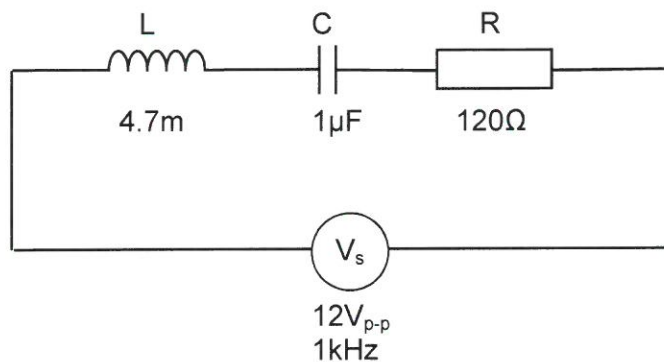
fx >> |

The results are shown above and are shown to be a correct calculation when compared to both the manual calculation and the Multisim findings.

*Have not found the current in
each resistor.*

Task 3 - Series AC Circuit

By using the circuit below, this task required the resonant frequency and the phase angle between each waveform to be calculated and proved using various methods.



Phase Angle and resonant Frequency at 1kHz

Phase Angle:

$$\text{Theta} = \tan^{-1}(\text{XL} - \text{XC} / \text{R})$$

$$\text{XL} = 2\pi fL = 2 * \pi * 1000 * (4.7 \times 10^{-3}) = 29.53 \quad \checkmark$$

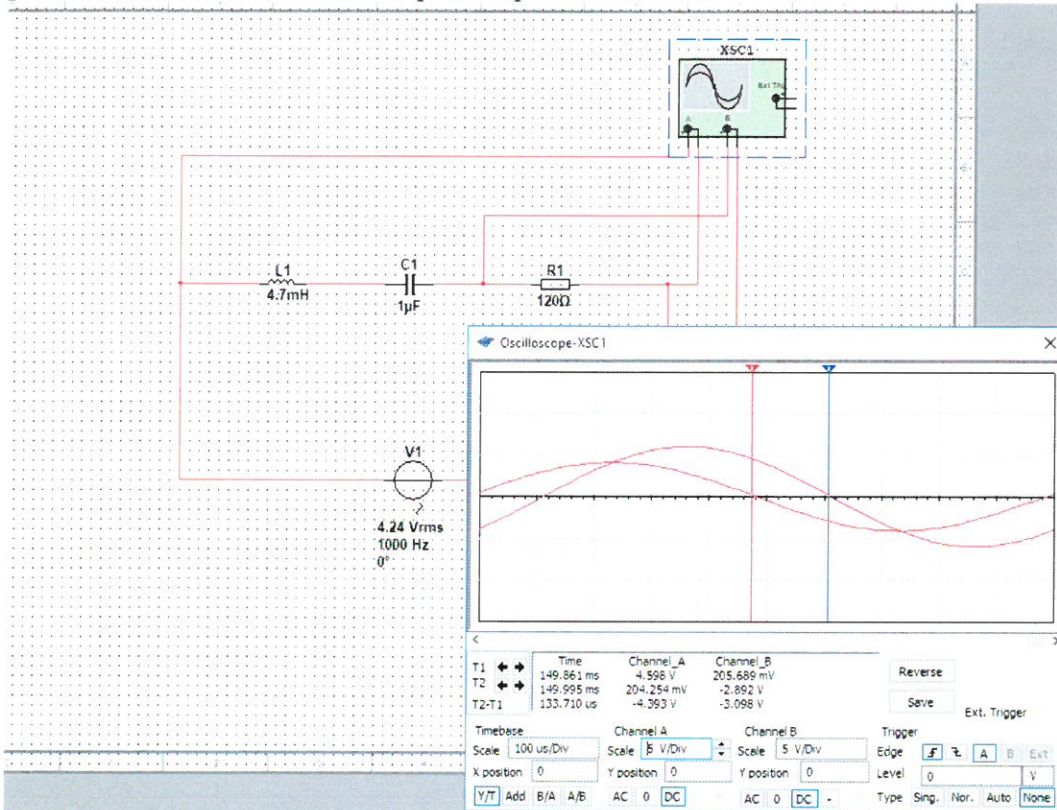
$$\text{XC} = 1 / (2\pi fC) = 1 / (2 * \pi * 1000 * (1 \times 10^{-6})) = 159.15 \quad \checkmark$$

$$\text{Theta} = \tan^{-1}((29.53 - 159.15) / 120) = 47.2^\circ \quad \checkmark$$

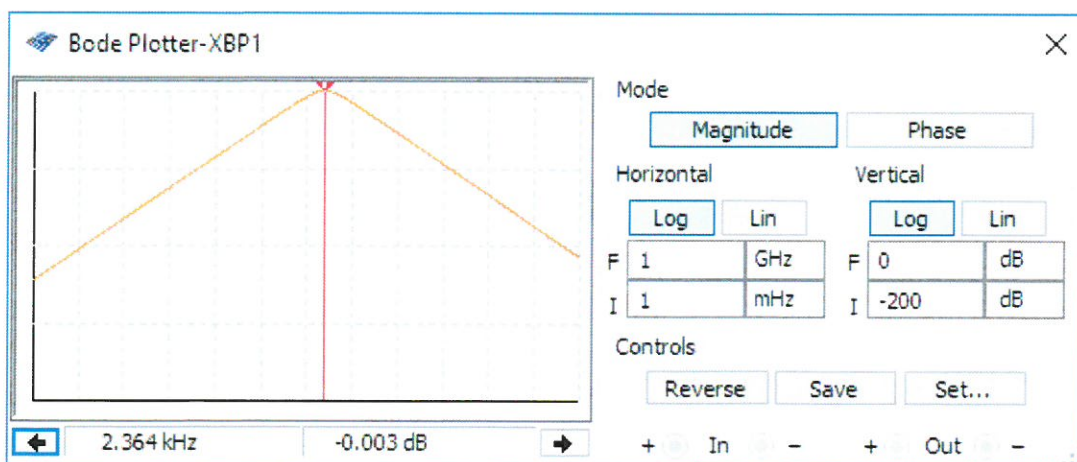
Resonant Frequency:

$$f_0 = 1 / (2\pi \sqrt{LC}) = 1 / (2 * \pi * \sqrt{(4.7\text{m} * 1\mu)}) = 2.321 \text{ KHz} \quad \checkmark$$

To prove the accuracy of the calculations, the circuit was designed and tested using Multisim to provide measurements at the requested points within the circuit.



Calculated from multisim. $(133 \times 10^{-6}) \times 1000 \times 360 = 47.88 \text{ deg}$



Phase angle = 2.364 kHz

A Matlab Program was then created to automatically calculate the required resonant frequency and the phase angle, and also produces a waveform plot diagram of the frequency.

```
% Daniel Chick - 29/11/18
% Assignment 1 Task 3, AC circuit

L=input(' Enter the Inductor value: ');          %Inductor Value
C=input(' Enter the Capacitor value: ');          %Capacitor Value
R=input('Enter the Resistor value: ');            %Resistor Value
V=input('Enter the voltage value: ');             %Voltage Value
f=input('Enter the frequency: ');                 %desired frequency
fprintf('\n')

#####

%Reactance Calculations
XL=2*pi*f*L;
XC=1/(2*pi*f*C);

%Phase Angle calculation
PA=(180/pi)*atan((XL-XC)/R);

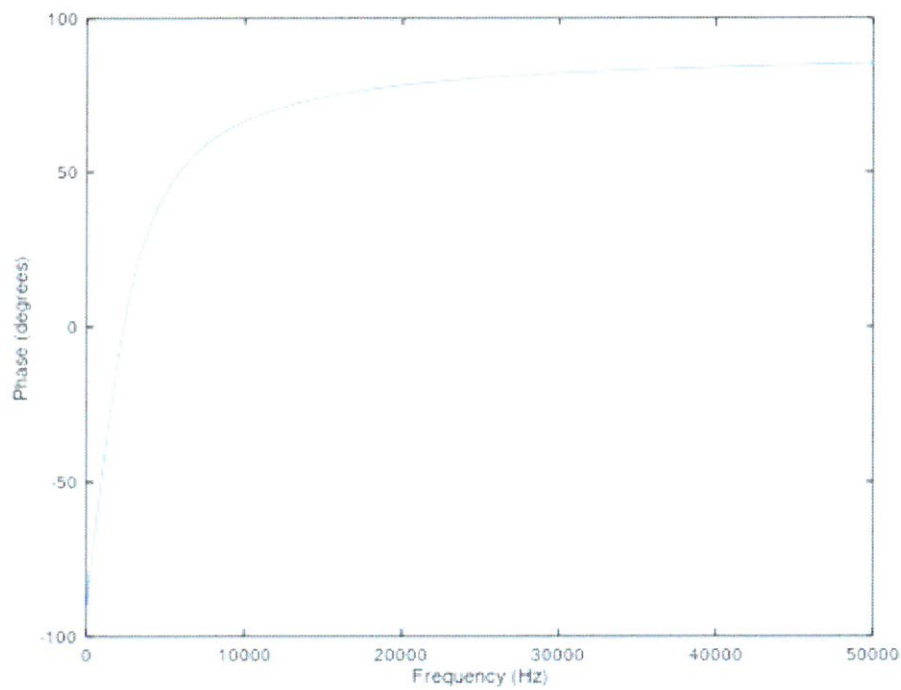
%Resonant Frequency Calculation
Rf=1/(2*pi*sqrt(L*C));

%For Loop to calculate the phase angle
for Q=1:10000
    freq(Q)=Q;                                     %Variable Frequency
    XL=2*pi*freq(Q)*L;
    XC=1/(2*pi*freq(Q)*C);
    QA(Q)=(180/pi)*atan((XL-XC)/R);
end

D1=[' The phase angle calculated is ',num2str(PA), ' degrees '];
disp(D1)

D2=[' The Resonant Frequency calculated is ',num2str(Rf), ' Hz '];
disp(D2)

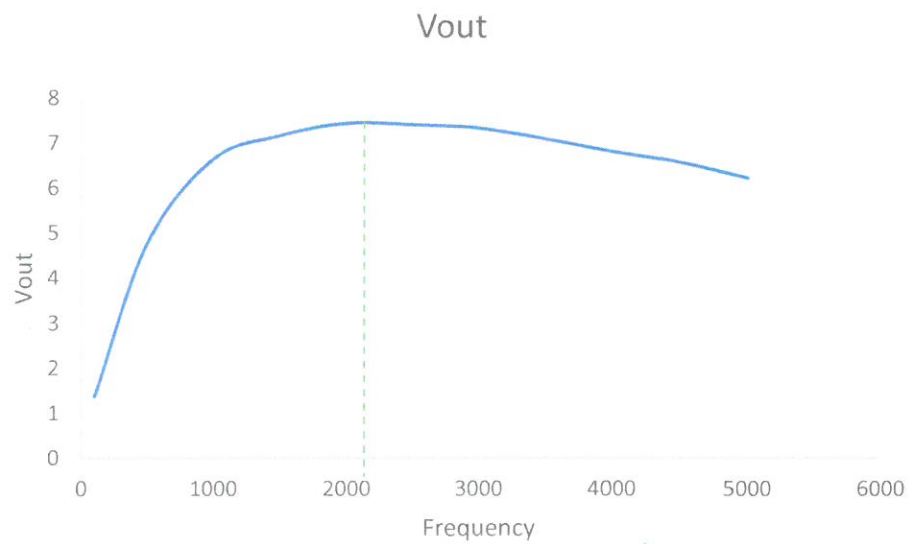
plot(freq,QA,'g--');
xlabel('Frequency (Hz)');
ylabel('Phase (deg)');
grid
```

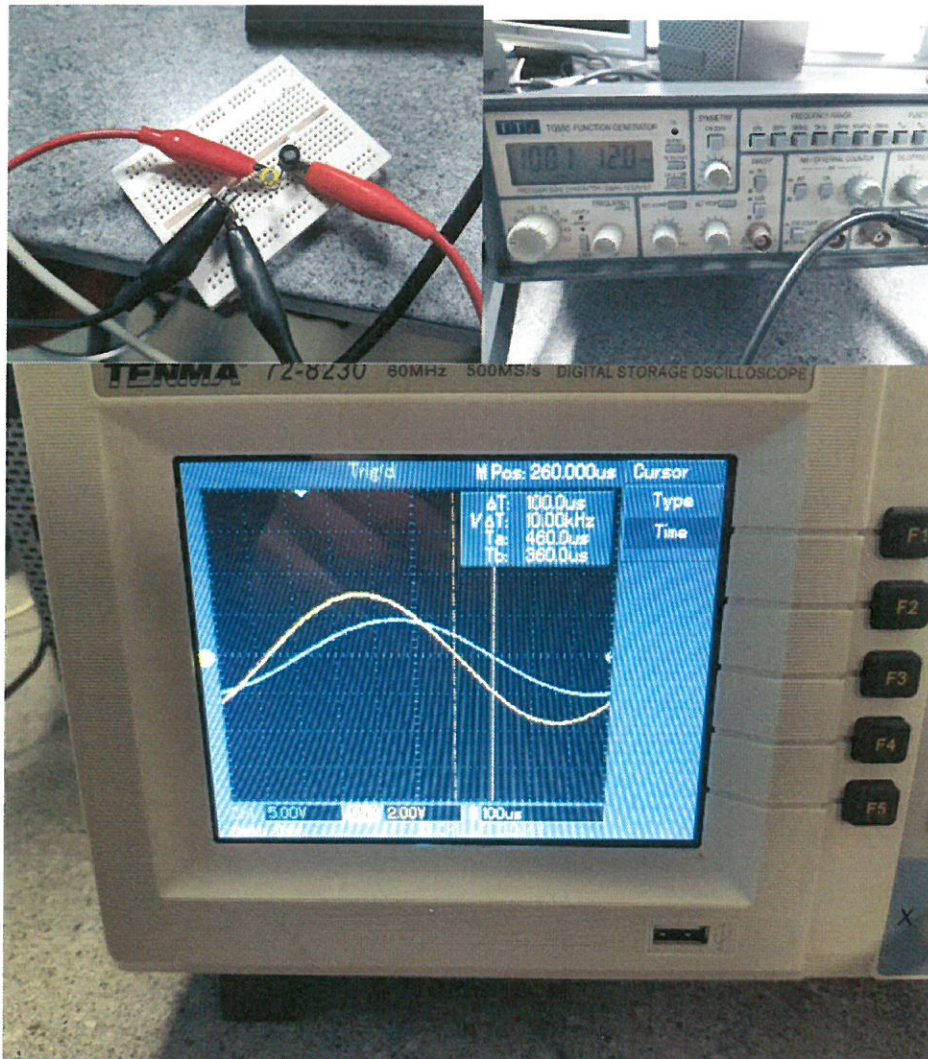


Missing the answer for angle and resonant.

The circuit was then physically created on breadboard and measurements were taken at set frequencies which were then used to construct a graph using Excel to show voltage across the frequency range.

Frequency	Vout
100	1.39
500	4.79
1000	6.65
1500	7.17
2000	7.44
2500	7.41
3000	7.33
3500	7.09
4000	6.81
4500	6.57
5000	6.22





From the Practical testing, you can see the resonant frequency as marked by the green line of approximately 2300Hz, the accuracy from this reading could be improved by taking more measurements at lower intervals and plotting a graph from the outcomes.

You can also see the time difference between each waveform. And from these measurements the phase angle could be calculated, this method is subject to a large amount of error as many factors could alter the outcome, such as user error, where the user places the oscilloscopes measuring functions in incorrect places.

From the Constructed circuit, the phase angle is $(100 \times 10^{-6}) \times 1000 \times 360 = 36 \text{ deg}$. This could be down to component error, where the figures from the component do not match the ones stated within the specification or user error where the measurement cursors are in the incorrect location for the reading.

Task 4 - Complex AC Circuits

This task required the calculation of the current running through the circuit at a set location, the current was first to be calculated using Mesh Analysis and then proven by constructing the circuit on Multisim and using the software's inbuilt Multimeter to monitor the current at the specified location.

Mesh Analysis

$$X_L = 2\pi fL = 2 * \pi * 1000 * (1.2 \times 10^{-3}) = j7.54 \Omega$$

$$X_C = 1 / (2 * \pi * 1000 * (33 \times 10^{-6})) = -j4.82 \Omega$$

Kirchoffs law for each loop

Loop 1

$$V = R_1 I_1 + X_C (I_1 - I_2)$$

$$10 = 22 I_1 + (-j4.82)(I_1 - I_2)$$

$$10 = (22 - j4.82) I_1 + j4.82 I_2 \quad = \text{Eq1}$$

Loop 2

$$0 = R_2 I_2 + X_L I_2 + X_C (I_2 - I_1)$$

$$0 = 39 I_2 + j7.54 I_2 + (-j4.82)(I_2 - I_1)$$

$$0 = j4.82 I_1 + (39 + j2.72) I_2 \quad = \text{Eq2}$$

Rearrange for Eq2

$$j4.82 I_1 = -(39 + j2.72) I_2$$

$$I_1 = -(39 + j2.72) I_2 / j4.82 \quad = \text{Eq3}$$

Sub I1 into Eq1

$$10 = -(22 - j4.82)(39 + j2.72) I_2 + j4.82 I_2 / j4.82$$

$$10 = j0.207(871.11 - j128.14) I_2 + j4.82 I_2$$

$$10 = (26.53 + j180.32) I_2 + j4.82 I_2$$

$$I_2 = 10 / (26.53 + j185.14)$$

$$I_2 = 0.0076 - j0.0529$$

Sub I2 into Eq 3

$$I_1 = -(39 + j2.72)(0.0076 - j0.0529) / j4.82$$

$$I_1 = 0.4237 + j0.0913$$

$$I = I_1 - I_2$$

$$(0.4237 + j0.0913) - (0.0076 - j0.0529)$$

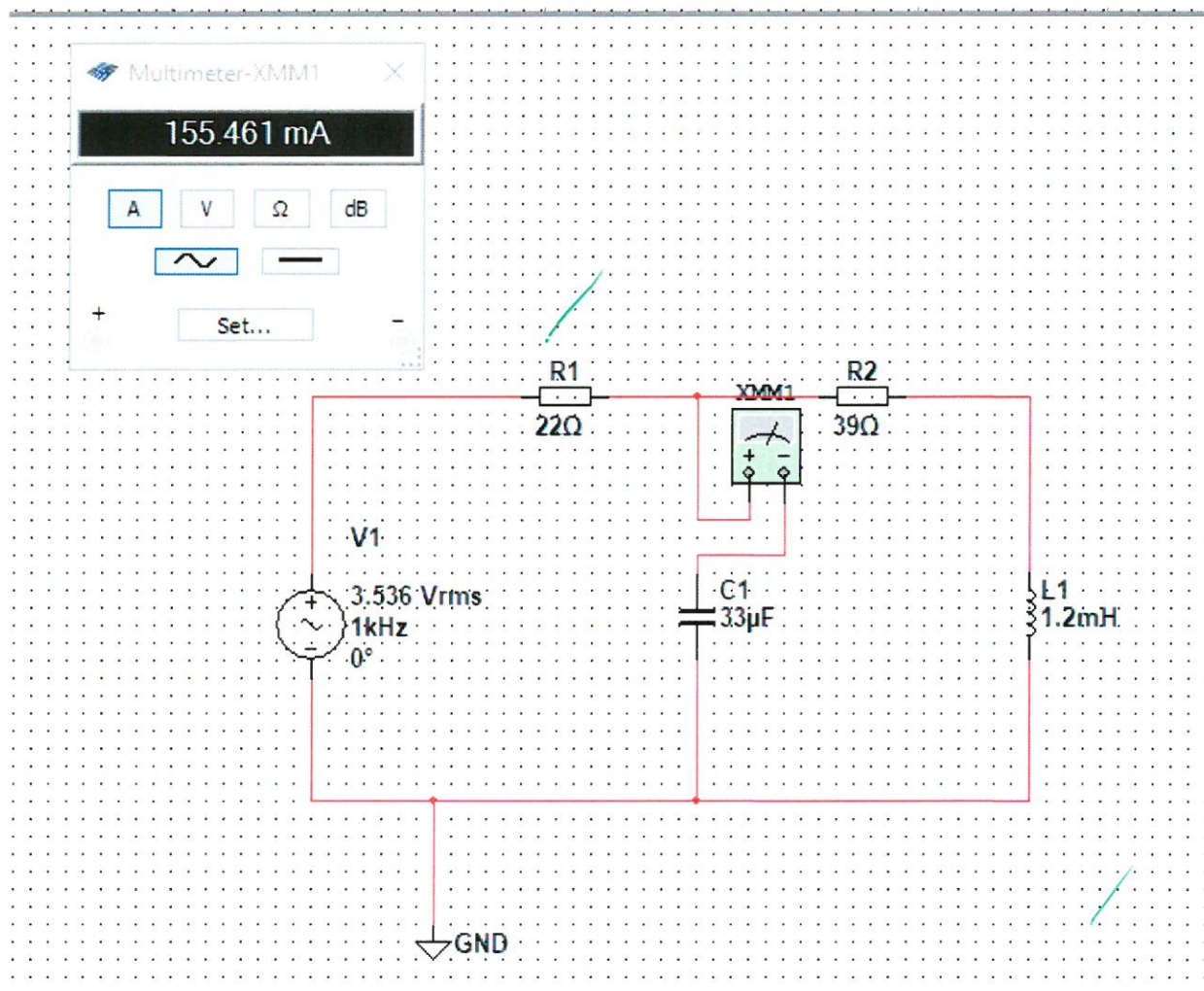
$$I = 0.4161 + 0.1442$$

$$\text{Pol}(0.4161, 0.1442)$$

$$\Theta = 19.1138, r = 0.44.4$$

$$I_{\text{rms}} = 0.44/2 * \sqrt{2} = 0.16 \text{ A} = 160\text{mA}$$

The circuit construction and readings are shown in the images below:



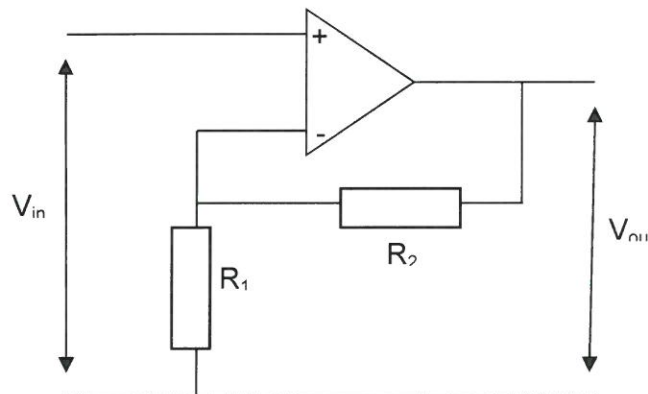
The figure stated from each method differs due to errors within the calculation. These errors could consist of rounding errors where the figure from a previous calculation is rounded up or down to a smaller figure, which then could affect the accuracy of the result.

Whereas the Simulation software uses actual figures to provide the measurements, and therefore is exact.

very good work.

Task 5 – Non Inverting Amplifier Circuit.

This task required the resistors R1 and R2 to be calculated from the following Amplifier Circuit.

Gain Calculation:

$$A_V = 1 + (R_f/R_{in})$$

$$A_V = 200$$
$$R_{in} = 2.7k\Omega$$

$$R_f/R_{in} = A_V - 1$$

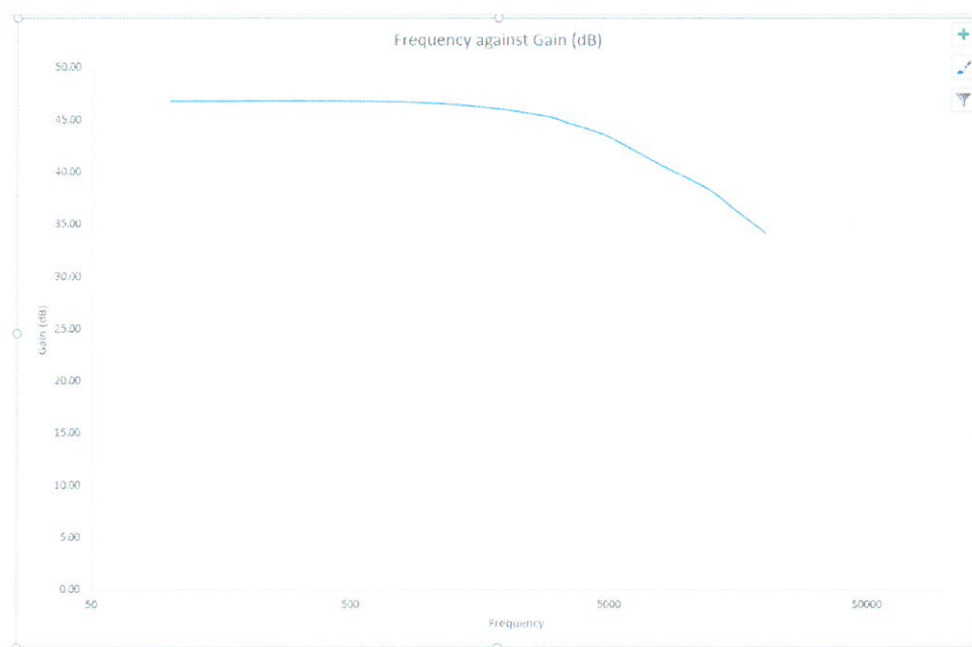
$$R_f = (200 - 1) \cdot R_{in}$$

$$R_f = 199 \cdot 2.7k\Omega$$

$$R_f = 537300 \Omega = 560k\Omega$$

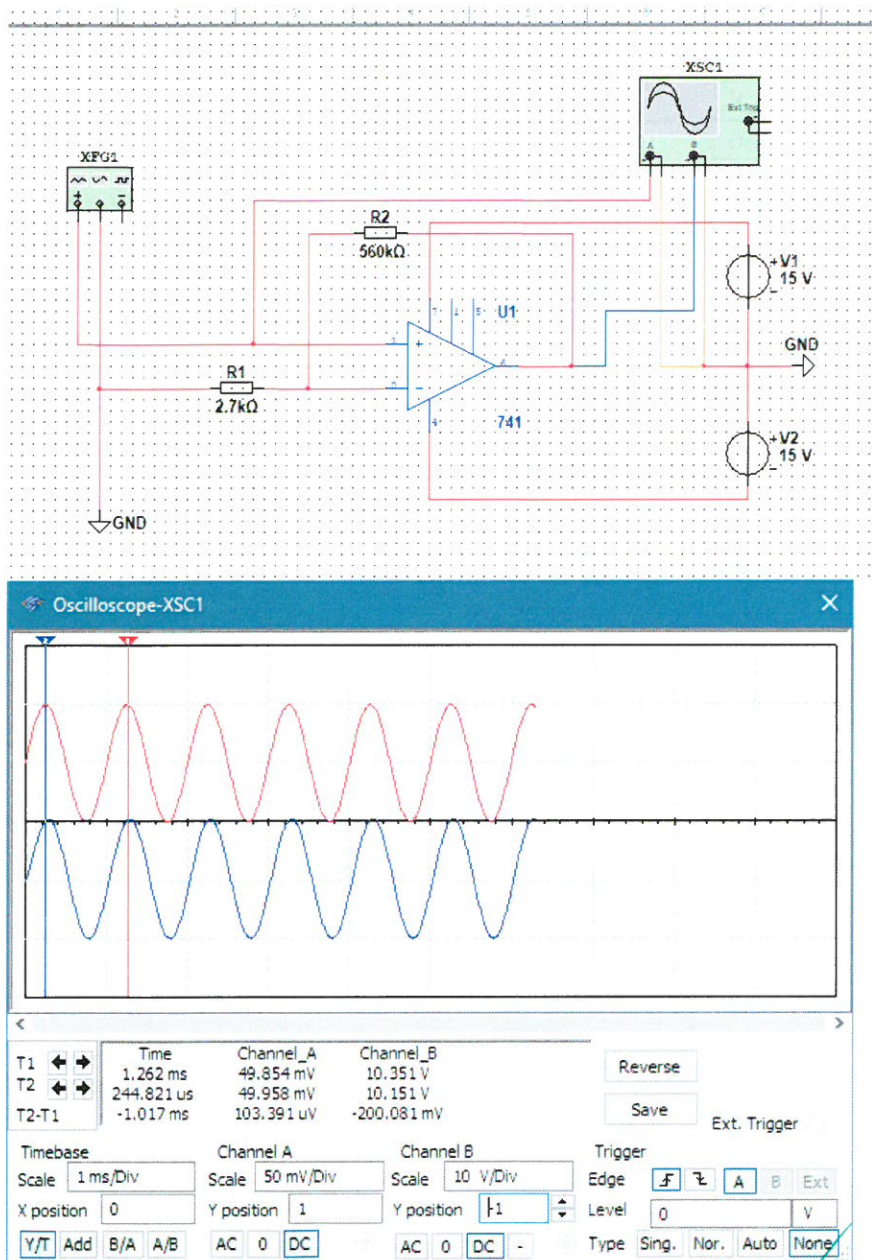
After the values of each resistor was calculated for the required gain, the circuit was constructed on breadboard and measurements were made by changing the frequency on a function generator and the output voltage was measured, this then allowed the gain and bandwidth to be calculated.

Frequency (Hz)	Vout (V)	Gain	Gain (dB)
100	10.89	217.8	46.76
500	10.89	217.8	46.76
1000	10.69	213.8	46.60
1500	10.3	206	46.28
2000	9.9	198	45.93
2500	9.5	190	45.58
3000	9.11	182.2	45.21
3500	8.51	170.2	44.62
4000	8.12	162.4	44.21
4500	7.72	154.4	43.77
5000	7.33	146.6	43.32
8000	5.35	107	40.59
12000	4.16	83.2	38.40
15000	3.37	67.4	36.57
20000	2.57	51.4	34.22



what is the bandwidth value?

The circuit was then proven using simulation software and the same measurements were taken.



Gain calculation = $10.35 / (49.85 \times 10^{-3}) = 207$.

From the outputs of the multisim circuit and the calculated measurements, there is a slight difference in the gain seen, this could be down to a number of small errors, such as the measurement cursors positions on the multisim oscilloscope, the measured position could be in an incorrect position on each wave causing an incorrect voltage reading which then affects the calculations outcome. This errors could be rectified by improving the accuracy of the position

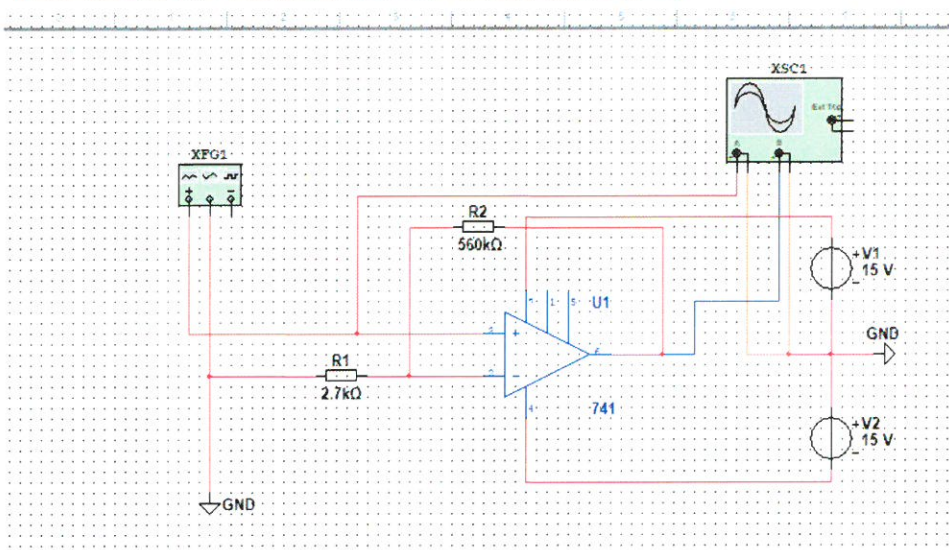
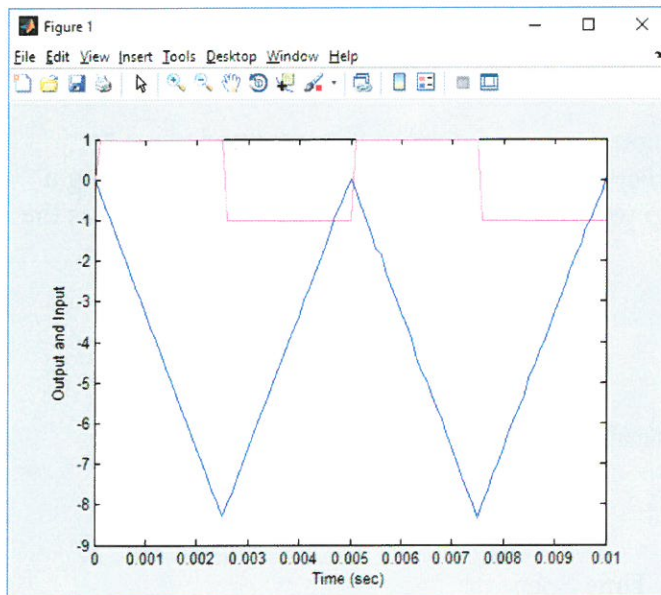
Task 6 – Integrator Circuit

This circuit is designed to change the inputted square wave, and display the outputted wave by using both MatLab and multisim to prove the correct functionality of both. It functions by using a capacitor running on a feedback from the Op-Amp which by charging and discharging, changes the output waveform to a sawtooth wave.

```

1. %Dan Chick - Task 6 Integrator Circuit.
2.
3. %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
4.
5. R1=200; C=0.0000015; fq=200;           % Inputted Values
6.
7. t = 0:0.0001:0.01;                     % Time Span
8.
9. %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
10.
11. for Os = 1:length(t)                   % Output Signal
12. Vo(Os) = -1/(R1*C)*quad('Vin',0,t(Os));
13. end;
14.
15. Is = 1*sign(sin(2*pi*fq*t));           % Input Signal
16.
17. %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
18.
19. plot(t,Is,'m-',t, Vo,'b-');             % Display results
20. xlabel('Time (sec)'); ylabel('Output and Input');
21.
22. %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
23.
24. % Daniel Chick A1T6 - "Vin" document
25.
26. %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
27.
28. function[V] = Vin(x)                   %Calculate a function value at point x
29.
30. V = 1*sign(sin(2*pi*200*x));           %The function expression

```



$C = 1.5\mu\text{F}$
 $R_{in} = 200\Omega$
 $f = 200\text{Hz}$
 $V_m = 1\text{V}$

