Abu Dhabi University

EEN 360 - Electronic Devices and Circuits II

Lab Report 2
Differential Amplifier

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Section 1

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Contents

Abstract

The purpose of this lab is to understand the operation of the MOSFET Differential Amplifier and to understand how to construct and simulate electronic components using MULTISIM from National Instruments.

1 Introduction

The MOSFET is used world wide very extensively for both digital and analogue signal processing and circuits. It is the key pillar of modern electronics. Among the many useful uses, one of the main usage of a MOSFET transistor is the development and manufacturing of MOSFET Differential Amplifier. MOSFET transistor are mainly used instead of other BJT transistors because the input resistance is literally close to infinity the reason behind it being that the gate pin is not connected by a conductor to the other pins of the transistor. The duty of the operational amplifier is to take the error of the two inputs (difference) and amplify the resulting signal.[1]

In this lab we will be first making a new component which is a NMOS Transistor and then a PMOS Transistor which has basic properties like a normal MOSFET.

In the general topology of a differential amplifier, two active devices are connected to a positive voltage supply through a passive series elements such as a resistor or current mirror circuit. The lower terminals of the active device are joined together and are connected to a current source for forcing the bias on the transistors to work in active mode.[2]

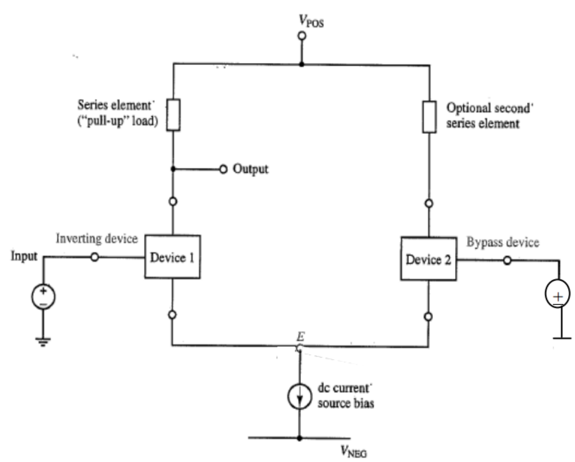


Figure 1: This is the basic topology for differential amplifier [2]

The current mirror is usually used in combination with the differential amplifier to affect the bias so that the transistors operate in active mode. The referencing current is produced outside the chip usually and then this current is mirrored all over the chip for biasing circuit purposes. The basic current biasing can be understood by the just imagining that if a castle has a gate and a army(current) is passing through. Then while the army is passing, the gate keeper cannot close the gate of the castle. Such is the case in a transistor, when a current is flowing, it forces it way through the transistor from drain to source.

2 Experiment Set-up

We connect the circuit as shown in the figure:-

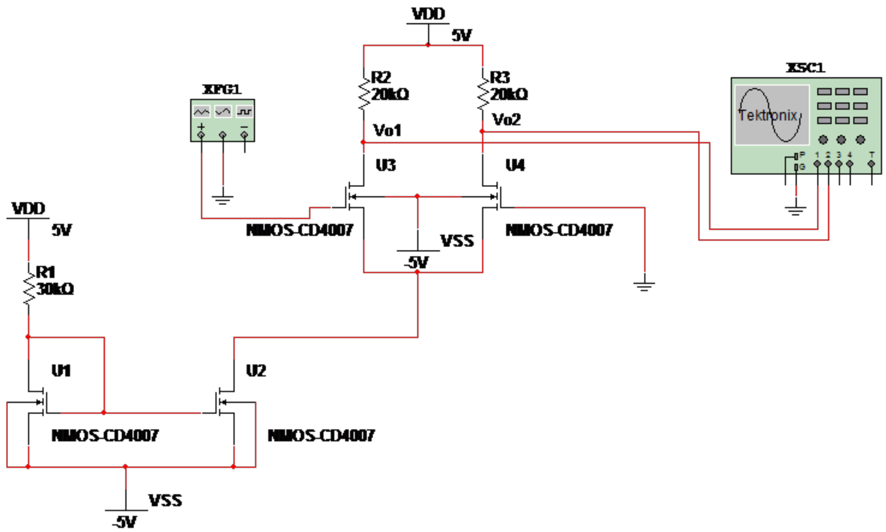


Figure 2: This is how we setup the circuit

3 List of Equipment used

- A PC Workstation.
- National Instrument's Multisim.
- Text Editor.

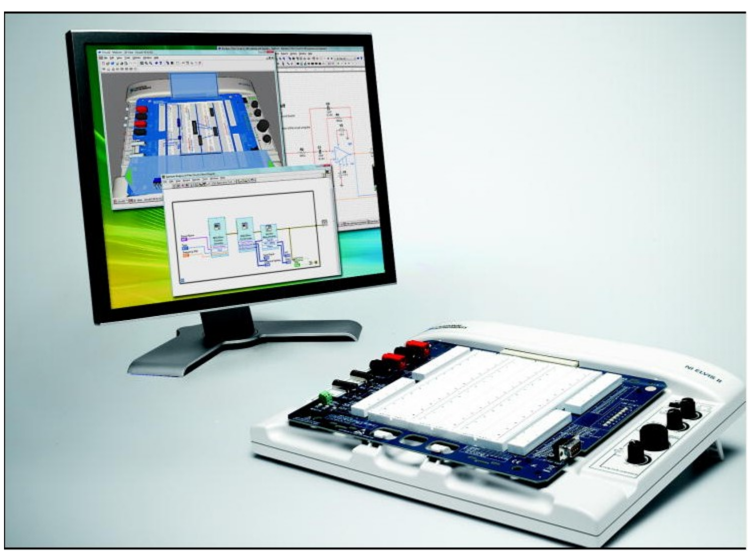


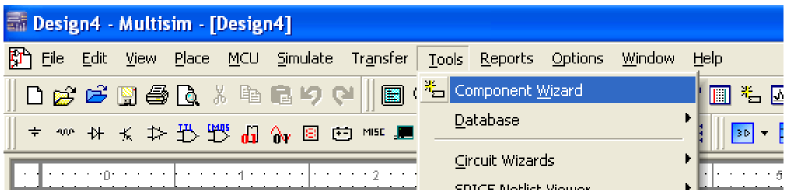
Figure 3: These are the things that are needed for the experiment to be performed[1]

4 Procedure

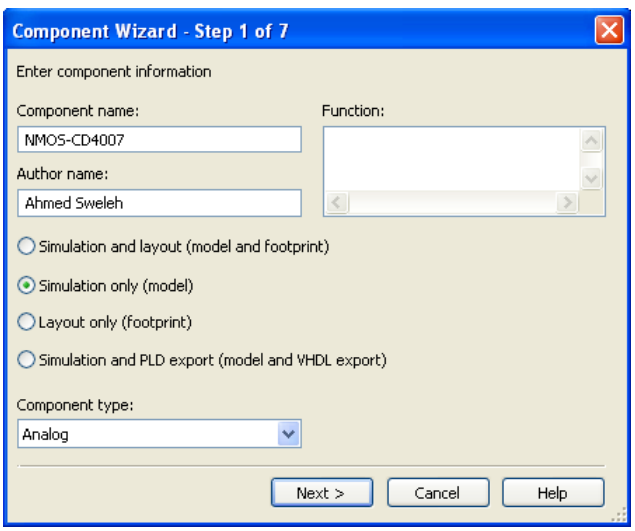
4.1 Constructing a component in Multisim

The MOSFET differential amplifier we will build today requires a special MOSFET component which we our self have to define and is CD4007 which is SMOS array that allows the use of matched transistor pairs.
To add a new component in Multisim, we do the following steps:-

- Go to Component Wizard in the tools menu.

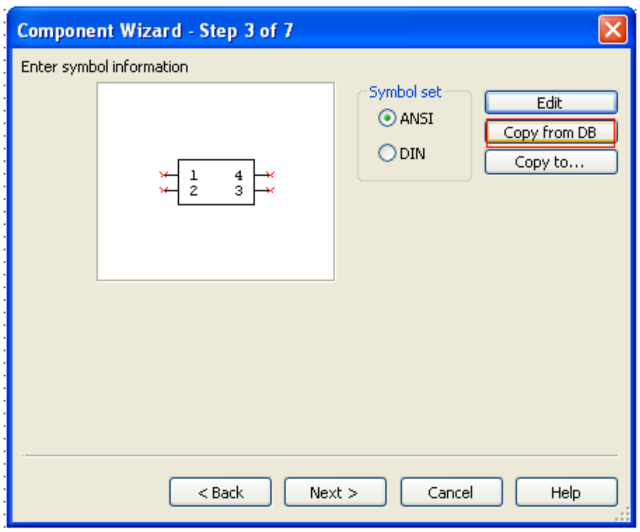


- Now just name the component as shown in the figure below

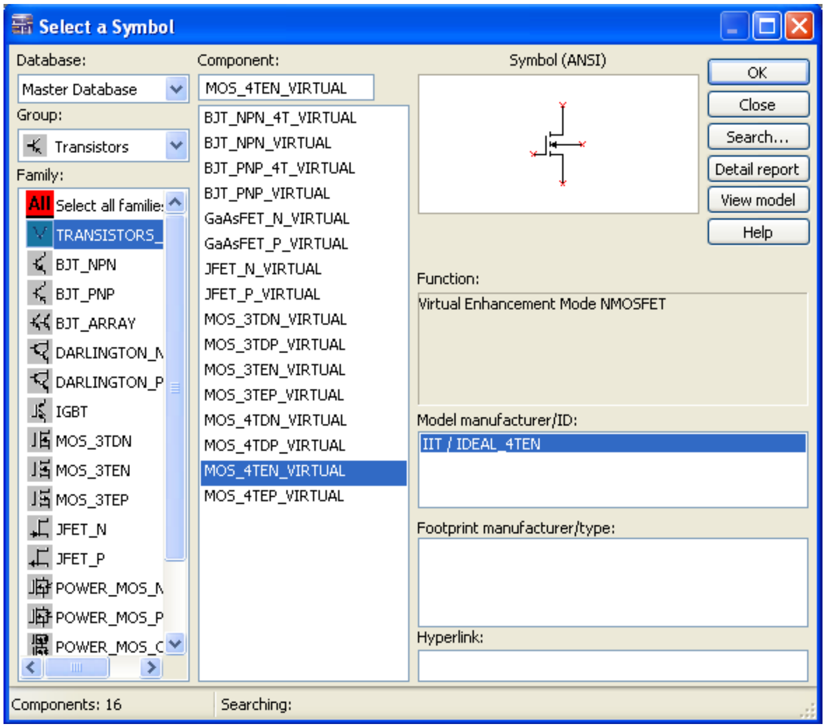


- Single section components should be selected and the number of pins should be 4.

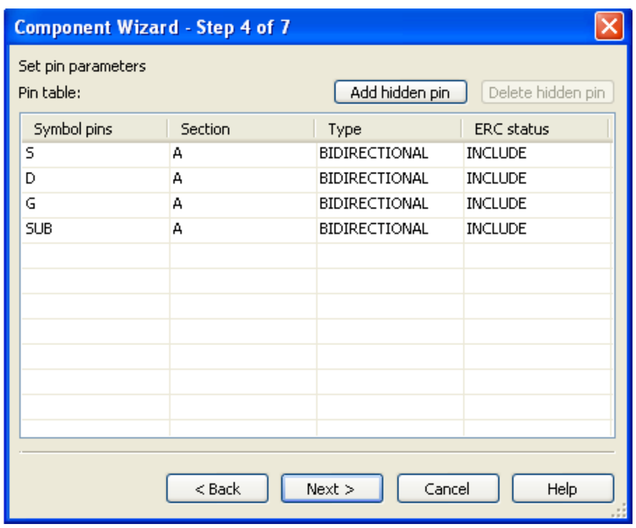
- Now that we have got that out of the way, we have to enter the information of the symbol and the information is available from Engineer and we have to copy the code from the text file into the DB.



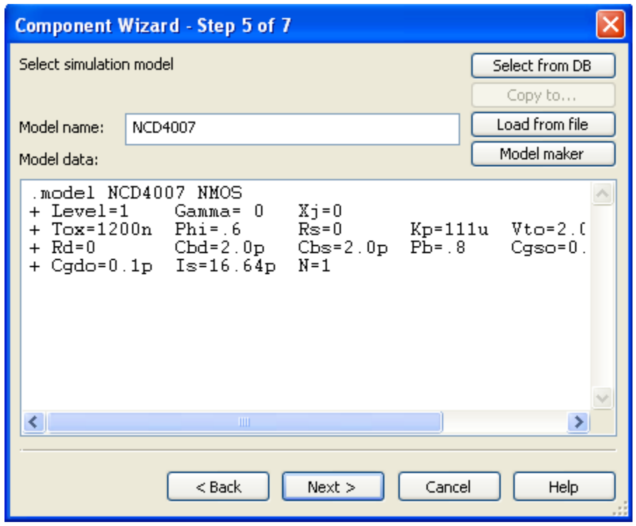
- Now we have to select the component icon from the window of the component wizard.



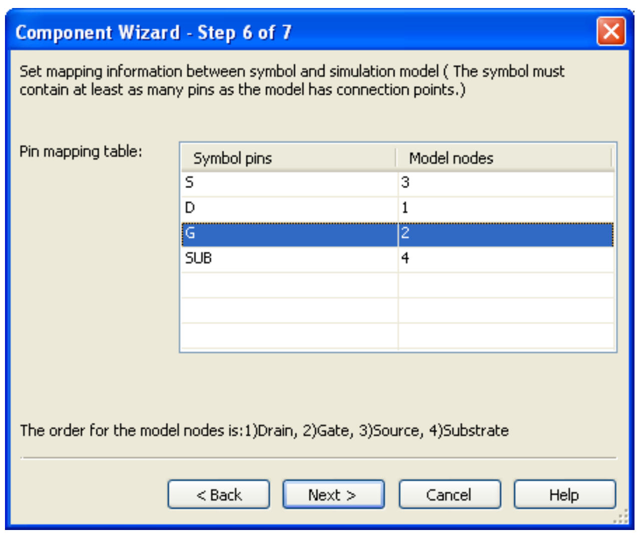
- Now we can select the pins and set the property.



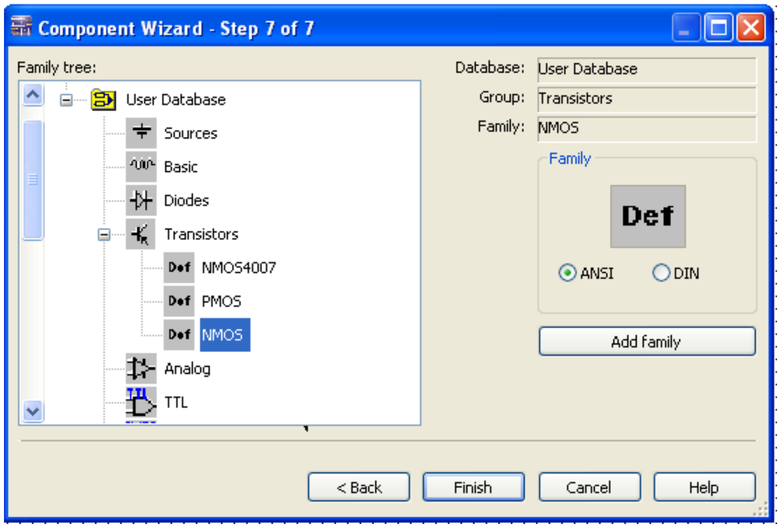
- Now we can paste the code.



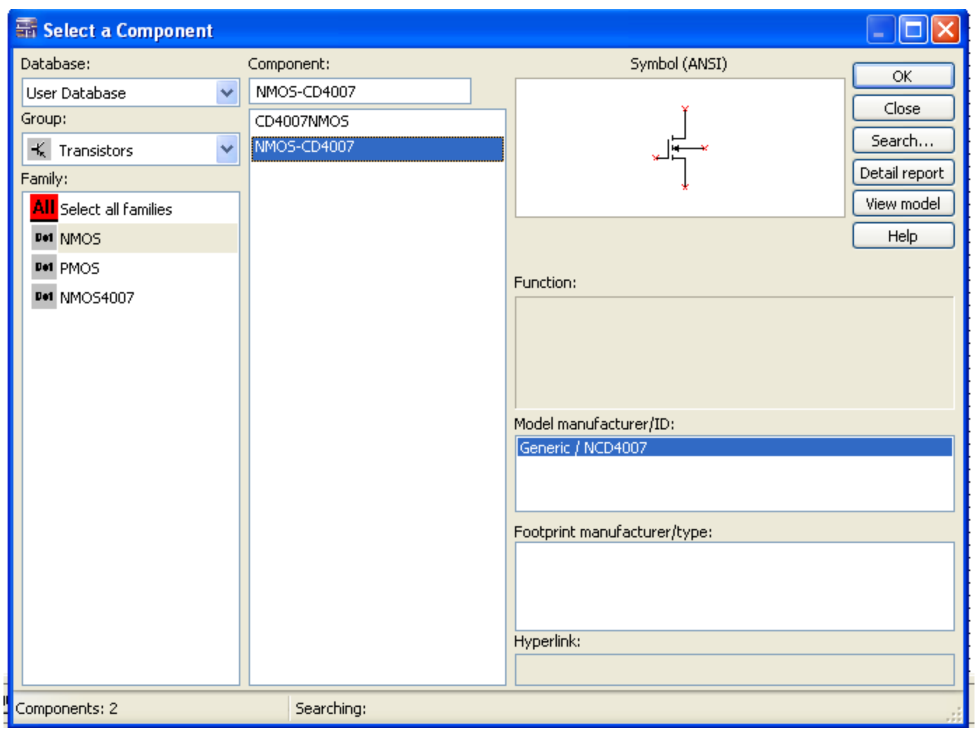
- Now we can set the pins.



- This is the last step and here we select the database in which the component should be stored.

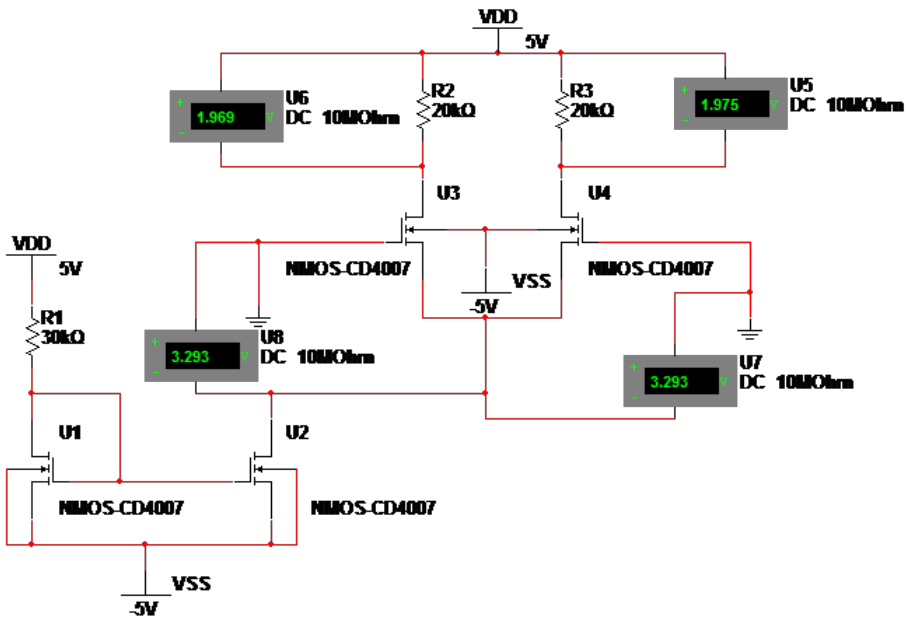


- Now we can see the new component in the database.



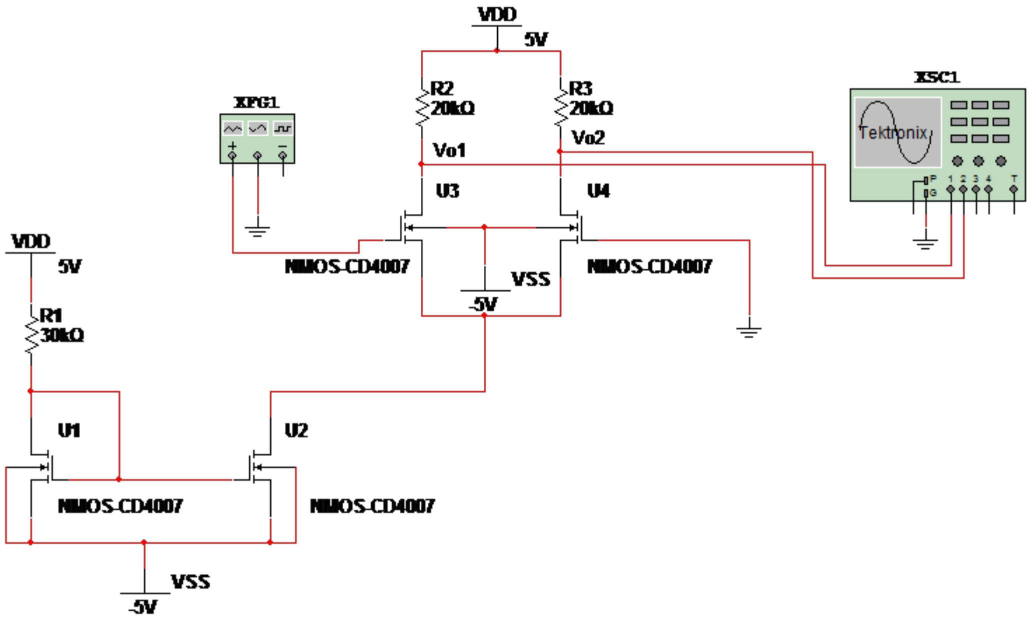
4.2 Measurement of DC operating point

N ow we have to measure the DC operating point. It is the point at which the amplifier starts to operate in active mode. With zero differential input, the bias current should be shared equally by U3 and U4. Resistors R2 and R3 are chosen to achieve a DC bias level of 3.3V at each output. The circuit below is built using the component.



4.3 Differential Small Signal Gain

I N this step we have to apply small sin wave at the input and measure the small signal gain from input to output in the circuit shown. Measure the single ended gain and the differential gain of the circuit.



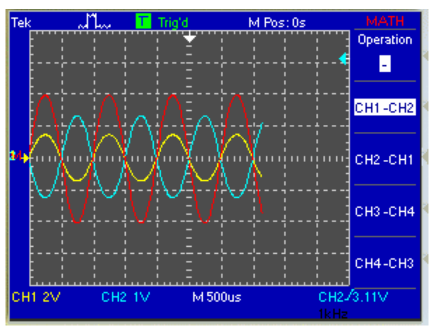


Figure 4: This should be the output.

5 Results and Discussions

At the end of the lab we got the following results:-

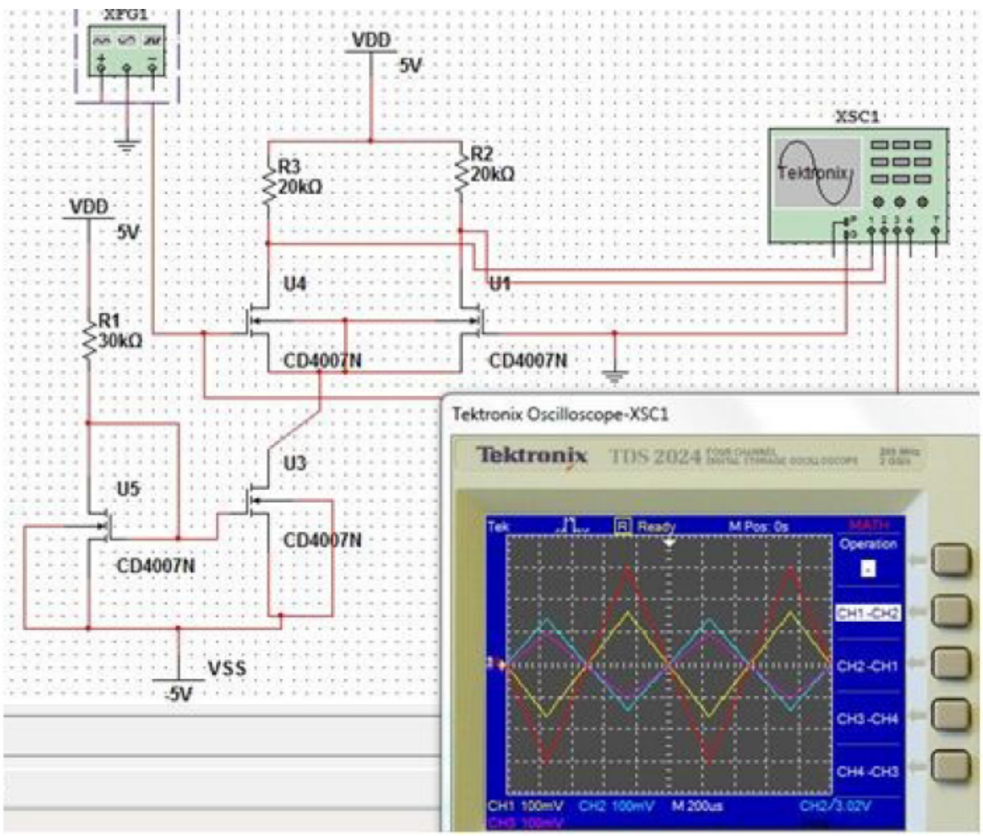


Figure 5: When we input the triangular wave and perform the math operation on the two received signals from channel A and channel B, the resulting wave is much more amplified triangular wave. Here the output is taken from both of the transistors separately.

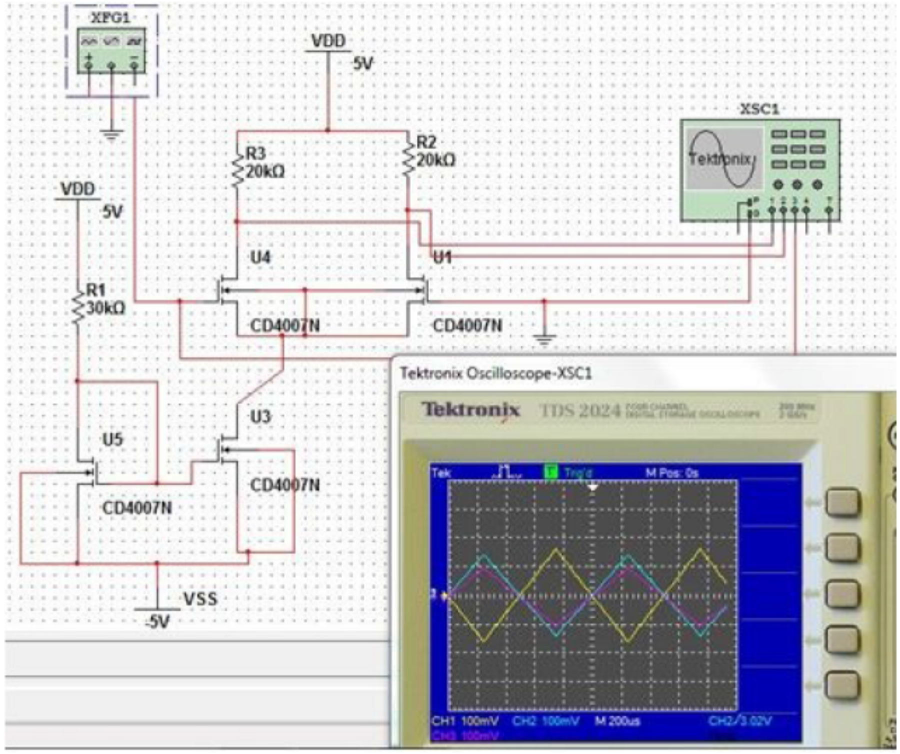


Figure 6: This is the output of each of the transistors when a triangular wave is input to the differential amplifier.

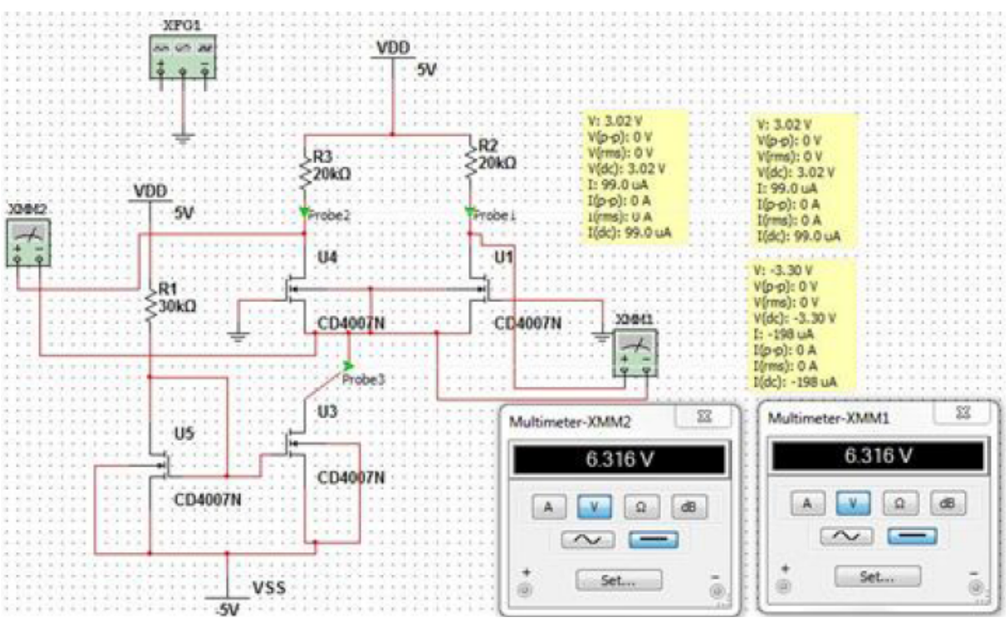


Figure 7: Here we are using probes to measure the voltages across the transistors separately and both of the gates of the transistor are grounded so that the input signal is zero. SO when the input signal is zero, the each amplifier produces about 6.316 Volts.

6 Conclusion

- The differential amplifier reduces noise by cancellation technique and extracts the useful information for amplification purposes. this is the reason that mostly it is used as the first stage amplifier.
- The differential gain is actually the amplification done on the the difference of the input given to the first transistor and second transistor.
- Single ended gain is the gain calculated from output over the input of the single transistor.
- Differential gain stage is usually followed single stage amplifier to amplify and stabilize the overall output signal and to increase further the gain of the total amplifier.
- The current mirror is usually used in combination with the differential amplifier to affect the bias so that the transistors operate in active mode. The referencing current is produced outside the chip usually and then this current is mirrored all over the chip for biasing circuit purposes. The basic current biasing can be understood by the just imagining that if a castle has a gate and a army(current) is passing through. Then while the army is passing, the gate keeper cannot close the gate of the castle.
- The lower terminals of the active device are joined together and are connected to a current source for forcing the bias on the transistors to work in active mode.
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7 Team Dynamics

Part and Member	**Weight Grade**	**Muhammad Obaidullah**	**Bilal Arshad**
Abstract	10%	50%	50%
Introduction	15%	50%	50%
Procedure Part 1	15%	50%	50%
Procedure Part 2	15%	50%	50%
Results Part 1	15%	50%	50%
Results Part 2	15%	50%	50%
Conclusion	15%	50%	50%
Total	100%	50%	50%

References

[1] Carlo Sapijaszko. *DeVry University Teaches Electronics and Circuits Courses Using NI ELVIS and NI Multisim* DeVry University . [Electronic]. Available: `http://sine.ni.com/cs/app/doc/p/id/cs-11163` [7 June 2013].

[2] Differential Amplifier. *MOSFET DIFFERENTIAL AMPLIFIER* TWO-WEEK LAB [Electronic]. Page 1. Available: `http://www.bu.edu/eng/courses/ec410/documents/mosfet-differential-amplifier.pdf` [7 June 2013].

[3] Navitron Ltd. *Wind Power* News and Information about Wind Energy Technologies. [Electronic]. Available: `http://www.alternative-energy-news.info/technology/wind-power/` [4 June 2013].