LAB MANUAL

Electronics Design   Laboratory

Prepared by
Sh.Dayal Sati (A.P.)

BRCM College of Engineering and Technology

Department of Electrical Engineering
Bahal, Bhiwani - 127028

TABLE OF CONTENT

EXERCISE NO 1
STUDY OF ELECTRONIC COMPONENTS

OBJECTIVES

      a.   To get familiar with basic electronic components such as Resistor, capacitors, Inductor, diodes, transistors, integrated circuits (IC), light emitter diode (LED), switches, fuses, batteries, power plugs, connectors, wires and cables.

      b.   To test and understand the function of various electronic components.

RESISTORS

   A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. The current through a resistor is in direct proportion to the voltage across the resistor's terminals. This relationship is represented by Ohm's law. A device used in electrical circuits to maintain a constant relation between current flow and voltage. Resistors are used to step up or lower the voltage at different points in a circuit and to transform a current signal into a voltage signal or vice versa, among other uses. The electrical behaviour of a resistor obeys Ohm's law for a constant resistance; however, some resistors are sensitive to heat, light, or other variables.

   Resistors are one of the most used components in a circuit. Most are color coded, but some have their value in Ohms and their tolerance printed on them. A multimeter that can check resistance can also be helpful, providing the resistor is already removed from the board (measuring it while still soldered in can give inaccurate results, due to connections with the rest of the circuit). They are typically marked with an "R" on a circuit board.


POTENTIOMETERS

Potentiometers are variable resistors. They normally have their value marked with the maximum value in Ohms. Smaller trimpots may use a 3-digit code where the first 2 digits are significant, and the 3rd is the multiplier (basically the number of 0′s after the first 2 digits). For example, code 104 = 10 followed by four 0′s = 100000 Ohms = 100K Ohms. They may also have a letter code on them indicating the taper (which is how resistance changes in relation to how far the potentiometer is turned). They are typically marked with an "VR" on a circuit board.

CAPACITORS

A capacitor (originally known as a condenser) is a passive two-terminal electrical component used to store energy electrostatically in an electric field. By contrast, batteries store energy via chemical reactions. The forms of practical capacitors vary widely, but all contain at least two electrical conductors separated by a dielectric (insulator); for example, one common construction consists of metal foils separated by a thin layer of insulating film. Capacitors are widely used as parts of electrical circuits in many common electrical devices.

Capacitors are also very commonly used. A lot have their values printed on them, some are marked with 3-digit codes, and a few are color coded. The same resources listed above for resistors can also help you identify capacitor values. They are typically marked with an "C" on a circuit board.
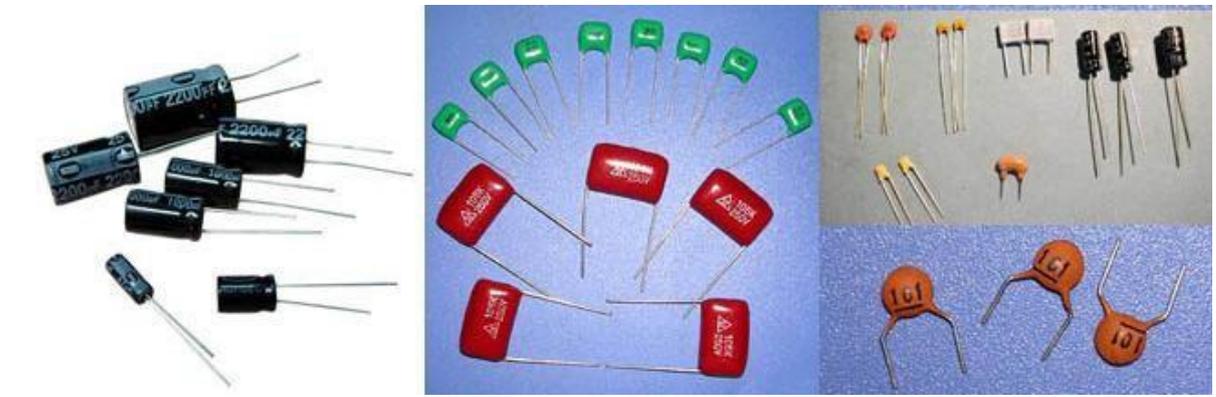
INDUCTORS

An inductor, also called a coil or reactor, is a passive two-terminal electrical component which resists changes in electric current passing through it. It consists of a conductor such as a wire, usually wound into a coil. When a current flows through it, energy is stored in a magnetic field in the coil. When the current flowing through an inductor changes, the time-varying magnetic field induces a voltage in the conductor, according to

Faraday's law of electromagnetic induction, which by Lenz's law opposes the change in current that created it.

Inductors, also called coils, can be a bit harder to figure out their values. If they are color coded, the resources listed for resistors can help, otherwise a good meter that can measure inductance will be needed. They are typically marked with an "L" on a circuit board.

TRANSFORMERS

A transformer is a static electrical device that transfers energy by inductive coupling between its winding circuits. A varying current in the primary winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic flux through the secondary winding. This varying magnetic flux induces a varying electromotive force (emf) or voltage in the secondary winding.

Transformers are normally pretty easy to identify by sight, and many have their specs printed on them. They are typically marked with an "T" on a circuit board.

FUSES

In electronics and electrical engineering, a fuse is a type of low resistance resistor that acts as a sacrificial device to provide overcurrent protection, of either the load or source circuit. Its essential component is a metal wire or strip that melts when too much current flows, which interrupts the circuit in which it is connected. Short circuit, overloading, mismatched loads or device failure are the prime reasons for excessive current. A fuse interrupts excessive current (blows) so that further damage by overheating or fire is prevented. Fuses can be easy to identify, and typically have their voltage and amperage rating marked on them.
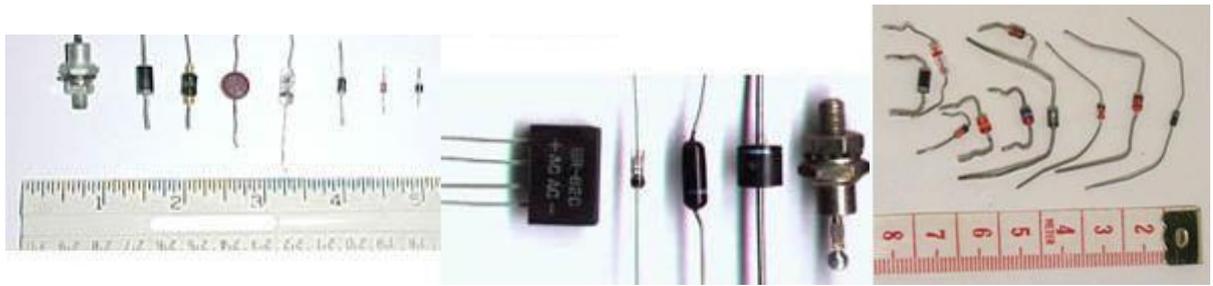
SEMICONDUCTORS

DIODES

In electronics, a diode is a two-terminal electronic component with asymmetric conductance, it has low (ideally zero) resistance to current flow in one direction, and high (ideally infinite) resistance in the other.

Semiconductors, such as Diodes (typically marked with an "D" on a circuit board).

TRANSISTORS

A transistor is a semiconductor device used to amplify and switch electronic signals and electrical power. It is composed of semiconductor material with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal. Today, some transistors are packaged individually, but many more are found embedded in integrated circuits.

Transistors (typically marked with an "Q" on a circuit board).
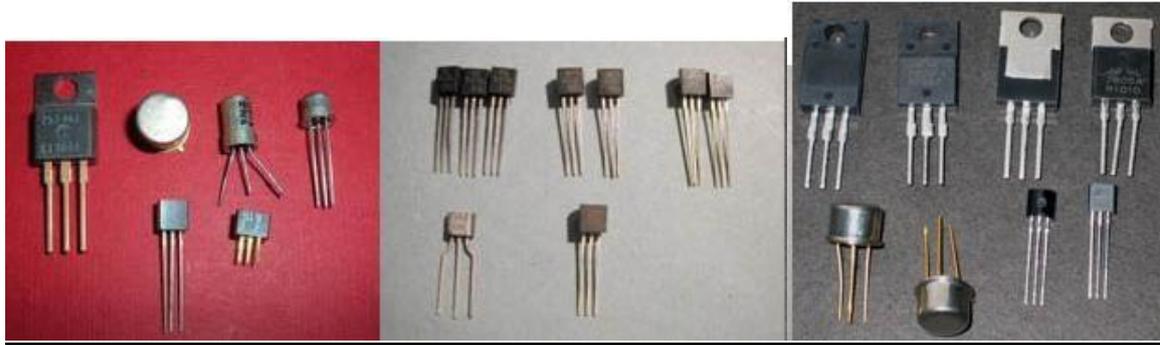
BRIDGE RECTIFIERS

A diode bridge is an arrangement of four (or more) diodes in a bridge circuit configuration that provides the same polarity of output for either polarity of input. When used in its most common application, for conversion of an alternating current (AC) input into a direct current (DC) output, it is known as a bridge rectifier. A bridge rectifier provides full-wave rectification from a two-wire AC input, resulting in lower cost and weight as compared to a rectifier with a 3-wire input from a transformer with a center-tapped secondary winding.

Bridge Rectifiers (typically marked with an "BR" on a circuit board)


INTEGRATED CIRCUITS

An integrated circuit or monolithic integrated circuit (also referred to as an IC, a chip, or a microchip) is a set of electronic circuits on one small plate ("chip") of semiconductor material, normally silicon. This can be made much smaller than a discrete circuit made from independent components. Integrated circuits are used in virtually all electronic equipment today and have revolutionized the world of electronics. Computers, mobile phones, and other digital home appliances are now inextricable parts of the structure of modern societies, made possible by the low cost of producing integrated circuits.

Integrated Circuits (typically marked with an "U" or "IC" on a circuit board)
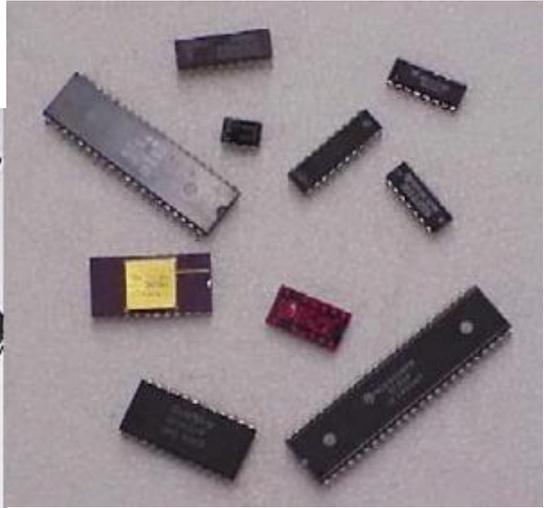
LED AND LED DISPLAY

A light-emitting diode (LED) is a semiconductor light source. LEDs are used as indicator lamps in many devices and are increasingly used for other lighting. LEDs emitted low-intensity red light, but modern versions are available across the visible, ultraviolet, and infrared wavelengths, with very high brightness.
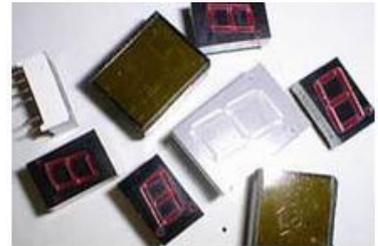
SWITCHES

In electrical engineering, a switch is an electrical component that can break an electrical circuit, interrupting the current or diverting it from one conductor to another. The most familiar form of switch is a manually operated electromechanical device with one or more sets of electrical contacts, which are connected to external circuits. Each set of contacts can be in one of two states: either "closed" meaning the contacts are touching and electricity can flow between them, or "open", meaning the contacts are separated and the switch is nonconducting.

BATTERIES

In electricity, a battery is a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy.

Batteries are also pretty easy to identify, and are well marked with their specification.

RELAYS

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

Relays are typically enclosed in plastic, and many have their specs printed on them. They are typically marked with a "K" on a circuit board.
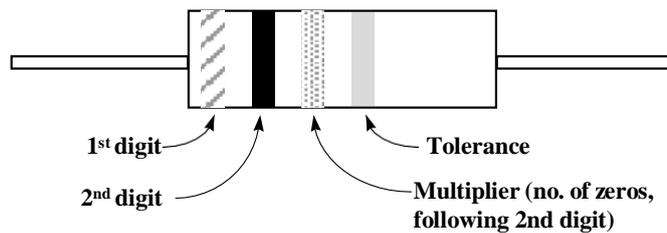
Lab Exercise

EQUIPMENT REQUIRED

Electronic components (Resistor, capacitors, diode, Transistor)
Digital multimeter (DMM)

A1.   Determining Resistor values

Resistor Colour Codes

1st digit
2nd digit
Tolerance
Multiplier (no. of zeros, following 2nd digit)

Colour-code bands on a resistor.

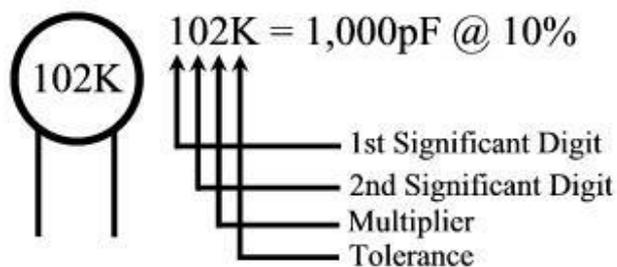| Colour	Band 1	Band 2	Band 3	Band 4
Black	0	0	×1	–
Brown	1	1	×10	±1%
Red	2	2	×100	±2%
Orange	3	3	×1000	–
Yellow	4	4	×10000	–
Green	5	5	×100000	±0.5%
Blue	6	6	×1000000	±0.25%
Violet	7	7	×10000000	±0.1%
Grey	8	8	–	–
White	9	9	–	–
Gold	–	–	×0.1	±5%
Silver	–	–	×0.01	±10%

Resistance measurement

Procedure

1. Connect probes: black probe to COM terminal and red probe to terminal marked with 'Ω'
2. Set function to resistance measurement
3. Set to the appropriate range (refer to above)
4. Connect the two probes' crocodile clips to the resistor (or to the resistor circuit via jumper wires) to make measurement
5. Note the reading, adjust range if necessary
6. Take the more accurate reading.

Determine the value for the given data

No.	Colour code	Actual Value	Measured Value (DMM)
1	Red, red, black		
2	Red, black, orange		
3	Blue, gray, green		
4		10M	
5		33K	

A2. Determining capacitor values

$102K = 1,000pF @ 10\%$

- 1st Significant Digit
- 2nd Significant Digit
- Multiplier
- Tolerance

Code	Tolerance
C	±0.25pF
J	±5%
K	±10%
M	±20%
D	±0.5pF
Z	80% / -20%

Determine the value of the ceramic capacitors

No.	Code Number	Actual Value
1	104	
2	223	
3	68	
4		$0.47\,\mu\,F$
5		33nF

A3.   Diode Testing

Draw the schematic symbol of a 1N4001 diode and identify the leads (Anode and Cathode) in the box below.
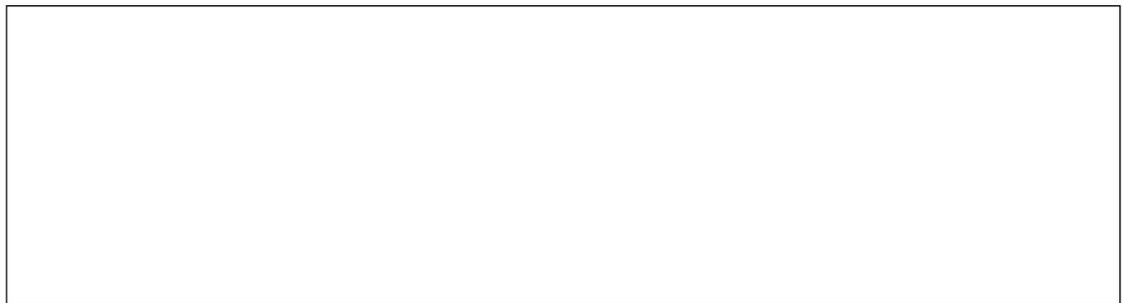
a.   Set the Lab DMM to *Diode Testing* mode.

 b. Measure the forward and reverse bias voltages of the given diodes and record them
   i.   Forward bias voltage:
         Place the RED probe on the Anode. Touch the BLACK probe to the Cathode and record the reading
   ii.   Reverse bias voltage:
         Place the RED probe on the Cathode. Touch the BLACK probe to the Anode and record the reading

No.	Diode Number	Forward Bias Voltage	Reverse Bias Voltage
1	1N4001		
2	1N914		
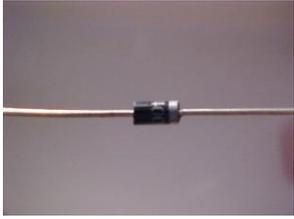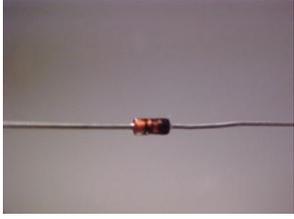
Result:

STUDY OF INSTRUMENTS AND EQUIPMENTS

OBJECTIVES

a. To get familiar with basic electronic instrument and Equipment handling and usage procedure for Digital Multimeter, DC power supply, Function Generator and CRO.

b. To study the self test / calibration procedure of CRO.

2A DIGITAL MULTI METER

INTRODUCTION

A Multimeter is an electronic device that is used to make various electrical measurements, such as AC and DC voltage, AC and DC current, and resistance. It is called a Multimeter because it combines the functions of a voltmeter, ammeter, and ohmmeter. Multimeter may also have other functions, such as diode test, continuity test, transistor test, TTL logic test and frequency test.

PARTS OF MULTIMETER

A Multimeter has three parts:

- Display
- Selection Knob
- Ports

The **display** usually has four digits and the ability to display a negative sign. A few multimeters have illuminated displays for better viewing in low light situations.

The **selection knob** allows the user to set the multimeter to read different things such as milliamps (mA) of current, voltage (V) and resistance (Ω).

Two probes are plugged into two of the **ports** on the front of the unit. **COM** stands for common and is almost always connected to Ground or '-' of a circuit. The **COM** probe is conventionally black but there is no difference between the red probe and black probe other than color. **10A** is the special port used when measuring large currents (greater than 200mA). **mAVΩ** is the port that the red probe is conventionally plugged in to. This port allows the measurement of current (up to 200mA), voltage (V), and resistance (Ω). The probes have a *banana* type connector on the end that plugs into the multimeter. Any probe with a banana plug will work with this meter.

SAFETY MEASURES

- Be sure the test leads and rotary switch are in the correct position for the desired measurement.
- Never use the meter if the meter or the test leads look damaged.
- Never measure resistance in a circuit when power is applied.
- Never touch the probes to a voltage source when a test lead is plugged into the 10 A or 300 mA input jack.
- To avoid damage or injury, never use the meter on circuits that exceed 4800 watts.
- Never apply more than the rated voltage between any input jack and earth ground.
- Be careful when working with voltages above 60 V DC or 30 V AC rms. Such voltages pose a shock hazard.
- Keep your fingers behind the finger guards on the test probes when making measurements.
- To avoid false readings, which could lead to possible electric shock or personal injury, replace the battery as soon as the battery indicator appears.

INPUT JACKS

The black lead is always plugged into the common terminal. The red lead is plugged into the 10 A jack when measuring currents greater than 300 mA, the 300 mA jack when measuring currents less than 300 mA, and the remaining jack (V-ohms-diode) for all other measurements.
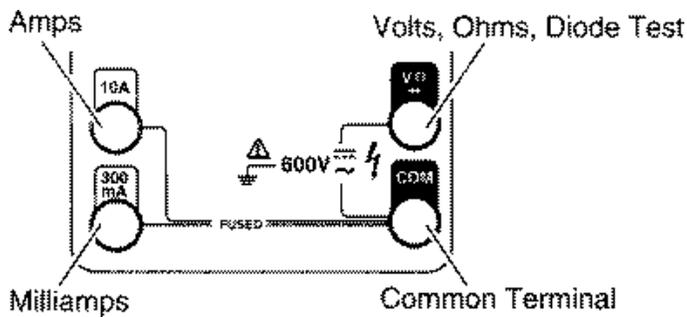
RANGE FIXING

The meter defaults to autorange when first turned on. You can choose a manual range in V AC, V DC, A AC, and A DC by pressing the button in the middle of the rotary dial. To return to autorange, press the button for one second.
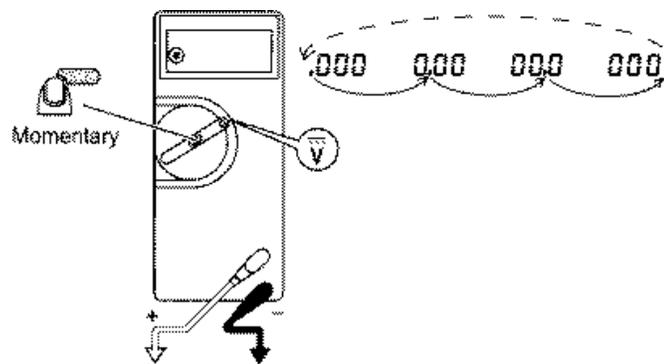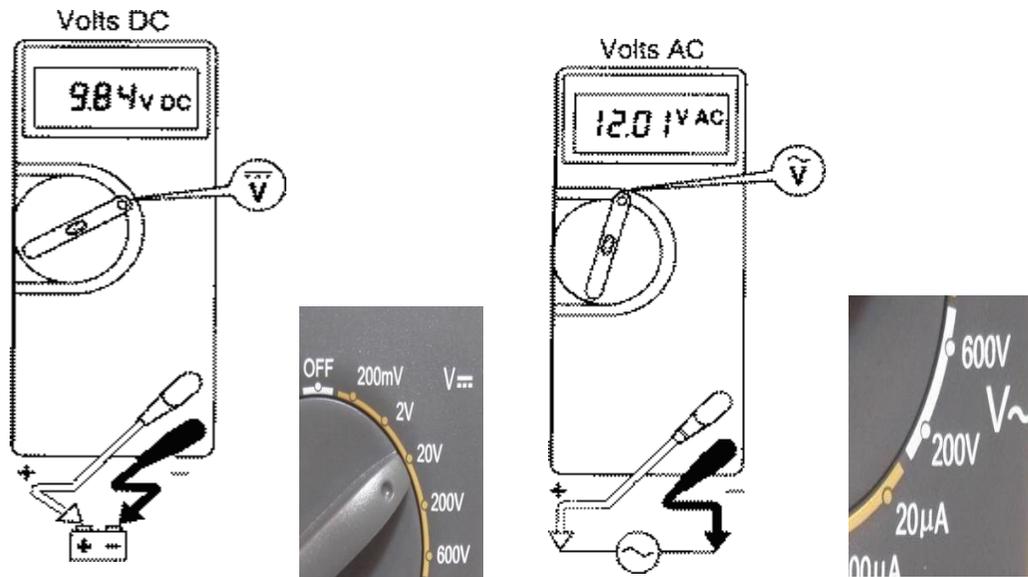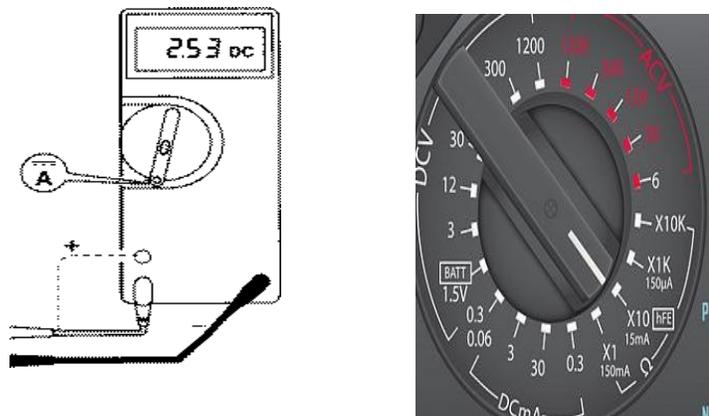

PROCEDURE FOR MEASUREMENT

VOLTAGE MEASUREMENT

D.C. / A.C. Voltage Measurment
1. Connect the positive(red) test lead to the 'V/mA' jack socket and the negative(black) lead to the 'COM' jack socket.
2. Set the selector switch to the desired mV D.C./D.C.V/A.C.V range.
3. Connect the test leads to the circuit to be measured.
4. Turn on the power to the circuit to be measured, the voltage value should appear on the digital display along with the voltage polarity(if reversed only).
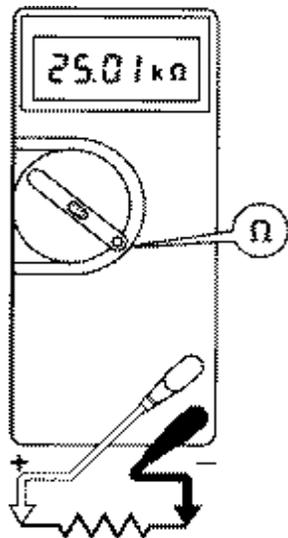
Volts DC

Volts AC

OFF 200mV V⎓
2V
20V
200V
600V

600V
V~
200V
20µA

CURRENT MEASUREMENT

1. Connect the positive(red) test lead to the 'V/mA' jack socket and the negative(black) lead to the 'COM' jack socket(for measurements up to 200mA). For measurements between 200mA and 10A connect the red test lead to the '10mA' socket.
2. Set the selector switch to the desired uA/mA/A range.
3. Open the circuit to be measured and connect the test leads in **SERIES** with the load in which current is to be measured.
4. To avoid blowing an input fuse, use the 10A jack until you are sure that the current is less than 300 mA. Turn off power to the circuit. Break the circuit. (For circuits of more than 10 amps, use a current clamp.) Put the meter in series with the circuit and turn power on.

RESISTANCE MEASUREMENT

1. Connect the positive(red) test lead to the 'V/mA' jack socket and the negative(black) lead to the 'COM' jack socket.
2. Set the selector switch to the desired 'OHM Ω'.
3. If the resistance to be measured ia part of a circuit, turn off the power and discharge all capacitors before measurement.
4. Connect the test leads to the circuit to be measured.
5. The resistance value should now appear on the digital display.
6. If the resistance to be measured is part of a circuit, turn off the power and discharge all capacitors before measurement.


CONTINUITY TEST

This mode is used to check if two points are electrically connected. It is often used to verify connectors. If continuity exists (resistance less than 210 ohms), the beeper sounds continuously.

1. Connect the positive(red) test lead to the 'V/mA' jack socket and the negative(black) lead to the 'COM' jack socket.

2. Set the selector switch to the ⫘ position.

3. Connect the test leads to two points of the circuit to be tested. If the resistence is Ohms the buzzer will sound.

4. If the resistance to be measured is part of a circuit, turn off the power and discharge all capacitors before measurement.
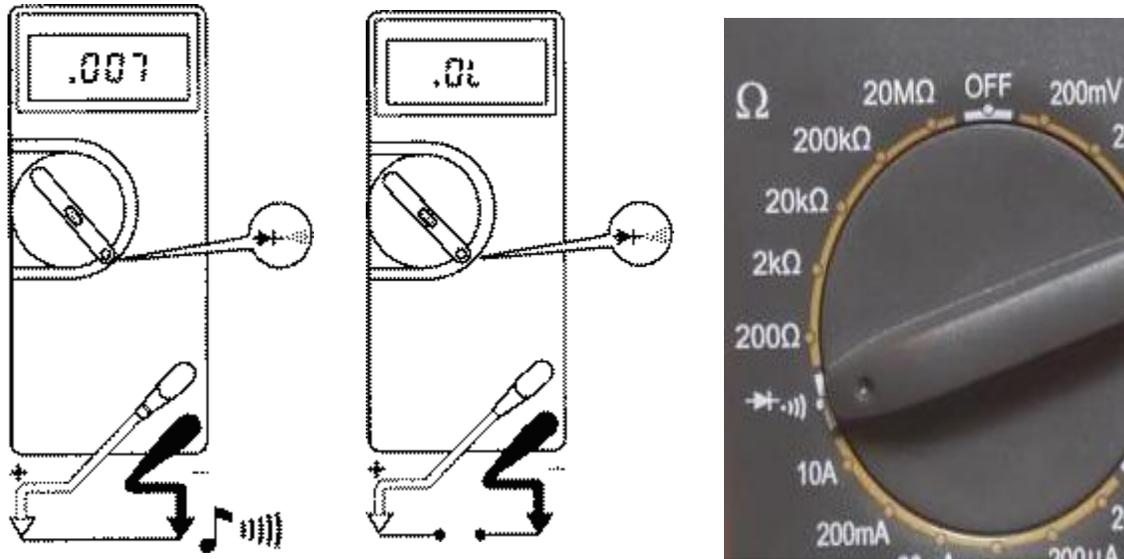
DIODE TEST

1. Connect the positive (red) test lead to the 'V/mA' jack socket and the negative(black) lead to the 'COM' jack socket.
2. Set the selector switch to the ⇥ position.
3. Connect the test leads to be measured.
4. Turn on the power to the circuit to be measured and the voltage value should appear on the digital display.
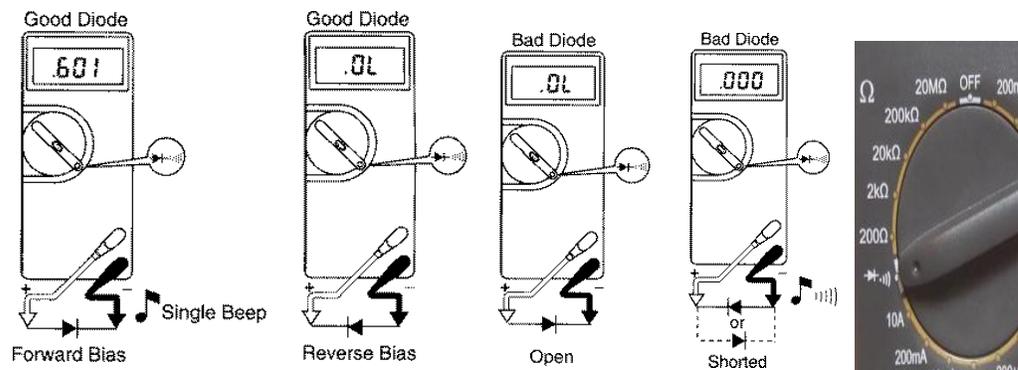
General Operation

Connection of Probes:
All multimeters come with two probes. They are to be connected to the terminals on the meter itself. The Black probe is to be connected to the COM terminal. Red probe is to be connected to terminal marked with :

- 'V-Ω for voltage measurement,
- 'mA' or '20A' for current measurement (there are two terminals, one for 2A range and the other for 20A range)
- 'V-Ω' for resistance measurement.

Setting of function:
The multimeter uses different circuits internally to measure different things. Therefore, you must select the correct function before using it.

Setting of Range:
- You can change the sensitivity of the meter by selecting different range for measurement. Set the range to the first range that is higher than the maximum value you expect to measure. This will give a more accurate reading. If you do not know what to expect, use the highest range first. After a reading is obtained, set the range to the appropriate one to get a better reading.
- When the value measured exceeds the existing range, the display will flash. When this happens, set the multimeter to a higher range until some values are displayed.

Precautions:

1. For current measurement, the maximum input current is 2A (if the RED mA and BLACK COM terminals are used) or 20A (if the RED 20A and BLACK COM terminals are used). Excessive current will blow the fuse on the 2A range, which must be replaced. The 20A range, however, is not protected by the fuse.
2. For voltage measurement (use the RED V-Ω and BLACK COM terminals), the maximum input voltage on :
   - all DC ranges is 1200V DC or peak AC
   - the 20V, 200V and 1000V AC ranges is 1000V rms continuous
   - the 2V and 200mV AC ranges is 1000V rms for not more than 15 seconds.
3. To avoid electrical shock and/or instrument damage, do not connect the COM input terminals to any source of more than 500 volts DC or peak AC above earth ground.

Resistance measurement

Procedure
1. Connect probes: black probe to COM terminal and red probe to terminal marked with '□ '
2. Set function to resistance measurement
3. Set to the appropriate range (refer to above)
4. Connect the two probes' crocodile clips to the resistor (or to the resistor circuit via jumper wires) to make measurement
5. Note the reading, adjust range if necessary
6. Take the more accurate reading.

Voltage measurement

Procedure

7. Connect probes: black probe to COM terminal and red probe to terminal marked with 'V'
8. Set function to voltage measurement
9. Set to the appropriate range (refer to above)
10. Set the AC-DC selection - depends on what type of signal you want to measure
11. Touch the two points where you want to make measurement
12. Note the reading, adjust range if necessary
13. Take the more accurate reading.

Note

Reading obtained is the voltage of where the red probe touch with reference to where the black probe touches. This may not indicate the voltage level from ground. To find the voltage level of a point from ground, black probe should be touching a ground point and the red probe on the point you want to measure.
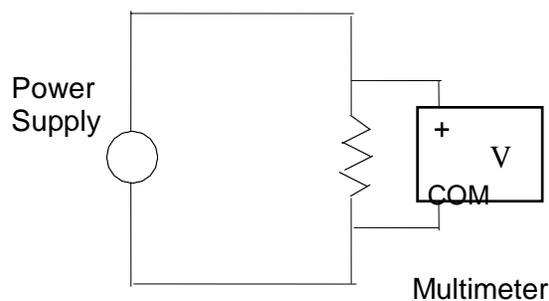
Current measurement

Procedure

1. Connect probes: black probe to COM terminal and red probe to terminal marked with 'A'
2. Set function to current measurement
3. Set to the appropriate range
4. Set AC-DC selection - depends on what type of signal you want to measure
5. Off the power to the circuit
6. Break the path which we want to make measurement
7. Connect the path with the two probes so that current now flow through the multimeter
8. On the power
9. Note the reading, change range if necessary
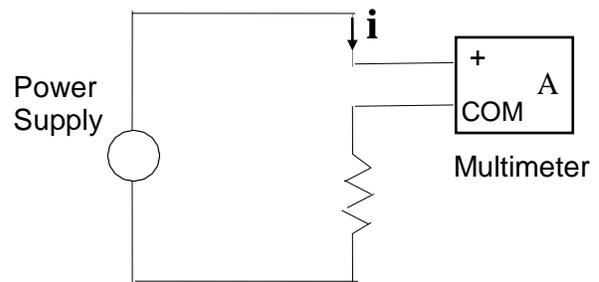10. Take the more accurate reading.

Note

Use the 20A range if you are not sure of the current to be measured.

Connection Methods to Measure Voltage and Current

Voltage Measurement

Current Measurement

2B DC VARIABLE POWER SUPPLY

Objective

- To study the function and operation of regulated power supply.

Equipment required

- Multimeter
- Dual DC variable regulated Power supply (0-30) Volts

Theory

A **power supply** is a device that supplies electric power to an electrical load. The term is most commonly applied to electric power converters that convert one form of electrical energy to another, though it may also refer to devices that convert another form of energy (mechanical, chemical, solar) to electrical energy. A regulated power supply is one that controls the output voltage or current to a specific value; the controlled value is held nearly constant despite variations in either load current or the voltage supplied by the power supply's energy source.

A power supply may be implemented as a discrete, stand-alone device or as an integral device that is hardwired to its load. Examples of the latter case include the low voltage DC power supplies that are part of desktop computers and consumer electronics devices.

Commonly specified power supply attributes include:

- The amount of voltage and current it can supply to its load.
- How stable its output voltage or current is under varying line and load conditions.

POWER SUPPLIES TYPES

- Battery
- DC power supply
- AC power supply
- Linear regulated power supply
- Switched mode power supply
- Programmable power supply
- Uninterruptible power supply
- High voltage power supply
- Voltage multipliers

DC POWER SUPPLY

SPECIFICATION

1. Adjustable 0~30V/0~2A
2. The design is limit the voltage overload
   The power supply input **220V, 230V, 240V AC**
3. Output voltage: 0-30V DC
4. Work temperature: -10ºC-40ºC

MAIN FUNCTION

1. Output constant current adjustable.
2. Output constant voltage adjustable.
3. LCD voltage and current display.
4. Constant voltage and current operation in individual.
5. Over current protection.

Adjustable power supply

2C CATHODE-RAY OSCILLOSCOPE (CRO)

Objective

- To introduce the basic structure of a cathode-ray Oscilloscope.
- To get familiar with the use of different control switches of the device.
- To visualize an ac signal, measure the amplitude and the frequency.
- To do self test/ calibration of CRO

Equipment Required

- Cathode-ray Oscilloscope
- Function Generator
- BNC connector

Theory

The device consists mainly of a vacuum tube which contains a cathode; anode, grid, X&Y-plates, and a fluorescent screen (see Figure below). When the cathode is heated (by applying a small potential difference across its terminals), it emits electrons. Having a potential difference between the cathode and the anode (electrodes), accelerate the emitted electrons towards the anode, forming an electron beam, which passes to fall on the screen.

When the fast electron beam strikes the fluorescent screen, a bright visible spot is produced. The grid, which is situated between the electrodes, controls the amount of electrons passing through it thereby controlling the intensity of the electron beam. The X&Y- plates are responsible for deflecting the electron beam horizontally and vertically.

A sweep generator is connected to the X-plates, which moves the bright spot Horizontally across the screen and repeats that at a certain frequency as the source of the signal. The voltage to be studied is applied to the Y-plates. The combined sweep and Y voltages produce a graph showing the variation of voltage with time.

Experimental Figures

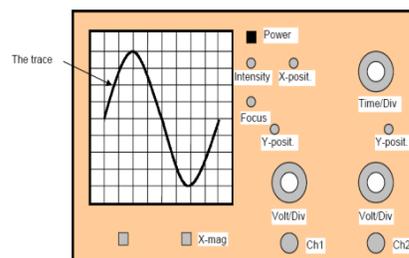
Fig 1. Cathode Ray tube Oscilloscope

Fig 2. Out Line Diagram of CRO

Procedure
1. Turn on the Oscilloscope
2. Adjust the intensity and the focus of the trace.
3. Use the X & Y knobs to center the trace horizontally and vertically.
4. Connect the cable from Ch1 of the CRO to Function generator.
5. A signal will appear on the screen.
6. Make sure that the inner red knobs of the Volt/Div and the Time/Div are locked clockwise.
7. Set the frequency of the generator to 100 Hz.
8. Adjust the Volt/Div and the Time/Div knobs so that you get a suitable size signal
9. Count the number of vertical squares lying within the signal, then calculate the peak to peak value as:
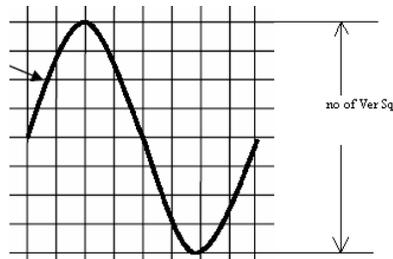
Vp-p = No. vertical Div * Volt/Divs

10. Count the number of horizontal squares lying within the one Duty Cycle, then calculate time value as:

Time = No. Horizontal Div * Time/Divs

11.Calculate the Frequency of signal by using the formula:

$$Freq = 1 / Time$$

Result:

25

2D FUNCTION GENERATOR

Objective

1. To get familiarization and study the operation of a function generator instrument
2. To identify key function generator specifications
3. To visualize the types of waveforms produced by a function generator

Equipment Required

- Oscilloscope
- Function generator.
- BNC connector cable

Theory

A **function generator** is electronic test equipment used to generate different types of waveforms over a wide range of frequencies. Function generators are capable of producing a variety of repetitive waveforms, generally from the list below

- *Sine wave:* A function generator will normally have the capability to produce a standard sine wave output. This is the standard waveform that oscillates between two levels with a standard sinusoidal shape.

- *Square wave:* A square wave is normally relatively easy for a function generator to produce. It consists of a signal moving directly between high and low levels.

- *Pulse:* A pulse waveform is another type that can be produced by a function generator. It is effectively the same as a square wave, but with the mark space ratio very different to 1:1.

- *Triangular wave:* This form of signal produced by the function generator linearly moves between a high and low point.
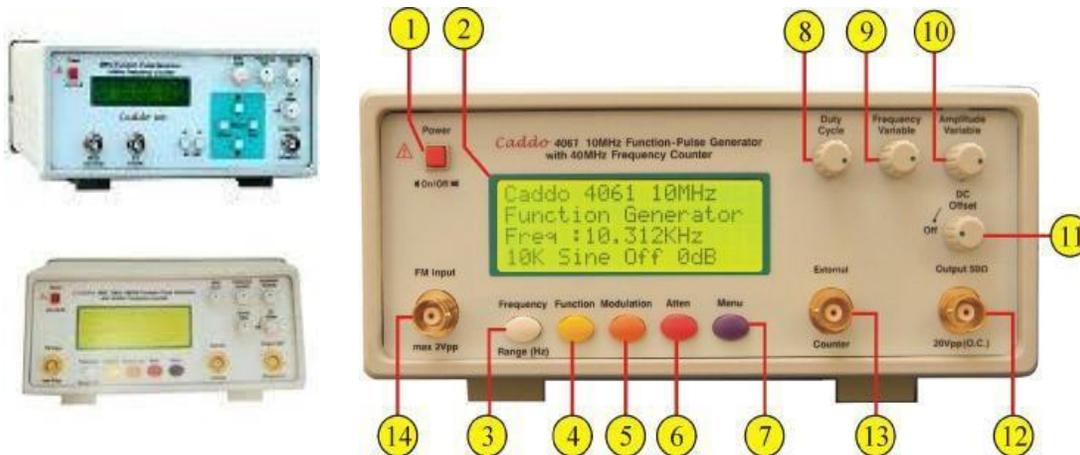
- *Saw tooth wave:* Again, this is a triangular waveform, but with the rise edge of the waveform faster or slower than the fall, making a form of shape similar to a saw tooth.

These waveforms can be either repetitive or single-shot Function generators are used in the development, test and repair of electronic equipment.
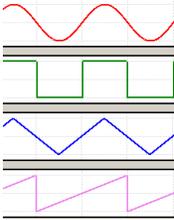
Types of Function Generator

PROCEDURE

1. Turn on the oscilloscope
2. Connect the function generator to one vertical channel of the oscilloscope using BNC Connector
3. Select the type of wave form by pressing Function control button.
4. Set the waveform at desired frequency by adjusting Frequency variable control button.
5. Now adjust the amplitude control of the function generator to establish a 4 V peak-to-peak (p-p) sinusoidal waveform on the screen.

Function Generator connected

Function Generator Controls

Knobs Number	Control Name	Functions
1	Power	Push button switch to power ON the instrument.
2	LCD Display	20 x 4 Character bright back lit Liquid Crystal Display.
3	Frequency	Used for selection of frequency range step by step.
4	Function	Used for selection of Particular waveform. A total number of 6 different waveforms : ❖ *Sine* ❖ *Square* ❖ *Triangle* ❖ *Ramp* ❖ *Pulse* ❖ *TTL are available.*
5	Modulation	Used for selection of Frequency Modulation.
6	Attenuation	Used for Selection of 20dB or 40dB attenuation
7	Menu	Used for selection of Function Generator/Frequency counter mode.
8	Duty Cycle	When pulse output function is selected, this controls the pulse duty cycle from 15% to 85%.
9	Frequency Variable	In conjunction with frequency range, selected by frequency key on front Panel.
10	Amplitude Variable	In conjunction with attenuators (6), this varies the level of output.
11	DC Offset	This control provides DC offset. Approximately ±5VDC is superimposed on the output. Keep the control off if DC offset is not required.
12	Output (BNC connector)	Output of 10 MHz function generator i.e. 20Vpp (Open Circuit)
13	External Counter (BNC Connector)	Input BNC connector for measuring the frequency of external signal when External Counter mode is selected by Menu key on the LCD display.
14	Modulation Input	Maximum modulation Input i.e. 2Vpp.

LAB Exercise

2A DIGITAL MULTI METER

    observation

Description	Value
Measurement of line voltage (ac)	
Measurement of resistance	
Measurement of continuity	

2B DC VARIABLE POWER SUPPLY

    Set 5V in both channel

2C CATHODE-RAY OSCILLOSCOPE (CRO)

Self test of CRO	
Description	**Value**
Measurement of voltage	
Measurement of Time	
Calculated frequency	

2D FUNCTION GENERATOR

- **Set sine wave_____Hz and display in CRO**
- **Set Triangle/ Square wave and display in CRO**

observation

Description	Sine wave	Square Wave
Measurement of voltage		
Measurement of Time		
Calculated frequency		

Result

Introduction to TINA Software

PART 1 – TINA Schematic Editor

General Instructions to Create circuit Schematic Design

Launch TINA Editor from Start- **All programs – TINA 9**: Move your cursor to the Toolbar and tips will appear as you move from one icon to another.   Spend a few minutes to familiarize yourself with the **Menu** bar, **Toolbars** and **Icons.**

At the top of the window, other than the Menu Bar,

    (i)   **Standard** Toolbar

    (ii)   **Schematic Editing Toolbar** There is also a Status Bar at the bottom of the screen.
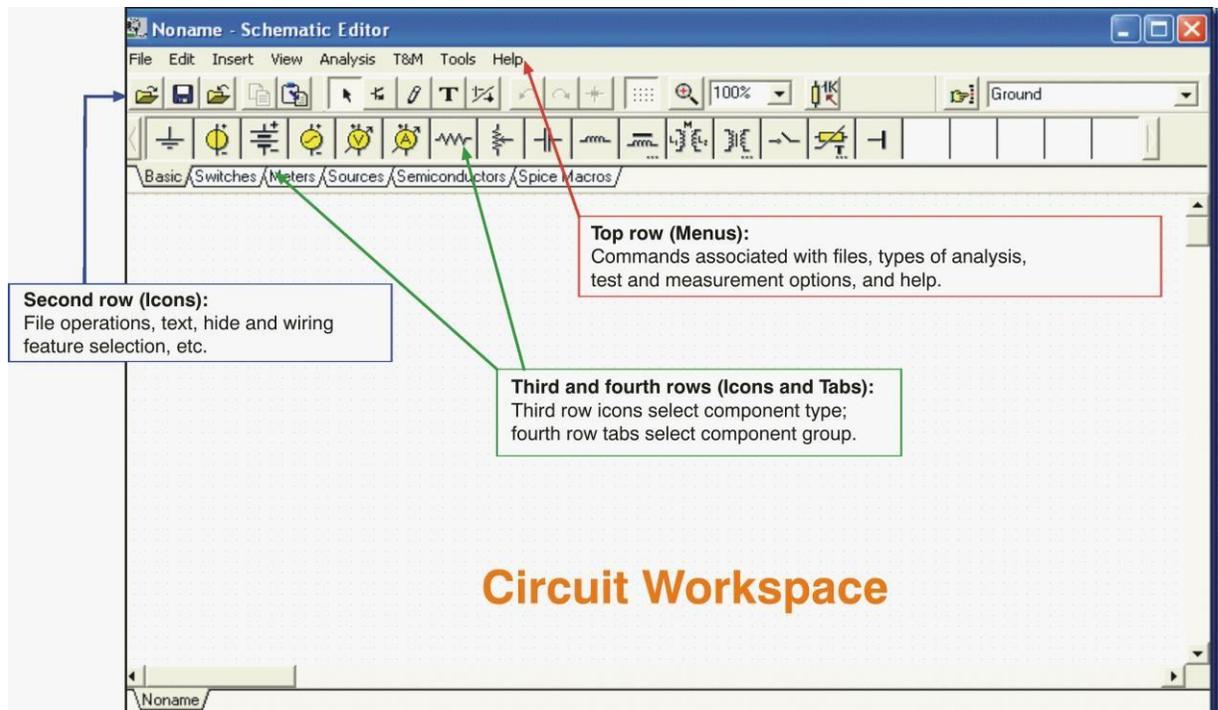
Figure 1:TINA Schematic Editor Window
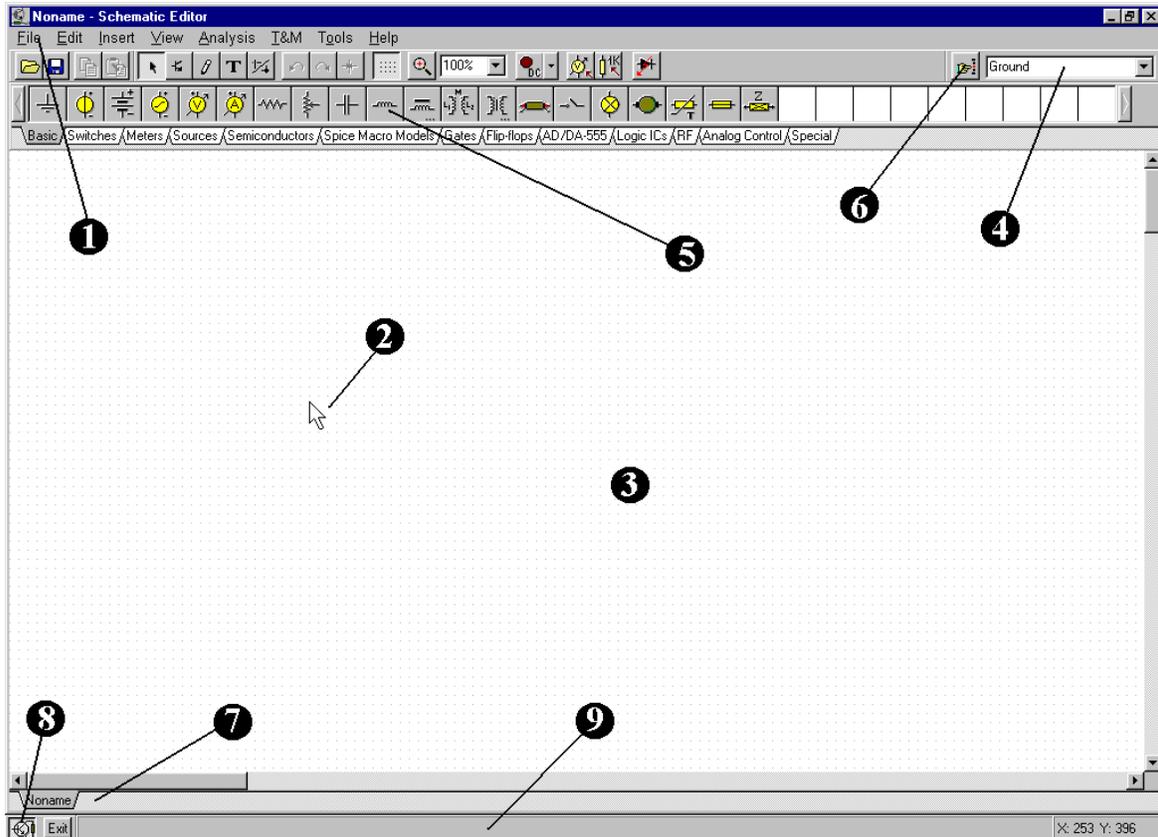
Figure 2:TINA Basic Screen Format

After start-up, the following screen appears on your monitor:

❶ **The Menu bar**

❷**The Cursor or pointer:** This is used to select commands and to edit schematics. You can move the cursor only with the mouse. Depending on the mode of operation, the cursor assumes one of the following forms: An **arrow**, when a command selection is required in the edit window. A **component symbol** (accompanied by an arrow and small box), when inserting that component onto the circuit in the schematic window. Until the position of the component on the schematic is chosen, its movement is controlled by the mouse. A **pen**, when defining the endpoint of a wire. An **elastic line**, when defining the endpoint of a wire or the second node of an input or output. An **elastic box**, when defining a block after fixing its first corner. A **dashed line box**, when positioning a component label or a text block. A **magnifying glass**, when defining a zoom window.

❸**The Schematic window:** This shows the circuit schematic currently being edited or analyzed. The schematic window is actually a window onto a larger drawing area. You can move the screen window over the full drawing area using the scroll bars at the right and bottom of the

screen. When selecting the New command on the File menu, the system automatically aligns the origin of the editor window with the center of the entire editor drawing area. The same is true when an existing circuit file is loaded, as this is the default window position. You can think of *TINA's* schematic as existing on several "layers." In addition to the primary layer that holds components, wires, and text, there are two other drawing layers, which you can turn on or off individually. It is generally convenient to have these two layers on. **View|Pin Markers On/Off:** Displays/hides component pin ends. **View|Grid On/Off:** Displays/hides the grid. A grid of closely spaced dots covering the entire drawing area may be made visible or invisible in the schematic window, depending on the current state of the *grid button* of the *Grid On/Off* switch on the *View* menu. At some schematic zoom levels, you will not see the dots of the grid; nevertheless, all component pins and connecting wires will be on the grid. These dots represent the only available interconnecting points. Component symbols are positioned on the drawing area horizontally and vertically. These symbols are rigid patterns with predefined pin positions and are handled as single units. This permits the software to unambiguously recognize the network nodes.

❹ **The Tool Bar:** You can select most of the editor commands (e.g., select, zoom, wire etc.,) from this tool bar. Most commands on the toolbar can also be found under the drop down menus, and can often be activated by Hotkeys. We show the menu name separated from the command name by a dot (Menu name.Command name) is shown below.
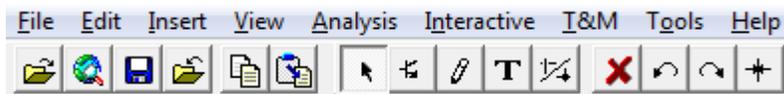
File.Open) Opens a schematic circuit file (.TSC or .SCH), TINA macro files (.TSM) or Spice netlist files (.CIR) / .TSC extension is the current schematic file extension used in TINA v9. The files will appear in the Netlist Editor, where you can execute most TINA analyses, and edit or complete the netlist.

(File.Open from the web) This command starts the built in web browser that allows you to navigate to any website and then directly open TINA files with TSC, SCH or CIR extension by simply clicking a link. It will also save TSM, LIB, and TLD files into their proper place in the user area. Finally, TINA will recognize the.ZIP file extension and will help you select, copy, and extract files. By default the built in web browser in TINA opens the TINA circuits on Web page on the www.tina.com website (at the time of writing this manual www.tina.com/English/tina/ circuits) where you will find interesting electronic circuit files which you can download or open directly from the web and then simulate with TINA.

(File.Save) Saves the actual circuit or subcircuit into its original storage location. It is advised to frequently save the circuit that you are working on to avoid loss of data in case of a computer crash.

(File.Close) Closes the actual circuit or an open subcircuit on the screen. It is very useful for closing an open subcircuit.

(Edit.Copy) Copy a selected part of the circuit or text to the clipboard.

(Edit.Paste) Paste Clipboard contents into the schematic editor. Note that the content may come from the schematic editor itself, TINA's diagram window, or any other Windows program.

Selection mode. If this button is pressed you can select and drag components with the cursor. To select a component (part), wire or text, just click on it with the cursor. You can also select several objects by holding down the Ctrl key and clicking on the objects one-by-one; or by clicking at one corner of the area, holding down the left mouse button, moving to the opposite corner and then releasing the mouse button. Selected objects will turn red. You can drag the selected objects by dragging one of them. Click and hold the left mouse button when the cursor is over one of the selected objects and move them with the mouse. You can unselect all selected object(s) by clicking on an empty area. One or more selected objects can be deleted while leaving the others still selected by holding the Ctrl key down and left-clicking the mouse.You can select all the wire segments, connected by the same ID on Jumpers, by holding down the Shift Key and clicking one of the wire segments.

(Insert.Last component) Retrieves the last component inserted, for a new insertion of another copy, with the same parameters as the previous insertion.

(Insert.Wire) Use this icon for inserting (adding) wires to the schematic design.

T *(Insert.Text)* Add comments into schematics and analysis results.

(Edit.Hide/Reconnect) Use Hide/Reconnect to place or remove a connecting dot between crossing wire or wire-component connection.

(Edit.Rotate Left (Ctrl L), (Edit.Rotate Right (Ctrl R), Rotates the selected component.

(Edit.Mirror) Mirrors the selected component. *Hotkeys* Ctrl L, Ctrl H

Switches On/Off the grid. i.e.makes the grid visible or invisible.

Explicitly zoom in on a selected portion of the current view. It will also zoom out a portion if you just click with the icon into the middle of the area you want to zoom out.

Select zoom ratio from a list from 10% to 200%. You can also select Zoom All which will zoom the effective drawing to full screen. *Interactive modes*, see also on the Interactive menu:

33

DC mode

AC mode

Continuous transient mode

Single shot transient mode, the time is the same as set at Analysis Transient

Digital mode

VHDL mode

With this listbox you can select the analysis and the Interactive Mode Options dialog.

 (Analysis.Optimization Target) Select Optimization Target to set up Optimization mode or to change settings.

 (Analysis.Control Object) Select Control Object for Parameter Stepping or Optimization.

 (Analysis.Faults enabled) If this button is pressed it enables component Faults, set by Fault property of components. You can set component faults with the Property Editor by double-clicking on components.

 (View.3D view/2D view) Hotkey F6. 2D/3D view. If this button is pressed, TINA's chematic Editor displays circuit components as 3D pictures of the real component assigned to the schematic symbol. This is a simple but useful check before starting the PCB design.

 (Tools.PCB Design) **Invokes the dialog which initiates the PCB design module of TINA.**

 (Tools.Find component) Find Component tool. Invokes a component searching and placement tool. This tool helps you find by name any component in the TINA catalog. The search string that you enter will be found wherever it occurs at the beginning, at the end, or anywhere within the component's name. This tool is useful when you don't know where a particular component is located, or if you want a list of all the components that match particular search criteria. A component found in a search can be placed immediately into the schematic by selecting it and pressing the Insert button of this tool.

 Component list. With this tool you can select components from a list.

➎**The Component bar:** Components are arranged in groups, named by the tabs on the Component bar. Once you have selected a group, the available component symbols appear above the tabs. When you click on the desired component (and release the button), the cursor changes to that component symbol and you can move it anywhere in the drawing area. You can also

rotate the component by pressing the + or - keys (on your computer's numeric keypad) or mirror it by pressing the asterisk (*) key (also on your computer's numeric keypad). Once you have selected the part's position and orientation, press the left button of the mouse to lock the symbol in place.

❻ **Find component tool:** This tool helps you find by name anycomponent in the TINA catalog. See more details above at the toolbar description.

❼ **Open files tab:** You can have several different circuit files or different parts (macros) of a circuit open in the schematic editor at the same time. Clicking on a tab brings that circuit page up in the editor.

❽ **The TINA Task bar:** *TINA's* Task bar appears at the bottom of the screen and provides speed buttons for the various tools or T&M instruments currently in use. Each tool or instrument operates in its own window and can be made active by clicking on its speed button (icon of the tool). Once the cursor is over the speed button, a brief hint appears. Note that the first button (furthest to the left), the Lock schematic button, has a special function. When the Lock schematic button is pressed, the schematic window is locked in place as a background behind other windows, so that it can never cover a diagram or virtual instruments. When the schematic window is not locked and it is currently selected, you will always see the entire schematic window with any other windows hidden behind.

❾ **The Help line:** The Help line, at the bottom of the screen, provides short explanations of items pointed to by the cursor.

PART 2 – TINA PCB Design Editor

General Instructions to design PCB Layout using TINA PCB Editor

Creating a Printed Circuit Board (PCB)

Once circuit diagram is completed, you can design printed circuit board to manufacture your design. PCB design is an integral part of the program. Once each component has a satisfactory physical part association,

we can proceed to PCB layout design. To do this, press the button on TINA's toolbar (the last icon on the right) or select the "PCB Design" command on the Tools menu. Set the items in the PCB Design dialog as shown below. Select "Start New Project", "Auto placement" and "Use board template". With the Browse button find and select the **1layer_A.tpt template** files from TINA's Template. The settings are appropriate for a double-sided PCB.

(Tools.PCB Design) **Invokes the dialog which initiates the PCB design module of TINA.**
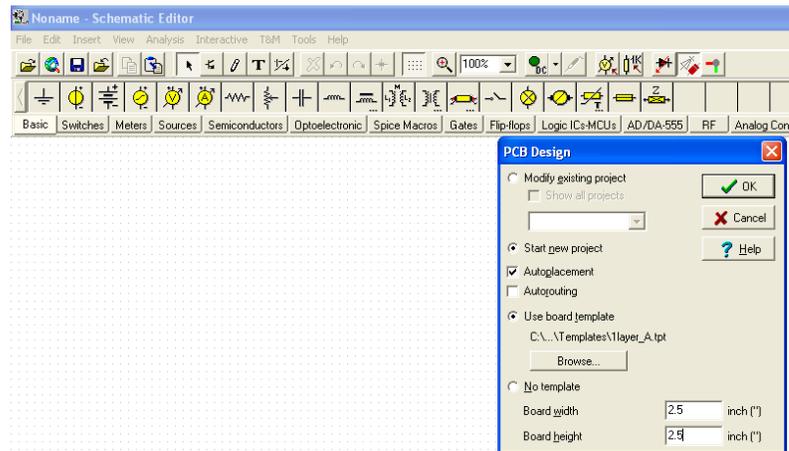
Figure 3:TINA PCB Launch screen

Setting and checking footprint names

In TINA, it is already assigned default footprint names to all parts which represent real components. The most important thing in PCB design is that every part in schematic must have a physical representation with exact physical size. This is accomplished through so called footprints–drawings showing the outline and the pins of the parts. TINA's footprint naming uses as a starting point the IPC-SM-782A(Surface Mount Design and Land Pattern Standard) and the

JEDEC standard JESD30C (Descriptive Designation System for Semiconductor Device Packages). (See http://www.jedec.org/download/search/ jesd30c.pdf.)
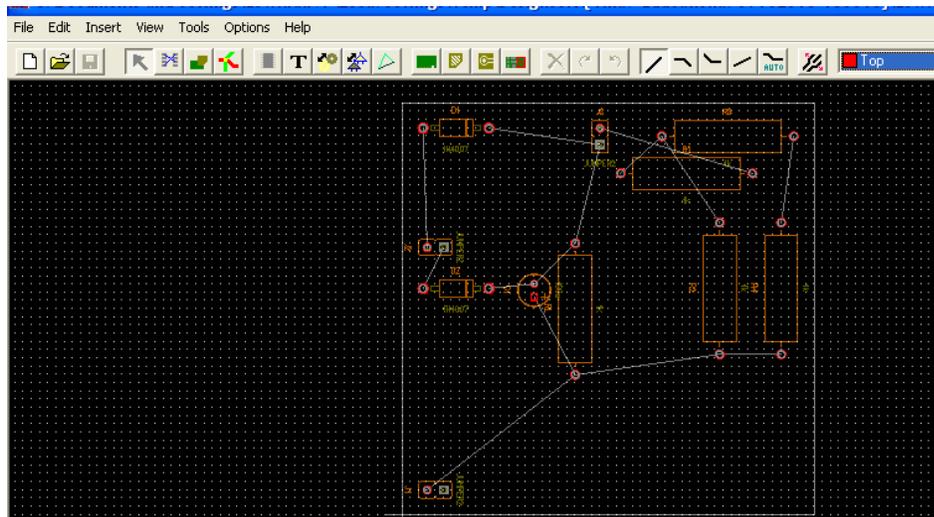
Figure 4:TINA PCB Editor window

Foot print can be edited using "Footprint name editor" which can be invoked from the Tools menu. In this dialog you see all of Tina's components and the corresponding footprint names
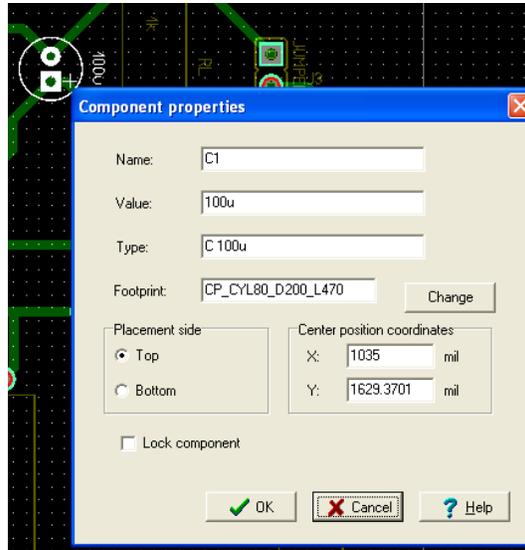

Figure 5:Component property editor

Clicking on the footprint name fields, from the available footprint names the required footprint can be selected. In the dialog, components that do not already have a footprint name association will be denoted by red characters and also by "???" in the footprint name field.
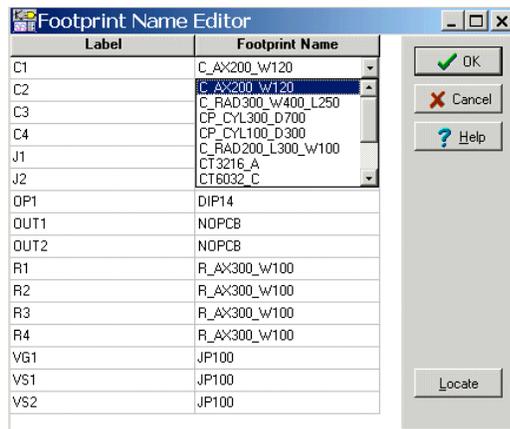
Figure 6:Component Footprint name editor
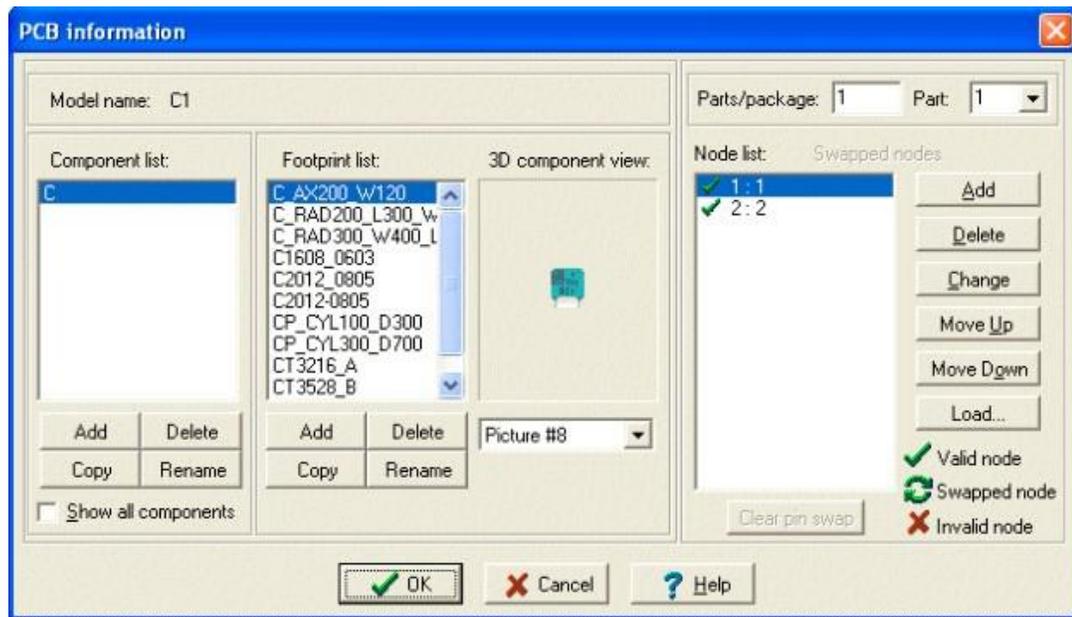
Figure 7:Component information

If you find the footprint name you want on the list, click on it and press OK: you will be returned to the component property dialog with the selected footprint name in the Footprint name line. To confirm the change, press OK on the component property dialog again .If you do not find the footprint name you want, you can add a new footprint using the Add buttons of the "PCB information" dialog. Press the Help button for more information. When everything looks good, you can make a final check by clicking the 2D/3D view button. The 3D view of those components for which a physical representation has already been added will appear

Experiment No 3
PCB Design – Full wave Rectifier

OBJECTIVE:
- To create a schematic drawing with TINA Editor
- To design a PCB layout using PCB Design Editor

Editing an Full wave rectifier Circuit Schematic

Create the circuit schematic for the full wave rectifier circuit as shown figure. Follow the general procedure given as General Instructions to Create circuit Schematic Design, to add parts and complete the circuit diagram.
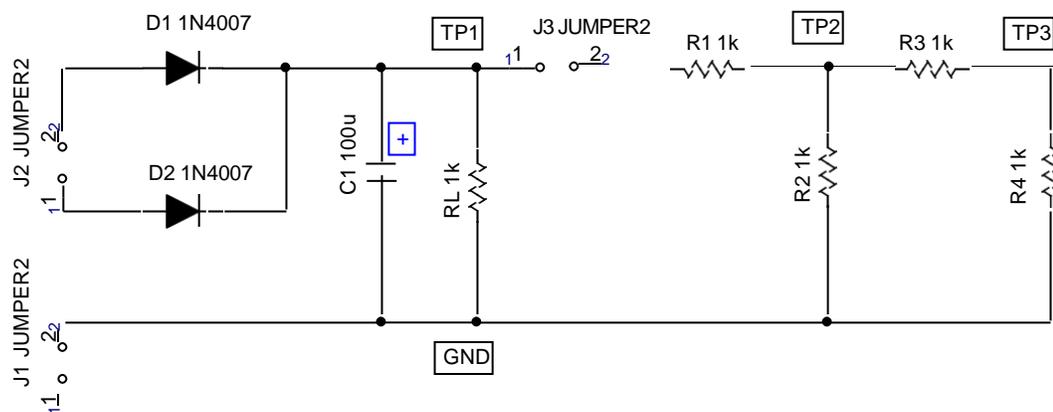
Figure 8: Fullwave rectifier circuit diagram
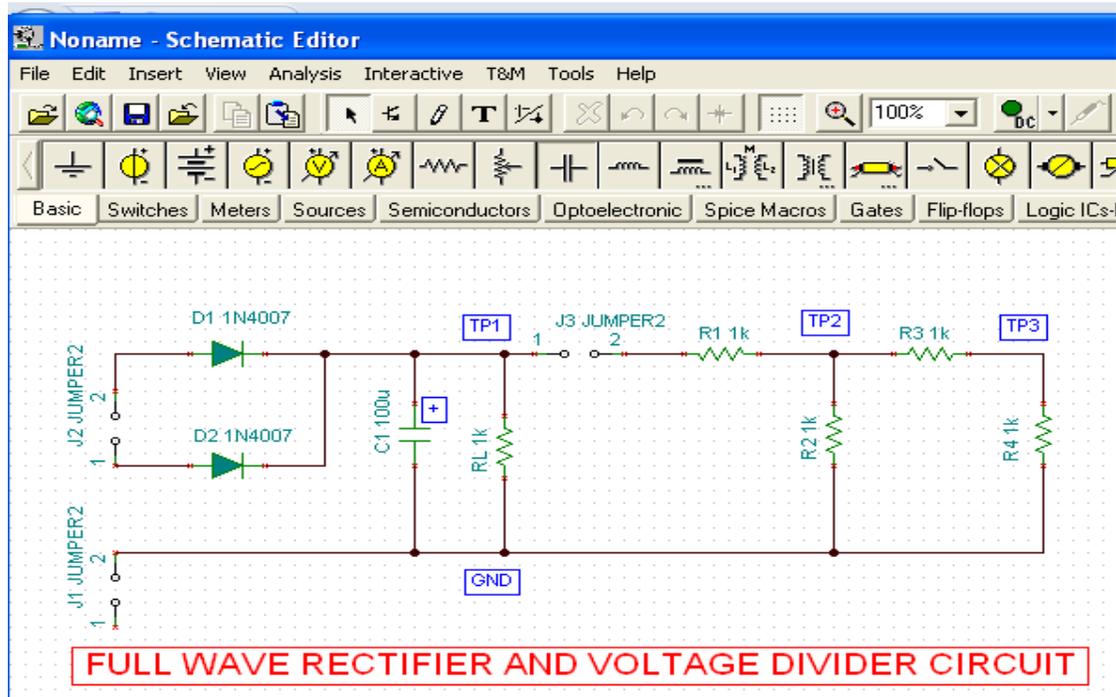
Figure 9: Circuit schematic of Fullwave rectifier circuit diagram in TINA Schematic Editor

Generate Bill of Materials from **File menu- Bill of Materials**

#	Quantity	Label	Value	Footprint
1	1	C1	100u	CP_CYL80_D200_L470
2	1	R1	1k	R_AX800_W200
3	1	R2	1k	R_AX800_W200
4	1	R3	1k	R_AX800_W200
5	1	R4	1k	R_AX800_W200
6	1	RL	1k	R_AX800_W200
7	1	D1	1N4007	DO41-10
8	1	D2	1N4007	DO41-10
9	1	J1	JUMPER2	JP100
10	1	J2	JUMPER2	JP100
11	1	J3	JUMPER2	JP100

Invoking TINA PCB Design
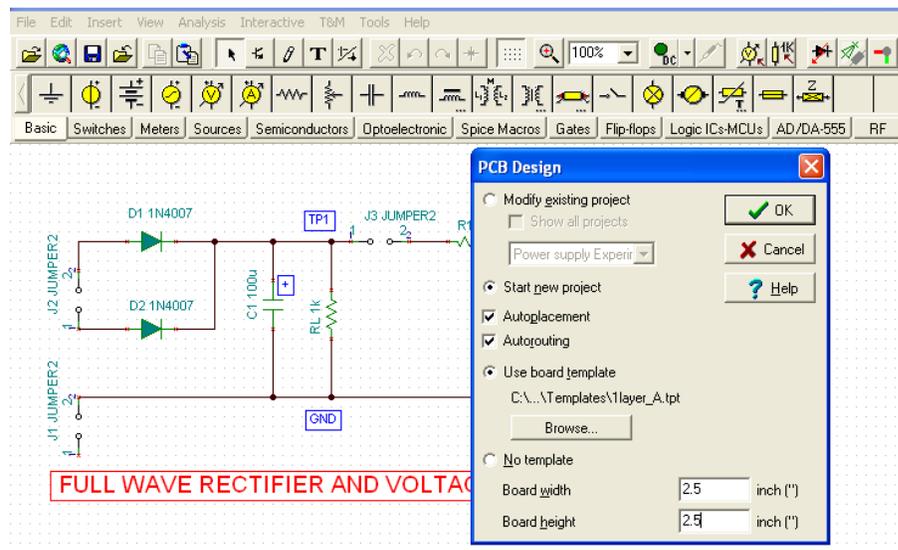
Figure 10: Invoking TINA PCB Editor

Once each component has a satisfactory physical part association, we can proceed to PCB layout design. To do this, press the button on TINA's toolbar (the last icon on the right) or select the **"PCB Design" command on the Tools menu.** Set the items in the PCB Design dialog as shown figure. Select "Start New Project", "Auto placement" and "Use board template". With the Browse button find and **select the 1layer_A.tpt template** files from TINA's Template.

Finally, you can set the **size of the PCB board in inches or mm** depending on the measurement unit settings in the View/ Options dialog of TINA. When everything is set properly, press the OK button and the PCB layout design will appear with all the components automatically placed on the PCB board.
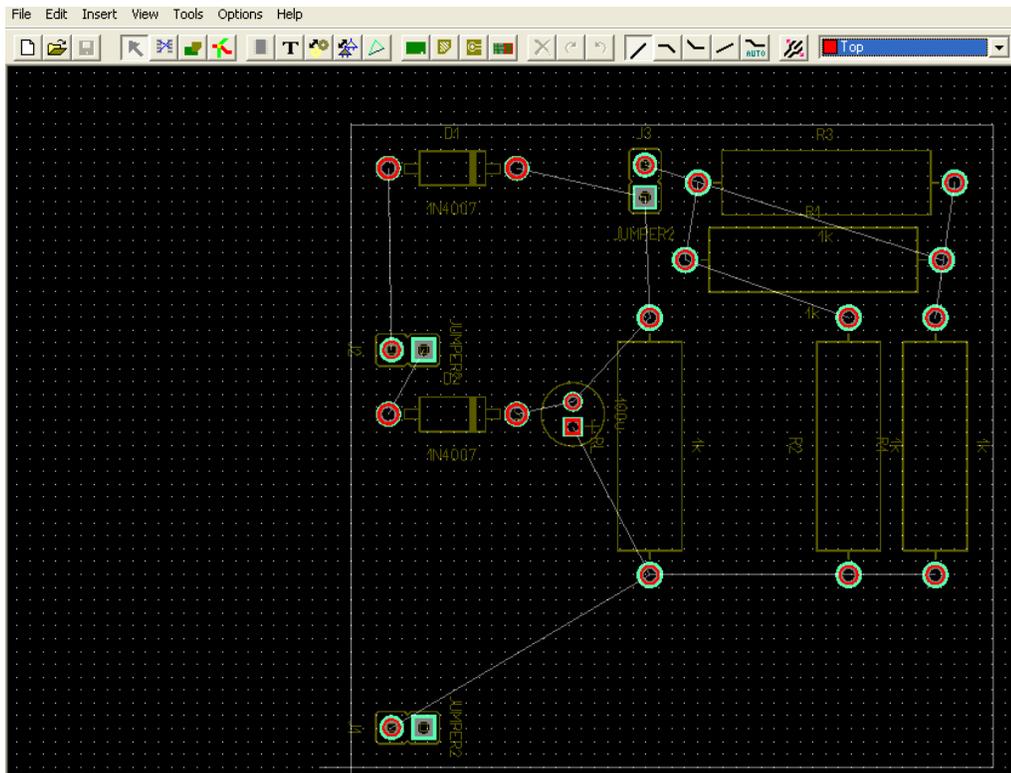

Figure 11: Autoplacement of components TINA PCB Editor

If you want to reorient the components, click the required component and drag the parts to new positions as, shown on the figure

Press F4 to invoke the Net Editor and set nets routing width. First, click on "Modify all" and enter 25 mil into the "Track width" field. Then select power nets (Ground, VCC, -VCC) and set their widths to 25mil.

To automatically route the netlist, press the F5 button or select "Autoroute board" command from the Tools menu. The following screen will appear:

To finish the design, let's add a text box to the silkscreen/ assembly layer. To do this, click the T button on the toolbar. The following message will appear
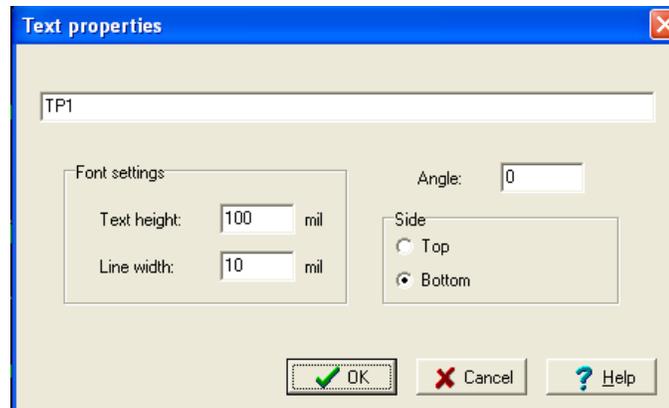
Enter the text into the empty upper field and press the OK button. The text will be attached to the cursor. Move it to the place it on either Top/Bottom layer and press the left mouse button.
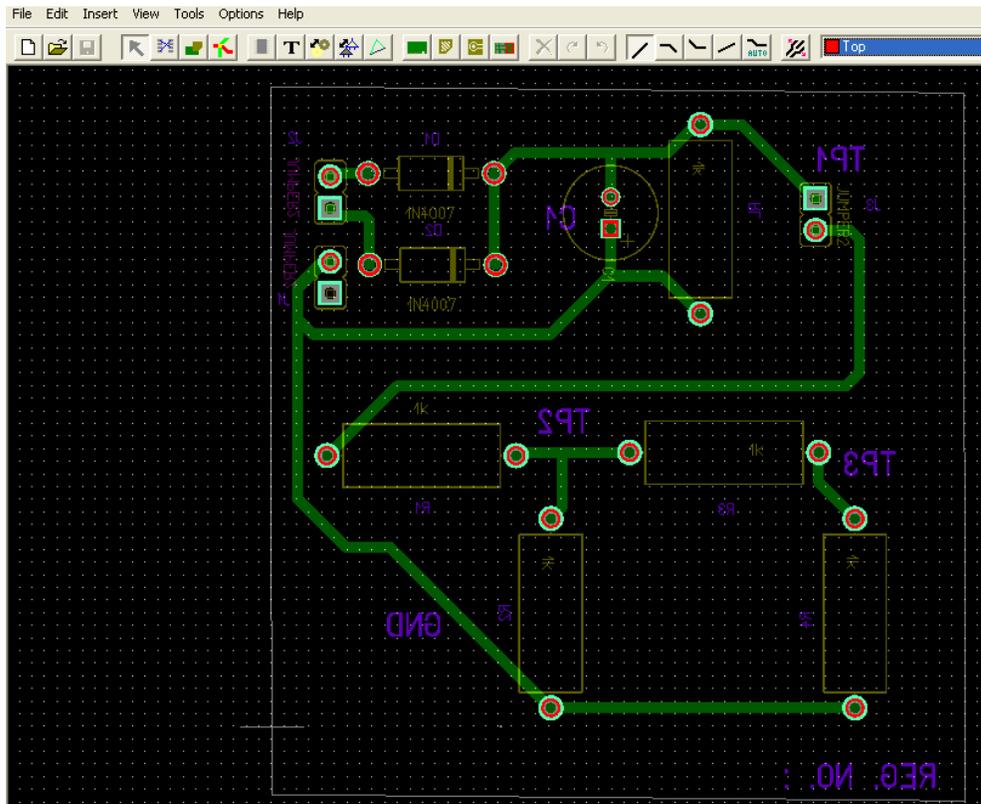

Figure 12: Fullwave circuit after routing and lablin in TINA PCB Editor

To see if everything is routed correctly, press F7 or select DRC (Design Rule Check) from the Tools menu. The following message will appear:

Finally, you can check your design in full 3D. To do this, press F3 or select 3D View from the View menu. After some calculation the following window will appear
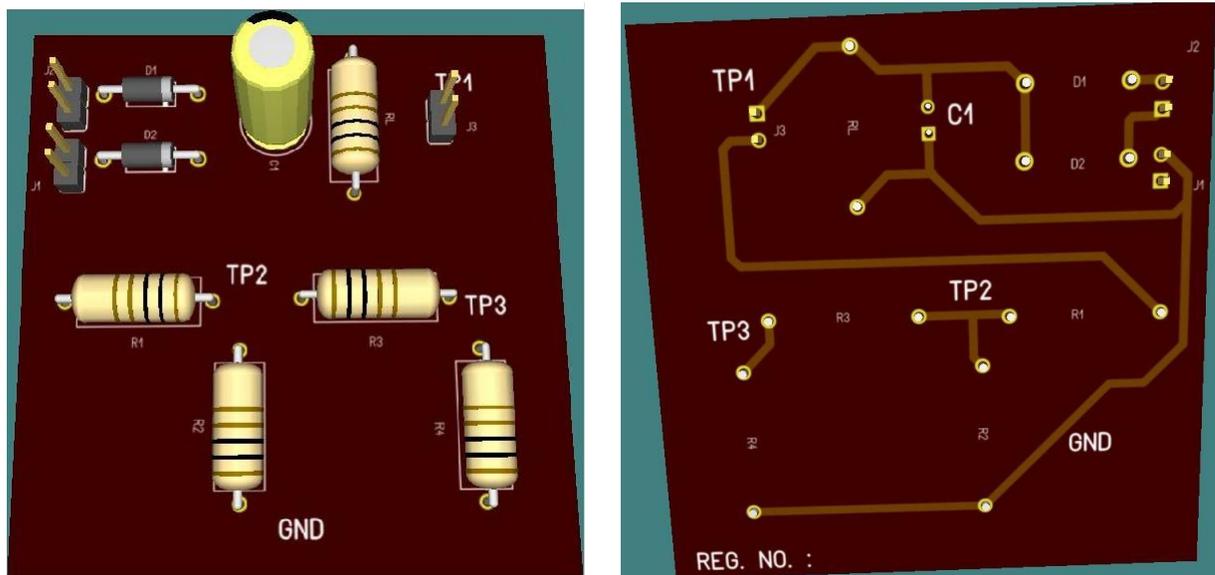
Figure 13: 3D View of Top and Bottom side of PCB

You can rotate the 3D model and zoom in and out with the control arrows at the bottom. You can display or hide these arrows through the Options menu with *"Use control arrows"* checkbox. You can also rotate this 3D model by clicking with the mouse at any point, holding down the left button and moving the mouse.

After this you can either print your design or create a Gerber file for a manufacturer. To print use Print…from File menu. To obtain Gerber files to direct a photo plotter, choose Export Gerber file from File menu. (Gerber option can be changed through Gerber output setting under Options menu.)
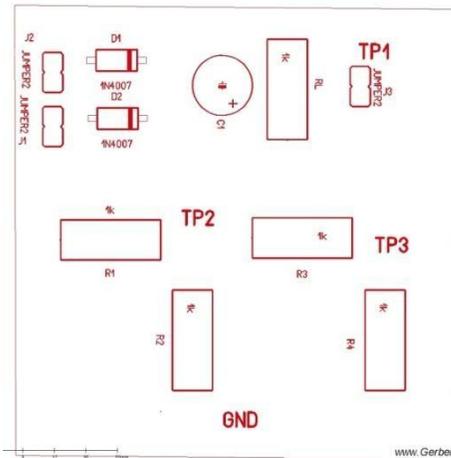
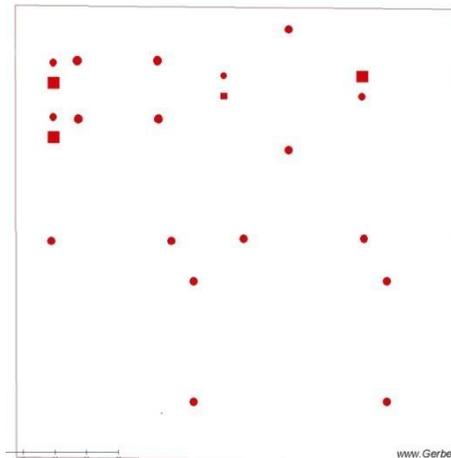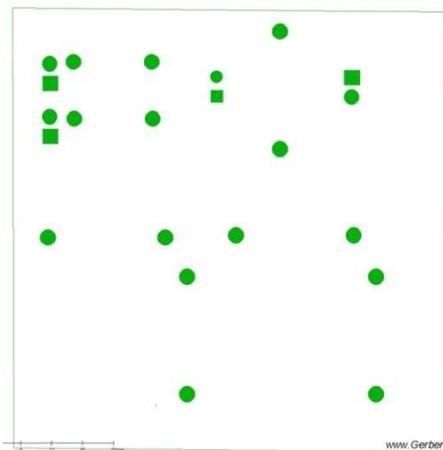**Generate the following output files**
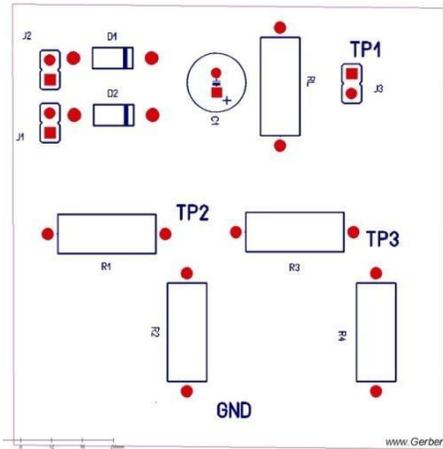
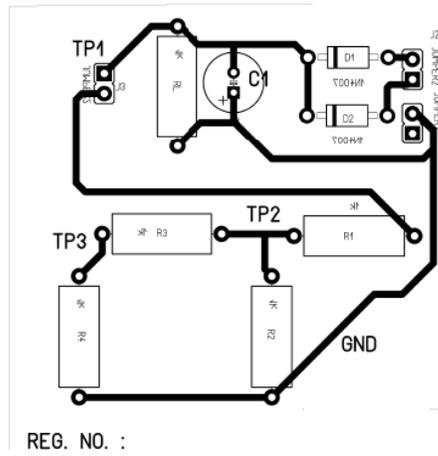Assembly Drawing
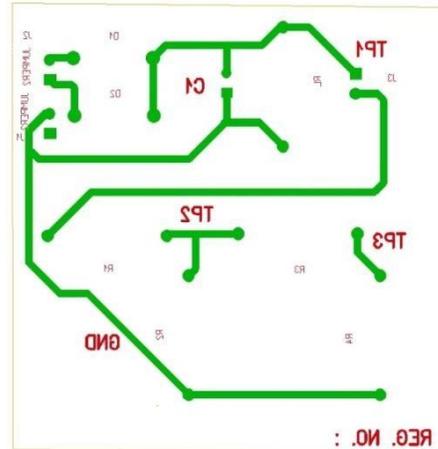
Routing (Bottom)

Silk screen

NC Drill Drawing

Solder mask (Bottom)

Top and Bottom layer

Design outputs

Result:

EXERCISE 4

## ASSEMBLY AND TESTING - FULL WAVE RECTIFIER

OBJECTIVE:

To assemble and test full wave rectifier circuit and to measure voltage drop across resistive network.

COMPONENTS REQUIRED:

| S.NO	COMPONENTS NAME	VALUE	QUANTITY
1.	PCB for full wave rectifier and voltage drop resistive network	-	1
2	Digital multimeter (DMM)-	-	1
3	Resistors	1 kΩ ,500 Ω,10 kΩ,4.7 k, 2.2 kΩ,22 kΩ	Each 1 no
4	AC power supply, connecting wires	-	1
5	soldering kit	-	1

CIRCUIT DIAGRAM:
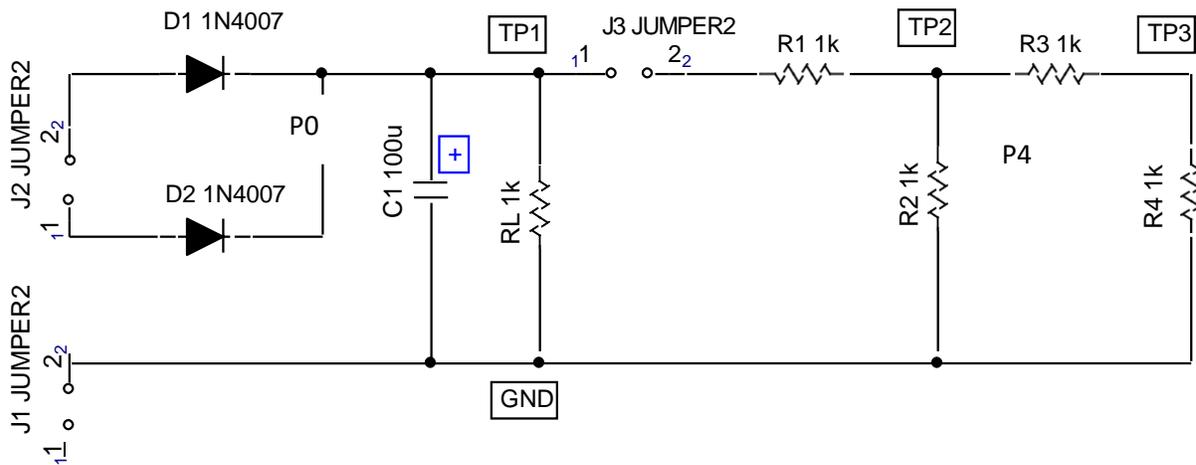
PROCEDURE:
1) Assembling the circuit

- Assemble the circuit by placing the diode, capacitor, connector and resistors in the PCB as per the assembly diagram shown in the figure.
- Bend the resistors lead to the appropriate size before inserting them into the board.

- Solder the resistor on bottom side of PCB board using soldering iron.

2) Testing the circuit

a) Connect the AC source from step down transformer to jumper J1 and J2.

b) Connect the positive terminals of multimeter to point TP1 and negative terminal to GND.

c) Measure the voltage V1 between TP1 and GND
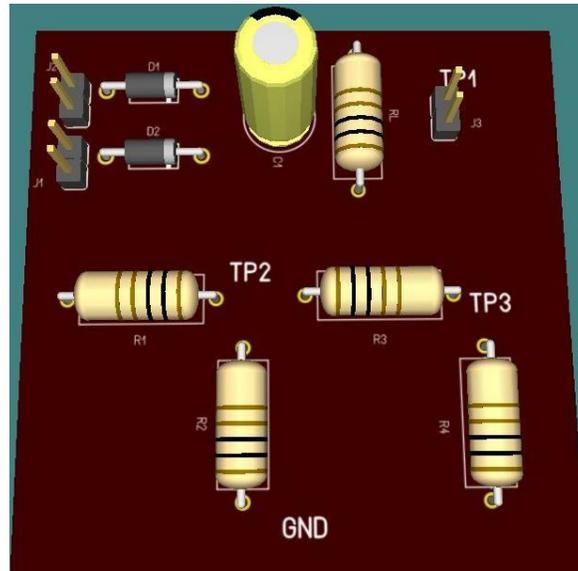
JOIN JUMPER 3 THEN.

d) Measure the voltage V2 between TP2 and GND

e) Measure the voltage V3 between TP3 and GND.

V1	
V2	
V3	

f) Measure the voltage across the individual resistor and note the values in the table below.

Resistor	Resistor value	Voltage drop across the resistor (v)
R_L		$V(R_L) =$
R1		$V(R1) =$
R2		$V(R2) =$
R3		$V(R3) =$
R4		$V(R4) =$

47

Calculate Vin=(V(R1) + V(R3) + V(R4))=   +   +   +   = -------- V

Calculate Vout=(V(R$_L$))=------V

3) TROUBLE SHOOTING:

a) Set the digital multimeter the continuity mode. Unplug the device or switch off the circuit before attempting a continuity test. Check the continuity between all five nodes.

b) When the resistor value differs from the circuit, the output value also differs.

RESULT:
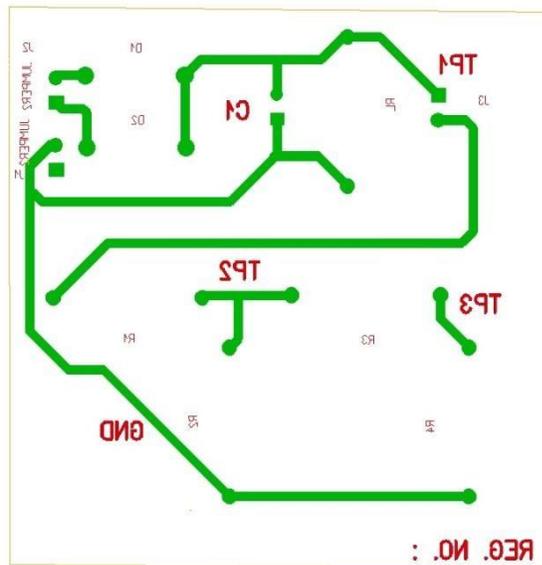
EXERCISE 5

Single side PCB Fabrication

OBJECTIVE:

To fabricate single side PCB for full wave rectifier circuit and resistive network.

COMPONENTS REQUIRED:

| S.NO	COMPONENTS NAME	VALUE	QUANTITY
1.	Single side copper clad PCB	(2.5 x 2.5) Square inch	1
2	Digital multimeter (DMM)	-	1
3	Ferric chloride solution and etching equipment		1
4	Drilling machine	0.8mm	1

ROUTING DIAGRAM:

PROCEDURE:

- Print bottom layout of the PCB design in a photo paper using high quality resolution
- Clean the single side copper clad thoroughly using fine emery sheet.
- Place toner side (Print side) on copper side of PCB
- Using Electric Iron box, press gently on the paper until the full toner transferred to the clad side
- Dip the clad in Ferric chloride solution and rinse for 5 -10 min until the unmasked copper get removed. Clean with fresh water.

49

- Then clean the surface with using fine emery sheet.
- Make through hole using 0.8mm drill in all the pads
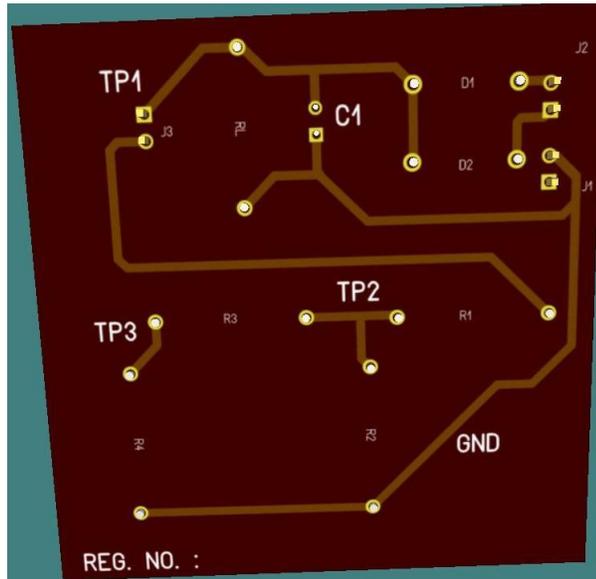
Testing:

Using digital multimeter, in continuity mode, Test for continuity of tracks, and short circuit.

RESULT: