



SRI CHANDRASEKHARENDRA SARASWATHI VISWA MAHAVIDYALAYA

(University established under section 3 of UGC Act 1956)

(Accredited with 'A' Grade by NAAC)

Enathur, Kanchipuram – 631 561

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

LABORATORY MANUAL FOR
ELECTRONIC DEVICES LABORATORY
FULL TIME B.E., II YEAR / III SEMESTER

Prepared by : Dr.S.Omkumar, ECE

Shri. R.Palani, Lab. Instructor/ECE

Approved by : Prof.V.Swaminathan, HOD/ECE



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MAHAVIDYALAYA**

**DEPARTMENT OF ELECTRONICS AND
COMMUNICATION ENGINEERING**

**ELECTRONIC DEVICES
LABORATORY MANUAL**

REGISTER NUMBER :

NAME OF THE STUDENT :

YEAR / SEM :

ELECTRONIC DEVICES LABORATORY SYLLABUS

1. Study of ELVIS
2. Study of LabVIEW
3. P-N Junction Diode Characteristics (Forward & Reverse bias)
4. Zener Diode Characteristics
 - Part A: V-I Characteristics
 - Part B: Zener Diode act as a voltage regulator
5. Rectifiers (without and with c-filter)
 - Part A: Half Wave Rectifier
 - Part B: Full Wave Rectifier
6. BJT characteristics (CE configuration)
 - Part A: Input Characteristics
 - Part B: Output Characteristics
7. FET Characteristics (CS configuration)
 - Part A: Drain (output) Characteristics
 - Part B: Transfer Characteristics
8. SCR Characteristics
9. UJT Characteristics
10. CRO operation and its Measurements
11. Clipper operation using ELVIS
 - a. Study the operation of positive, negative biased and combinational clippers
12. Transistor biasing using ELVIS
13. BJT –CE Amplifier using Multisim/LabVIEW.
14. Emitter Follower-CC Amplifier using Multisim/LabVIEW.
15. FET-CS Amplifier using Multisim /LabVIEW.

ELECTRONIC DEVICES LABORATORY

LIST OF EXPERIMENTS

1. Study of ELVIS
2. Study of LabVIEW
3. Study of MULTISIM
4. Study and plot VI Characteristics of a **PN Junction Diode** (IN 4001) using discrete Components, MULTISIM and ELVIS.
5. Study and plot VI Characteristics of a **Zener Diode** (ZENER/6.1V) using discrete Components, MULTISIM and ELVIS.
6. Design, Construct and Test a Voltage Regulator with **Zener Diode** (ZENER/6.1V) using discrete components, MULTISIM and ELVIS.
7. Design, Construct and Test a **Half Wave Rectifier** using diode and to draw its performance characteristics using discrete Components, MULTISIM and ELVIS.
8. Design, Construct and Test a **Full Wave Rectifier** using diode and to draw its performance characteristics using discrete Components, MULTISIM and ELVIS.
9. Study and plot Input and output characteristics of a **Bipolar Junction Transistor (BJT)** in Common Emitter (CE) configuration using discrete Components, MULTISIM and ELVIS.
10. Study and plot the Drain and Transfer characteristics of a **Junction Field Effect Transistor** using discrete Components, MULTISIM and ELVIS.
11. Study and plot the characteristics of **Silicon Controlled Rectifier** (SCR) using discrete Components, MULTISIM and ELVIS.
12. Study and plot the characteristics of **Uni- Junction Transistor** (UJT) using discrete Components, MULTISIM and ELVIS.
13. Study the characteristics of **Cathode Ray Oscilloscope** (CRO) and its operation.
14. Construct and Test **Positive Clipper / Negative Clipper** circuits using discrete components, MULTISIM and ELVIS.
15. Construct and Test **Positive Clamper / Negative Clamper** using discrete components, MULTISIM and ELVIS.
16. Study and plot Input and output characteristics of a **Bipolar Junction Transistor (BJT)** in Common Emitter (CB) configuration using discrete Components, MULTISIM and ELVIS.
17. Study of input-output waveforms of **Common Collector** (CC) amplifier using MULTISIM and ELVIS.
18. Study of characteristics of Bipolar Junction Transistor (BJT) biasing using ELVIS

Introduction

There are 3 hours allocated to a Electronic Devices and Circuits Laboratory session in lab. It is a necessary part of the course at which attendance is compulsory.

Here are some guidelines to help you perform the experiments and to submit the

Reports:

1. Read all instructions carefully and carry them all out.
2. Ask the demonstrator if you are unsure of anything.
3. Record actual results (comment on them if they are unexpected!)
4. Write up full and suitable conclusions for each experiment.
5. If you have any doubt about the safety of any procedure, contact the demonstrator beforehand.
6. **THINK** about what you are doing!

Course Designed by	Department of Electronics and Communication Engineering	
Category	Simulation based Experiments (SBE)	
	Discrete based Experiments (DBE)	
Broad Area of Syllabus	ELECTRONICS DEVICES LABORATORY	
Staffs Responsible for Preparation of Contents in the Manual	Dr.S.Omkumar, Asso.Prof/ECE Shri.R.PALANI, Lab Instructor/ECE	
Date of Preparation	June 2021	Approved by: Prof. V.Swaminathan HOD/ ECE

STUDY OF ELVIS

EX.NO: 1

DATE:

AIM:

To Study the NI ELVIS.

THEORY:

Educational Laboratory Virtual Instrumentation Suite (ELVIS) Virtual instrumentation is defined as the combination of measurement and control hardware and application software with industry-standard computer technology to create user-defined instrumentation systems

Virtual instrumentation provides an ideal platform for developing instructional curriculum and conducting scientific research. The modular nature of virtual instrumentation makes it easy to add new functionality. NI ELVIS uses LabVIEW-based software and NI data acquisition hardware to create a virtual instrumentation system that provides the functionality of a suite of instruments.

1. Concepts in Context

Projects that inherently challenge to employ innovative design thinking often involve interacting with an unknown process or device. Designing a test in this style not only requires an understanding of specifications, the limitations of the equipment, and the fundamental concepts being applied but it also requires to contend with outside factors and how one change can have a cascading effect on the experimental setup.

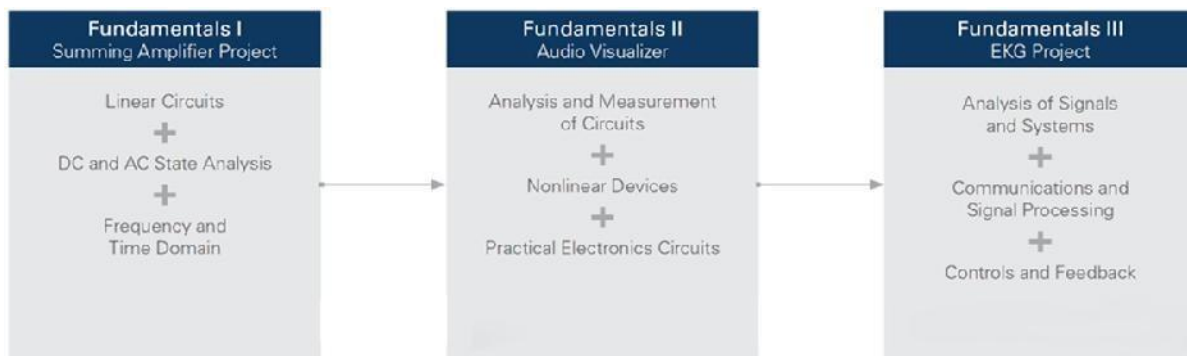


Figure 1: Topic distribution of the Fundamentals series of courses

Fundamentals seeks to convey the fundamentals of electrical engineering including circuits, electronics, and signals and systems all in one series of courses that iteratively build on each other. So rather than teaching Operational Amplifiers as an individual topic, the signals that go into the OpAmp and how those characteristics influence the performance of the OpAmp is analysed. OpAmps, and signals to fully comprehend every element of the project.

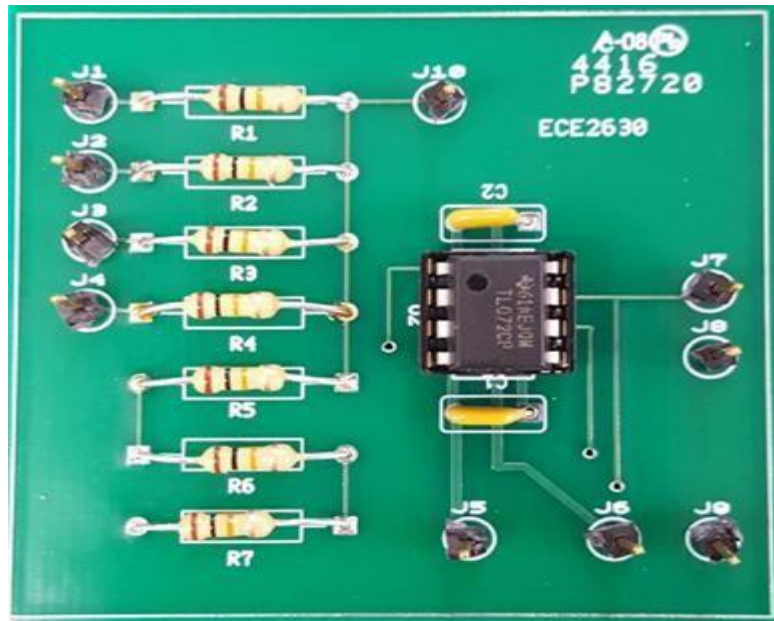


Figure 2: Fundamentals I at UVA final summing amplifier project

To most effectively analyze concepts in this manner, the ability to effectively instrument and analyze the experiment, but precise control and the ability to manipulate the type and behavior of the inputs to the system are critical for understanding. The NI ELVIS II is the only engineering laboratory solution that combines 7 traditional instruments with fully customizable I/O, enabling complete implementation of the concepts in context approach.

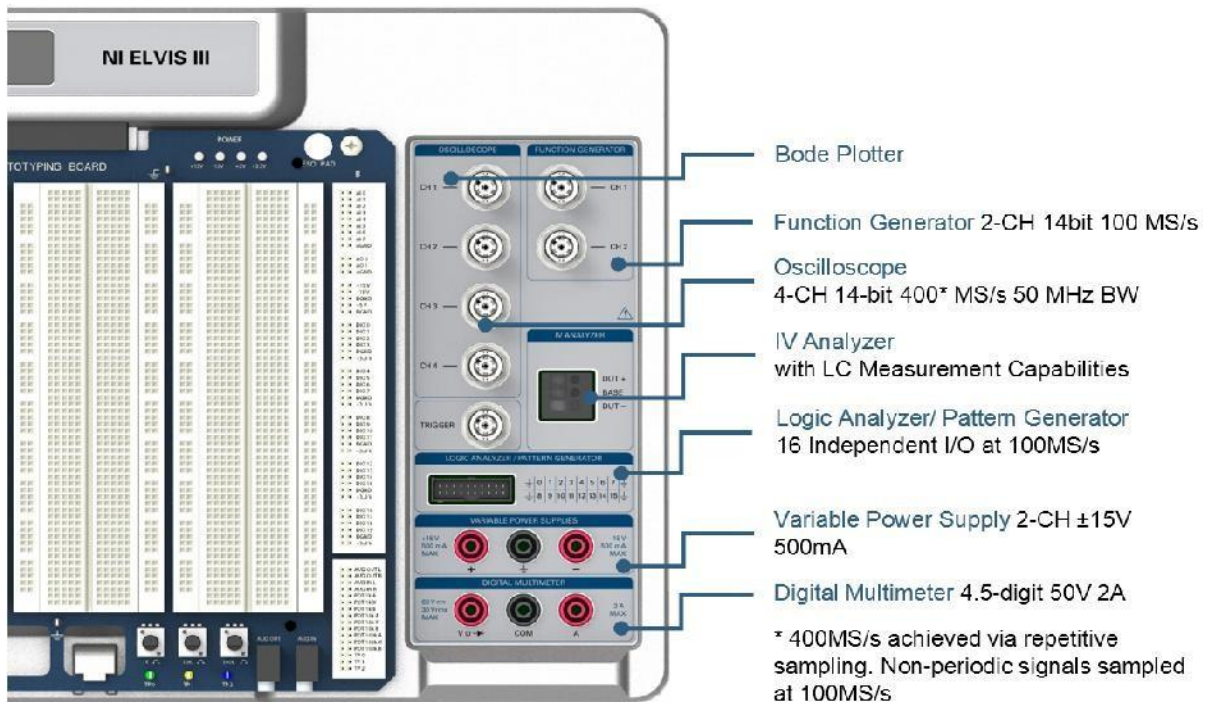


Figure 3: NI ELVIS II instrumentation specifications

The NI ELVIS II combines instrumentation and control specifically to service experiments and learning experiences like this one. The need to create a controller which precisely shakes a beam yet the amplifier for the shaker and the signal conditioning for the force transducer needs to be stable and accurate to ensure a successful experiment. Instruments such as a 4-channel oscilloscope and a 16-channel logic analyzer gives the security of knowing the results of their experiment are valid.

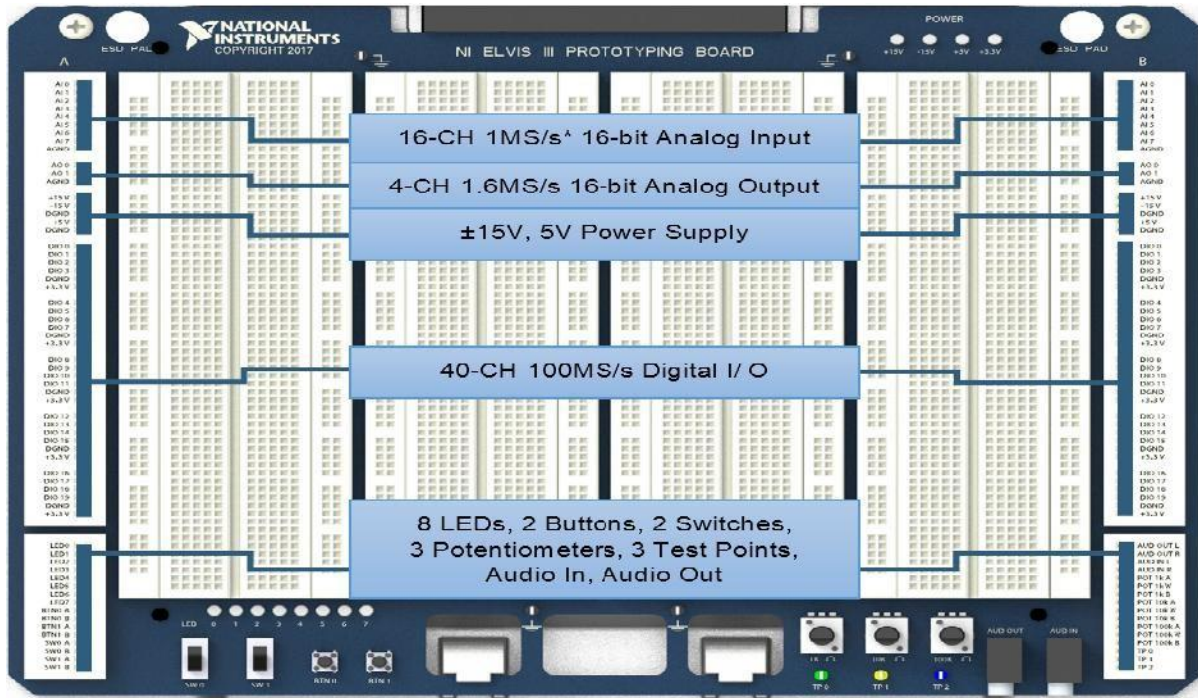


Figure 4: NI ELVIS II control I/O specifications



Figure 5: Output waveform of EKG in LabVIEW

NI ELVIS II enables to teach innovation by allowing to challenge with more projects that follow the engineering design process.

- (a) an ability to apply knowledge of mathematics, science and engineering
- (d) an ability to function on multidisciplinary teams
- (e) an ability to identify, formulate, and solve engineering problems
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

RESULT:

Thus the Study of NI ELVIS was done successfully.

STUDY OF LabVIEW

EX.NO: 2

DATE:

AIM:

To Study the LabVIEW

THEORY:

LabVIEW is a graphical programming language frequently used for creating test, measurement, and automation applications. The NI ELVIS software, created in LabVIEW, takes advantage of the capabilities of virtual instrumentation. The software includes SFP instruments, the LabVIEW API, and Signal Express blocks for programming the NI ELVIS hardware. LabVIEW uses icons instead of lines of text to create applications. Unlike text-based programming languages, LabVIEW uses dataflow programming, where the flow of data determines execution. A virtual instrument (VI) is a LabVIEW program that models the appearance and function of a physical instrument. The flexibility, modular nature, and ease-of-use programming possible with LabVIEW makes it popular in top university laboratories. With LabVIEW, one can rapidly create applications using intuitive graphical development and add user interfaces for interactive control. Scientists and engineers can use the straightforward I/O functionality of LabVIEW along with its analysis capabilities. One can also use LabVIEW in the classroom to solve purely analytical or numerical problems. The NI ELVIS 2.0 or later software includes a calibration utility that can used to recalibrate the NI ELVIS variable power supplies and function generator circuitry.

Signal Express

Signal Express is an interactive, standalone non programming tool for making measurements. Signal Express can be interactively used for the following:

- Acquiring, generating, analyzing, comparing, importing, and saving signals.
- Comparing design data with measurement data in one step.
- Extending the functionality of SignalExpress by importing a custom VI created in LabVIEW or by converting a SignalExpress project to a LabVIEW program so we can continue development in the LabVIEW environment.

NI ELVIS uses LabVIEW-based software instruments, a multifunction DAQ device, and a custom-designed bench top workstation and prototyping board to provide the functionality of a suite of common laboratory instruments. The NI ELVIS hardware provides a function generator and variable power supplies from the bench top workstation.

Using NI ELVIS in Signal Express

To use an NI ELVIS instrument within Signal Express complete the following steps: 1. Launch Signal Express.

1. Click the **Add Step** button.
2. If NI ELVIS 2.0 or later is installed, NI ELVIS is in the list of steps. Expand NI ELVIS. 3. Choose the instrument to add under **Analog** or **Digital»Acquire** or **Generate Signals**.
4. Click the **Configure** button to select the DAQ device cabled to the NI ELVIS Benchtop Workstation.
5. Set the various controls on the configuration panel appropriately for the measurement.
6. Run the Signal Express project.

NI ELVIS LabVIEW

The NI ELVIS LabVIEW soft front panel (SFP) instruments combined with the functionality of the DAQ device and the NI ELVIS workstation provide the functionality of the following SFP instruments:

- Arbitrary Waveform Generator (ARB)
- Bode Analyzer Digital Bus Reader
 - Digital Bus Writer
- Digital Multimeter (DMM)
- Dynamic Signal Analyzer (DSA)
 - Function Generator (FGEN)
- Impedance Analyzer
- Oscilloscope (Scope)
 - Two-Wire Current Voltage Analyzer
 - Three-Wire Current Voltage Analyzer
- Variable Power Supplies












NI ELVIS Express VI			
 NI ELVIS Oscilloscope	 NI ELVIS Digital Multimeter	 NI ELVIS Bode Analyzer	 NI ELVIS Two-Wire Current-Voltage Analyzer
 NI ELVIS Three-Wire Current-Voltage Analyzer	 NI ELVIS Impedance Analyzer	 NI ELVIS Variable Power Supplies	 NI ELVIS Arbitrary Waveform Generator
 NI ELVIS Function Generator	 NI ELVIS Digital Reader	 NI ELVIS Digital Writer	—

Table: NI ELVIS Express VI

Using NI ELVIS with LabVIEW

This section provides an overview of using NI ELVIS with LabVIEW.

LabVIEW Express VIs When using NI ELVIS 2.0 or later, many of the NI ELVIS instruments have an associated LabVIEW Express VI. The Express VIs are the recommended method for programming NI ELVIS in LabVIEW. Express VIs allow you to interactively configure the settings for each instrument. This enables you to develop LabVIEW applications without extensive programming expertise. To access the NI ELVIS Express VIs, open a LabVIEW block diagram and select **Instrument I/O»Instrument Drivers»NI ELVIS** from the function palette.

RESULT:

Thus the Study of LabView was done successfully.

STUDY OF MULTISIM

EX.NO: 3

DATE:

AIM:

To Study the operational Amplifier using MULTISIM Software

THEORY:

The purpose of this study is to demonstrate the use of MultiSim to simulate operational amplifier circuits (μ A741 OpAmp), such as inverting and non-inverting amplifiers, filters, and oscillators. The circuit shown in Figure 1 is used as a simulation example in the current tutorial.

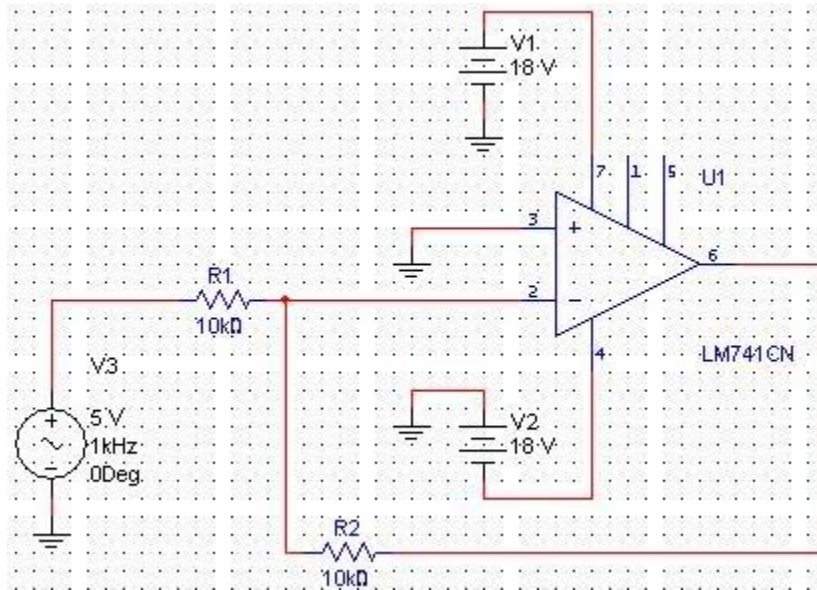
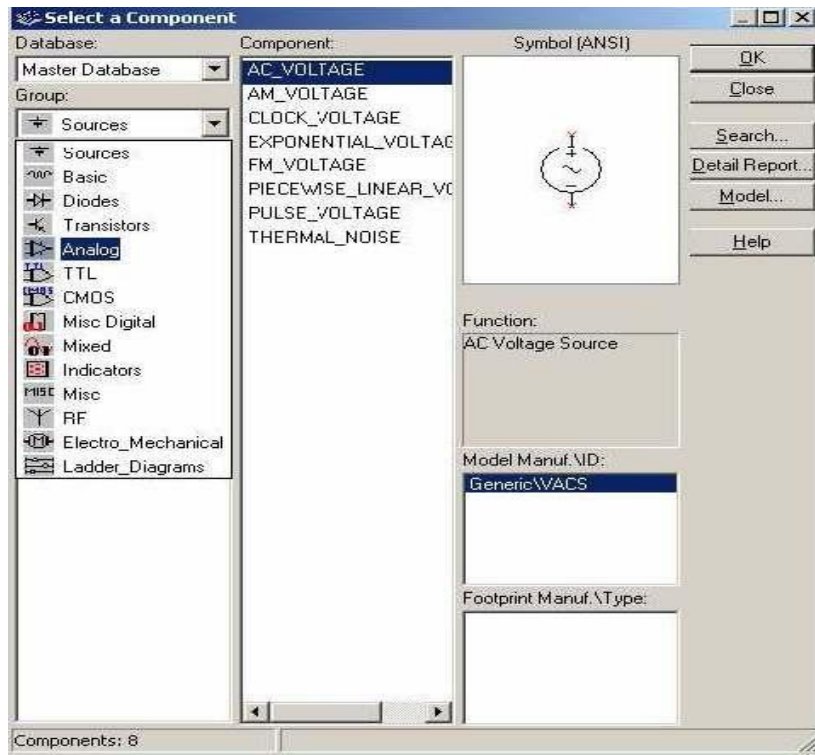
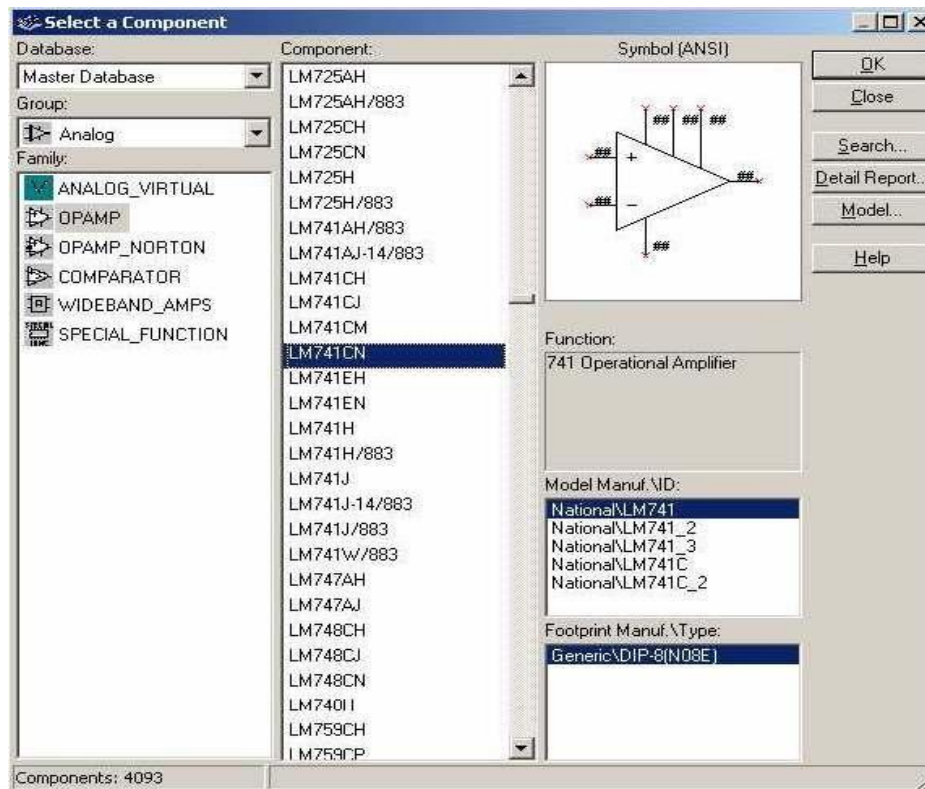


Figure 1. An inverting unity gain operational amplifier circuit

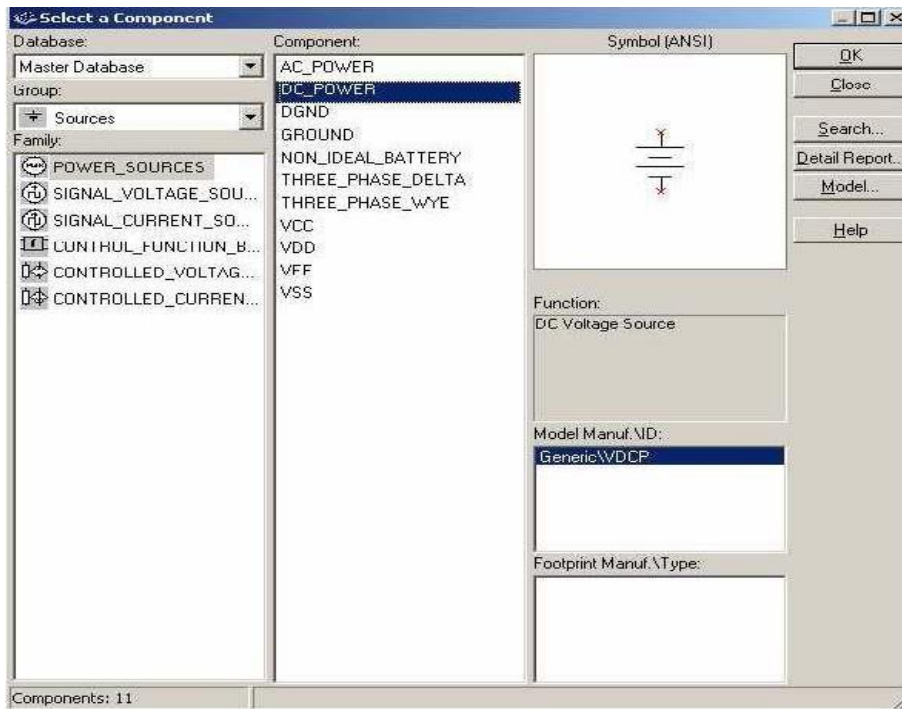
- 1) Start the MultiSim program as shown in the previous tutorial (For Windows users the default location can be found by clicking: Start ->All Programs -> Electronics Workbench -> DesignSuite Freeware Edition 9 -> MultiSim 9).
- 2) We will be creating a new schematic and simulation so choose File->SaveAs, navigate to or create a directory where we can save this schematic and simulation then fill in the filename as shown below. (I called this one tut1.) Click OK when we have navigated to the proper directory and entered a name for the project.
- 3) We should now have a blank schematic. Start placing components by selecting Place->Component from the menu bar. We will see another dialog box as shown. Start with the OpAmp so pick Analog Components in the drop down menu as shown:



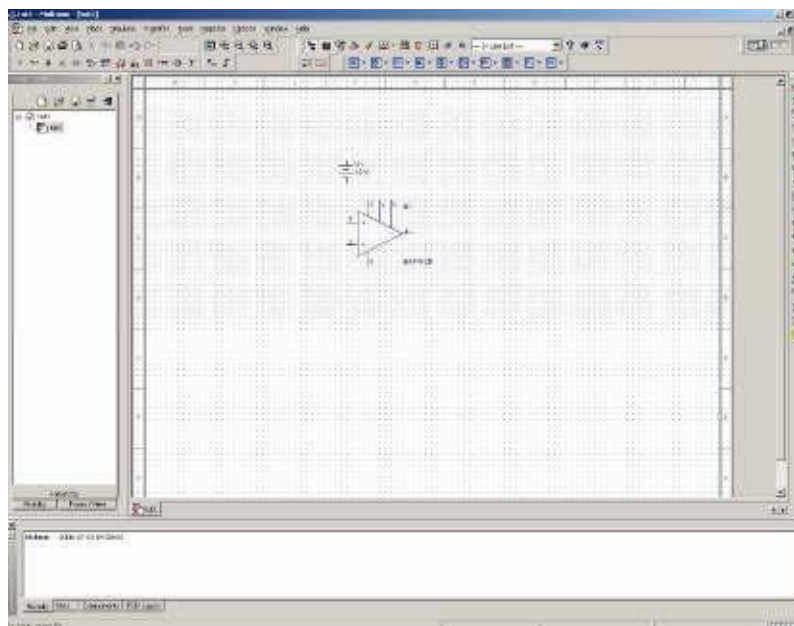
4) We should see a new dialog box. Select OPAMP then LM741CN as shown below then click OK.



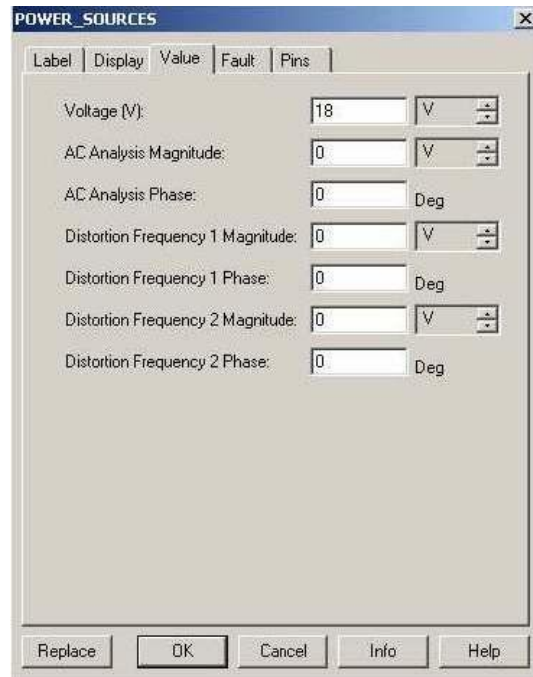
5) Place the OpAmp on the schematic. Next we must add a couple of power supply connections. We will add a DC source by again selecting Place->Component. Only this time pick SOURCES from the drop down menu. Then select POWER_SOURCES and DC_POWER as shown below then click OK.



6) Put the battery (DC power source) on the schematic somewhat above the OpAmp as shown below.

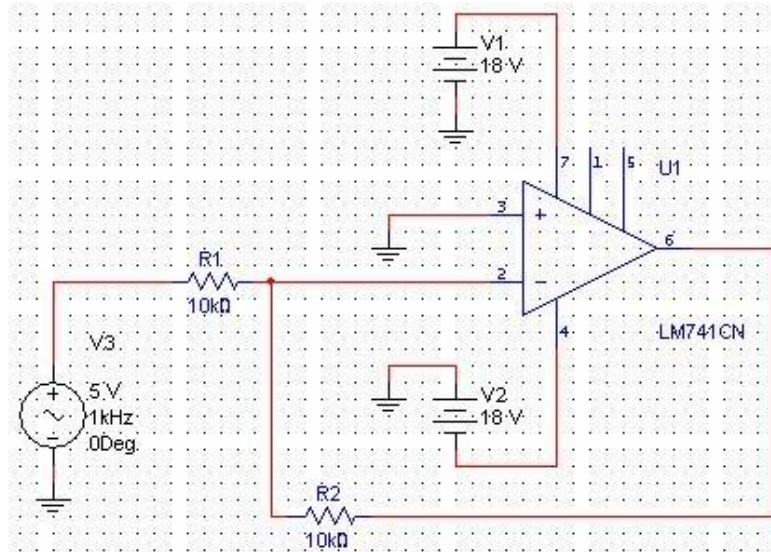


7) Double click on the “12V”. Change the voltage from 12 to 18 then click OK.

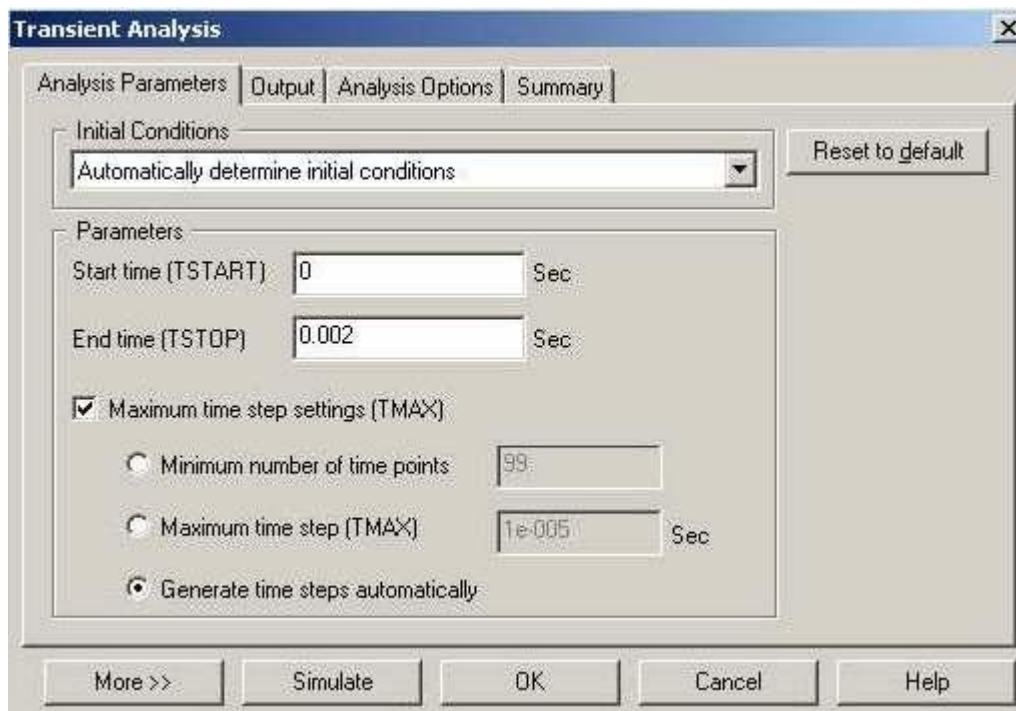


8) Place the rest of the components on the schematic as shown below. Use Place->Wire to add wires for connecting components together. Resistors are under the Basic components drop down menu. Note we must specify “k_” in the filter to locate the 10K resistors. Note GROUND symbols are at SOURCES->POWER_SOURCES. Wer completed schematic should resemble the one below.

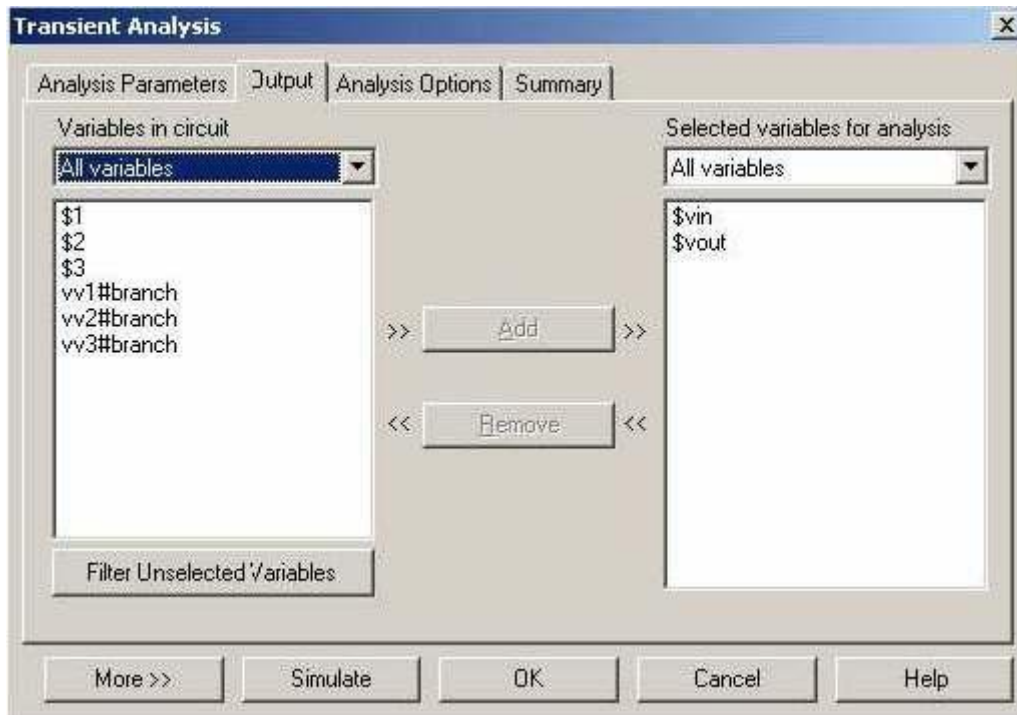
9) Be sure all components are connected as shown above. Now we will name the input and output signals to make them easier to locate in simulation. First highlight the wires above the 5V 1KHz source V3. Do this by placing the cursor on the red wire and left clicking once. Now right click once and select “properties” from the popup menu. Change the net name to Vin as shown on the next page then click OK. Use the same method to change the output net name to “Vout”.



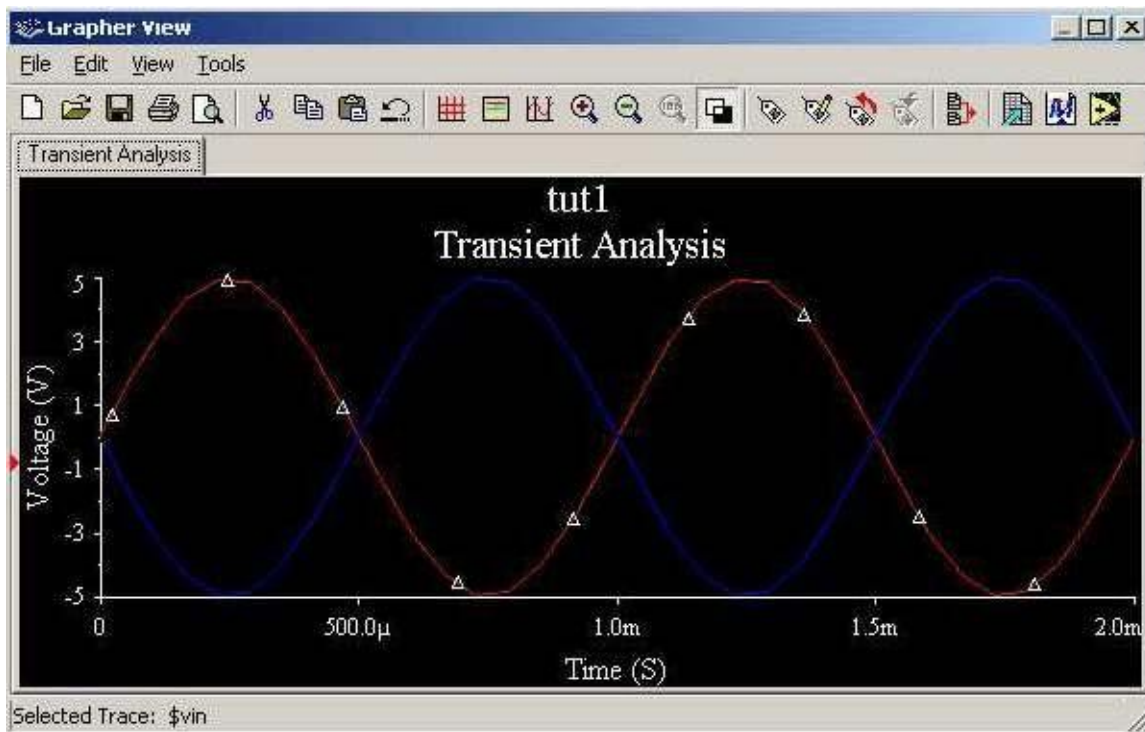
10) We will now run a simulation. First select Simulate->Analyses->Transient Analysis from the top menu bar. Change the End Stop Time (TSTOP) to 0.002 as shown below.



11) Next choose the Output page and select the two signals we want to see on the output. The dialog box should now look like the one on the next page.



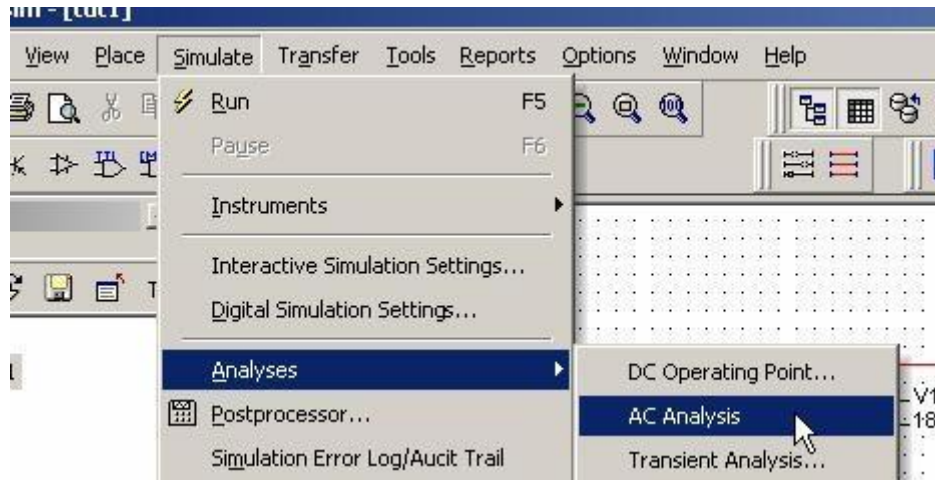
12) At this point we are ready to simulate. Left click on the Simulate button to run the simulation. We should get a result window that looks like the one below.



Now run an AC analysis to make a Bode plot of the response of our circuit. For an ideal Op Amp the gain would be always be 1. In the real world, capacitive and inductive

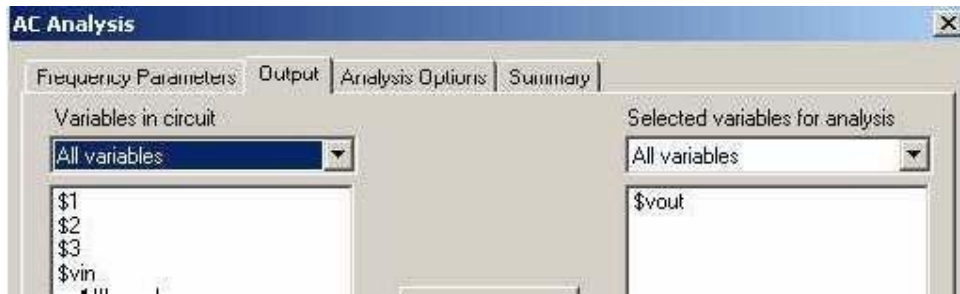
effects at higher frequencies cause the gain (and phase) to shift. The Bode plot is a graph of gain and a graph of phase shift relative to input frequency.

13) Select Simulate->Analyses->AC Analysis as shown.

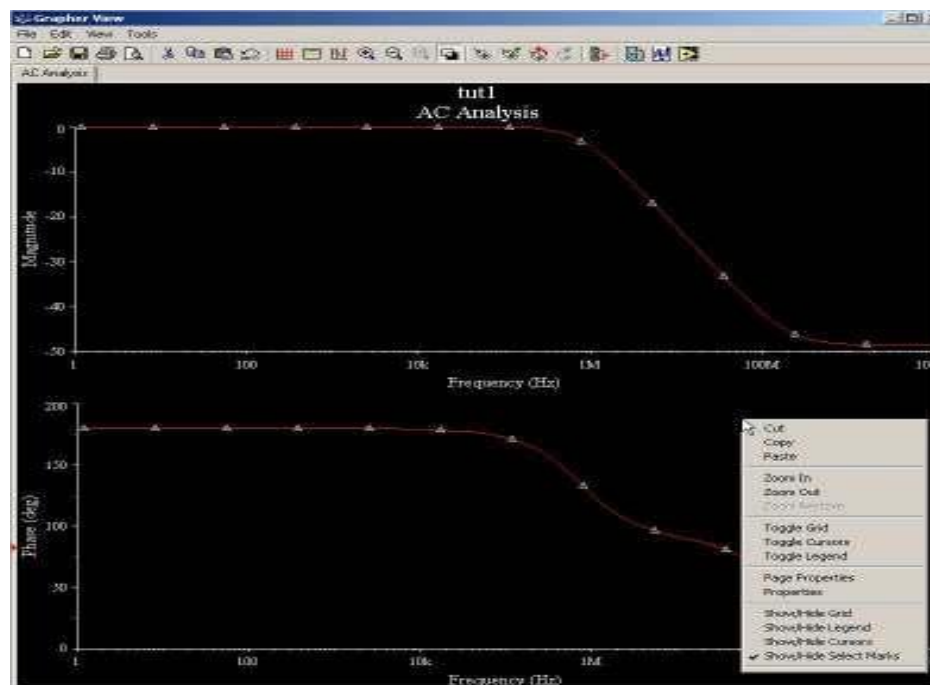


14) Make sure the frequency dialog box looks as shown below then click the Output tab. Make Vout the only output then click the Simulate button as before.





15) The simulation results should appear as below. Note the top graph is gain in decibels (0 db is the same as unity gain or 1). See how the gain rolls off starting around 1 MHz. The bottom graph is phase shift. Since this is an inverting configuration, expect the phase shift to be 180 degrees. But notice how it drops to around 90 degrees by 10MHz then rolls down to around 0 by 10GHz.

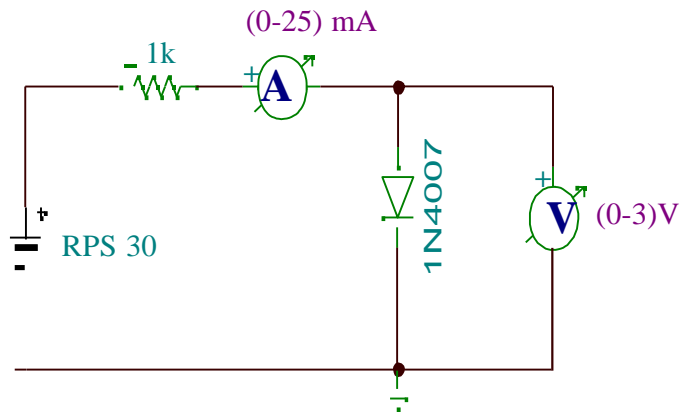


16) Put the cursor in the graph and right click to get the menu show. From there we can turn the grids on or off, add cursors, etc. we can also choose Properties and change the axes of the graphs. Use File->Print to print the Bode plot.

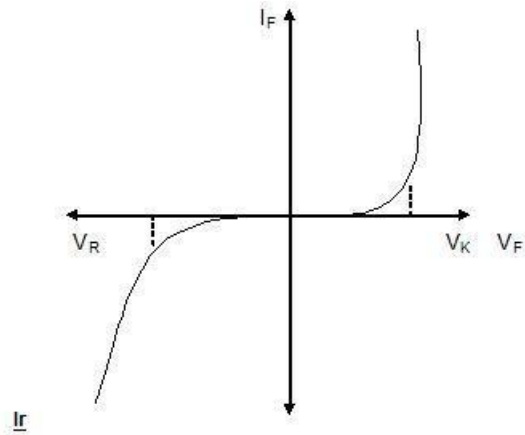
RESULT:

Thus the study of operational Amplifier using MULTISIM was done successfully.

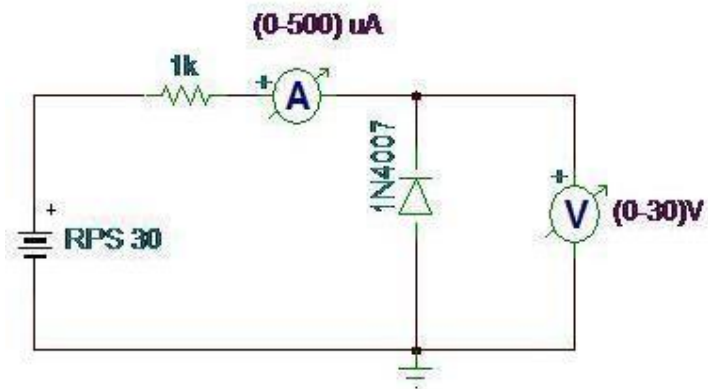
FORWARD BIAS CHARACTERISTICS:



MODEL GRAPH:



REVERSE BIAS CHARACTERISTICS:



CHARACTERISTICS OF PN DIODE

EX.NO: 4

DATE:

AIM:

To Study and plot VI Characteristics of a PN Junction Diode (IN 4001) using discrete Components, MULTISIM and ELVIS. Also calculate the forward resistance 'R_F' and cut- in voltage.

COMPONENTS & EQUIPMENTS REQUIRED:

S.No	APPARATUS	RANGE	QUANTITY
1	PN Junction diode	IN 4001	1
2	Resistor	1 K Ω	1
3	Ammeter	(0-30) mA, (0-500) μ A	Each 1
4	Voltmeter	(0-30)V, (0-3)V	Each 1
5	Regulated Power Supply	(0-30)V	1
6	Bread board	-	1
7	Connecting wires	-	Few

THEORY:

When a P and N type semi-conductors are formed together a P-N junction is created. There are two types of biasing. When a P-type semiconductor is connected to positive terminal of the battery and N-type Semiconductor to the negative terminal, the junction barrier vanishes leading to forward current. But when connections are interchanged the junction barrier increases very much leading to no current flow. But a small value of current, due to the minority carriers, known as reverse saturation current, is present there.

PROCEDURE:

1. Connections are given as per the circuit diagram.
2. Input supply voltage is varied.
3. The corresponding forward voltage and current are noted.
4. The readings are tabulated and the graph is plotted between the voltage on X-axis and current on Y-axis.
5. From the graph, the forward resistance $R_F = V_f/I_f$ and the cut-in voltage are calculated.

TABULATION:

Forward Bias

Sl. No.	V_{IN} (in Volts)	V_f (in Volts)	I_f (in mA)

Reverse Bias

Sl. No.	V_{IN} (in Volts)	V_R (in Volts)	I_R (in μA)

CALCULATIONS:

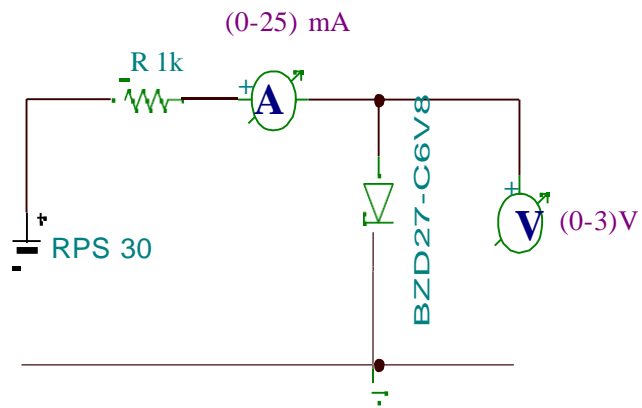
RESULT:

Thus the forward and reverse characteristics of a PN junction diode were plotted and the following observations were made.

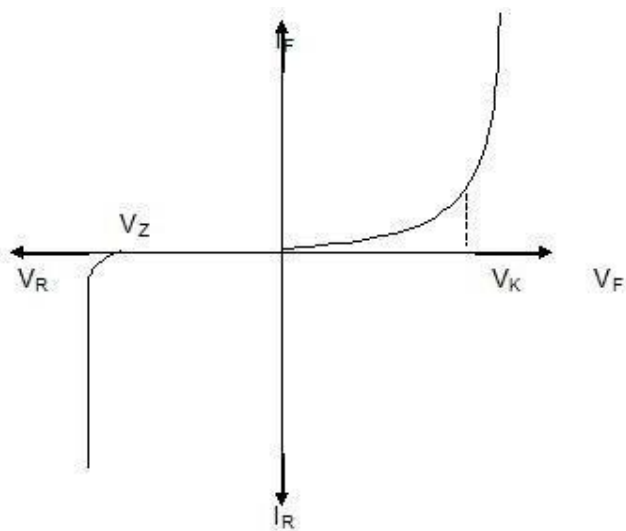
Forward resistance =

Cut-in voltage =

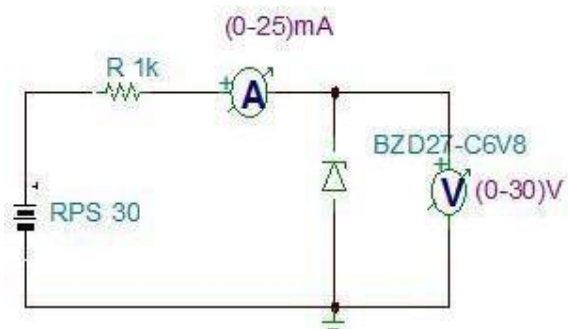
FORWARD BIAS CHARACTERISTICS:



MODEL GRAPH:



REVERSE BIAS CHARACTERISTICS:



CHARACTERISTICS OF ZENER DIODE

EX.NO:5

DATE:

AIM:

To Study and plot VI Characteristics of a Zener Diode using discrete Components, MULTISIM and ELVIS. Also to find the value of forward resistance, cut-in voltage and breakdown voltage.

COMPONENTS & EQUIPMENTS REQUIRED:

S.No	APPARATUS	RANGE	QUANTITY
1.	Zener diode 6.1V	Zener Diode	1
2.	Resistor	1 K Ω	1
3.	Ammeter	(0-30) mA	1
4.	Voltmeter	(0-30)V,(0-3)V	Each1
5	Regulated Power Supply	(0-30)V	1
6	Bread board	-	1
7	Connecting wires	-	Few

THEORY:

A Zener Diode conducts both in forward and reverse biased condition. In the forward bias condition, it acts like an ordinary PN-junction diode. But in reverse bias, due to avalanche breakdown at a particular value of voltage, known as Zener voltage, the current starts increasing abruptly even if the reverse voltage is kept constant. Hence Zener Diode is used as voltage regulator.

PROCEDURE:

1. Connections are given as per the circuit diagram.
2. Input supply voltage is varied.
3. The corresponding forward voltage and current are noted.
4. The readings are tabulated and the graph is plotted between the voltage on x-axis and current on y-axis.
5. From the graph the forward resistance $R_F = \frac{V_f}{I_f}$ and cut-in voltage are calculated.

TABULATION:

Forward Bias

Sl. No.	V_{IN} (in Volts)	V_f (in Volts)	I_f (in mA)

Reverse Bias

Sl. No.	V_{IN} (in Volts)	V_R (in Volts)	I_R (in mA)

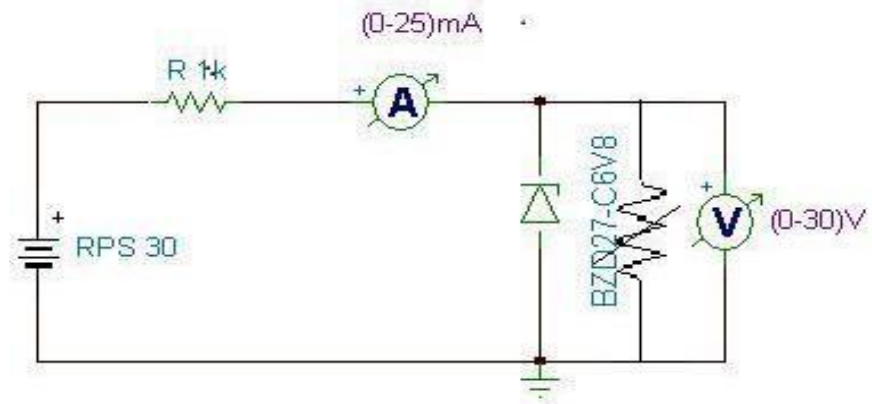
CALCULATIONS:

RESULT:

Thus the forward and reverse characteristics of a Zener diode were plotted and following observations were made.

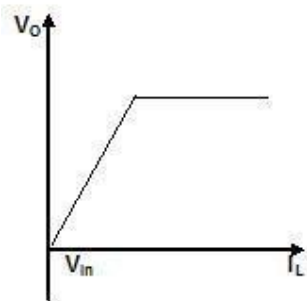
Forward resistance	=
Cut-in voltage	=
Breakdown voltage	=

CIRCUIT DIAGRAM:

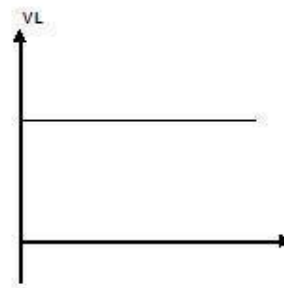


MODEL GRAPH:

LINE REGULATION:



LOAD REGULATION:



VOLTAGE REGULATOR USING ZENER DIODE

EX.NO: 6

DATE:

AIM:

To Design, Construct and Test a Voltage Regulator with Zener Diode using discrete components, MULTISIM and ELVIS. Also to find its regulated voltage.

COMPONENTS & EQUIPMENTS REQUIRED:

S.No	APPARATUS	RANGE	QUANTITY
1	Zener Diode	Zener diode	1
2	Voltmeter	(0-30) V	1
3	Resistor	100 Ω	1
4	Ammeter	(0-50) mA	1
5	DRB Box	-	1
6	Bread board	-	1
7	Connecting wires	-	Few

THEORY:

The distinct property of the Zener diode as compared to ordinary P-N Jn diode is : it maintains a constant voltage level when it is reverse biased. When the reverse voltage exceeds the breakdown value, avalanche breakdown occurs. The electrons having acquired higher momentum overcome the potential barrier. In this region, the diode has dynamic resistance due to which current increases abruptly and its resistance decreases. Since the load is connected in parallel, the voltage remains constant. Hence the name “constant voltage regulator”.

TABULATION:

Line Regulation

$R_L =$

Sl.NO	V_{in} (V)	V_o (V)	I_l (mA)

Load Regulation

$V_{IN} =$

Sl.NO	R_l (Ω)	V_o (v)	I_l (mA)

CALCULATIONS:

PROCEDURE:

Line Regulation

1. The connection is made as per the circuit diagram
2. Keep the Load resistance value constant, say, $R_L = K\Omega$.
3. Vary the input voltage and note down the corresponding output voltage.
4. Find the breakdown voltage value and also plot the graph.

Load Regulation

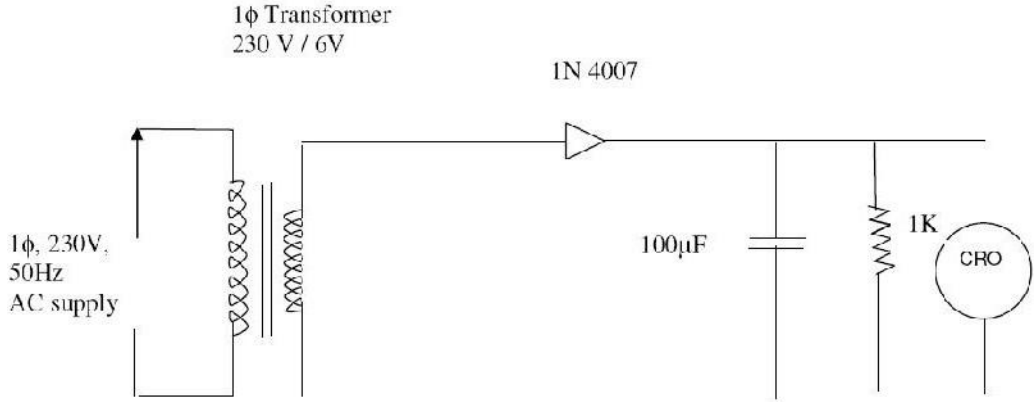
5. Keep the input voltage constant ,say, $V_{in} =$
6. Vary the Load resistance and note down the corresponding output voltage.
7. Find the breakdown voltage value and also plot the graph

RESULT:

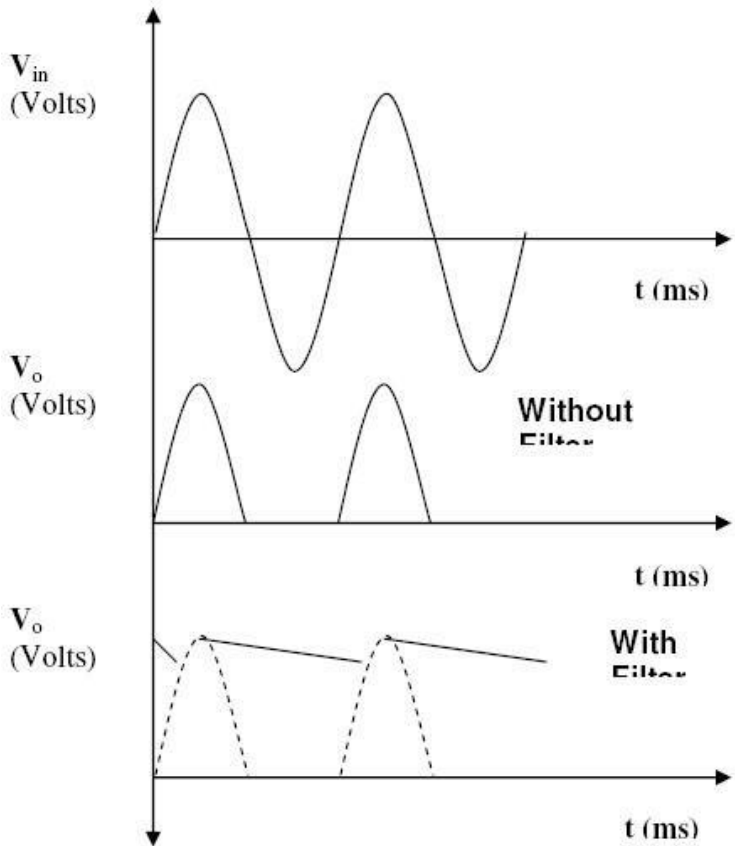
A voltage regulator using Zener diode has been constructed and its characteristics were verified.

Regulated voltage =

CIRCUIT DIAGRAM:



MODEL GRAPH:



HALF WAVE RECTIFIER

EX.NO: 7

DATE:

AIM:

To construct a Half Wave Rectifier using diode and to draw its performance characteristics using discrete Components, MULTISIM and ELVIS.

APPARATUS REQUIRED:

S.No	APPARATUS	RANGE	QUANTITY
1	Transformer	230/(12-0-12)V	1 No
2	R.P.S	(0-30)V	2
3	Ammeter	(0-30)mA, (0-250) μ A	Each 1
4	Voltmeter	(0-30)V, (0-2)V	Each 1
5	Diode	IN4001	1
6	Resistor	1K Ω	1
7	Capacitor	100 μ f	1
8	Bread Board	-	1
9	Connecting wires	-	Few

THEORY:

In half wave rectifier only half cycle of applied AC voltage is used. Another half cycle of AC voltage (negative cycle) is not used. Only one diode is used which conducts during positive cycle. The circuit diagram of half wave rectifier without capacitor is shown in the following figure. During positive half cycle of the input voltage anode of the diode is positive compared with the cathode. Diode is in forward bias and current passes through the diode and positive cycle develops across the load resistance R_L . During negative half cycle of input voltage, anode is negative with respected to cathode and diode is in reverse bias. No current passes through the diode hence output voltage is zero.

TABULATION:

WITHOUT FILTER

Vm	Vrms	Vdc	Ripple factor	Efficiency

WITH FILTER

Vm	Vrms	Vdc	Ripple factor	Efficiency

PROCEDURE:**WITHOUT FILTER:**

1. Give the connections as per the circuit diagram.
2. Give 230v, 50HZ I/P to the step down TFR where secondary connected to the Rectifier I/P.
3. Take the rectifier output across the Load.
4. . Plot its performance graph.

WITH FILTER:

1. Give the connections as per the circuit diagram.
2. Give 230v, 50HZ I/P to the step down TFR where secondary connected to the Rectifier I/P.
3. Connect the Capacitor across the Load.
4. Take the rectifier output across the Load.
5. Plot its performance graph.

FORMULAE:**WITHOUT FILTER:**

- (i) $V_{rms} = V_m / \sqrt{2}$
- (ii) $V_{dc} = V_m / \pi$
- (iii) Ripple Factor = $\sqrt{(V_{rms} / V_{dc})^2 - 1}$
- (iv) Efficiency = $(V_{dc} / V_{rms})^2 \times 100$

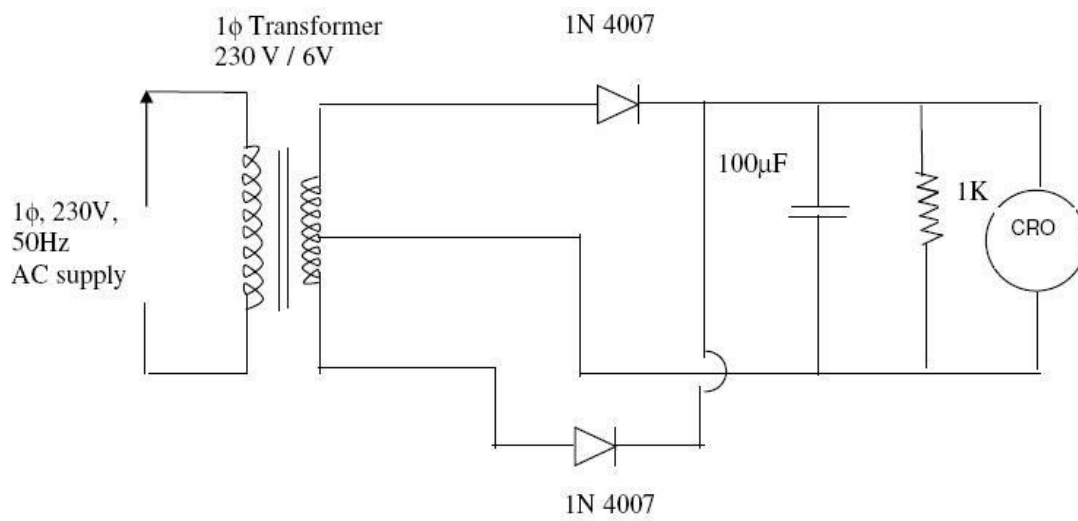
WITH FILTER:

- (i) $V_{rms} = \sqrt{V_{rms}'^2 + V_{dc}^2}$
- (ii) $V_{rms}' = V_{rpp} / (\sqrt{3} \times 2)$
- (iii) $V_{dc} = V_m - V_{rpp} / 2$
- (iv) Ripple Factor = V_{rms}' / V_{dc}

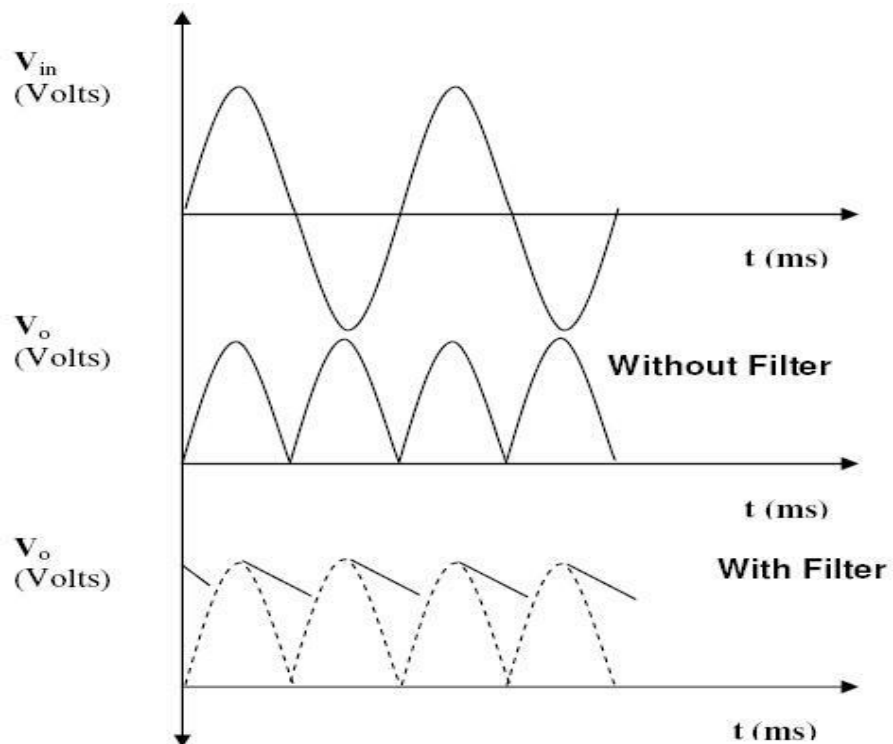
RESULT:

Thus the performance characteristics of Half wave rectifier was obtained.

CIRCUIT DIAGRAM:



MODEL GRAPH:



FULL WAVE RECTIFIER

EX.NO: 8

DATE:

AIM:

To construct a Full Wave Rectifier using diode and to draw its performance characteristics using discrete Components, MULTISIM and ELVIS.

COMPONENTS & EQUIPMENTS REQUIRED:

SNo	APPARATUS	RANGE	QTY
1	Transformer	230 /(12-0-12)V	1
2	R.P.S	(0-30)V	2
5	Diode	IN4007	1
6	Resistor	1K Ω	1
7	Capacitor	100 μ f	1
8	Bread Board	-	1
9	Connecting Wires	-	Few

THEORY:

The Bridge rectifier is a circuit, which converts an ac voltage to dc voltage using both half cycles of the input ac voltage. The Bridge rectifier circuit is shown in the following figure. The circuit has four diodes connected to form a bridge. The ac input voltage is applied to the diagonally opposite ends of the bridge. The load resistance is connected between the other two ends of the bridge. For the positive half cycle of the input ac voltage, diodes D1 and D2 conduct, whereas diodes D3 and D4 remain in the OFF state. The conducting diodes will be in series with the load resistance RL and hence the load current flows through RL. For the negative half cycle of the input ac voltage, diodes D3 and D4 conduct whereas, D1 and D2 remain OFF. The conducting diodes D3 and D4 will be in series with the load resistance RL and hence the current flows through RL in the same direction as in the previous half cycle. Thus a bi-directional wave is converted into a unidirectional wave

TABULATION:**Without Filter**

V_m	V_{rms}	V_{dc}	Ripple factor	Efficiency

With Filter

V_{rms}	V_{rpp}	V_{dc}	Ripple factor	Efficiency

FORMULA:**Without Filter**

- (i) $V_{rms} = V_m / \sqrt{2}$
- (ii) $V_{dc} = 2V_m / \pi$
- (iii) $RippleFactor = \sqrt{(V_{rms}/V_{dc})^2}$
- (iv) $Efficiency = (V_{dc}/V_{rms})^2 \times 100$

With Filter

- (i) $V_{rms} = V_{rpp} / (2\sqrt{3})$
- (ii) $V_{dc} = V_m - V_{rpp}$
- (iii) $RippleFactor = V_{rms}' / V_{dc}$

PROCEDURE:**Without Filter**

1. Give the connections as per the circuit diagram.
2. Give 230v, 50HZ I/P to the step down TFR where secondary connected to the Rectifier I/P.
3. Take the rectifier output across the Load.
4. Plot its performance graph.

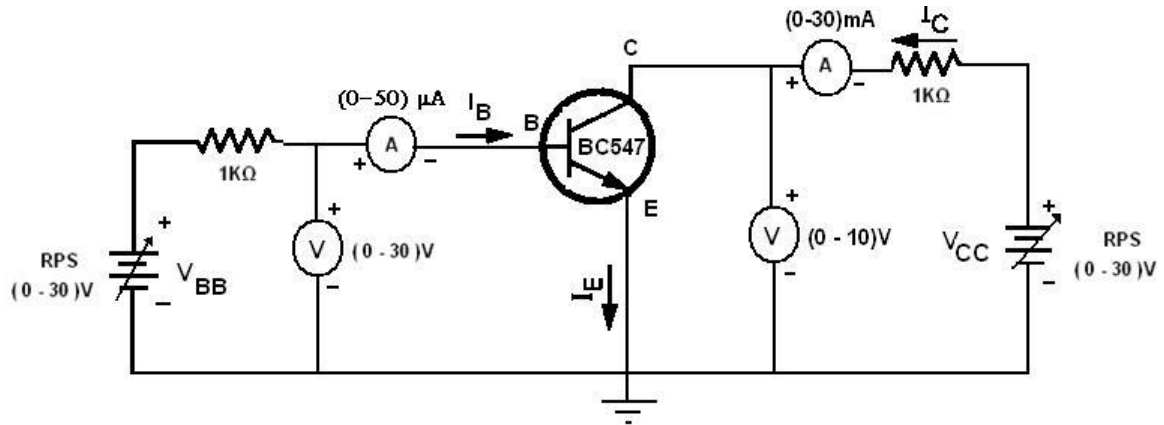
With Filter

5. Give the connections as per the circuit diagram.
6. Give 230v, 50HZ I/P to the step down TFR where secondary connected to the Rectifier I/P.
7. Connect the Capacitor across the Load.
8. Take the rectifier output across the Load.
9. Plot its performance graph.

RESULT:

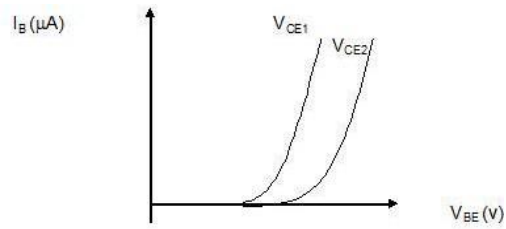
Thus the performance characteristics of Full wave rectifier were obtained.

CIRCUIT DIAGRAM:

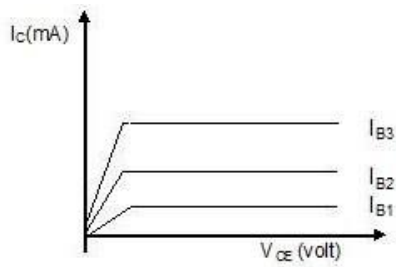


MODEL GRAPH:

Input Characteristics of BJT



Output Characteristics of BJT



CHARACTERISTICS OF BJT IN CE CONFIGURATION

EX.NO: 9

DATE:

AIM:

To plot the input and output characteristics of a Bipolar Junction Transistor (BJT) in Common Emitter (CE) configuration using discrete Components, MULTISIM and ELVIS.

COMPONENTS & EQUIPMENTS REQUIRED:

S.NO	APPARATUS	RANGE	QUANTITY
1	RPS	(0-30)V	2
2	Resistor	1K Ω	2
3	DC Voltmeter	(0-30)V	1
4	DC Voltmeter	(0-10)V	1
5	DC Ammeter	(0-500) μ A	1
6	DC Ammeter	(0-30)mA	1
7	BJT	BC547/BC 107	1
8	Breadboard	-	1
9	Connecting wires	-	Few

THEORY:

The input is applied between base and emitter and output is taken from the collector and emitter. Here, emitter of the transistor is common to both input and output circuits and hence the name common emitter (CE) configuration. Regardless of circuit configuration, the base emitter junction is always forward biased while the collector-base junction is always reverse biased, to operate transistor in active region.

INPUT CHARACTERISTICS:

$V_{CE} =$

S.NO	V_S (volt)	V_{BE} (volt)	I_B (μ A)

OUTPUT CHARACTERISTICS:

$I_B =$

S.NO	V_S (VOLTS)	V_{CE} (VOLTS)	I_C (mA)

PROCEDURE:

Input Characteristics

- 1) Connections are made as per the circuit diagram.
- 2) The output voltage V_{CE} is kept constant.
- 3) By varying the input voltage V_{BE} , the corresponding input currents I_B are noted down
- 4) A graph is plotted between V_{BE} and I_B .
- 5) The inverse slope of the curve gives forward input resistance.

Output Characteristics

1. Connections are made as per the circuit diagram.
2. The input current I_B is kept constant.
3. By varying the output voltage V_{CE} , the corresponding output current I_C is noted down.
4. A graph is plotted between V_{CE} and I_C .
5. The inverse slope of the curve gives forward output resistance.

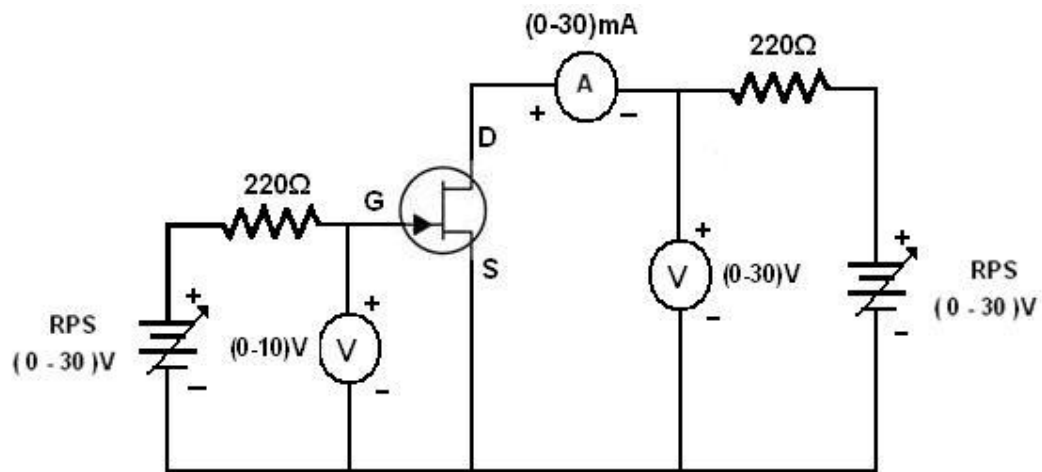
RESULT:

The input and output characteristics of the transistor in CE mode are drawn and the input and output resistances are calculated.

Input resistance =

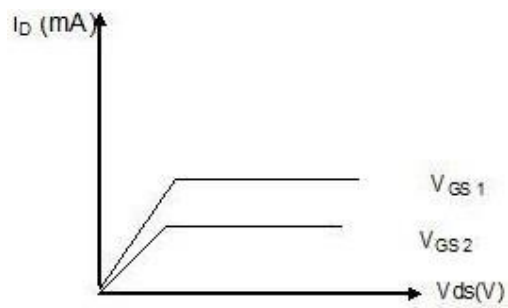
Output resistance =

CIRCUIT DIAGRAM:

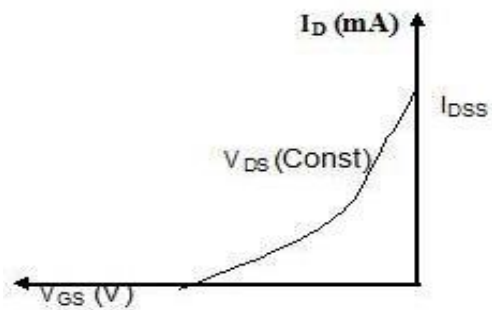


MODEL GRAPH:

Drain Characteristics



Transfer Characteristics



CHARACTERISTICS OF JFET

EX.NO: 10

DATE:

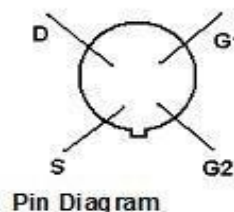
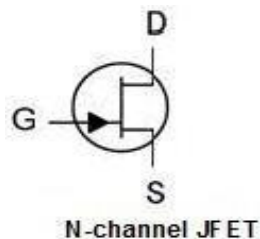
AIM:

To study and plot the Drain and Transfer characteristics of a Junction Field Effect Transistor (JFET / BFW 10) and to calculate the Trans conductance (g_m), Drain to Source resistance (r_d), Amplification factor (μ) using discrete Components, MULTISIM and ELVIS

COMPONENTS & EQUIPMENTS REQUIRED:

S.NO	APPARATUS	RANGE	QUANTITY
1	Regulated Power Supply	(0-30) V	2
2	Resistor	1K Ω	2
3	DC Voltmeter	(0-10) V	1
4	DC Voltmeter	(0-30) V	1
5	DC Ammeter	(0-30) mA	1
6	JFET	BFW10/11	1
7	Bread board	-	1
8	Connecting wires	-	Few

THEORY:



Unlike BJT, JFET is a Unipolar Junction Transistor with three terminals – Drain, Source and Gate. The channel of semiconductor material is doped to contain abundance of positive charge carriers (*p-type*), or of negative carriers (*n-type*). The Contacts at each end form the source and drain. The gate (control) terminal has doping opposite to that of the channel, so that there is a P-N junction at the interface. Terminals to connect with the outside are usually made Ohmic.

TABULATION:

DRAIN CHARACTERISTICS

Sl.No.	V _S (in Volts)	V _{GS} =		V _{GS} =	
		V _{DS} (V)	I _D (mA)	V _{DS} (V)	I _D (mA)

CALCULATIONS:

Drain Resistance $r_d = V_{DS} / I_d$

TRANSFER CHARACTERISTICS

Sl.No.	V _S (in Volts)	V _{DS} =	
		V _{GS} (V)	I _D (mA)

CALCULATIONS:

Amplification factor $(\mu) = g_m \times r_d$

PROCEDURE:

The connections are given as per the circuit diagram.

DRAIN CHARACTERISTICS

1. Voltage V_{GS} is kept at some fixed level.
2. The Drain to Source voltage V_{DS} is varied and the corresponding drain current I_d is noted. The Graph was plotted between V_{DS} on the x-axis and I_d on y-axis.
3. The drain resistance (r_d) was determined as $r_d = V_{DS} / I_d$

TRANSFER CHARACTERISTICS

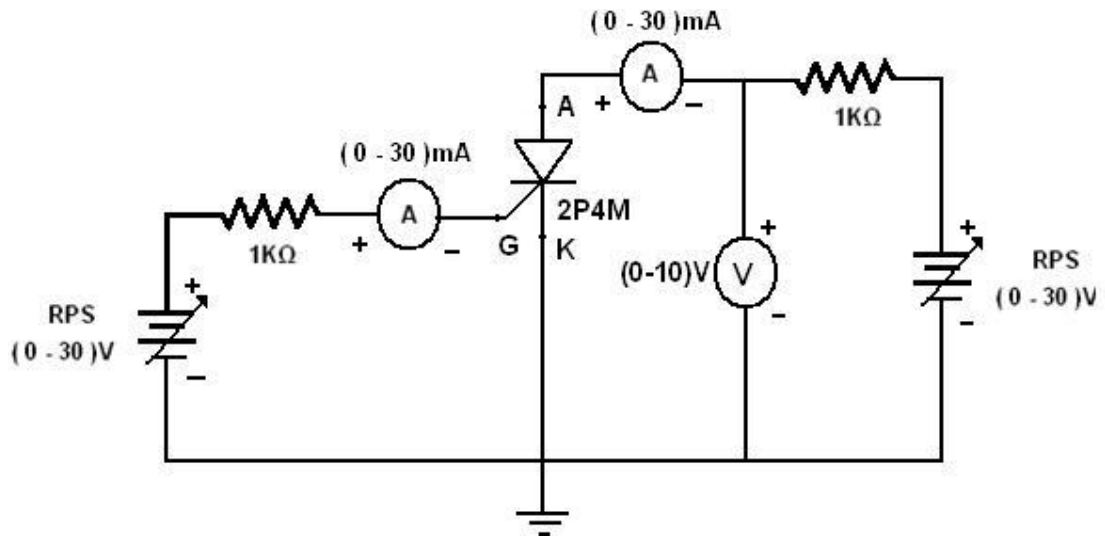
1. The V_{DS} is kept at some particular value.
2. The Source voltage V_{GS} is varied at some particular level and the corresponding drain current I_d was noted.
3. A graph was plotted between V_{GS} and I_D .
4. Transfer conductance value was determined by $g_m = I_d / V_{gs}$

RESULT:

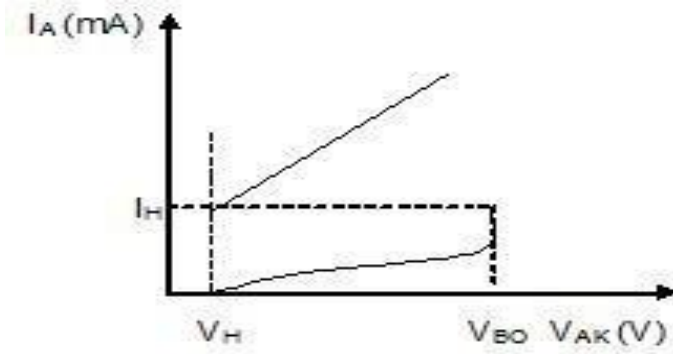
Thus the Drain and transfer characteristics of the given JFET were studied and the following values were determined.

- a) Drain resistance (r_d) =
- b) Trans-Conductance (g_m) =
- c) Amplification factor (μ) =

CIRCUIT DIAGRAM:



MODEL GRAPH:



CHARACTERISTICS OF SCR

EX.NO: 11

DATE:

AIM:

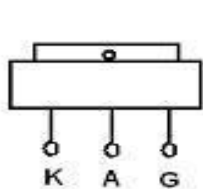
To study and plot the characteristics of silicon controlled rectifier (SCR) and also to find the holding voltage (V_H) and find the holding current using discrete Components, MULTISIM and ELVIS

COMPONENTS & EQUIPMENTS REQUIRED:

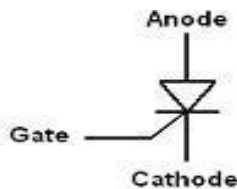
S.NO	APPARATUS	RANGE	QUANTITY
1	RPS	(0-30)V	2
2	Resistor	1K Ω	2
3	DC Voltmeter	(0-10)V	1
4	DC Ammeter	(0-30)mA	2
5	DC Ammeter	(0-3)mA	1
6	SCR	TYN612/2P4M	1
7	Breadboard	-	1
8	Connecting wires	-	Few

THEORY:

A SCR has two states, either it conducts heavily or does not conduct. Thus SCR behaves like a switch. To operate the SCR, the first method is to keep the gate open and make supply voltage equal to breakdown Voltage. The second method is to operate it with supply voltage less than breakdown voltage and then by means of a small voltage applied to the gate. Applying a small positive voltage to gate is equivalent to Close the SCR because the breakdown voltage is usually much greater than the supply voltage. Once SCR starts conducting, there is no need for any gate pulse.



Pin Diagram of SCR



Symbol of SCR

TABULATION:

I_G

S.No	V _S (volts)	V _{AK} (volts)	I _A (mA)

CALCULATIONS:

PROCEDURE:

1. The connections are given as per the circuit diagram.
2. The gate current I_g is increased until the SCR gets triggered.
3. For that particular value of I_g the anode voltage is varied and the corresponding anode current I_a is noted.
4. The graph between the anode voltage V_a on x-axis and the anode current I_a on y-axis are plotted.
5. For the next set of gate current I_g , the above procedure is repeated.
6. From the graph, the holding current I_H , holding voltage V_H , and breakdown voltage are calculated.

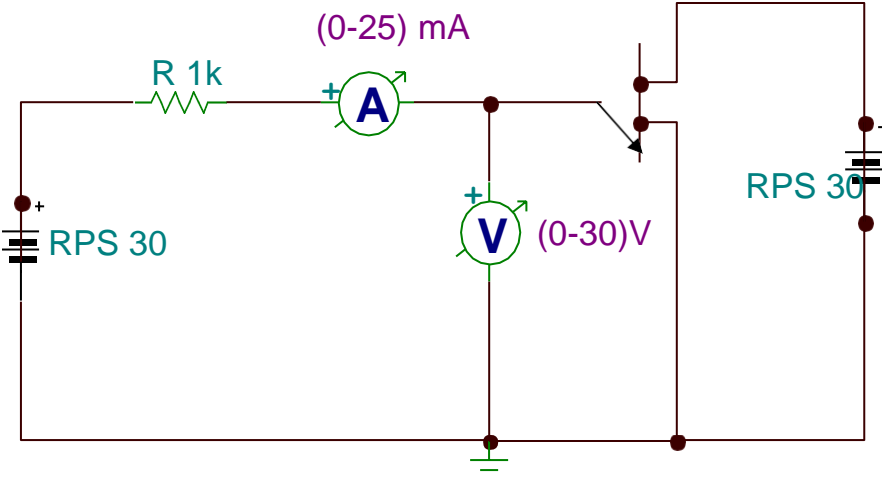
RESULT:

Thus the V-I characteristics of SCR were drawn and verified.

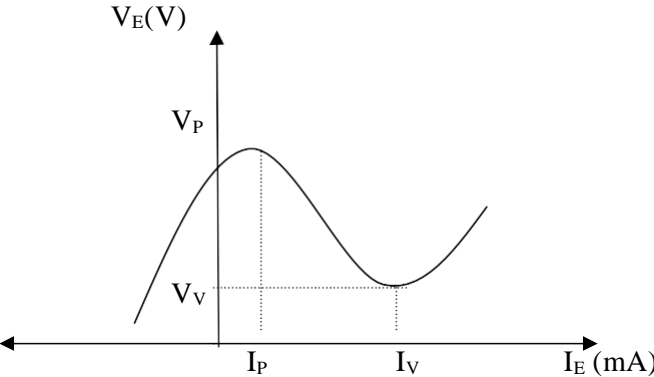
Holding current =

Holding voltage=

CIRCUIT DIAGRAM:



MODEL GRAPH:



CHARACTERISTICS OF UJT

EX.NO: 12

DATE:

AIM:

To study and plot the characteristics of Uni- Junction Transistor (UJT) and also its negative resistance using discrete Components, MULTISIM and ELVIS.

COMPONENTS & EQUIPMENTS REQUIRED:

S.No	APPARATUS	RANGE	QUANTITY
1	UJT	2N2646	1
2	Ammeter	(0-25) mA	1
3	Voltmeter	(0-30)V	1
4	Resistor	1K Ω	1
5	RPS	(0-30)V	2
6	Bread board	-	1
7	Connecting wires	-	Few

THEORY:

UJT is a three terminal semiconductor-switching device. As it has only one junction (p-n) and three terminal it is called so. It consists of a lightly doped n-type silicon bar with a heavily doped p-type Material alloyed to form a p-n rectifying junction. The ohmic carriers B_1 and B_2 are attached to it at opposite ends.

PROCEDURE:

1. The connections are made as per the circuit diagram.
2. V_{BB} was kept fixed and I_E was gradually increased by varying V_S and the corresponding V_E readings are noted.
3. The same procedure was repeated for other values of V_{GS} .
4. A Graph was drawn keeping V_E on y-axis and I_E on x-axis.

TABULATION:

$V_{BB} = \underline{\hspace{2cm}}$

Sl.No.	V_S (volts)	V_E (in volts)	I_E (in mA)

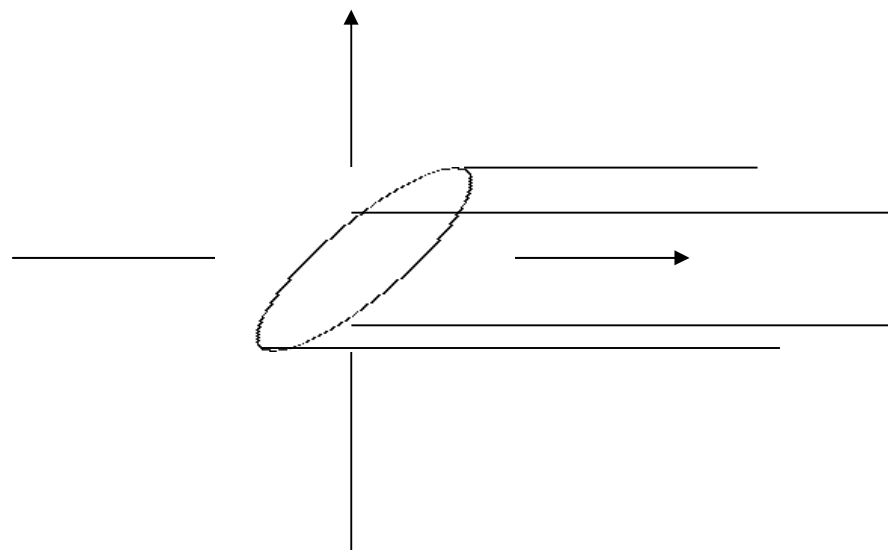
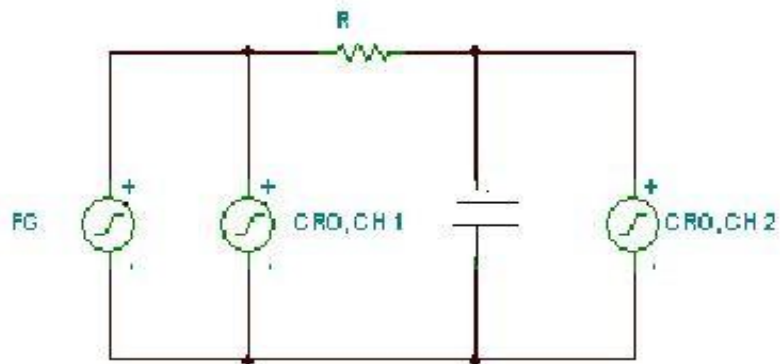
CALCULATION:

RESULT:

Thus the characteristics of UJT was obtained

1. Negative Resistance = ----- at V_{bb} =-----
Negative Resistance = ----- at V_{bb} =-----
2. Peak Voltage (V_p) = ----- at V_{bb} = -----
Peak Voltage (V_p) = ----- at V_{bb} = -----
3. Valley Voltage(V_v) = ----- - at V_{bb} = -----
Valley Voltage(V_v) = ----- - at V_{bb} = -----

CIRCUIT DIAGRAM:



STUDY OF CRO AND ITS OPERATION

EX.NO: 13

DATE:

AIM:

To study the characteristics of cathode ray oscilloscope and its operation.

COMPONENTS & EQUIPMENTS REQUIRED:

S.No	APPARATUS	RANGE	QUANTITY
1	CRO	(0-30)MHz	1
2.	Function Generator	(0-3)MHz	1
3.	Resistor	10k Ω	1
4	Capacitor	0.01 μ F	1
5	Bread board	-	1
6	Connecting wires	-	few

FORMULA:

$$\text{Practical} = \phi = \sin^{-1} [A/B]$$

$$\text{Theoretical} = \phi = \tan^{-1} WCR$$

THEORY:

The CRO is a versatile electronic testing and measuring instrument that allows the amplitude of the signal which may be voltage, current, power etc. to be displayed primarily as a function of time. The CRT is the heart of CRO. It consists of an electron gun which emits electron. These electrons can be accelerated by anode and are brought to focus on a fluorescent screen. When the electron beam strikes the screen of the electron beam comes under the influence of the vertical and horizontal deflection plates before it strikes the screen.

PROCEDURE:

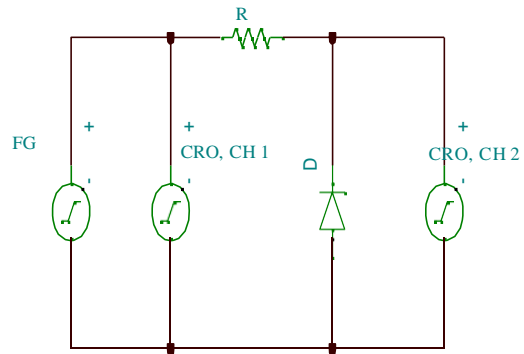
The CRO is switched on and the Y shift control and brightness control are adjusted in order to bring the trace of the screen. The function generator is connected to the input of RC network and with the help of RC network the phase shift wave is with A and B values are measured and with the help of this, phase difference is calculated.

RESULT:

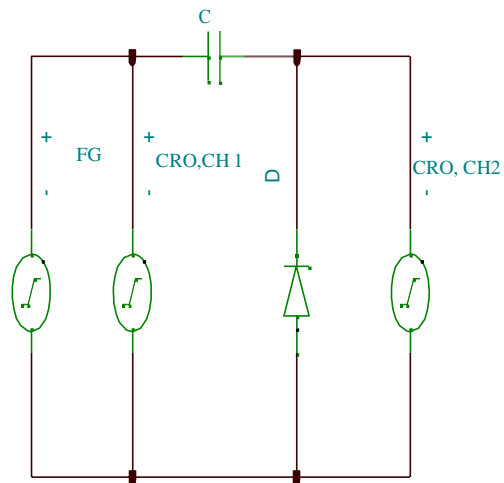
The characteristics of cathode ray oscilloscope are verified and the practical and theoretical values are equal.

CIRCUIT DIAGRAM:

Positive Clipper



Negative Clipper



POSITIVE AND NEGATIVE CLIPPER

EX.NO: 14

DATE:

AIM:

To Construct and Test Positive Clipper / Negative Clipper circuits using discrete components, MULTISIM and ELVIS and to draw the respective output waveforms.

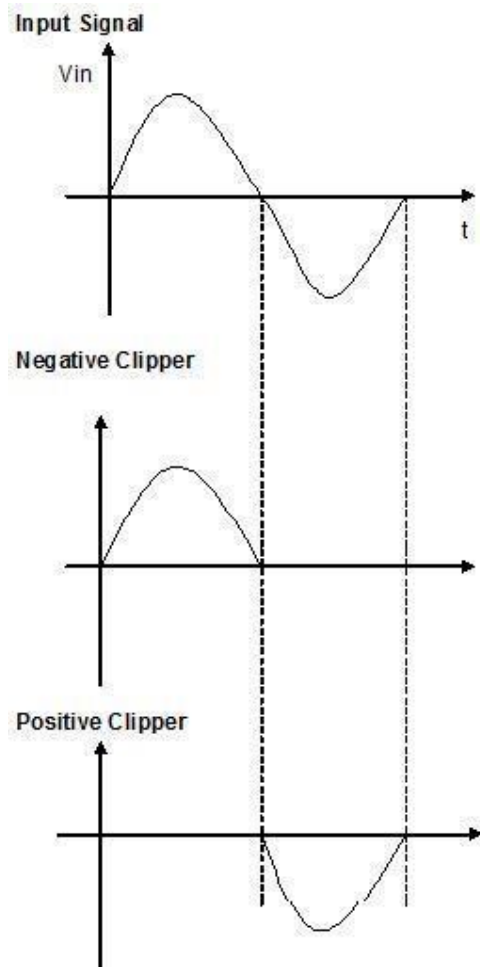
COMPONENTS & EQUIPMENTS REQUIRED:

S.No	APPARATUS	RANGE	QUANTITY
1	P-N Jn diode	1N 4007	1
2	Resistor	220 Ω /1K Ω	1
3	Capacitor	100 μ F/1 μ F	1
4	Transformer	230/(12-0-12) V	1
5	Bread board	-	1
6	Connecting wires	-	few

THEORY:

The Circuit which removes or clips a portion of the input signal either +ve or -ve side without distortion in the remaining part of the input signal is known as 'clipper'. The clipper circuit is also called as 'slicers'. In case of +ve clipper, the -ve half cycle is retained or appearing in the output and -ve clipper the +ve half cycle will be appearing in the output.

MODEL GRAPH:



PROCEDURE:**For Positive and Negative clippers**

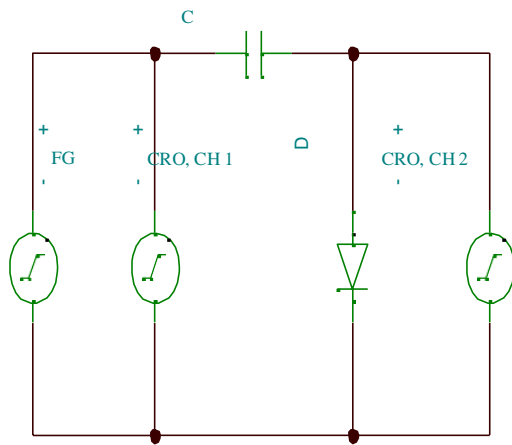
1. The connections are made as per the circuit diagram.
2. The output will be appearing in CRO .
3. The output voltage , T_{ON} (+ve cycle) and T_{OFF} are noted down.
4. Amplitude of the output signal is noted down.
5. I/p is verified with O/p and the waveforms are drawn.
6. The diode connection is reversed and the same procedure is repeated for –ve clipper

RESULT:

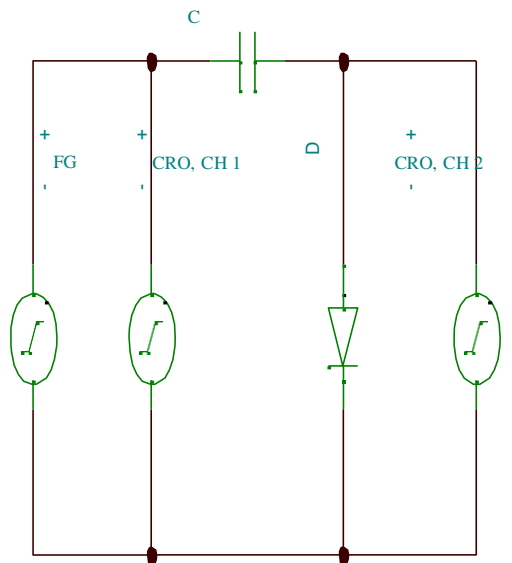
The circuits for Positive and Negative clippers are constructed and the outputs are verified.

CIRCUIT DIAGRAM:

Positive Clamper



Negative Clamper



POSITIVE AND NEGATIVE CLAMPERS

EX.NO: 15

DATE:

AIM:

To Construct and Test Positive Clamper / Negative Clamper using discrete components, MULTISIM and ELVIS.

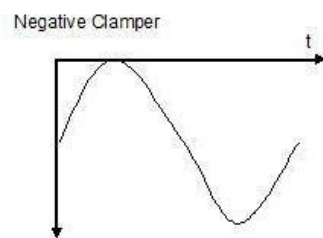
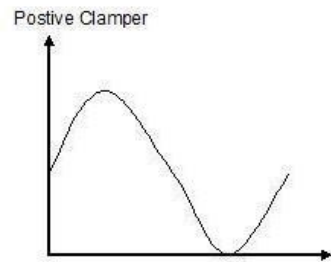
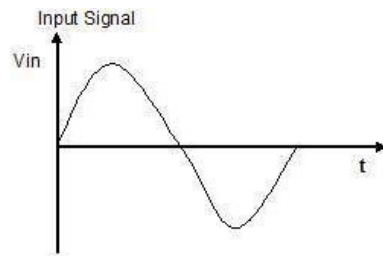
COMPONENTS & EQUIPMENTS REQUIRED:

S.No	APPARATUS	RANGE	QUANTITY
1	P-N Jn diode	IN 4007	1
2	Resistor	220 Ω /1K Ω	1
3	Capacitor	100 μ F/1 μ F	1
4	Transformer	230/(12-0-12) V	1
5	Bread board	-	1
6	Connecting wires	-	few

THEORY:

The Clamper is a circuit which shifts positive or negative peak of the input signal to a desired D.C level. In case of positive clamper , the output would be available entirely in the +ve side (because -ve half cycle gets shifted to +ve side) and in negative clamper, it is entirely in the -ve side (because +ve half cycle gets shifted to -ve side).

MODEL GRAPH:



PROCEDURE:

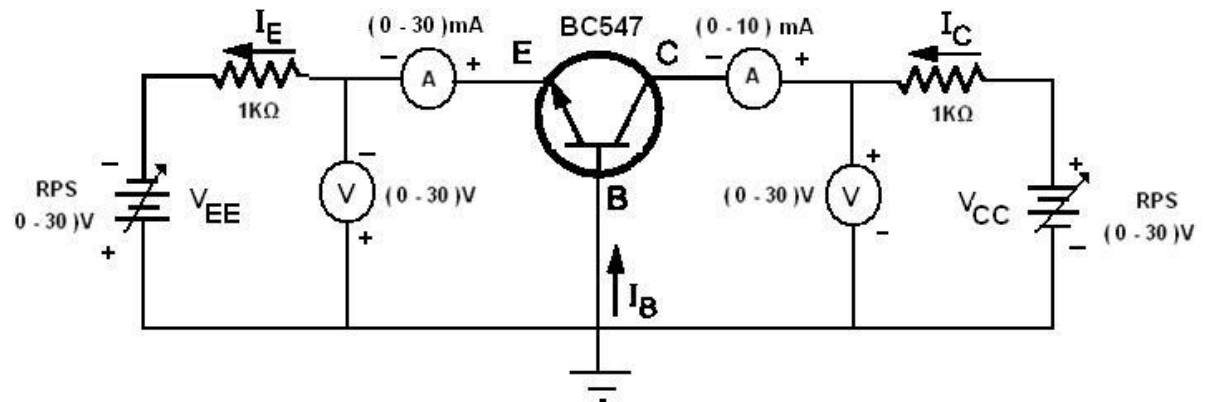
For Positive and Negative Clampers -

1. The connections are made as per the circuit diagram.
2. The output will be appearing in CRO .
3. The output voltage , T_{ON} (+ve cycle) and T_{OFF} are noted down.
4. Amplitude of the output signal is noted down.
5. I/p is verified with O/p and the waveforms are drawn.
6. The diode connection is reversed and the same procedure is repeated for negative clamper.

RESULT:

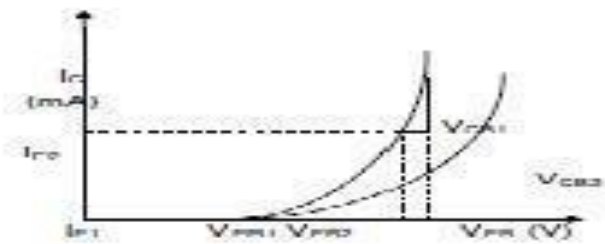
The circuits for Positive and Negative clamper are constructed and the outputs are verified.

CIRCUIT DIAGRAM:

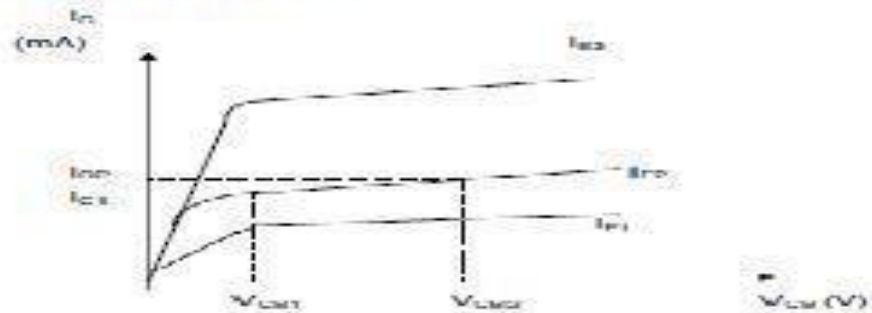


MODEL GRAPH:

Input Characteristics



OUTPUT CHARACTERISTICS:



CHARACTERISTICS OF BJT IN CB CONFIGURATION

EX.NO: 16

DATE:

AIM:

To plot the input and output characteristics of a Bipolar Junction Transistor (BJT) in Common Base (CB) configuration using discrete Components, MULTISIM and ELVIS

COMPONENTS & EQUIPMENTS REQUIRED:

S.NO	APPARATUS	RANGE	QUANTITY
1	RPS	(0-30)V	2
2	Resistor	1K Ω	2
3	DC Voltmeter	(0-30)V	1
4	DC Voltmeter	(0-10)V	1
5	DC Ammeter	(0-500) μ A	1
6	DC Ammeter	(0-30)mA	1
7	BJT	BC547/BC107	1
8	Breadboard	-	1
9	Connecting wires	-	Few

THEORY:

The input is applied between emitter and base and output is taken from the collector and base. Here, base of the transistor is common to both input and output circuits and hence the name common base (CB) configuration. Regardless of circuit configuration, the base emitter junction is always forward biased while the collector-base junction is always reverse biased, to operate transistor in active region.

**TABULATION:
Input Characteristics**

$V_{CB} = \text{-----}$

SL.N	V_S (volt)	V_{EB} (volt)	I_E (A)

Output Characteristics

$I_E = \text{_____}$

SL.NO	V_S (VOLTS)	V_{CB} (VOLTS)	I_C (mA)

CALCULATIONS:

PROCEDURE:

Input Characteristics

1. Connections are made as per the circuit diagram.
2. The output voltage V_{CE} is kept constant.
3. By varying the input voltage V_{BE} , the corresponding input currents I_B are noted down
4. A graph is plotted between V_{BE} and I_B .
5. The inverse slope of the curve gives forward input resistance.

Output Characteristics

1. Connections are made as per the circuit diagram.
2. The input current I_B is kept constant.
3. By varying the output voltage V_{CE} , the corresponding output current I_C is noted down.
4. A graph is plotted between V_{CE} and I_C .
5. The inverse slope of the curve gives forward output resistance

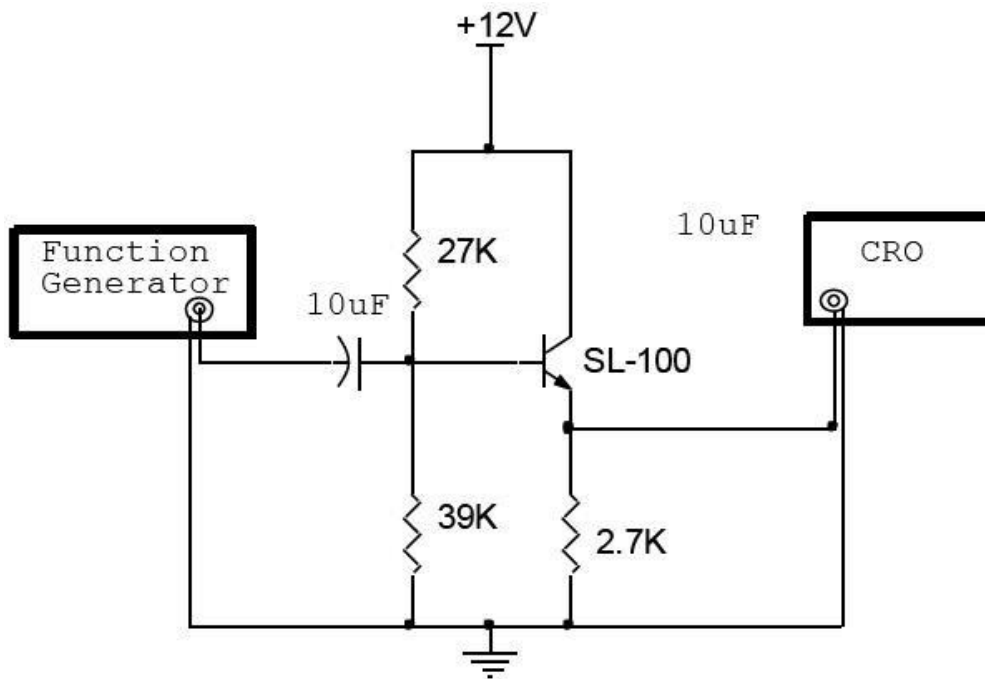
RESULT:

The input and output characteristics of the transistor in CB mode are drawn and the input and output resistances are calculated.

Input resistance =

Output resistance =

CIRCUIT DIAGRAM:



OBSERVATIONS:

DC Voltage in absence of input signal: $V_E = \text{_____} \text{V}$

AC Input voltage: $V_i = 1 \text{ V}$

EMITTER FOLLOWER-CC AMPLIFIER

EX.NO: 17

DATE:

AIM:

To observe input-output waveforms of common collector (CC) amplifier. To measure gain of amplifier at different frequencies and plot frequency response using MULTISIM and ELVIS.

COMPONENTS & EQUIPMENTS REQUIRED:

S.No	APPARATUS	RANGE	QUANTITY
1	CRO	(0-30)MHz	1
2.	Function Generator	(0-3)MHz	1
3	Resistor	27K Ω ,2.7K Ω ,39K Ω	1
4	Capacitor	10 μ F	1
5	Transistor	SL100	1
7	Regulated Power Supply	(0-30)V	1
8	Bread board	-	1
9	Connecting wires	-	Few

THEORY:

The common collector (CC) amplifier is also known as emitter follower. It is used as a current amplifier. Voltage gain of CC amplifier is less than unity while current gain is $(\beta+1)$. CC amplifier has high input impedance and low output impedance. There is no phase reversal between input and output.

PROCEDURE:

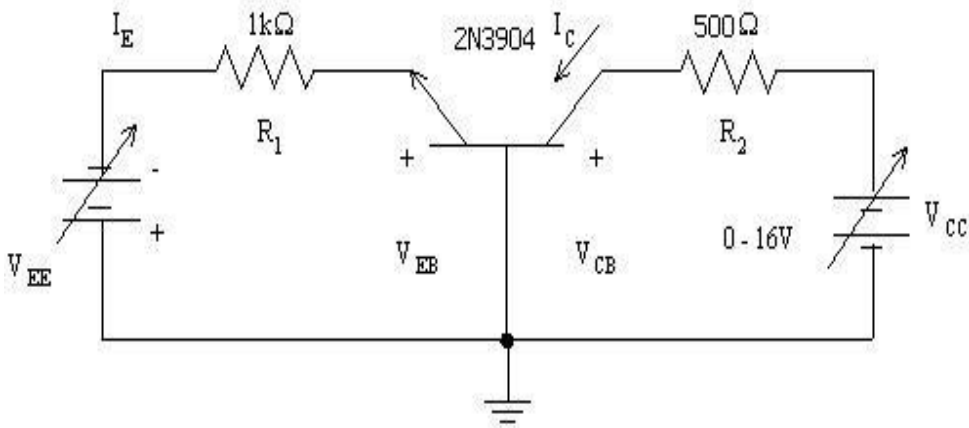
1. Measure Emitter voltage in absence of input AC signal.
2. Connect function generator at the input of the amplifier circuit.
3. Set input voltage 1V and frequency 100 Hz.
4. Connect CRO at the output of the amplifier circuit.
5. Observe output signal and measure output voltage
6. Draw input and output signal

RESULT:

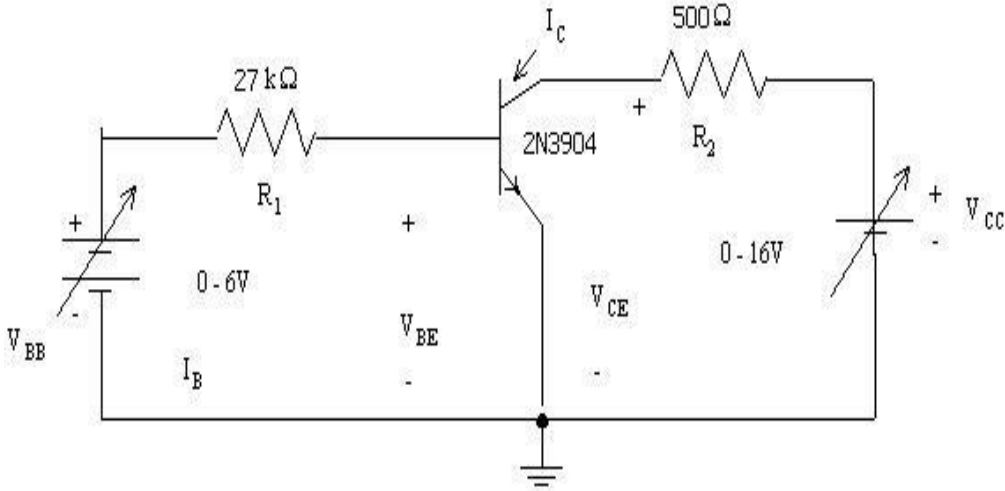
Thus the input-output waveforms of common collector (CC) amplifier are verified.

CIRCUIT DIAGRAM:

CB configuration circuit using npn transistor



CE configuration circuit using npn transistor



TRANSISTOR BIASING USING ELVIS

EX.NO: 18

DATE:

AIM:

To study the characteristics of Bipolar Junction Transistor (BJT) biasing using ELVIS and to determine the characteristic curves (CB-Common Base, CE- Common Emitter) for the BJT.

COMPONENTS & EQUIPMENTS REQUIRED:

S.No	APPARATUS	RANGE	QUANTITY
1	NI ELVIS	-	1
2	Resistor	1K Ω ,27K Ω ,500 Ω	1
3	Transistor	2N3904	1
4	Regulated Power Supply	(0-30)V	1
5	Bread board	-	1
6	Connecting wires	-	Few

THEORY:

The bipolar junction transistor (BJT) can be modeled as a current controlled current source. As an aid in visualizing the current/voltage relationships and transistor operation, a family of static characteristics plots of collector current versus collector-base voltage for several values of emitter current are plotted. This constitute the CB (Common Base) Collector characteristics. The CE(Common Emitter) Collector characteristics constitute a family of static characteristics plots of collector current versus collector-emitter voltage for several values of base current.

These curves can be used to calculate the large signal current gain β_{DC} (or h_{FE}) and the small signal current gain, β_{AC} (or h_{fe}). These values are in general calculated for a given bias point I_{CQ} , V_{CEQ} using the following equations:

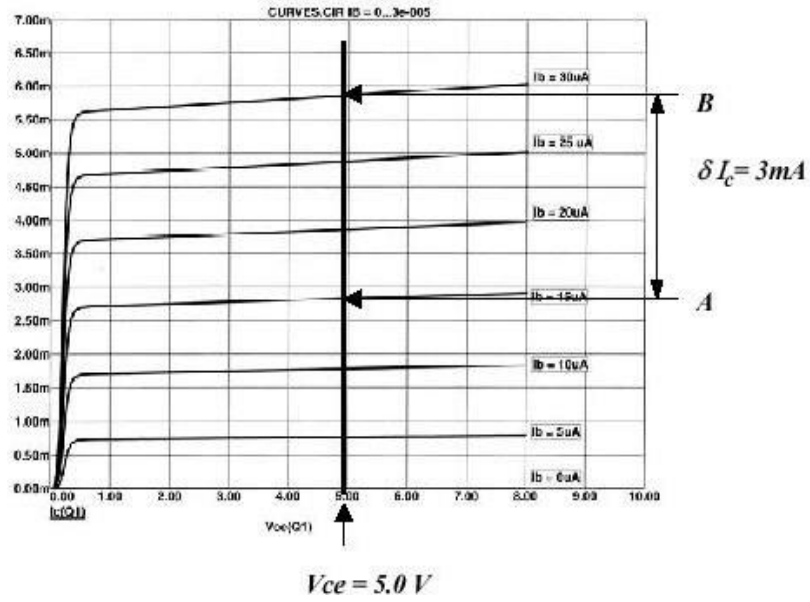
$$\beta_{DC} = I_{CQ} / I_{BQ}$$

$$\beta_{AC} = |I_{CQ} - I_{CQ'}| / |I_{BQ} - I_{BQ'}|$$

From this, one can see that a large signal gain depends only on the Q point and the small signal gain depends only on small deviations around the Q point.

MODEL GRAPH:

Characteristic curves for the BJT transistor (CE)



PROCEDURE:

1) Transistor Common-Base Collector Characteristics

- a) Connect the circuit shown in figure. Use Regulated Power Supply.
- b) Vary V_{cc} from 0-10V in steps of 1 and measure (record) the collector current and the voltage across collector and base .
- c) Repeat the procedure for different values of I_E (vary I_E from 0-10mA in steps of 2mA).
- d) Plot the V-I characteristics with I_c on Y-axis and V_{cb} on X-axis.
- e) Calculate α_{DC} and α_{AC} from the curves.

2) Transistor Common-Emitter Collector Characteristics

- a) Connect the circuit shown in figure.
- b) Vary V_{cc} from 0-10V in steps of 1 and measure (record) the collector current and the voltage across collector and emitter .
- c) Repeat the procedure for different values of I_B . (vary I_B from 0-200 μ A in steps of 50 μ A).
- d) Plot the V-I characteristics with I_c on Y-axis and VCE on X-axis. e) Calculate β_{DC} and β_{AC} from the curves.
- f) Calculate transconductance parameter g_m .

3) Transistor Common-Emitter Base Characteristics

- a) Vary V_{BB} from 0-2V in steps of 0.2V, and measure the base current and the voltage across base and the emitter.
- b) Repeat the procedure for different values of V_{CE} (0V, 0.1V, 1V, 2V)
- c) Plot the V-I characteristics with $I_B(\mu A)$ on Y-axis and V_{BE} on X-axis.
- d) Calculate the base spreading resistance r_b .

RESULT:

Thus the performance characteristics of Bipolar Junction Transistor (BJT) biasing using ELVIS was done successfully.