Basics of Electronics Lab
(ECE-103-F)
LAB MANUAL
I and II SEMESTER

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BASICS OF ELECTRONICS (ECE-103 -F)

LIST OF EXPERIMENTS

EXPERIMENT NO: 1

AIM: To get familiar with working knowledge of the following Instruments:

(a) Cathode Ray Oscilloscope (CRO) (b) Function Generator

(c) Multimeter (Analog and Digital) (d) Power Supply

THEORETICAL CONCEPT:

(a)CATHODE RAY OSCILLOSCOPE

The cathode-ray oscilloscope (CRO) is a common laboratory instrument that provides accurate time and amplitude measurements of voltage signals over a wide range of frequencies. Its reliability, stability, and ease of operation make it suitable as a general purpose laboratory instrument. The heart of the CRO is a cathode-ray tube shown schematically in Fig. 1.

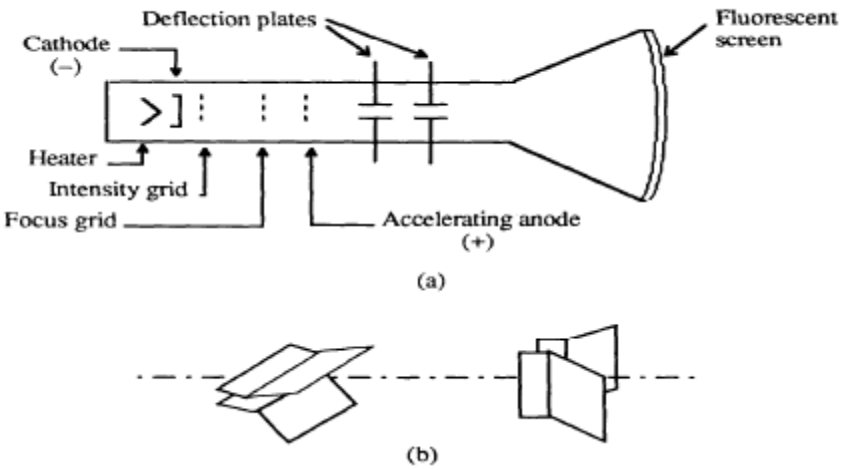


Figure1. Cathode ray tube (a) Schematic (b) details of deflection plates

The cathode ray is a beam of electrons which are emitted by the heated cathode (negative electrode) and accelerated toward the fluorescent screen. The assembly of the cathode, intensity grid, focus grid, and accelerating anode (positive electrode) is called an electron gun. Its purpose is to generate the electron beam and control its intensity and focus. Between the electron gun and the fluorescent screen is two pair of metal plates – on e oriented to provide horizontal deflection of the beam and one pair oriented to give vertical deflection to the beam. These plates are thus referred to as the horizontal vertical deflection plates. The combination of these two deflections allows the beam to reach any portion of the fluorescent screen. Wherever the electron beam hits the screen, the phosphor is excited and light is emitted from that point. This conversion of electron energy into light allows us to write with points or lines of light on an otherwise darkened screen.

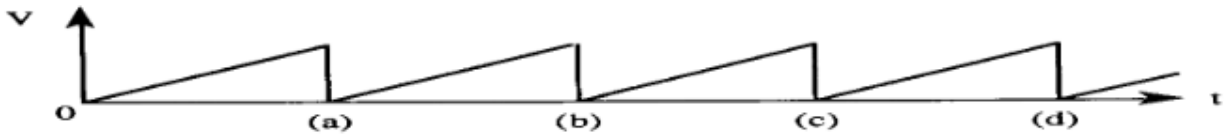
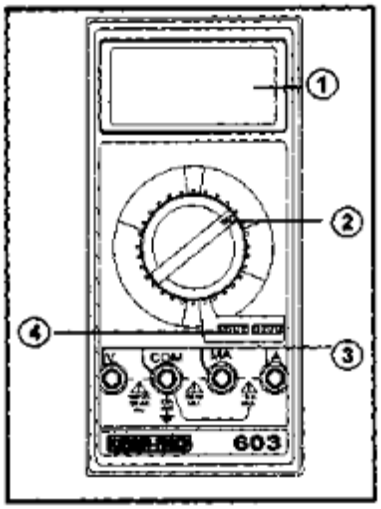


Figure 2.Voltage difference V between horizontal plates as a function of time t

(b) MULTIMETER



A multimeter 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. Multimeters may also have other functions, such as diode and continuity tests. The descriptions and pictures that follow are specific to the Fluke 73 Series III Multimeter, but other multimeters are similar.

(c) FUNCTION GENERATOR

A function generator is a device that can produce various patterns of voltage at a variety of frequencies and amplitudes.

It is used to test the response of circuits to common input signals. The electrical leads from the device are attached to the ground and signal input terminals of the device under test.

Features and controls

Most function generators allow the user to choose the shape of the output from a small number of options.

-Square wave - The signal goes directly from high to low voltage.

-Sine wave - The signal curves like a sinusoid from high to low voltage.

-Triangle wave - The signal goes from high to low voltage at a fixed rate.

The amplitude control on a function generator varies the voltage difference between the high and low voltage of the output signal.

The direct current (DC) offset control on a function generator varies the average voltage of a signal relative to the ground.

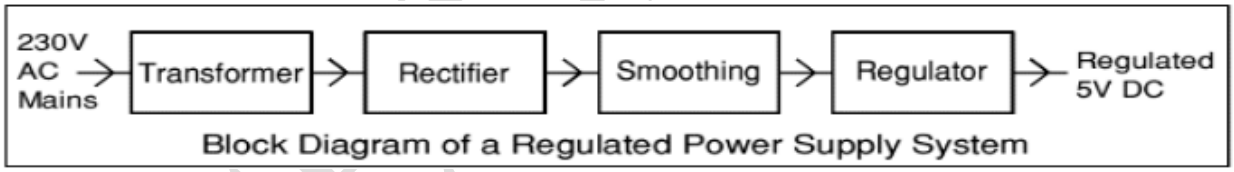
The frequency control of a function generator controls the rate at which output signal oscillates. On some function generators, the frequency control is a combination of different controls.

One set of controls chooses the broad frequency range (order of magnitude) and the other selects the precise frequency. This allows the function generator to handle the enormous variation in frequency scale needed for signals.

(d)POWER SUPPLY

There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function.

For example a 5V regulated supply:



Block Diagram of a Regulated Power Supply System

- Each of the blocks is described in more detail below:
- Transformer- steps down high voltage AC mains to low voltage AC.
- Rectifier- converts AC to DC, but the DC output is varying.
- Smoothing- smoothes the DC from varying greatly to a small ripple.
- Regulator- eliminates ripple by setting DC output to a fixed voltage.

EXPERIMENT NO: 2

AIM: Plot the forward and reverse V-I Characteristics of a PN junction Diode.

THEORETICAL CONCEPT:

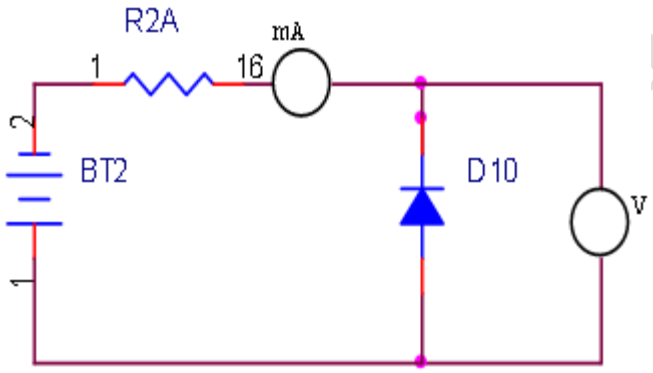
A P-N junction is known as Semiconductor diode or Crystal diode. It is the combination of P-type & N-type Semiconductor which offers nearly zero resistance to current on forward biasing & nearly infinite Resistance to the flow of current when in reverse biased.

Forward biasing: When P-type semiconductor is connected to the +ve terminal and N-type to - ve terminal of voltage source. Nearly zero resistance is offered to the flow of current.

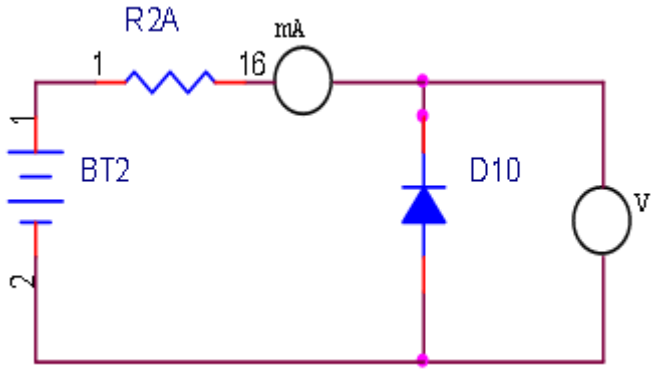
Reverse biasing: When P-type semiconductor is connected to the –ve terminal and N-type to +ve Terminal. Nearly zero current flow in this condition.

EXPERIMENTAL SETUP:

(1) When diode is forward biased



(2) When diode is reverse biased



SPECIFICATION OF APPARATUS USED: Diode Characteristics Kit, Power Supply, Ammeter (0-20mA), Voltmeter (0-20V), Connecting Leads

PROCEDURE:

1. Connect the circuit as shown in figure.
2. Switch on the power supply.
3. Vary the value of input dc supply in steps.
4. Note down the ammeter & voltmeter readings for each step.
5. Plot the graph of Voltage Vs Current
6. Connect the circuit as shown in figure.

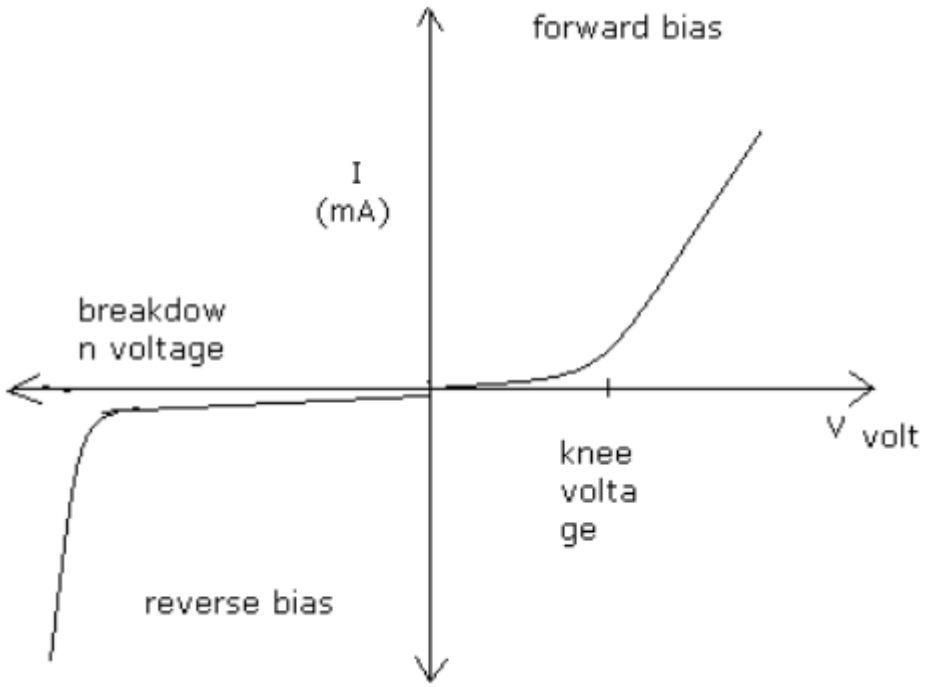
PRECAUTIONS:

1. While doing the experiment do not exceed the ratings of the diode. This may lead to damage the diode.
2. Connect voltmeter and Ammeter in correct polarities as shown in the circuit diagram.
3. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

OBSERVATION DATA:

SNo.	**When diode is forward biased**		**When diode is reverse biased**	
	Current(mA)	**Voltage(V)**	**Current(µA)**	**Voltage(V)**

GRAPH:



RESULT AND COMMENTS:

- The graph has been plotted between voltage and current.
- The diode does not conduct in Reverse Bias state and conduct in Forward Bias state.

EXPERIMENT NO: 3

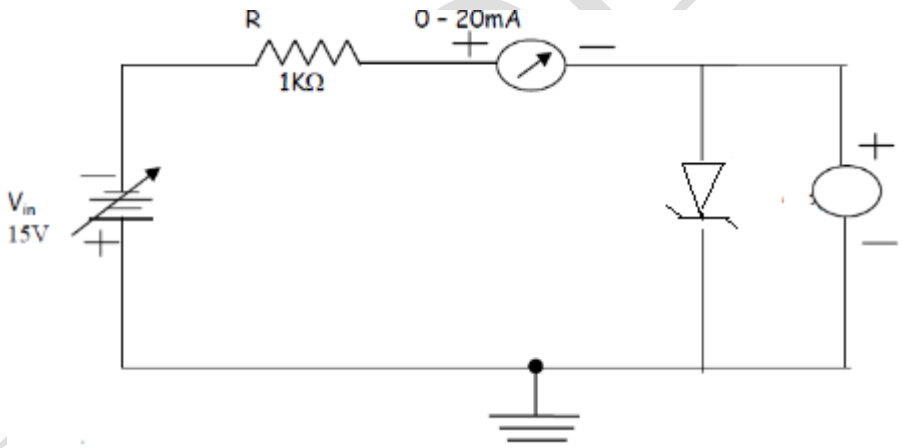
AIM: Study of Zener diode in Breakdown region

THEORETICAL CONCEPT: An ideal P-N Junction diode does not conduct in reverse biased condition. A zener diode conducts excellently even in reverse biased condition. These diodes operate at a precise value of voltage called break down voltage. A zener diode when forward biased behaves like an ordinary P-N junction diode. A zener diode when reverse biased can either undergo avalanche break down or zener break down.

Avalanche breakdown:-If both p-side and n-side of the diode are lightly doped, depletion region at the junction widens. Application of a very large electric field at the junction may rupture covalent bonding between electrons. Such rupture leads to the generation of a large number of charge carriers resulting in avalanche multiplication.

Zener breakdown:-If both p-side and n-side of the diode are heavily doped, depletion region at the junction reduces. Application of even a small voltage at the junction ruptures covalent bonding and generates large number of charge carriers. Such sudden increase in the number of charge carriers results in zener mechanism.

EXPERIMENTAL SETUP:



SPECIFICATION OF APPARATUS USED: Diode Characteristics Kit, Power Supply, Ammeter (0-20mA), Voltmeter (0-20V), Connecting Leads. Zener Diode

PROCEDURE:

1. Connect the circuit as shown in figure.
2. Vary V_z gradually and note down the corresponding readings of I_z.
1. Step Size is not fixed because of non linear curve and vary the X-axis variable (i.e. if output variation is more, decrease input step size and vice versa).
3. Tabulate different reverse currents obtained for different reverse voltages.

PRECAUTIONS:

1. While doing the experiment do not exceed the ratings of the diode. This may lead to damage the diode.
2. Connect voltmeter and Ammeter in correct polarities as shown in the circuit diagram.
4. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

OBSERVATION DATA:

Reverse voltage across diode V_z(volts)	Reverse current through the diode I_z(mA)

RESULT AND COMMENTS:

The Zener diode characteristics have been studied.

APPLICATIONS:

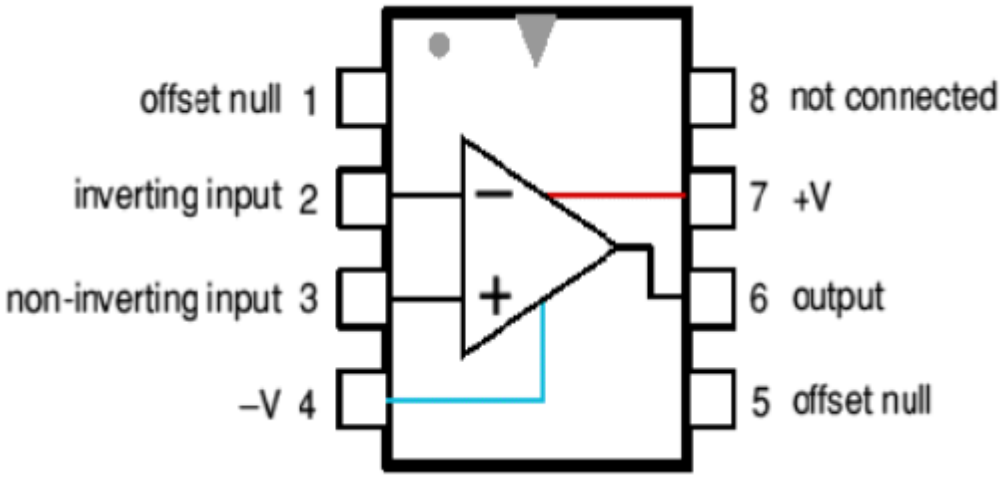
1. Voltage regulation
2. Meter protection
3. Zener diode as a peak clipper
4. Zener diode as a reference element

EXPERIMENT NO. 4

AIM: -To get familiar with pin configuration of typical OP-AMP 741 and its use as:

1. Inverting amplifier
2. Non-Inverting amplifier
3. Summing amplifier
4. Difference amplifier

THEORETICAL CONCEPT: -The op-amp is a multi-terminal device used in a number of electronic circuits



(a)Inverting Amplifier: - In the inverting amplifier only one input is applied and that is to the inverting input (V2) terminal. The non-inverting input terminal (V1) is grounded.

Since,

$$V_1 = 0 \text{ volts and } V_2 = V_{in}$$

$$V_o = -A_{vin}$$

The –ve sign indicates the output voltage is 180°out of phase with respect to the input and amplified by gain A.

(b)Non-Inverting Amplifier:-The input is applied to the non-inverting input terminal and the Inverting terminal is connected to the ground.

$$V_1 = V_{in} \text{ and } V_2 = 0 \text{ volts}$$

$$V_o = A_{vin}$$

The output voltage is larger than the input voltage by gain A & is in phase with the input signal.

(c)Summing Amplifier:

If each input voltage is amplified by a different factor in other words weighted differently at the output, the circuit is called then summing amplifier.

$$\frac{Rf}{Ra} \neq \frac{Rf}{Rb} \neq \frac{Rf}{Rc}$$

$$Vo = -\left[\frac{Rf}{Ra}Va + \frac{Rf}{Rb}Vb + \frac{Rf}{Rc}Vc\right]$$

The circuit can be used as averaging circuit, in which output voltage is equal to average of all the input voltages.

In this case, $R_a=R_b=R_c=R$ and $R_f/R=1/n$, where n is number of inputs.

Here $R_f/R=1/3$

$V_o=-(V_a+V_b+V_c)/3$

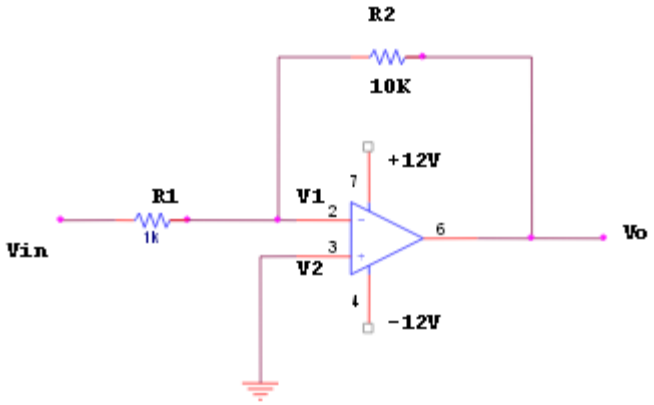
In all these applications input could be either ac or dc.

c) Difference Amplifier:

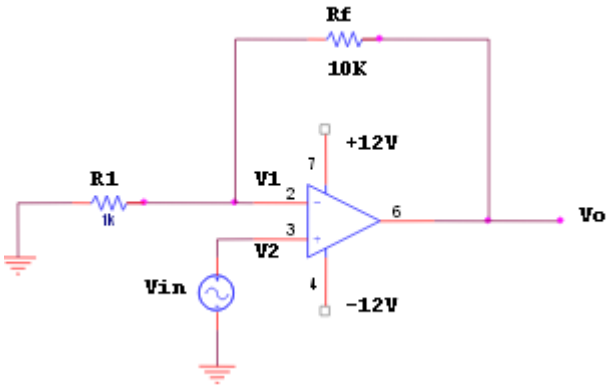
The output voltage is directly proportional to the input difference of two voltages:

$$Vo = (Vin1 - Vin2)$$

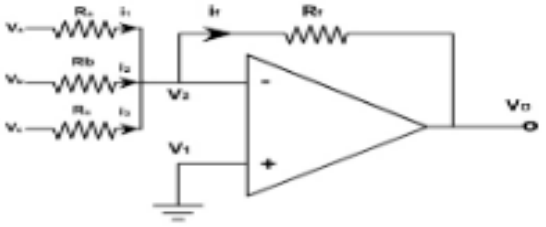
EXPERIMENTAL SETUP:



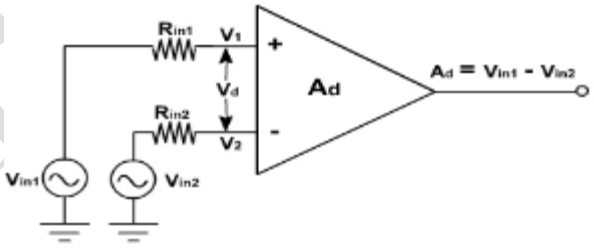
(a)Inverting amplifier



b) Noninverting amplifier



(c)Summing Amplifier



(d) Difference Amplifier

SPECIFICATION OF APPARATUS USED: - CRO, Function Generator, Bread Board, 741 IC, ±12V supply, Resistors1KΩ, 10KΩ, and Connecting leads.

PROCEDURE: -

1. Connect the circuit for Inverting, Non-inverting and Summing and Difference amplifier on a Breadboard.
2. Connect the input terminal of the op-amp to function generator and output terminal to CRO.
3. Feed input from function generator and observe the output on CRO.
4. Draw the input and output waveforms on graph paper.

PRECAUTIONS:-

1. Do not use open ended wires for connecting to 230 V power supply.
1. Before connecting the power supply plug into socket, ensure power supply should switched off
2. Ensure all connections should be tight before switching on the power supply.

RESULT AND COMMENTS: -

Desired and Amplified output waveforms are obtained.

EXPERIMENT NO: 5

AIM: Use of OP-AMP as an Integrator.

THEORETICAL CONCEPT:

A circuit in output voltage waveform is an integral of the input voltage waveform is called an integrator. In this circuit, the feedback resistor of an OP-AMP is replaced by a capacitor. The output obtained will be an integral of the input wave.

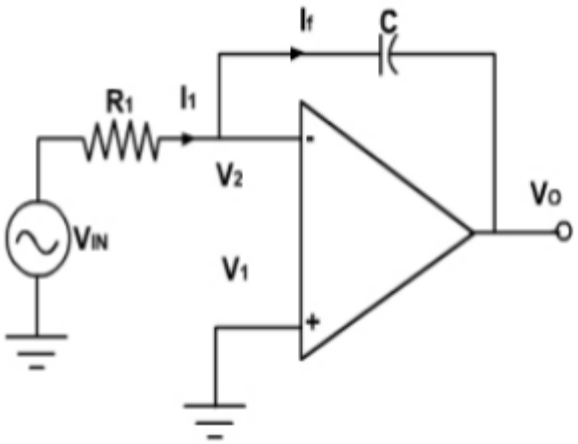
$$I(t) = v(t)/R$$

Output Voltage= $1/C \int v(t)/R\, dt = -1/RC \int V(t)\, dt$

The circuit therefore provides an output voltage proportional to the integral of the input voltage. If the input voltage is a constant, v=V, then the output will be a ramp,

$$V_o(t) = -1/RC \int Vi(t)\, dt$$

EXPERIMENTAL SETUP:



Here, the feedback element is a capacitor. The current drawn by OPAMP is zero also the V_2 **is** virtually grounded.

Therefore $i_1=i_f$ and $v_2=v_1=0$

SPECIFICATION OF APPARATUS USED: - CRO, Function Generator, Power supply, connecting, leads, Integrator circuit kit.

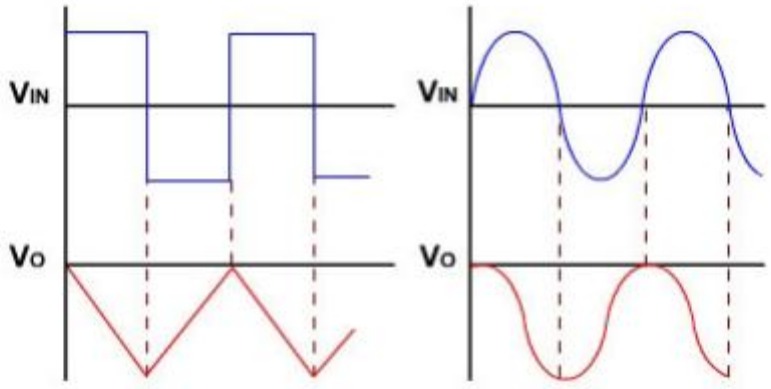
PROCEDURE:

1. Connect the circuit according to the diagram and switch on the power supply.
2. Supply the input wave to the input terminal of the given circuit.
3. Set the output voltage at 1 V peak and frequency at 1 KHz.
4. Observe the output waveform on the CRO.

PRECAUTIONS:

1. Connect the circuit properly as shown in fig.
2. Set the input waveform of correct amplitude and frequency.
3. Connect the CRO to the output terminal.

OBSERVATION DATA:



RESULT AND COMMENTS:

The output waveform is obtained and observed on the CRO.

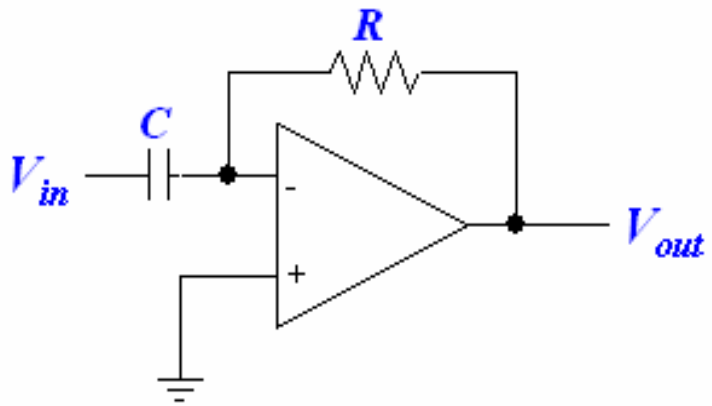
EXPERIMENT NO: 6

AIM: Use of OP-AMP as a Differentiator.

THEORETICAL CONCEPT: The circuit in which output voltage is the differentiation of input voltage is called differentiator. In this circuit, the capacitor is connected in series with the input resistor. It is an electronic circuit in which the OP-Amp is employed in such a way that the output voltage comes out to be as a derivative of the input voltage. This type of circuit is called an OP-AMP differentiator. The output is proportional to the time derivative of the input wave.

Output Voltage = -R I = -RC d/dt Vin

EXPERIMENTAL SETUP:



SPECIFICATION OF APPARATUS USED: - CRO, Function Generator, Power supply, connecting, leads, Differentiator circuit kit.

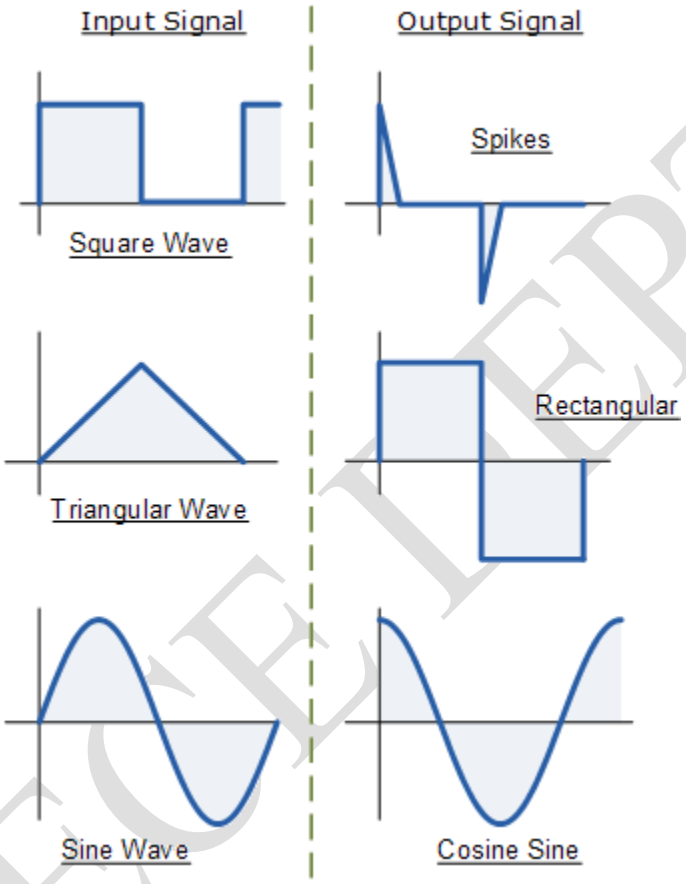
PROCEDURE:

1. Connect the circuit according to the diagram and switch on the power supply.
2. Supply the input wave to the input terminal of the given circuit.
3. Set the output voltage at 1 V peak and frequency at 1 KHz.
4. Observe the output waveform on the CRO.

PRECAUTIONS:

1. Connect the circuit properly as shown in figure.
2. Set the input waveform of correct amplitude and frequency.
3. Connect the CRO to the output terminal.

OBSERVATION DATA:



RESULT AND COMMENTS:

The output waveform is obtained and observed on the CRO.

EXPERIMENT NO: 7

AIM: Verification of Truth tables of logic gates (NAND, NOR, EX-OR, AND, OR, NOT).

THEORETICAL CONCEPT:

NAND GATE: The IC no. for NAND gate is 7400. The NOT-AND operation is known as NAND operation. If all inputs are 1 then output produced is 0. NAND gate is inverted AND gate.

NAND

$F = (xy)'$

x	y	F
0	0	1
0	1	1
1	0	1
1	1	0

NOR GATE: The NOR gate has two or more input signals but only one output signal. IC 7402 is two inputs IC. The NOT- OR operation is known as NOR operation. If all the inputs are 0 then the output is 1. NOR gate is inverted OR gate.

NOR

$F = (x + y)'$

x	y	F
0	0	1
0	1	0
1	0	0
1	1	0

EX-OR GATE: The EX-OR gate can have two or more inputs but produce one output. 7486 is two inputs IC. EX-OR gate is not a basic operation and can be performed using basic gates.

Exclusive-OR (XOR)

$F = xy' + x'y$
$= x \oplus y$

x	y	F
0	0	0
0	1	1
1	0	1
1	1	0

AND GATE The AND operation is defined as the output as one if and only if all the inputs are one.7408 is the two Input AND gate IC.A and B are the Input Terminals and Y is the Output terminal.

Y=A.B

AND

$F = xy$

x	y	F
0	0	0
0	1	0
1	0	0
1	1	1

OR Gate: The OR operation is defined as the output as one if one or more than one inputs are one. 7432 is the two Input OR gate IC. A and B are the input terminals and Y is the Output terminal.

Y = A + B

OR

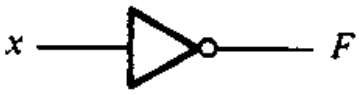
$F = x + y$

x	y	F
0	0	0
0	1	1
1	0	1
1	1	1

NOT GATE: The NOT gate is also known as Inverter. It has one input (A) and one output (Y). IC No. is 7404. Its logical equation is,

Y = NOT (A)

Inverter



$F = x'$

x	F
0	1
1	0

SPECIFICATION OF APPARATUS USED: Power Supply, Digital Trainer Kit, Connecting leads, ICs (7400, 7402, 7404, 7432, 7408, 7486).

PROCEDURE:

1. Fix the IC's on breadboard and give the input supply.
2. Connect the +ve terminal of supply to pin 14 and -ve to pin 7.
3. Give input at pin 1, 2 and take output from pin 3. It is same for all except NOT and NOR IC.
4. For NOR, pin 1 is output and pin 2 and3 are inputs.
5. For NOT, pin 1 is input and pin 2 is output.
6. Note the values of output for different combination of inputs and draw the TRUTH TABLE.

PRECAUTIONS:

1. Make the connections according to the IC pin diagram.
2. The connections should be tight.
3. The Vcc and ground should be applied carefully at the specified pin only.

OBSERVATION DATA:

AND			**OR**			**NOR**			**NAND**			**EX-OR**		
Inputs		Output	Inputs		Output	Inputs		Output	Inputs		Output	Inputs		Output

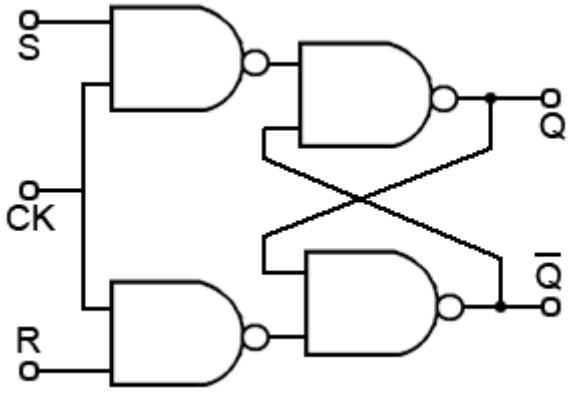
RESULT AND COMMENTS: We have learnt all the gates ICs according to the IC pin diagram.

EXPERIMENT NO: 8

AIM: -Verification of Truth table of S-R Flip-Flop.

THEORETICAL CONCEPT: A clock signal is used to synchronize circuits. The cycle time reflects how long sequential operations take. Flip-flops further restrict the memory writing interval, to just the positive edge of the clock signal. This ensures that memory is updated only once per clock cycle. There are several different kinds of flip-flops, but they all serve the same basic purpose of storing bits. The tables that we've made so far are called characteristic tables. They show the next state Q(t+1) in terms of the current state Q(t) and the inputs

EXPERIMENTAL SETUP:



SPECIFICATION OF APPARATUS REQUIRED: - IC 7400, IC 7404 etc., Power Supply, Digital Trainer Kit, Connecting Leads

PROCEDURE: -

1. Connections are made as per circuit diagram.
2. Verify the truth table for various combinations of inputs.

PRECAUTIONS:

1. Make the connections according to the IC pin diagram.
2. The connections should be tight.
3. The Vcc and ground should be applied carefully at the specified pin only.

OBSERVATION DATA:

S	R	Q_n	Q_{n+1}	Condition
0	0	NC	NC	No Change
1	0	1	0	Set
0	1	0	1	Reset
1	1	0	0	Invalid

RESULT AND COMMENTS: We have learnt S-R Flip-flop according to their circuit diagram and working operation.

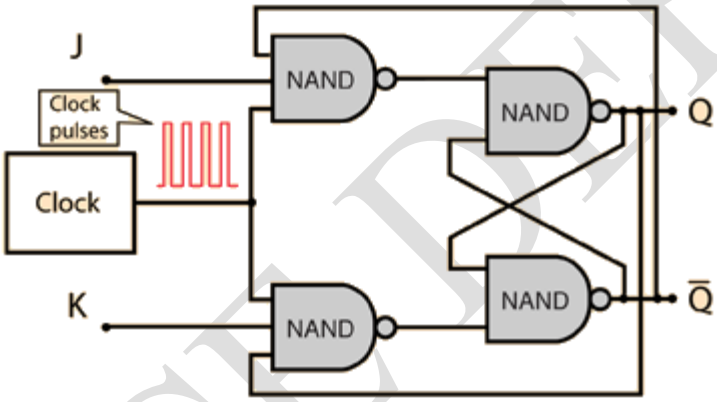
EXPERIMENT NO: 9

AIM: -Verification of Truth table of J-K Flip-Flop.

THEORETICAL CONCEPT: The J-K flip-flop is the most versatile of the basic flip-flops. It has the input- following character of the clocked D flip-flop but has two inputs, traditionally labeled J and K. If J and K are different then the output Q takes the value of J at the next clock edge. If J and K are both low then no change occurs.

If J and K are both are high at the clock edge then the output will toggle from one state to the other. It can perform the functions of the set/reset flip-flop and has the advantage that there are no ambiguous states. It can also act as a T flip-flop to accomplish toggling action if J and K are tied together. This toggle application finds extensive use in binary counters.

EXPERIMENTAL SETUP:



SPECIFICATION OF APPARATUS REQUIRED: - IC 7400, IC 7404 etc., Power Supply, Digital Trainer Kit, Connecting Leads

PROCEDURE: -

1. Connections are made as Connecting Leads per circuit diagram.
2. Verify the truth table for various combinations of inputs

PRECAUTIONS:

1. Make the connections according to the IC pin diagram.
2. The connections should be tight.
3. The Vcc and ground should be applied carefully at the specified pin only

OBSERVATION DATA:

Inputs			Output		Comments
J	K	Clock	Q	Q’	
0	0	↑	Q	Q’	No Change
0	1	↑	0	1	Reset
1	0	↑	1	0	Set
1	1	↑	Q’	Q	Toggle

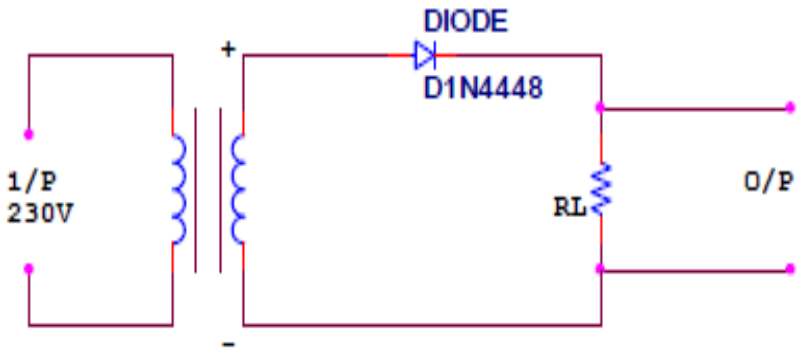
RESULT AND COMMENTS: We have learnt S-R Flip-flop according to their circuit diagram and working operation.

EXPERIMENT NO.10

AIM: To study half wave rectifier

THEORETICAL CONCEPT: Rectification is a process of conversion of AC to DC. In half-wave rectifier, only one diode is used. During +ve half Cycle the diode is forward biased &, it conducts current through the load resistor R .During –ve half cycle diode is reverse biased Hence, no current flow through the circuit. Only +ve half cycle appears across the load, whereas, the –ve half Cycle is suppressed.

EXPERIMENTAL SETUP:



SPECIFICATION OF APPARATUS USED: Power supply, rectifier kit.CRO, Connecting Leads.

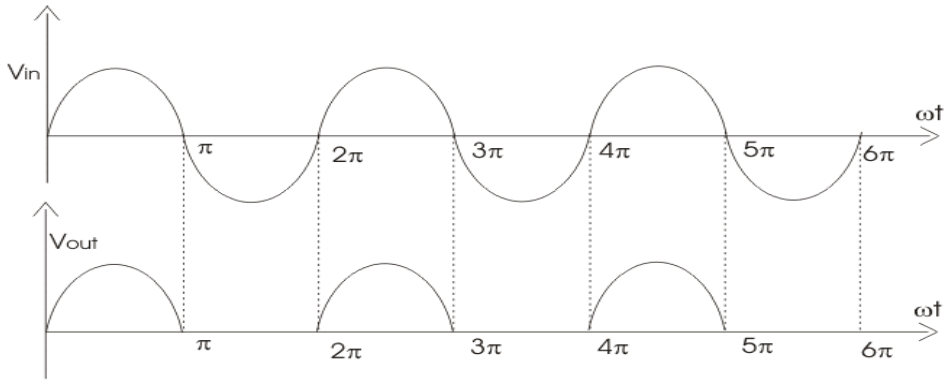
PROCEDURE:

1. Connect the circuit as shown in figure.
2. Supply the input AC signal to the circuit.
3. Output signal is obtained on CRO which shows the DC(pulsating output).
4. Draw the wave form.

PRECAUTIONS:

1. Connection should be proper & tight.
2. Switch ‘ON’ the supply after completing the circuit.
3. Note down the input & output wave accurately.

OBSERVATION DATA:



RESULT AND COMMENTS: Input and output waveform of half wave rectifier is as shown.

EXPERIMENT NO. 11

AIM: To study Light emitting diode

THEORETICAL CONCEPT: The LED consists of a chip of semiconducting material impregnated, or doped, with impurities to create a p-n junction. As in other diodes, current flows easily from the p-side, or anode, to the nside or cathode, but not in the reverse direction. Charge-carriers—electrons and holes—flow into the junction from electrodes with different voltages. When an electron meets a hole, it falls into a lower energy level, and releases energy in the form of a photon.

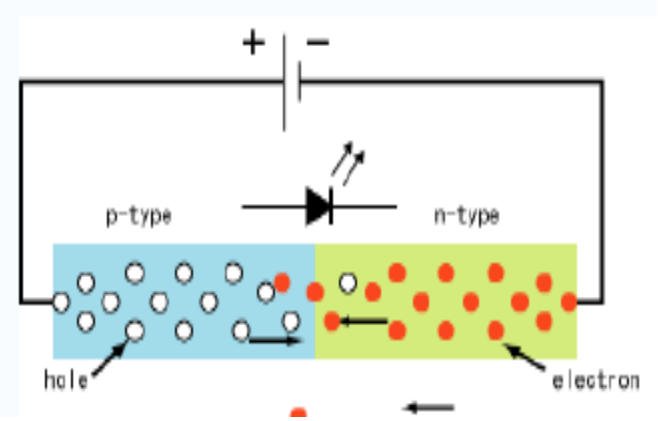
The wavelength of the light emitted, and therefore its color, depends on the band gap energy of the materials forming the p-n junction. In silicon or germanium diodes, the electrons and holes recombine by a non-radiative transition which produces no optical emission, because these are indirect band gap materials. The materials used for the LED have a direct band gap with energies corresponding to near-infrared, visible or near-ultraviolet light.

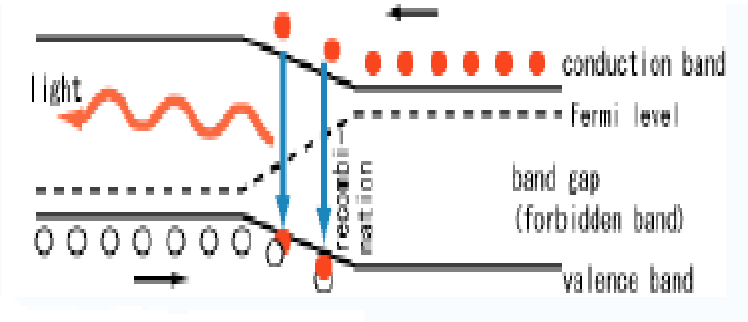
LED development began with infrared and red devices made with gallium arsenide. Advances in materials science have made possible the production of devices with ever-shorter wavelengths, producing light in a variety of colors.

LEDs are usually built on an n-type substrate, with an electrode attached to the p-type layer deposited on its surface. P-type substrates, while less common, occur as well. Many commercial LEDs, especially GaN/InGaN, also use sapphire substrate.

Most materials used for LED production have very high refractive indices. This means that much light will be reflected back in to the material at the material/air surface interface. Therefore Light extraction in LEDs is an important aspect of LED production, subject to much research and development.

EXPERIMENTAL SETUP





Advantages:

1. **Efficiency:** LEDs produce more light per watt than incandescent bulbs
2. **Color:** LEDs can emit light of an intended color without the use of color filters that traditional lighting methods require. This is more efficient and can lower initial costs.
3. **Size:** LEDs can be very small (smaller than 2 mm2]) and are easily populated onto printed circuit boards.
4. **On/Off time:** LEDs light up very quickly. A typical red indicator LED will achieve full brightness in microseconds. LEDs used in communications devices can have even faster response times.
5. **Lifetime:** LEDs can have a relatively long useful life. One report estimates 35,000 to 50,000 hours of useful life, though time to complete failure may be longer. Fluorescent tubes typically are rated at about 10,000 to 15,000 hours, depending partly on the conditions of use, and incandescent light bulbs at 1,000–2,000 hours.
6. **Toxicity:** LEDs do not contain mercury, unlike fluorescent lamps.

Disadvantages:

1. **High initial price:** LEDs are currently more expensive, price per lumen, on an initial capital cost basis, than most conventional lighting technologies.
2. **Temperature dependence:** LED performance largely depends on the ambient temperature of the operating environment. Over-driving the LED in high ambient temperatures may result in overheating of the LED package, eventually leading to device failure.

3. **Voltage sensitivity:** LEDs must be supplied with the voltage above the threshold and a current below the rating. This can involve series resistors or current-regulated power supplies.