Chapter = 18

Electronics

Electronics:"A Branch of science and technology that deal with flow of charge carriers through semiconductors is called Electronics".

Main applications of Electronics: Electronics has widely applications in every field of like TV, microwave oven, washing machine, cameras, digital watches, mobile and digital phones, calculators, computers, medical equipment's, industrial etc.

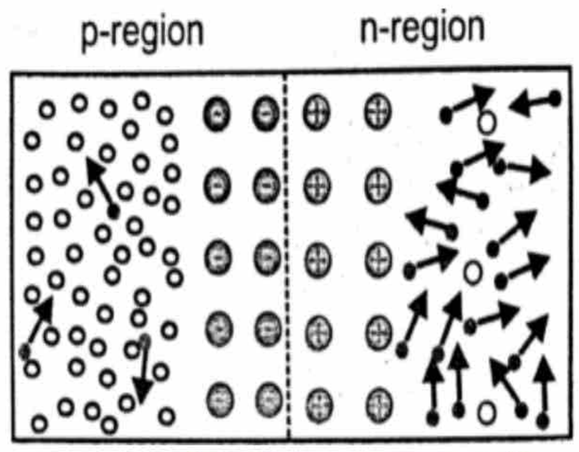
Brief review of PN Junction and its characteristics

What is PN junction or semiconductor diode?
A crystal of silicon or germanium is grown in such a way that one half is doped with trivalent impurity (p type) and other half is doped with pentavalent impurity (n type), it is called pn junction.

Name Majority charge carriers in n & p type substance?
In n type substance electrons are majority carriers. In p type substance holes are majority carriers
Name Minority charge carriers in n and p type substance? In n type substance holes are minority carriers. In p type substance electrons are minority carriers.
What is Depletion region? The region across the junction which contains no charge carriers is called depletion region.

what is Potential barrier?

Due to formation of depletion region, a potential difference develops across the junction which stop further diffusion of electrons in p-type region.
This potential difference is called potential barrier.
Potential barrier for **silicon is 0.7 V and for Germanium is 0.3 V.**

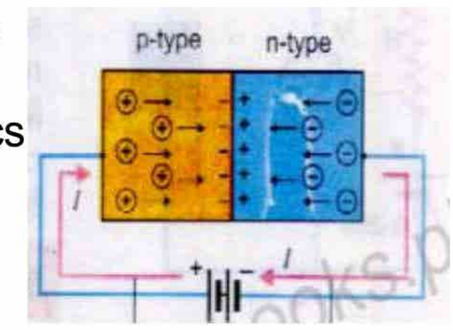


What is Biasing? Describe forward and reverse biased pn junction.

The process of connecting the battery to any device i.epn junction is called biasing. There are two types of biasing

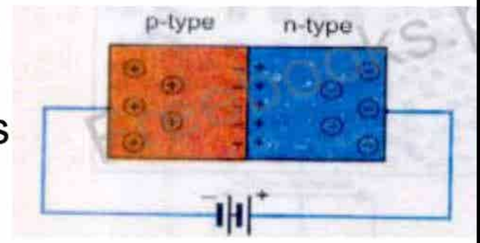
i. Forward biasing
ii. Reverse biasing

Forward biased pn junction: A junction is forward biased when potential difference is applied in such a way that p-side is connected to positive terminal of battery and n-type is connected to negative terminal of battery. It has following characteristics



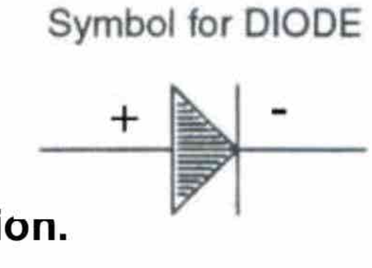
- Width of depletion is decreased in forward biasing.
- Resistance in forward biased is Very few ohm
- Formula for forward resistance is $r_f = \frac{\Delta V_f}{\Delta I_f}$.
- The graph b/w forward current and forward voltage is called forward characteristics

Reverse biased pn junction: A junction is reverse biased when potential difference Is applied in such a way that p-side is connected to negative terminal of battery and n-side is connected to positive terminal of battery. It has following characteristics



- The width of depletion region is increased in reverse biasing
- Resistance of high (mega ohm) is in reverse biasing.
- The graph b/w reverse current and reverse voltage is called reverse characteristics.

Symbolic representation of diode: Arrow head represents P region and also called anode. Vertical line shows n region and Called cathode



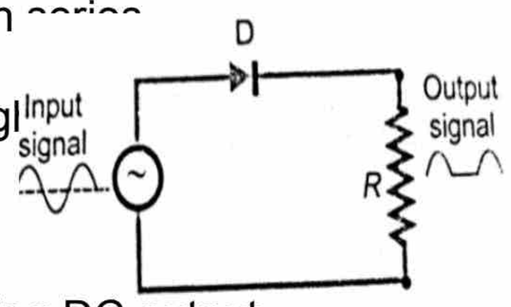
It is property to conduct current in one direction only in forward biased condition.

What is Rectification? Explain half wave and full wave rectification.

Rectification and rectifier:"The process of converting AC wave from into DC wave form is called rectification". And the device which converts AC waveform into DC waveform is called rectifier. It has two types

Half rectification: Such type of rectification in which only half of input AC is converted into DC is called half wave rectification.

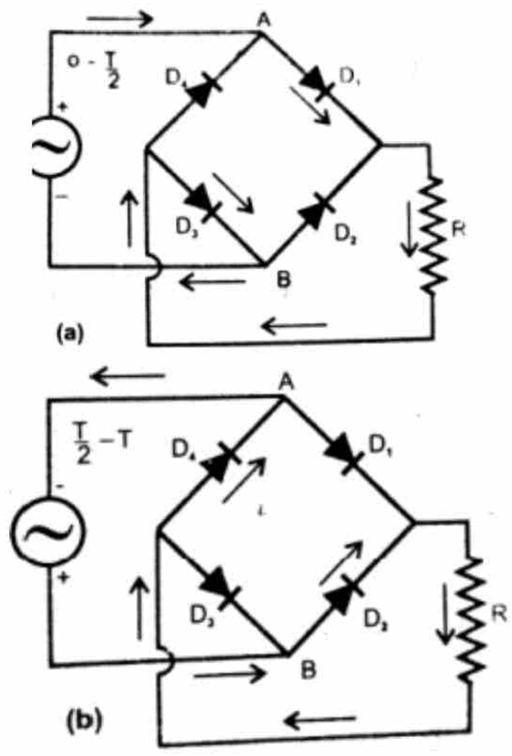
Consider an alternating voltage applied to diode D connected with resistance R in series



During the positive half cycle 0 to T/2 of input cycle,
The diode is forward biased so it will offer low resistance and current flows through
During the negative cycle T/2 to T of input cycle, the diode is reverse biased
And it offer very high resistance and current flow through R is almost zero
The same process continues for next cycles and so on for AC input,
Current will flow in one direction, so it is called direct current.This is called pulsating DC output.

Full wave rectification: Such type of rectification in which both input cycles of AC are converted into DC is called full wave rectification.

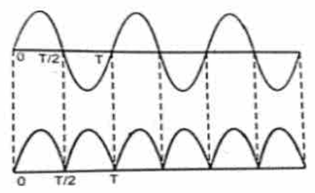
Let us consider a full wave rectifier circuit consists of four diodes
In the form of bridge that's why it is called bridge wave rectifier
Circuit.
During the positive half cycle 0 to T/2 of ac input, the terminal A of bridge
Is positive with respect to B, so diodes D1 and D3 becomes forward biased
And conducts
During the negative half cycle T/2 to T of ac input. The terminal A of bridge
Is negative with respect to B, so diodes D1 and D4 becomes forward biased
And conduct.
From the output of both half cycles current through R flows in the same direction
The output is pulsating dc. The pulsed can be removed by filter circuit
Filter circuit: such a circuit which is the combination of capacitors and inductors
Used to remove the pulses is called filter circuit.



Specially designed PN junction diodes

There are following most commonly used diodes

i. Light emitting diode(LED)
ii. Photo diode
iii. Photo voltaic cell



What is LED (Light emitting diode).write its two uses.

Such type of diode which is made up oof gallium arsenide/phosphide in which potentialal barrier b/w p and n side is such that when electron combin bine e with hole during forward biased a photon of vivisi sible light is emitted, is called LED.

Uses: There are following uses of LED

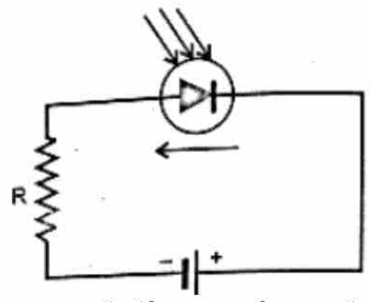
i. It is used as small light source as indicator
ii. A specially array of LEDs for displaying digits in electronic devices which is called seven segment display
iii. They are used in calculators and digital watches

What is Photo diode? Write applications.

The diode which convert light energy into electrical energy is called photo diode. It is used for detection of light and operated in reverse biased only. A photo diode can switch on and off in **nano seconds**.

Applications of photodiode: There are following applications of photodiode

i. Detection of visible and invisible light
ii. Automatic switching
iii. Logic circuits
iv. Optical communication devices



What is Photovoltaic cell? Write its one use.

It is pn junction in which potential barrier b/w p and n region is used to derive current through external circuit when light is incident on junction.. A single photovoltaic cell produces a small voltage0.6V and current of few mA. They are in satellite to converts the solar energy into electrical power.

Multiple choice questions

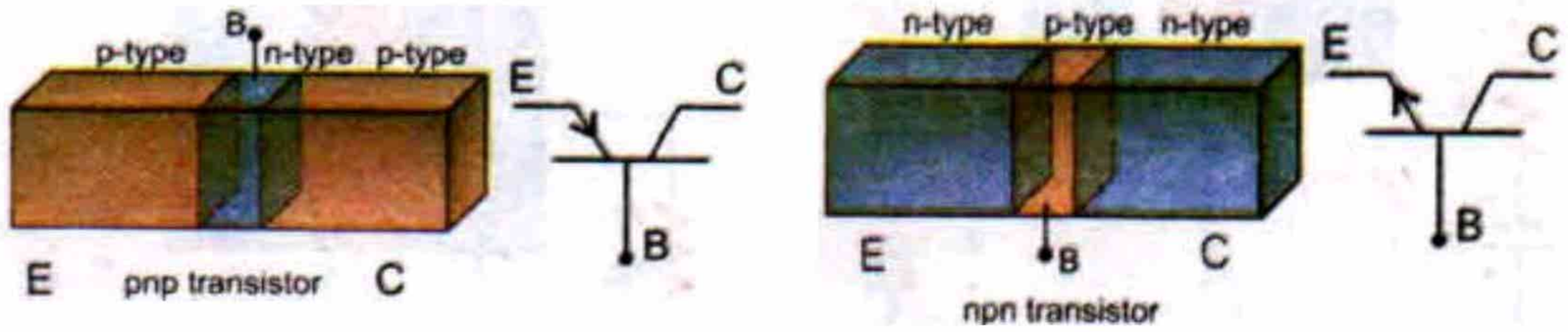
1	The reverse current through a semiconductor diode is due to	Holes	Electrons	Majority carriers	**Minority carriers**
2	The potential barriers for silicon at room temperature is	0.9V	0.3V	**0.7V**	0.5V
3	Process of conversion of AC into DC	**Rectification**	Amplification	Oscillation	Modulation
4	process of conversion of DC into AC	Rectification	Amplification	**Oscillation**	Modulation
5	The device used for rectification is called	**Rectifier**	Transformer	Thermistor	Wheat stone bridge
6	The diode characteristics curve is the graph between	Time and current	**Voltage and current**	Forward voltage and reverse current	None of these
7	Potential barrier for germanium is	0.9V	**0.3V**	0.7V	0.5V
8	The diode cannot be used as	**Amplifier**	Detector	Rectifier	Modulator
9	Photo diode is used for detection of	**Light**	Heat	Current	Magnet
10	Pulsating DC can be made smooth by using a circuit known as	**Filter**	Tank	Acceptor	All of these
11	The number of diodes in bridge rectifier is	2	3	**4**	5
12	The no. of LEDs needed to display all the digits is	4	6	**7**	8
13	The potential barrier in a diode stops the movement of	Holes only	Electrons only	**Both electrons and holes only**	None of these

14	In n type minority carrier are	Free electrons	**Holes**	Protons	Mesons
15	A potential barrier of 0.7V exist across pn junction made from	**Silicon**	Germanium	Indium	Gallium
16	When a PN junction is reverse biased the depletion region is	**Widened**	Narrowed	Normal	No change
17	The output voltage of a rectifier is	Smooth	**Pulsating**	Perfectly direct	Alternating
18	A LED emits light only when it is	Reverse biased	**Forward biased**	Unbiased	None
19	Which factor does not affect the conductivity of PN junction diode	Doping	Temperature	Voltage	**Pressure**
20	The size of depletion region is of the order of	**10^{-6}m**	10^{-4} m	10^{-3}m	10^{-2} m
21	Minority carriers in p type substance	Protons	Holes	**Electrons**	Neutrons
22	Photo diode can turn its current on and off in	Micro second	Milli second	**Nano second**	Pico second
23	Reverse current through PN junction is	Infinite	Zero	**Less than forward current**	Greater than forward current
24	Holes can exist in	Super conductor	Conductor	**Semi-conductor**	Insulator
25	In forward biasing, the value of resistance is	Large	Very large	Small	**Very small**
26	Light emitting diodes (LEDs) are made from semiconductor	Silicon	Germanium	Carbon	**Gallium arsenide**
27	Potential difference across the two terminal of silicon diode is	0.3V	**0.7V**	0.9V	1.2V
28	In photovoltaic cell, current is directly proportional to	Wavelength of light	**Intensity of light**	Frequency of light	Energy
29	For an ideal diode resistance in forward biased	**Zero**	Infinity	Negative	None
30	For an ideal diode resistance in reverse biased	Zero	**Infinity**	Negative	None
31	The mobility of electrons ---- the mobility of holes therefore npn devices are fast and preferred	**2 to 3 times**	5 to 7 times	9 to 11 times	10 to 12 times
32	The magnitude of voltage gain of an amplifier having r_{ie}=1 ohm, β=100, R_c=200 ohm	**20000**	1000	50	5

What is Transistor? Give the types of transistor.

The word transistor is derived from "Transfer resistor". It is multi electrode semiconductor device that amplifies the electrical signal when transferred through it from its input terminal to output terminal. Transistor was firstly invented by John Bardeen in 1948.

Definition: A transistor consists of a single crystal of Ge or Si which is grown in such a way that it has three regions (base, emitter and collector). OR Two back to back pn junctions made in a single piece of semiconductor crystal is called transistor



Types: There are two types of transistor

i. p-n-p transistor
ii. n-p-n transistor

p-n-p transistor: Such type of transistor in which n type substance is sandwiched b/w two p type substances is called p-n-p transistor.

n-p-n transistor: Such type of transistor in which p type substance is sandwiched b/w two n type substances is called n-p-n transistor.

Main parts of transistor: There are three main parts of transistor

Base: the central region which is very thin of size 10^{-6} **m** is called base. It control the flow of electrons from emitter to collector.

Emitter: the region has greater concentration of impurity than collector. The width of emitter is slightly smaller than in size as compared to collector

Collector: it is larger than emitter and used to collect charge carriers through base. Collector is comparatively larger in size than the emitter and has less concentration of impurity as compared to emitter.

What are the Junctions in transistor and biasing requirement under normal operation.

There are two junctions in transistor

i. Emitter base junction
ii. Collector base junction

Biasing requirements under normal operation of transistor:

Emitter base junction is **forward biased** Collector base junction is **reverse biased**

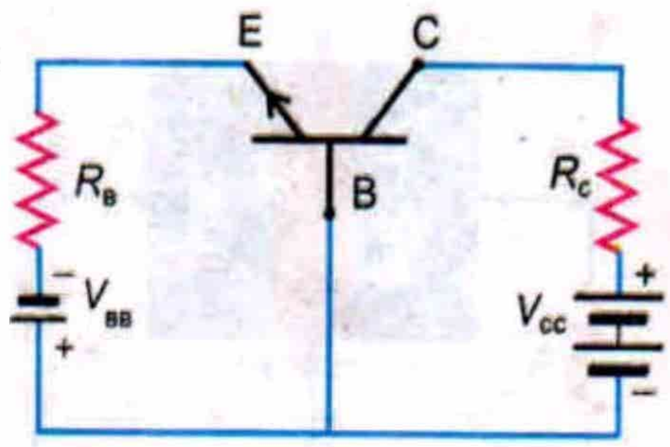
Explain the Current flow through npn transistor.

Let us consider the flow of current in an npn transistor as shown in fig.

In this emitter base junction is forward biased, so emitter injects a larger number of electrons in base region. The free electrons in the base can flow in either flow out of base to positive terminal of V_{BB} or they can be attracted towards the collector due to V_{CC}.

Electronic current I_E flow from emitter to base, a very small part of current I_B flow out of the base and remaining current I_C flow out of the collector

$I_E=I_C+I_B$ ---------- (1)



Current gain: The ratio of collector I_C to base current I_B is called current gain.

$\beta = \frac{I_C}{I_B}$. It value ranges from 30 to 500.

What are the advantages& disadvantages of transistor?

Advantages of transistor: Transistors have small size, light weight, low cost, Longer life.

Disadvantages: transistor is highly sensitive for temperature and low current Handling.

What is amplifier? How Transistor is used as an amplifier? Derive the formula for gain.

Amplifier: A device for reproducing a small value electrical signal into large value of signal is called amplifier.

Transistor as an amplifier: In maximum electronic circuits, transistors are basically used as an amplifier. An amplifier is thus the building block of every complex electronic circuit so that study of transistor is very important.

Construction: In normal operation of transistor emitter base is used as input terminals and base collector is used as output terminals. V_{BB} forward biased the emitter base junction and V_{CC} reverse biased the base collector junction. Vcc is very greater than V_{BB}. V_{BE} and V_{CE} are the input and output voltages respectively as shown in fig.

Gain of amplifier:

The base current is $I_B = \frac{V_{BE}}{r_{ie}}$, r_{ie} is base emitter resistance and transistor amplifies the base current β times

$$Ic = \beta I_B$$

$$Ic = \beta \frac{V_{BE}}{r_{ie}} \text{ ----------(1)}$$

output voltage $Vo = V_{CE}$

$$V_{CC} = I_C R_C + V_{CE}$$

$$V_{CE} = V_{CC} - I_C R_C \quad \text{putting the value of } I_C$$

$$V_{CE} = Vo = V_{CC} - \beta \frac{V_{BE}}{r_{ie}} R_C \text{ ----------(2)}$$

When a small voltage signal ΔV_{in} is applied at input terminals

V_{BE} changes to $V_{BE} + \Delta V_{in}$ I_B changes to $I_B + \Delta I_B$

I_c changes to $I_c + \Delta I_c$ V_o changes to $V_o + \Delta V_o$

putting the above values into in equation (2)

$$V_o + \Delta V_o = V_{CC} - \beta \frac{(V_{BE} + \Delta V_{in})}{r_{ie}} R_C \text{ ----------(3)}$$

subtract equation (3) from equation (2)

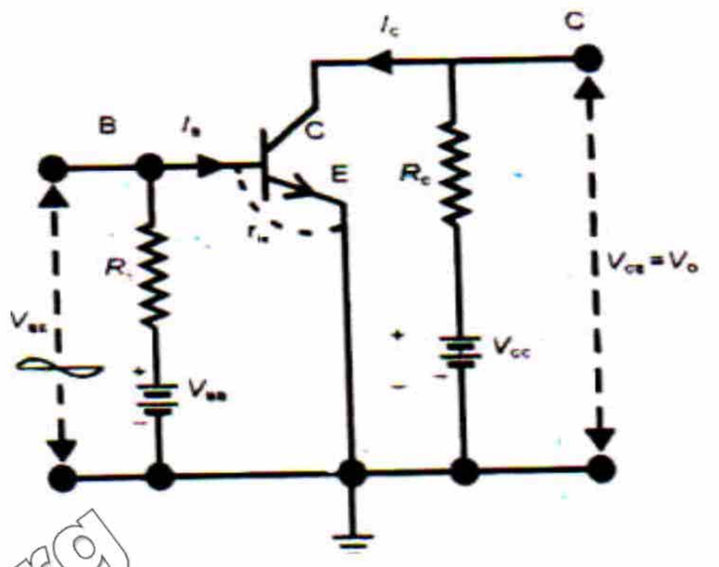
$$V_o + \Delta V_o - Vo = V_{CC} - \beta \frac{(V_{BE} + \Delta V_{in})}{r_{ie}} R_C - V_{CC} + \beta \frac{V_{BE}}{r_{ie}} R_C$$

$$\Delta V_o = -\beta \frac{(V_{BE})}{r_{ie}} R_C - \beta \frac{(\Delta V_{in})}{r_{ie}} R_C + \beta \frac{V_{BE}}{r_{ie}} R_C$$

$$\Delta V_o = -\beta \frac{R_C}{r_{ie}}$$

$\frac{\Delta V_o}{\Delta V_{in}} = -\beta \frac{R_C}{r_{ie}}$, As the ratio of output voltage to input voltage is called voltage gain denoted by G so

$G = -\beta \frac{R_C}{r_{ie}}$, - ive sign shows there is phase shift of 180^o b/w input and output signals..



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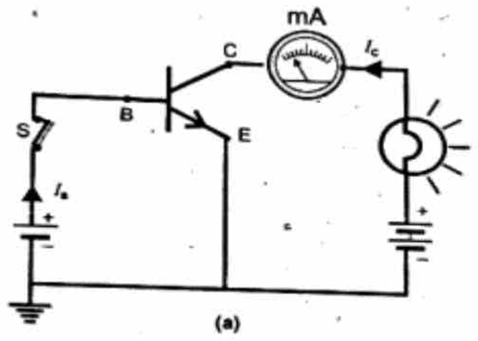
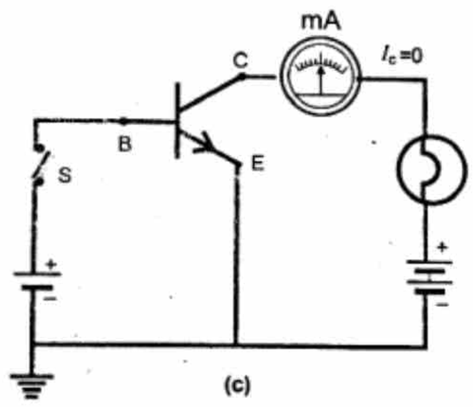
How Transistor is used as switch?

Transistor is used as switch in many electronic circuits. The emitter and collector behave as the terminals of switch.
The circuit in which the current is to be turned off and on is connected across these terminals.
To turn on the switch, small potential V_B is applied across the base to emitter terminals
As shown in fig. so increase in base current I_B, heavy current IC starts flow in common
Emitter circuit, large collector current is possible only when there is small resistance b/w
Collector and emitter and potential drop across CE is nearly 0.1 V.
To turn off switch: In this the base current I_B by opening the circuit is zero
So collector current is also zero, at this stage the resistance b/w C and E is nearly infinity

As shown in fig





Multiple choice questions

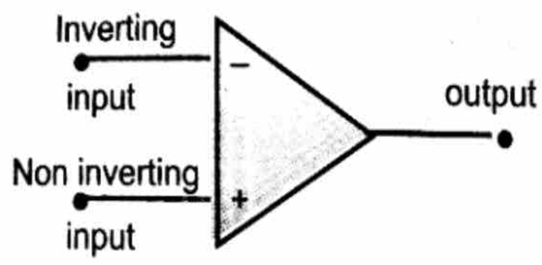
1	If I_E,I_B and I_C are emitter,base and coller current respectively in a transistor then	**$I_E=I_C+I_B$**	$I_C=I_E+I_B$	$I_B=I_C+I_E$	None of these
2	SI unit of current gain is	Ampere	Volt	Ohm meter	**No unit**
3	Central region of transistor is called	**Base**	Emitter	Collector	Neutral
4	In n-p-n transistor current does not flow in the direction from	Emitter to collector	Emitter to base	Base to collector	**Collector to emitter**
5	A circuit which converts low voltage to high voltage is called	**Amplifier**	Rectifier	Transistor	Inductor
6	When emitter base junction of transistor is reverse biased collector current	Reveres	Increase	Decrease	**Stops**
7	In npn transistor p works as	Collector	emitter	**Base**	Any of these
8	Base of transistor is very thin of the order of	10^{-2} m	10^{-4}m	**10^{-6} m**	10^{-8} m
9	An expression for current gain of transistor is given by ß=?	I_B/I_C	**I_C/I_B**	I_B+I_C	I_C-I_E

What is Operational amplifier? Write the characteristics of op-amp?

Operational amplifier: "Such an integrated amplifier silicon chip which is enclosed a capsule and pins are connected with working terminals such as input output and power supply is called operational amplifier".

Symbolic representation of Op-amp:

Two input terminals



Inverting input: A signal applied at inverting input terminals has Phase shift of 180°.

Non inverting input: A signal applied at non-inverting has no phase Shift.

Characteristics of op-amp: There are following characteristics of op-amp

Input resistance: The resistance b/w positive and negative inputs of amplifier whose value is several mega ohm

Output resistance: The resistance b/w output terminal and ground. Its value is few ohm

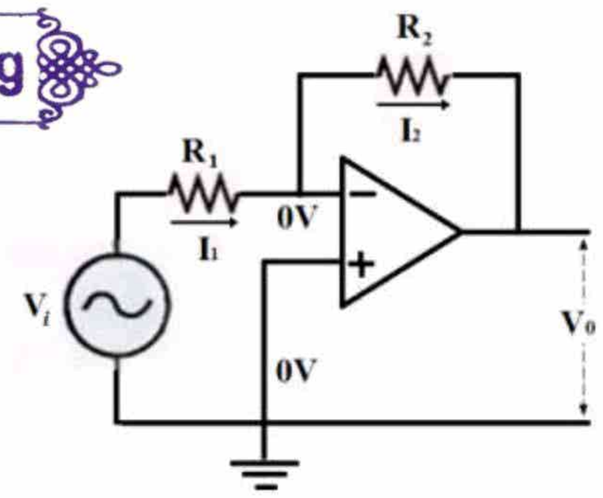
Open loop gain: The ratio of output voltage to voltage differences b/w inverting and non-inverting inputs when no external connection is made $AoL = \frac{Vo}{Vi}$, open loop gain is 10^5.

What is inverting amplifier? Explain Operational amplifier as inverting amplifier.

Inverting amplifier: "Such an amplifier in which output amplified signal has phase shift of 180° with respect to input signal is called inverting amplifier". Its gain is $G = -\frac{R_2}{R_1}$.

Gain of inverting amplifier: Let us consider a circuit in input signal V_{in} which is to amplified, is applied at inverting terminals (-) through resistor R1 and Vo is its output. Non inverting terminal (+) is grounded, its potential is zero, As Vo may have any value b/w +Vcc 12V and –Vcc (-12V) as shown in fig

$$\text{Current through } R_1 = I_1 = \frac{V_{in}}{R_1} \text{ ----------(1)}$$



$$\text{Current through } R_2 = I_2 = \frac{V_- + (-Vo)}{R_2} = \frac{0 - Vo}{R_2} = \frac{-Vo}{R_2} \text{ ------(2)}$$

Using Kirchoff current rule $I_1 = I_2$

$$\frac{V_{in}}{R_1} = \frac{-Vo}{R_2}$$

$$\frac{Vo}{V_{in}} = -\frac{R_2}{R_1}, \text{ As the ratio of output to input voltage is called voltage gain so}$$

$$G = -\frac{R_2}{R_1}, \text{ This is called gain of inverting amp. } -\text{ive sign shows the phase shift of } 180^o \text{ w.r.t input signal}$$

WHAT IS NON INVERTING AMP? EXPLAIN OP-AMP AS NON INVERTING AMPLIFIER.

Non-inverting amplifier: Such an amplifier in which output amplified signal and input signals are in same phase is called non inverting amplifier, its gain is $G = 1 + \frac{R_2}{R_1}$.

Gain of non-inverting amplifier: let us consider a circuit of non-inverting amplifier. The input voltage Vi is applied across the non- inverting terminal (+). Open loop gain is high of the order of 10^5.
Gain:

$$\text{Current through } R_1 = I_1 = \frac{0 - V_{in}}{R_1} = \frac{-V_{in}}{R_1} \text{ ----------(1)}$$

$$\text{Current through } R_2 = I_2 = \frac{V_- + (-Vo)}{R_2} = \frac{V_i - Vo}{R_2} \text{ ------(2)}$$

Using Kirchoff current rule $I_1 = I_2$

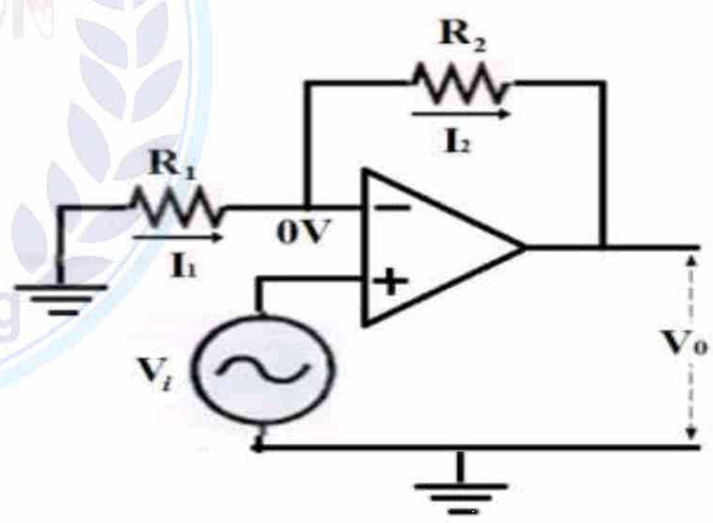
$$\frac{-V_i}{R_1} = \frac{Vi - Vo}{R_2}$$

$$\frac{-V_i}{R_1} = \frac{Vi}{R_2} - \frac{Vo}{R_2}$$

$$\frac{Vo}{R_2} = \frac{V_i}{R_2} + \frac{V_i}{R_1} = V_i[\frac{1}{R_2} + \frac{1}{R_1}]$$

$$\frac{Vo}{V_{in}} = R_2[\frac{1}{R_2} + \frac{1}{R_1}]$$

$$G = \frac{R_2}{R_2} + \frac{R_2}{R_1}$$

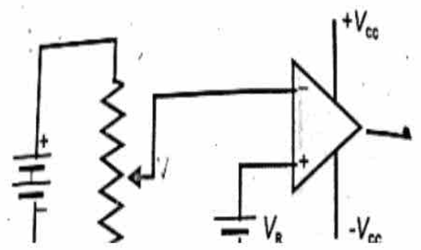


$$G = 1 + \frac{R_2}{R_1} \text{ This is called gain of non - inverting amp. + ive sign shows that input and output signals are in phase}$$

What is comparator? How Operational amplifier is used as comparator?

Comparator: "An electrical circuit which is used to compare the voltage signal levels".
In op-amp two inputs of equal but opposite polarity are required

Most op-amp operates with V_{CC}=±12V.
As open loop gain of op-amp is high so small change in potential b/wive and positive inputs produces such a large amplified out put that gets saturated.
VR=reference voltage is connected with + terminal
V= Compared voltage is connected with –ive terminal.
When V->V+ or V>V_R then Vo= -Vcc
When V- < V+ or V<V_R then Vo= +Vcc

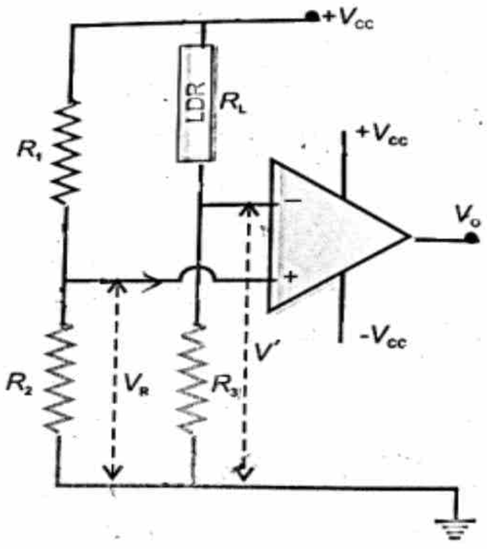


What is night switch and LDR? How OP- AMP is used AS A NIGHT SWITCH?

Automatic night switch: It remains closed when the intensity of light is sufficient and it switches ON the light when the intensity of light falls below a required level.
Light dependent resistor (LDR): It is light dependent resistance whose resistance depends on light. It has low resistance when intensity of light is high and high resistance when intensity of light is low.
During day time, when light falls on LDR, R_L is small so from equation

$$V_R = \frac{R_2}{R_1 + R_2} Vcc$$ V will be large V>VR so that Vo=-Vcc

The output of op-amp is connected with relay system which switches only when Vo=+Vcc
Relay switch: This is system which switches on only whenVo=+Vcc.



Digital system

Digital system: A system that deal with quantities or variables which has two values Or states is called digital system.
Logic gates: The circuits which are used to perform switching action are called logic gates.
What are Fundamental logic gates? There are three fundamental logic gates
(1) OR gate (2) AND gate (3) NOT gate

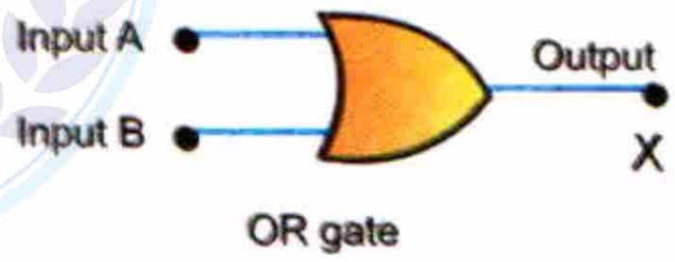
What is OR gate? Write its equation and truth table.

OR gate consists of two or more input but single output and it perform the function of addition when all inputs or either input is 1 then it show 1 other wise zero $X = A + B$

Truth table of OR gate.

2 input OR gate

A	B	X=A+B
0	0	0
0	1	1
1	0	1
1	1	1



OR gate

What is AND Gate? Write its equation and truth table?

AND gate consists of two or more inputs and one output and perform the function of multiplication, if all input are 1 then it shows 1 other wise zero.
$X = A.B$

Truth table of AND gate

2 input AND gate

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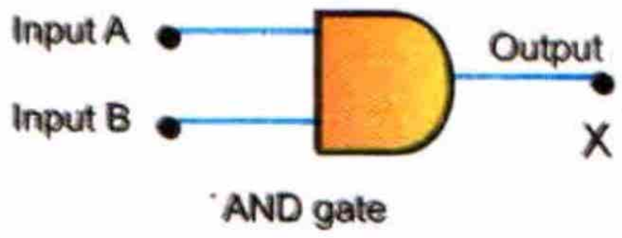
A	B	X=A.B
0	0	0
0	1	0
1	0	0
1	1	1



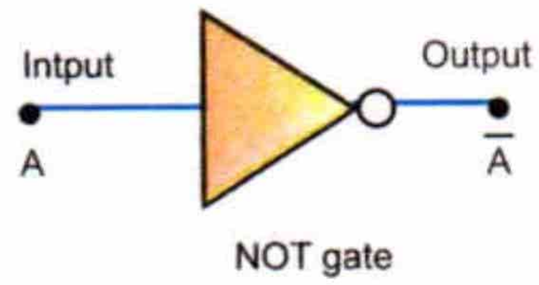
What is NOT gate? Write its equation and draw its truth table.

The gate which perform the operation of inversion is called NOT gate. $X = \overline{A}$

Truth table of NOT gate

NOT gate

A	$X = \overline{A}$
0	1
1	0



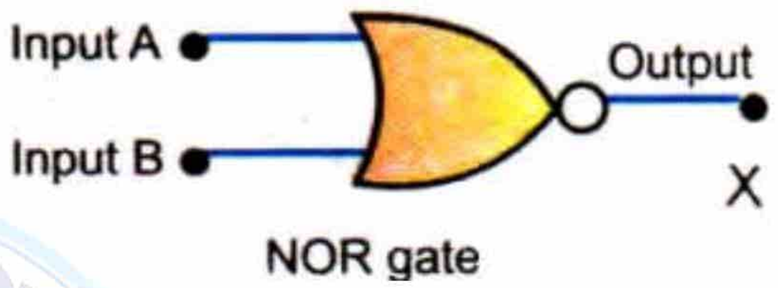
What is NOR gate? Write its equation and draw its truth table.

The combination of NOT gate and OR gate is called NOR gate.

$X = \overline{A + B}$

2 input NOR gate

A	B	$X = \overline{A + B}$
0	0	1
0	1	0
1	0	0
1	1	0



What is NAND gate? Write its equation and draw its truth table.

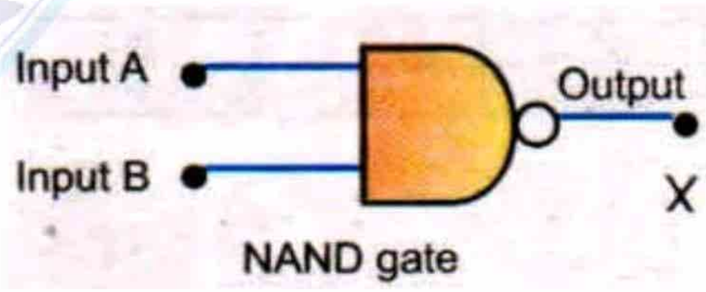
The combination of NOT and AND gate is called NAND gate.

$X = \overline{A.B}$ Symbol

Truth table of NAND gate

2 input NAND gate

A	B	$X = \overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0



NAND and NOR gates are called universal gates.

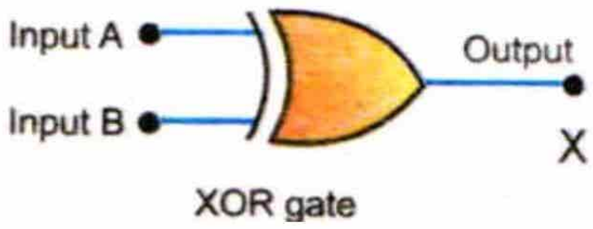
What is Ex OR gate? Write its equation and draw its truth table?

A gate which is constructed by AND,OR and NOT gate is called Ex-OR gate. $X = A.\overline{B} + \overline{A}.B$

$A.B$

Truth table of XOR.
2 input XOR gate

A	B	$X = A.\overline{B} + \overline{A}.B$
0	0	0
0	1	1
1	0	1
1	1	0

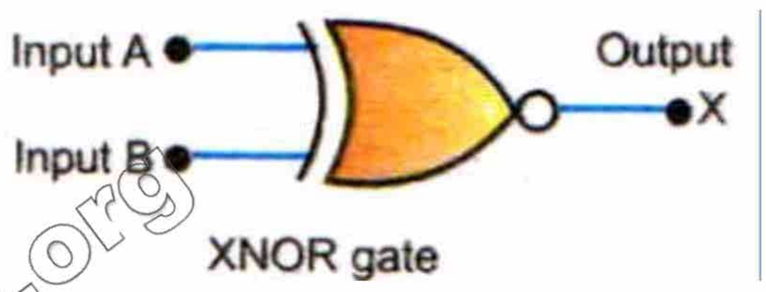


What is X NOR gate? Write its equation and draw its truth table?

The gate which is obtained by inverting the output of XOR gate is called XNOR gate $X = \overline{A.\overline{B} + \overline{A}.B}$

Truth table of XNOR gate.
2 input XNOR gate

A	B	$X = \overline{A.\overline{B} + \overline{A}.B}$
0	0	1
0	1	0
1	0	0
1	1	1



DESCRIBE THE APPLICATIONS OF LOGIC GATES.

Sensors: The device which converts various physical quantities into electrical voltage is called sensor. For example LDR, microphone thermistor etc.

- Logic gates are widely used in control system.
- They control the temperature, pressure or some other physical quantities of the system.
- As gates only operate with electrical voltage so they require sensor.

ICs:ICs are integrated circuits chips are manufactured on wafers of semiconductor material.

Multiple choice questions

1	The term inverter is used for	NOR gate	NAND gate	**NOT gate**	AND gate
2	Mathematical notation for NOT gate is	**X=$\bar{A}$**	X=$\bar{A}.B$	X=$\overline{A.B}$	X=$\overline{A+B}$
3	Which one of the following is called fundamental gate?	NOR gate	**NOT gate**	NAND gate	Ex-OR gate
4	Two input NAND gate with inputs A and input B has an output zero if	B=0	**A=B=1**	A=B=0	None of these
5	The mathematical notation for NAND gate is	X=$\bar{A}$	X=$\bar{A}.B$	**X=$\overline{A.B}$**	X=$\overline{A+B}$
6	The electric circuit which gives the inversion process	XNOR gate	OR gate	AND gate	**NOT gate**
7	Any logical expression can be	AND gate	NAND gate	**AND,OR,NOT**	NOT gate

	realized using only			**gate**	
8	If both inputs are low the output is high for	OR gate	AND gate	XOR gate	**NOR gate**
9	Universal gate is the gate which can perform the function of switching	Buffer gate	**Any logic gate**	Any basic	Any exclusive gate
10	Gain of operational amplifier as inverting amplifier is given as G=?	R1/R2	R1xR2	**-R2/R1**	-R1/R2
11	The magnitude of open loop gain of operational amplifier is of the order	10^3	**10^5**	10^7	10^9
12	The device which keeps to work on the input with amplification is called	**Op-amp**	Inverter	Diode	None of these
13	LDR is abbreviated for	**Light dependent resistance**	Light depositing resistance	Light doped resistance	All of these
14	For non-inverting amplifier if R1=infinity and R2=0 then gain of amplifier is	-1	**+1**	Zero	Infinite
15	Gain of operational amplifier is the independent of	**Internal structure**	External structure	Batteries	Potential changes
16	Logic gates can control some physical parameters like	**Temperature, pressure**	Current, voltage	Resistance, inductance	Capacitance, impedance
17	The basic logic gate whose output is 1 when input are different	AND	**OR**	NOT	NAND
18	Integrated amplifier is known as	Power amplifier	Push pull amplifier	**Operational amplifier**	Current amplifier
19	Automatic function of street light can be one by use of	Inductor	Capacitor	Emf	**Comparator**
20	An op-amp can be used as	Comparator	Inverting amplifier	Non inverting amplifier	**All of these**
21	Automatic working of street light is due to	Inductor	Capacitor	**Comparator**	Rectifier
22	Gain of op amplifier in the R=infinity and R2=0	Infinity	**One**	Zero	-1
23	A NAND gate with two input A&B has an output zero if	A is zero	B is zero	Both A&B zero	**Both A&B are 1**
24	The output of AND gate will be one if	Both input are 1	Either input is one	**Both input are one**	None of these

25	A complete amplifier circuit made on a silicon chip and enclosed in a small capsule is used as	Diode	Inductor	Resistor	**Operational amplifier**
26	Which one can be used as temperature sensor in electric circuit	Capacitor	Diode	LDR	**Thermistor**
27	The circuit which compare two voltages	LDR	Sensor	**Comparator**	Logic gate

EXERCISE SHORT QUESTIONS

1.How does the motion of an electron in an n-type substance differ from the motion of holes in a p-type substance?**

In n-type material, the electrons are the majority carriers. They move from lower potential to higher potential. In p-type materials, the holes are the majority carriers. They move from higher potential to lower potential.

2.What is the net charge on an n-type or a p-type substance?**

Net charge on n type or p type substance is zero. They have only charge when they are connected to battery. Otherwise all the atoms in an n type or p type substance are electrically neutral as doping does not change the proportion of negative and positive charges.

3.The anode of a diode is 0.2 V positive with respect to its cathode. Is it forward biased?**

Yes , it forward biased as anode is positive with respect to cathode, but potential barrier for silicon is 0.7 V and Ge is 0.3 V so diode will no conduct in both.

4.Why charge carriers are not present in the depletion region?**

As during the formation of pn junction free electrons near the junction in the n region begin to diffuse across the junction into the p-type region where they combine with holes near the junction, and neutralize holes in p-type. As a result, a charge less region is formed across the junction in which charge carriers are not present. This region is known as depletion region.

5. **What is the effect of forward and reverse biasing of a diode on the width of depletion region?

When the diode is forward biased, the width of depletion region is decreased. When the diode is reversed biased, the width of depletion region is increased.

6.****Why ordinary silicon diodes do not emit light?**

Ordinary silicon diodes do not emit light because

i. It is opaque to light
ii. When electrons from n-side cross the junction and recombine with holes on p side most of energy is released in the form of heat, that's why they do not emit light

7.Why a photo diode is operated in reverse biased state?**

Basically Photo diode is used for detection of light. It is operated in the reverse biased condition because

i. When no light is incident on the junction, the reverse current is almost negligible.
ii. When a photo diode is exposed to light, the reverse current increases with intensity of light.

8. ** Why is the base current in a transistor very small?

The base current in transistor is very small due to

i. Base is very thin as compared to emitter and base
ii. Base is very lightly doped
iii. very few charge carriers (electrons or holes)from emitter may combine with electrons or holes of base

9. What is the biasing requirement of the junctions of a transistor for its normal operation

Emitter base junction is forward biased
Collector base junction is reverse biased

10. What is the principle of virtual ground?**

As open loop gain of op-amp is very high of the order of 10^5. So the input voltage is reduced to such a small value that it may be assumed to be at the ground, this is called virtual ground mean not really grounded.

11. **The inputs of a gate are 1 and 0. Identify the gate if its output is (a) 0, (b) 1...

a) The gate may be AND, NOR or XNOR
b) The gate may be OR, NAND, XOR

Numerical problems

18.1: The current flowing into the base of a transistor is $100\,\mu A$. Find its collector current I_C, its emitter current I_E and the ratio I_C/I_E , if the value of current gain β is 100.

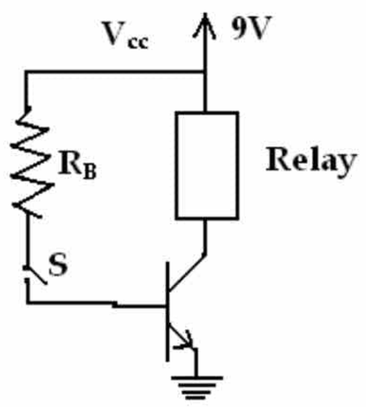
Given Data : $I_B = 100*10^{-6}\,A$ current gain $= \beta = 100$, Ic $= ?$ $I_E = ?$ Ration $Ic/I_E = ?$

$$\beta = \frac{Ic}{I_B} \Rightarrow Ic = \beta I_B = 100*100*10^{-6} = 10^{-2}\,A, \quad I_E = Ic + I_B = 10^{-2} + 100*10^{-6} = 10.1*10^{-3}\,A$$

$$\frac{Ic}{I_E} = \frac{10^{-2}}{10.1*10^{-3}} = 0.99$$

18.2: Fig. shows a transistor which operates a relay as the switch S is closed. The relay is energized by a current of 10mA. Calculate the value R_B which will just make the relay operate. The current gain β of the transistor is 200. When the transistor conducts, its V_{BE} can be assumed to be 0.6V.

Given Data : $Ic = 10mA = 10*10^{-3}\,A$, gain $= \beta = 200$, $V_{BE} = 0.6V$, $V_{CC} = 9V$, $R_B = ?$



As we know that $R_B = V/I_B$ so first of all value calculate I_B and V

$\beta = Ic/I_B \Rightarrow I_B = Ic/\beta = 10*10^{-3}/200 = 0.5*10^{-4}\,A$

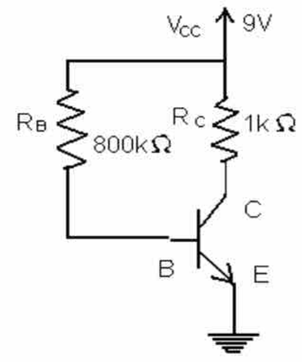
$V = V_{cc} - V_{BE} = 9 - 0.6 = 8.4 volt$ Putting in R_B

$$R_B = \frac{V}{I_B} = \frac{8.4}{0.5*10^{-4}} = 168*10^3\,ohm = 168K\Omega$$

18.3: In circuit (Fig.P.18.3), there is negligible potential drop between B and E, where β is 100, calculate (i) base current (ii) collector current (iii) potential drop across R_C (iv) V_{CE}.

Given data : Vcc $= 9V$, $V_{CE} = 7.875V$, Rc $= 1K\Omega = 10^3\,\Omega$, $R_B = 100K\Omega = 100*10^3\,\Omega$, $\beta = 100$, $I_B = ?$ $Ic = ?$, $Vc = ?$

$$Ic = \frac{Vcc - V_{CE}}{Rc} = \frac{9 - 7.875}{10^3} = 1.125*10^{-3}\,A = 1.125mA$$



$$\beta = \frac{Ic}{I_B} \Rightarrow I_B = \frac{Ic}{\beta} = \frac{1.125*10^{-3}}{100} = 11.25*10^{-6}\,A = 11.25\mu A$$

$Vc = IcRc = 1.125*10^{-3}*10^3 = 1.125 volt$

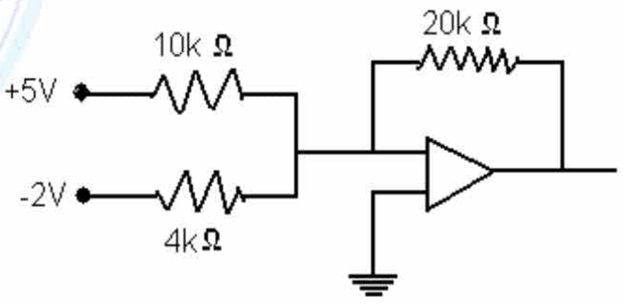
18.4: Calculate the output of the op-amp circuit shown in Fig.P.18.4.

Given Data : $R1 = 10K\Omega = 10*10^3\,\Omega$, $R_2 = 4K\Omega = 4*10^3\,\Omega$, output of op – amp $=$ Vo $= ?$

Using Kirchoff current rule, current through R_1 + Current through R_2 = Current through R_3

$$\text{Current through } R_1 = I_1 = \frac{5}{10*10^3} = 0.5*10^{-3}\,A ---------(1)$$

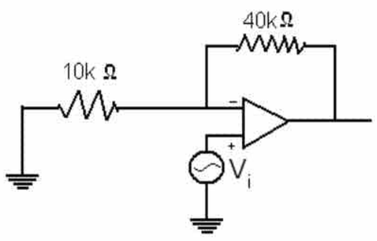
$$\text{Current through } R_2 = I_2 = \frac{-2}{4*10^3} = -0.5*10^3\,A ---------(2)$$



Total current $= I = I_1 + I_2 = 0.5*10^{-3} + (-0.5*10^3) = 0$

So output voltage is also $=$ Vo $= 0$

18.5: Calculate the gain of non-inverting amplifier shown in Fig.P.18.5.



Given Data : $R_1 = 10K\Omega = 10*10^3\,\Omega$, $R_2 = 40K\Omega = 40*10^3\,\Omega$, $Gain = ?$

$$Gain = G = 1 + \frac{R_2}{R_1} = 1 + \frac{40*10^3}{10*10^3} = 1 + 4 = 5$$