BEC :- (Basic electronic circuits)

Basic electrical quantities :-

1) current
2) voltage
3) power

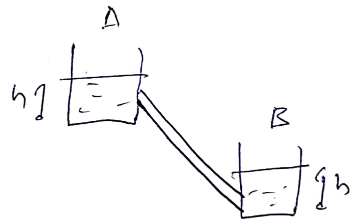
Electricity is a flow of electric charges.

Current is the rate of flow of electrons (Unit Ampere) A

$$I = \frac{Q}{t} = \frac{\text{charge}}{\text{time}}$$

Voltage (or) Potential difference :- It is the electrical force that would drive an electric current between two points. Unit is Volt (V)

no flow.



height difference - potential diff   flow of water

water - electrons (electric current)

Circuit :- A voltage source (battery) has two terminals that has a difference in electric potential. When there is a closed path between these two terminals, it is called a circuit.

In the absence of a circuit, current will not flow, if there is a voltage.

Terminal:- It is a point where electrical connection can be made.

Circuit elements:-

Passive elements. (will not be able to amplify power)

Resistor (R) (Ω)
Inductor (L) (Henry)
Capacitor (C) (Faraday)

Variable elements

Resistor (R)
Inductor (L)
Capacitor

Resistor:- Electrical component that opposes the flow of electric current

Q. What is material used for making Resistor? (Carbon metal (?) metal oxide

→ Power is dissipated in resistor in form of heat

⇒ **Inductor:-** It is also called coil, choke, reactor.
It is a passive two terminal elect compn. that stores energy in magnetic field.

Capacitor: It is a passive ~~two~~ two terminal electrical component that stores energy in electrical field.

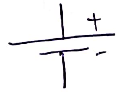
Active elements:

Transistor is an example for an active element that can amplify power.

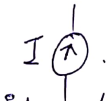
Ex: Sound is amplified in an amplifier

→ Sources are of two categories:

Independent sources:

① Voltage source  (Polarity)

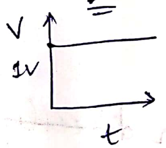
↳ A two terminal device which can maintain ~~as~~ constant voltage.

② Current source 

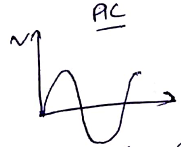
An electronic circuit that delivers constant current to the load.

Various voltage / current wave forms:

DC



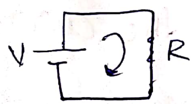
AC

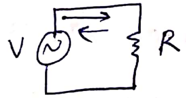


AC voltage source

Standard Indian electric supply
220V, 50 Hz

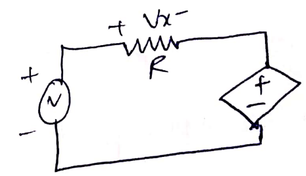
American electric supply
120V, 60Hz





Dependent Sources :

1) Voltage source whose magnitude is dependent on voltage ~~of~~ or) current elsewhere in circuit.

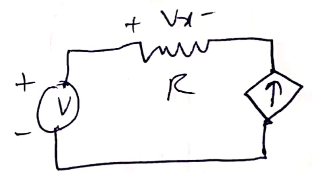


$V_d = aV_x$.

2) Dependent current source :

Current source whose magnitude is dependent on voltage or current elsewhere in a circuit.

dependent VCVS
CCVS
VCCS
CCCS



$i_d = bV_x$.

Ohm's law :- $\boxed{V = IR}$

The current through a conductor between two points is directly proportional to the voltage across the points.

Series and parallel circuits:-

In a series circuit, voltage divides in ~~directly~~ proportional to resistance value and the current flowing through the elements is same.

Eg:-

$$\boxed{R_{eff} = R_1 + R_2 + \dots R_n}$$

$$I = \frac{V}{R_1+R_2+R_3} = \frac{V}{6}$$

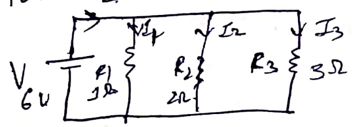
$$V_{R_1} = IR_1 = \frac{V}{6}$$

$$V_{R_2} = IR_2 = \frac{V}{3}$$

$$V_{R_3} = IR_3 = \frac{V}{2}.$$

In a parallel circuit, voltage remains the same and the current divides in inverse relation to that of resistor.

Eg:-



$$\frac{1}{R_{eff}} = \frac{1}{1} + \frac{1}{2} + \frac{1}{3}$$

$$\frac{1}{R_{eff}} = 1 + \frac{5}{6} = \frac{11}{6}.$$

$$I_1 = \frac{V}{R_1} = \frac{6}{1} = 6A$$

$$I_2 = \frac{V}{R_2} = \frac{6}{2} = 3A$$

$$I_3 = \frac{V}{R_3} = \frac{6}{3} = 2A.$$

$$I = I_1 + I_2 + I_3$$

$$I = 6 + 2 + 3$$

$$I = 11A$$

$$V = IR = 11 \times \frac{6}{11} = 6V.$$

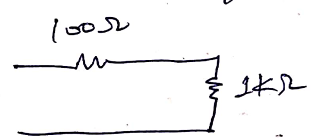
$$\boxed{\frac{1}{R_{eff}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots \frac{1}{R_n}}$$

Equivalent Resistances.

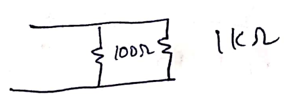
Series resistors : $R_{eq} = R_1 + R_2 + R_3 + \dots$

Parallel resistors :- $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$

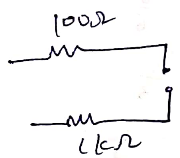
Eg:- 1)



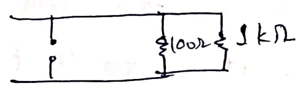
$R_{eq} = 1100\Omega$

2) 

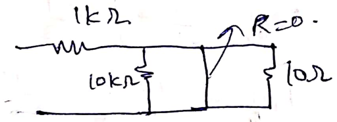
$R_{eq} = \frac{100 \times 10\cancel{00}}{11\cancel{00}} = 90.90\,\Omega$

3) 

$R_{eq} = \infty.$

4) 

$R_{eq} = 90.90\,\Omega$

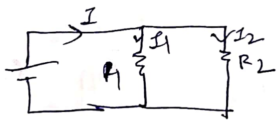
5) 

$R_{eq} = 1\,k\Omega$

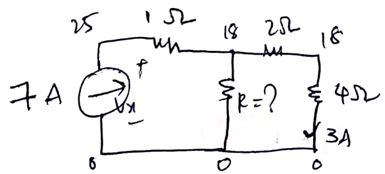
→ Power generated and Dissipated in the circuit !

Power generated by voltage source $P = IV.$

Power dissipated in resistor R_1 $P = I^2R_1 = \frac{V^2}{R_1}$

1) 

$P = \frac{V^2}{R_{eff}}$ $\frac{1}{R_{eff}} = \frac{1}{R_1} + \frac{1}{R_2}$

2) 

$V_x = 25V.$

$V = 18$ $I = 7A.$ $I_2 = 3A$ $I_1 = ?$

$I = I_1 + I_2$

$V = IR$

$7 = 3 + I_2$

$\frac{\cancel{18}^{9}}{\cancel{4}_{2}} = R$

$\boxed{R = 4.5\,\Omega}$ $\boxed{I_2 = 4}$

Semi-conductor devices :-

Materials can be classified into three categories based on conductivity (σ) (or) resistivity (ρ).

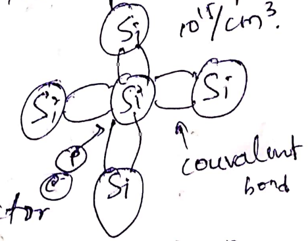
1. conductors (ρ) $< 10^{-3}\,\Omega$-cm
2. Semi-conductors. $\rho_{silicon}$ at room-tmp. $= 2.31 \times 10^{5}\,\Omega$-cm
3. Insulators (ρ) $> 10^{8}\,\Omega$-cm.

Intrinsic semi-conductors :-

Semi-conductors in its pure form is called as intrinsic semi-conductors.

Extrinsic semi-conductors :-

Pure semi conductor added with dopant impurities $10^{15}/cm^3$.



Intrinsic carrier concⁿ :-

No. of $e^{\ominus}$ (or) holes in a semi-conductor at room tmp. Unit /cm³. Intrinsic carrier concⁿ of silicon at room tmp $1.45 \times 10^{10}\ cm^{-3} = n_i$

In, Intrinsic semi-conductor at thermal equilibrium.

$n_o p_o = n_i^2$

n_o = electron carrier conⁿ at room tmp $\quad n_o\ 1.45 \times 10^{10}$

p_o = hole carrier conⁿ at room tmp. $\quad p_o$

$+N_D \rightarrow 10^{15}$

$n_o + N_D \cong N_D \rightarrow 10^{15}/cm^3$

Calculations of $e^{\ominus}$ and hole con^n in a doped

→ Donor doped (Phosphorus) N_D

the $e^{\ominus}$ concentration in a donor doped semi-conductor is $n_0 + N_D \approxeq N_D$

where N_D is donor doping concentration.

→ the whole conc^n is $P_0 = \frac{n_i^2}{n_0 + n_D} = \frac{n_i^2}{n_D}$

Q) Calculate $e^{\ominus}$ and hole concentrations in a silicon doped with donor con^n (P). of $10^{16}\,cm^{-3}$.

Sol:- $P_0 = \frac{(1.45 \times 10^{10})^2}{10^{16}} = 2.10 \times 10^{20-16} = 2.10 \times 10^4$

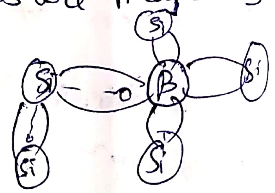
$n_0 (2.10 \times 10^4) = (1.45 \times 10^{10})^2$

$e = n_0 + n_D$ $\quad n_0 = \frac{2.10 \times 10^{20}}{2.10 \times 10^4} \approx N_D = 10^{16}$.

$= n_D = 10^{16}$

→ If intrinsic silicon is doped with donor impurity (… e^- are majority carriers and holes are the minority carriers. (n-type material)

→ If intrinsic silicon is doped with donor impurity (B) e^- are minority carriers and holes are majority carriers (p-type material)



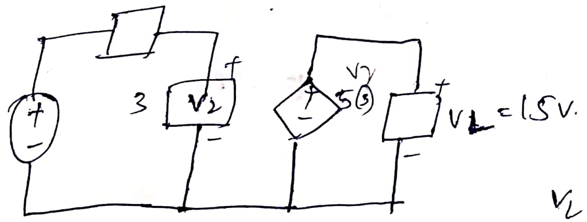
Kirchoff's Current Law:

Alg. Sum of all the currents through a point is zero

Kirchoff's voltage law:

Alg sum of voltages in a closed loop is zero.

Q1)

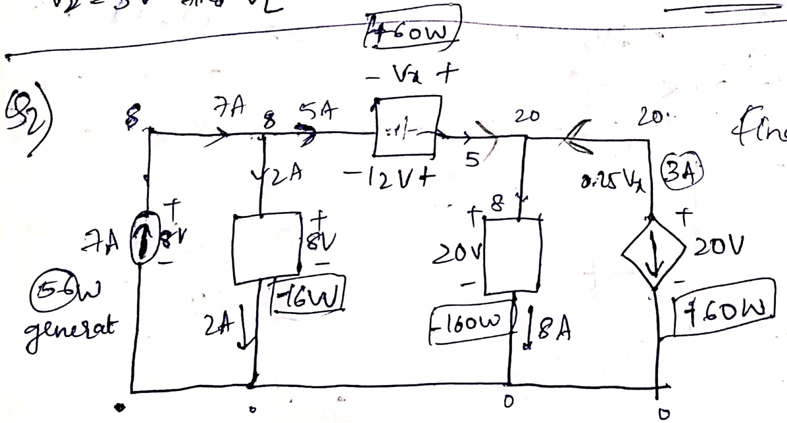


$V_2 = 3V$ find V_L

$V_L - 5V_2 = 0$

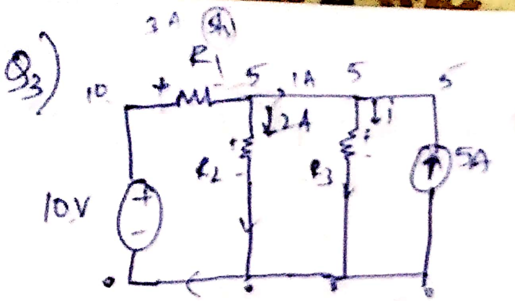
$V_L = 5V_2$

Q2)



Find power absorbed by each element.

Q3)



Voltage Source, produces a current 3A, determine i

$5 - iR_3 + (2)\left(\frac{5}{2}\right) = 0$

$\boxed{10 = iR_3}$

$i = 1A$

$10 - i_1R_1 - iR_2 = 0$

$10 = (3)R_1 + (2)R_2$

$10 = 3R_1 + 2R_2$

$10 = 3\left(\frac{5}{3}\right) + 2R_2$

$\boxed{\frac{5}{2} = R_2}$

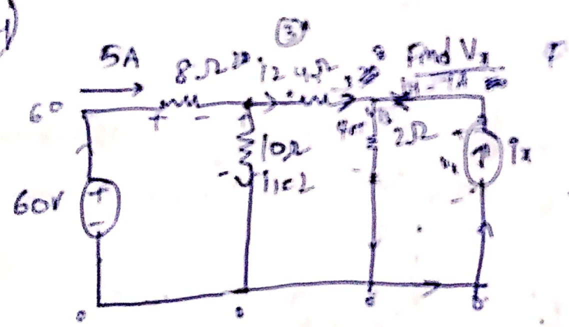
$i = \frac{V}{R}$

$3 = \frac{5}{R}$

$\boxed{R_1 = \frac{5}{3}}$

$5 - iR_3$

Q4)



Find V_x

$60 - (5)(8) - I_1(10) = 0$

$60 - 40 = 10i_1$

$20 = 10i_1$

$\boxed{i_1 = 2}$

$\boxed{V_x = 8}$

$20 - 3(4)$

$20 = 3(4) - i_3(2) + 10$

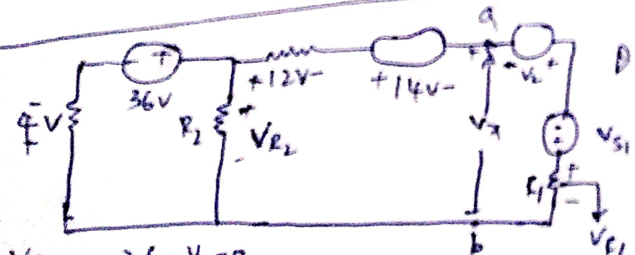
$8 + 20 = 2i_3$

$-3(4) - i_3(2) + 20 = 0$

$-12 + 20 = 2i_3$

$\frac{8}{2} = i_3$

Q5)



Determine V_{R_2} and V_x

$V_{R_2} - 26 - 4 = 0$

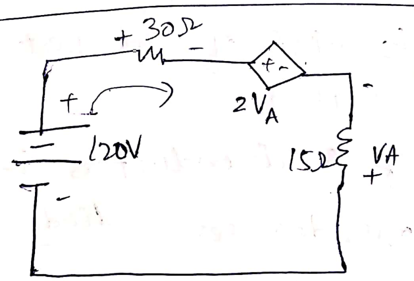
$32 - 26 = V_x$

$\boxed{V_x = 6V}$

$36 - 4 - V_{R_2} = 0$

$V_{R_2} = 32$

Q6)



Compute power absorbed in each element

$i = \frac{V}{R}$

$i = \frac{V_A}{15}$

$15i = V_A$

$120 - 30i - 2V_A + V_A = 0$

$120 - 30i = V_A$

$120 - 30i = 15i$

$120 = 45i$

$\frac{8}{3}\cancel{\frac{120}{45}} = i$

$\boxed{i = \frac{8}{3}}$

$P = 2V_A \times i$

$= 2 \times 40 \times \frac{8}{3}$

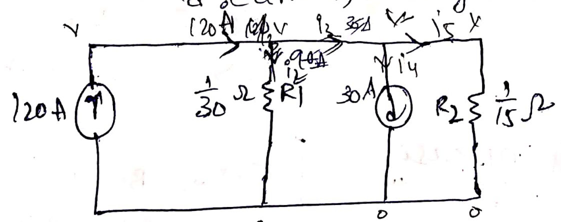
$= \frac{80 \times 8}{3}$

$\boxed{P = \frac{640}{3} \text{ W}}$

$V_A = \frac{15 \times 8}{3}$

$\boxed{V_A = 40}$

Q7) Find current, voltage & power associated with each element



$120 - i\left(\frac{1}{30}\right) = 0$

$120 = \frac{i}{30}$

90A

$\frac{1}{30} + \frac{1}{15}$

$\frac{1}{R} = 45$

$R = \frac{1}{45}$ Ω

23/01/2020

Rectification :- (AC-DC):

$\boxed{P}$ ← n-type
mobile: majority - $e^{\ominus}$, minority - holes

$\boxed{B}$ → p-type
majority - holes, minority - $e^{\ominus}$

I = conventional current.

$\xrightarrow{I}$ I_h

$\xrightarrow{I}$ $\xleftarrow{I_e}$

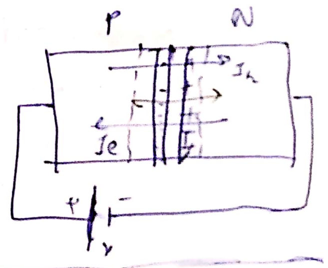
I_h = hole current
I_e = $e^{\ominus}$ current

Forward bias :

when (+) terminal of the battery is connected to p region, (−) terminal of the battery is connected to n-region.

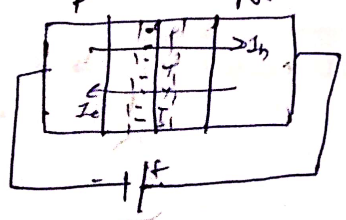
This combination of semi-conductors is called diode

length of depletion layer decreases



Reverse bias :-

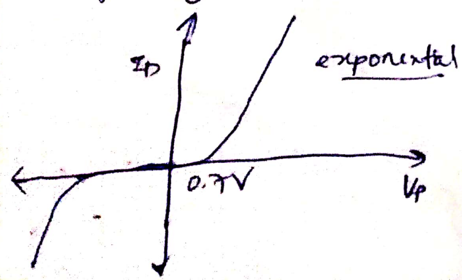
− terminal to p region
+ terminal to n region

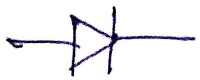


length of depletion layer increases

$V_I = 0$, $V < 0.7V$
$V_I > 0$ $V \geq 0.7V$

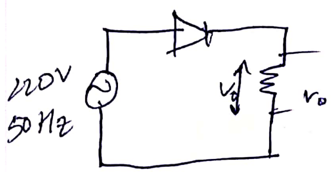
Silicon Built-in-potential
$V_I = 0.7V$

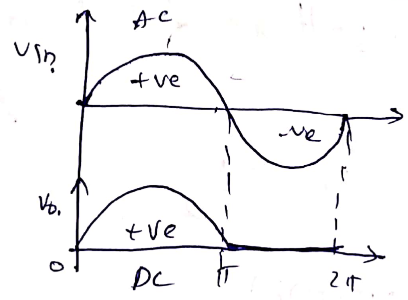




Diode.

Half-wave Rectifier





$$V_{avg} = \frac{1}{2\pi}\int_0^{\pi} V_m \sin\theta \, d\theta$$

$$= \frac{V_m}{2\pi} - (\cos\theta)_0^{\pi} = \frac{-V_m}{2\pi}(-1-1) = \frac{V_m}{\pi}$$

$\cos^2\theta$

$\sin^2\theta = 1$

$$\boxed{V_{avg} = \frac{V_m}{\pi}}$$

$$V_{rms} = \sqrt{\frac{1}{2\pi}\int_0^{\pi} (V_m \sin\theta)^2 \, d\theta}$$

$$= \sqrt{\frac{V_m^2}{2\pi}\int_0^{\pi}\left(\frac{1-\cos 2\theta}{2}\right) d\theta}$$

$$= \sqrt{\frac{V_m^2}{4\pi}\left[(\theta)_0^{\pi} - (\cos 2\theta)_0^{\pi}\right]} = \sqrt{\frac{V_m^2}{4\pi}\left[\pi - (1-1)\right)} = \sqrt{\frac{V_m^2}{4}}$$

$$\boxed{V_{rms} = \frac{V_m}{2}}$$

$$\text{Efficiency} = \frac{V_{avg}}{V_{rms}} = \frac{\frac{V_m}{\pi}}{\frac{V_m}{2}} = \frac{2}{\pi} = 66.7\%$$

$$i_D = I_S\left(e^{V_D/V_T} - 1\right)$$

I_S = Saturation current

V_D = Voltage across diode

V_T = Thermal voltage

= 26 mV (at room tmp)

$e \ll \frac{V_D}{V_T}$

$$\boxed{i_D = I_S e^{V_D/V_T}} \text{ (approx)}$$

(Q) Find out the average and rms voltages of Indian supply voltage fed to a half-wave rectifier.

$\boxed{V_m = V_0\sqrt{2}}$

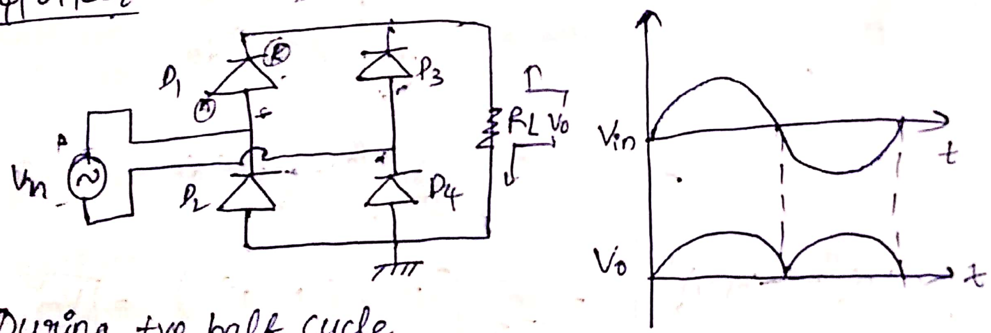
Sol: $V_{avg} = \frac{V_m}{\pi}$ $V_{rms} = \frac{V_m}{2}$

$V = \underbrace{220\sqrt{2}}_{V_m} \sin(\underbrace{2\pi(50)}_{\omega = 2\pi f} t)$

$V_{avg} = \frac{220\sqrt{2}}{\pi} = 98.98V$ $V_{rms} = \frac{\overset{110}{\cancel{220}}\sqrt{2}}{\cancel{2}} = 110\sqrt{2} = 155.50V$

24/01/2020

Full-wave Rectifier



During +ve half cycle

D_1 ON D_3 OFF

D_2 OFF D_4 ON.

During -ve half cycle

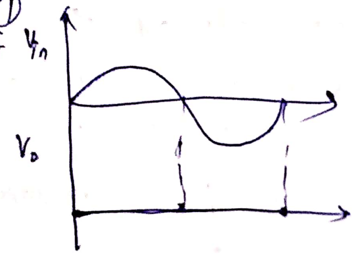
D_1 OFF D_3 ON

D_2 ON D_4 OFF

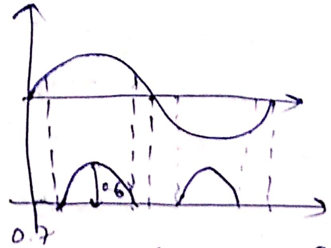
Q) Draw wave forms at output of a resistor $V_{source} = 1.4 \sin(\frac{\omega}{50}$ to a full-wave rectifier. Plot source ~~code~~ and output ~~code~~ forms.

Assume potential drop in each diode is 0.7V.

① Sol:



②



if $V_{source} = 2\sin\omega t$.

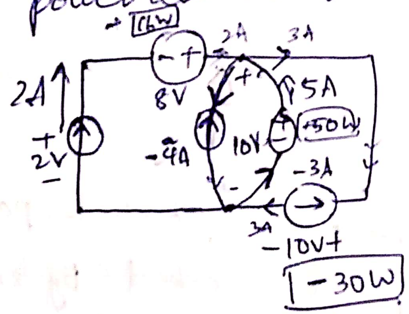
$$V_{avg} = \frac{1}{\pi}\int_0^{\pi} V_m \sin\theta \, d\theta$$

$$= \frac{V_m}{\pi} - (\cos\theta)_0^{\pi} = \frac{V_m(2)}{\pi} = \frac{2V_m}{\pi}$$

$$V_{rms} = \frac{\sqrt{2}\times V_m}{2} = \frac{V_m}{\sqrt{2}}$$

Problem ①

Determine power delivered by each element on circuit.

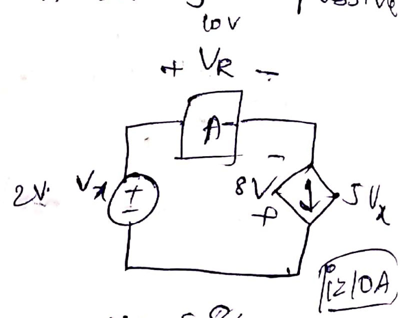


2A+3A

2V+8V

(2) Same current flows through each element. The voltage-controlled dependent source provides a current which is 5 times as large as the voltage V_x.

(a) for $V_R = 10V$ and $V_x = 2V$, determine power absorbed by each element (b) Is element A likely a passive (or) active source? Explain



a) For $V_x = 2 \times 10 = +20W$

For $V_R = 10(10) = -100W$ (passive)

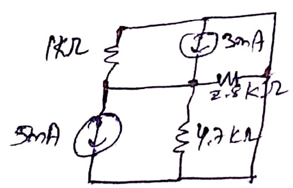
For $V = 8(10) = +80W$

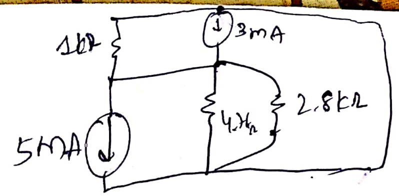
$+2 - 10 + 8$

(5) Circuit below is in fact a single-node-pair circuit.

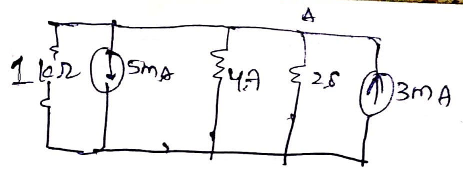
(a) Determine the power absorbed by each resistor.

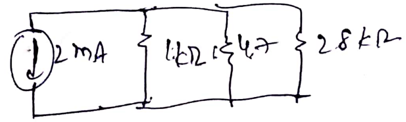
(b) Determine the power supplied by each current source (c) Show that the sum of the absorbed power calculated in (a) is equal to sum of the supplied power calculated in (b)





$\Rightarrow$





$$\frac{1}{R} = \frac{1}{1} + \frac{1}{4.7} + \frac{1}{2.8}$$

$$= 1 + 0.35 + 0.21$$

$$\frac{1}{R} = 1.56$$

$$\boxed{R = 0.64k\Omega}$$

$$V = IR$$

$$V = 2\cancel{m}\times 10^{-3} \times 0.64\times 10^{3}$$

$$\boxed{V = 1.28\ V}$$

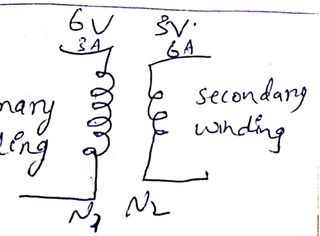
28/01/2020

DC Power Supply:-

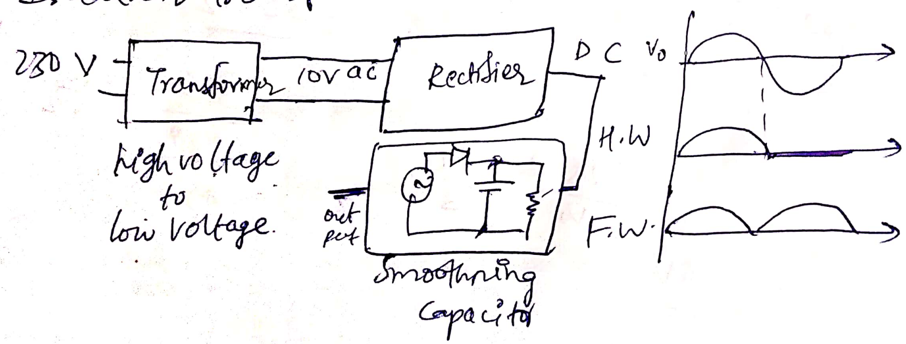
Transformers (Bring down high voltages to low V without change of frequency)

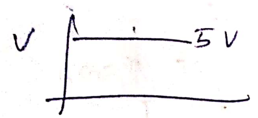
↳ A device. that

$P_{ac} = VI\cos\phi$. Transformers $\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1}$ Primary winding



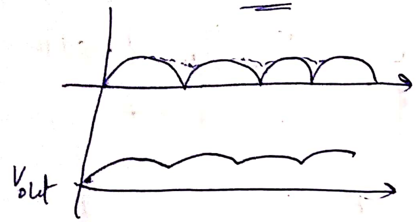
→ If the term ratio is 1, then it is Isolation transformer

→ 

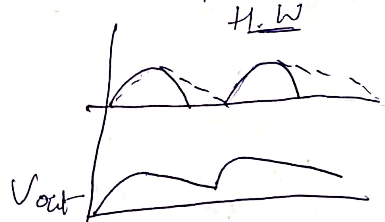


DC: Const voltage (magnitude) is supplied.

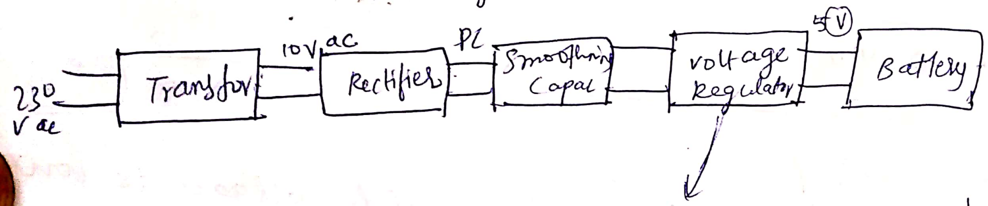
F.W



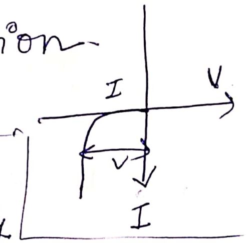
H.W



To avoid low voltage conditions (dimness of light)
We use voltage regulator



"zener diode" reverse biased. p n junction



Q) Design a dc power supply to provide 3.7 volts at the output for Indian supply $V_0 = (220V\ rms)$ (Full wave rectifier).

$V = 230\sqrt{2}\sin(2\pi \cdot 50)t$

$= 325.2 \sin(2\pi \cdot 50 \cdot t)$

$N_1 \quad N_2$
$100 : 3$

$\frac{325.2}{V_2} = \frac{100}{3}$

$\boxed{V_2 = 9.76V}$

$\frac{V_1}{V_2} = \frac{N_1}{N_2}$

$\frac{325.2}{}$

$\frac{325.2}{10} = \frac{100}{N_2}$

$N_2 = \frac{1000}{325.1} = 3.07 \approx 3$

28/01/2020

Tutorial:-

$v_1 = 200\sin(2\pi \cdot 50 \cdot t)$

$v_2 = 200\sin(2\pi\, 250\, t)$

Find Vavg, Vrms and plot the graphs

(i) $V_{avg} = \frac{V_m}{\pi}$ $\qquad V_{rms} = \frac{V_m}{2}$

$= \frac{200}{\pi} = 63.69 \qquad V_{rms} = \frac{200}{2} = 100$

$V_{avg} = \frac{1}{2\pi}\int_0^{\pi} 200\sin(100\pi t)\,d\theta = \frac{100}{\pi}\left(-\right)\left(\frac{\cos 100\pi t}{100\pi}\right)_0^{\pi} = \frac{1}{\pi^2}($

(i) $V_{avg} = V_m$ $\qquad$ ωt

sin (

(1) Half-wave Rectifier

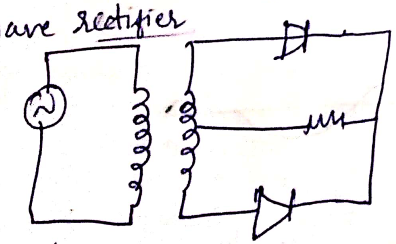
a) $V_{avg} = \frac{V_m}{\pi} = \frac{200}{\pi} = 63.69 \qquad V_{rms} = \frac{V_m}{2} = \frac{200}{2} = 100.$

b) $V_{avg} = \frac{V_m}{\pi} = \frac{200}{\pi} = 63.69 \qquad V_{rms} = \frac{V_m}{2} = \frac{200}{2} = 100.$

(2) Full-wave Rectifier.

a) $V_{avg} = \frac{2V_m}{\pi} = 2(63.69) = 127.38 \qquad V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{200}{\sqrt{2}} = 141.44$

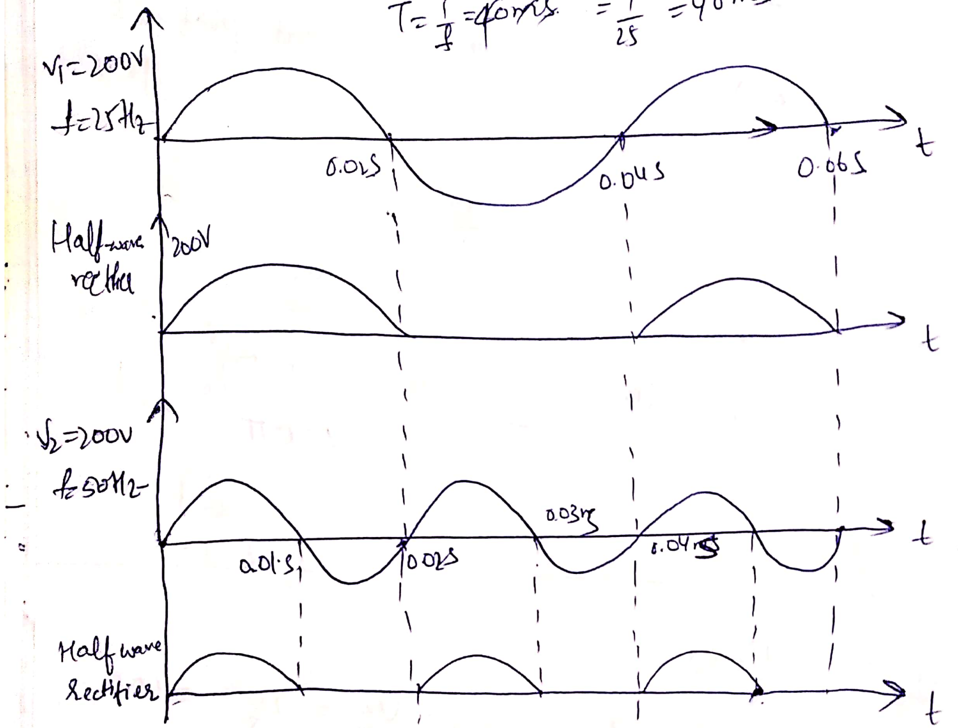
Full-wave Rectifier



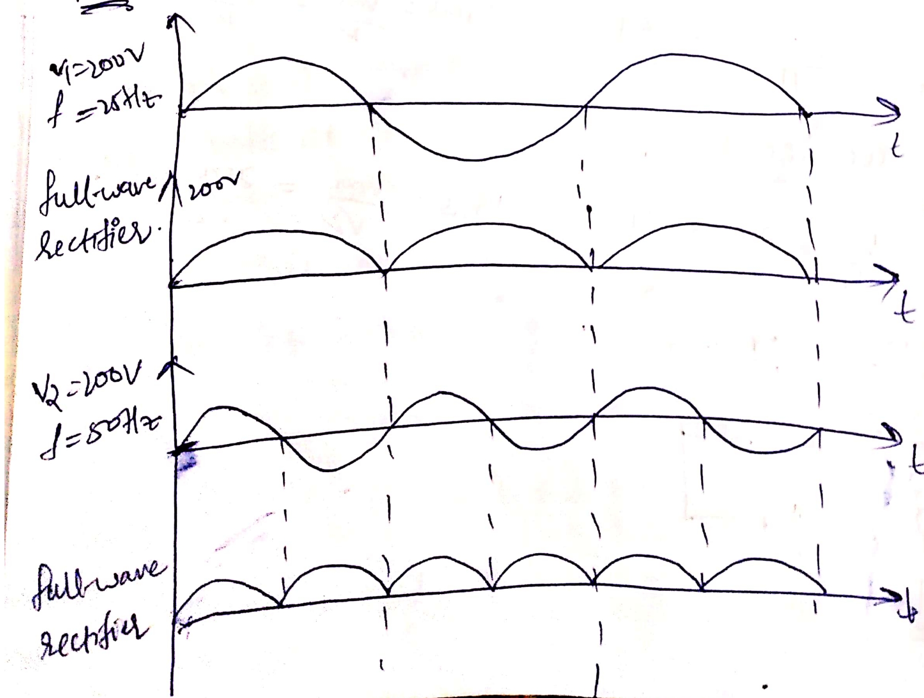
Centre-tapped

Plot :

$T = \frac{1}{f} = 40ms = \frac{1}{25} = 40ms$



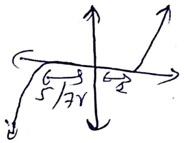
Plot :



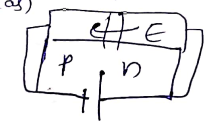
f ↑ no. of cycles ↑

30/01/2020

Zener Diode Breakdown



In a reverse biased p-n junction the electric field across the junction enables tunneling of electrons from valence band to conduction band of a semi-conductor resulting in large no. of free minority carriers. (holes) suddenly ↑ reversing current (increas)



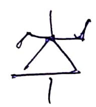
Zener breakdown occur at $z > 5V$.
Avalanche break down at $z > 7V$.

Avalanche breakdown :

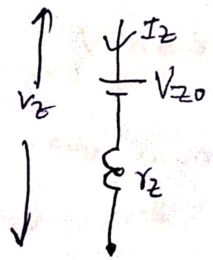
Carriers near the depletion region are accelerated by electric field. These accelerated carriers have sufficient energy to release free electron hole pair through collisions, thereby carrier multiplication occurs resulting in breakdown, called as Avalanche breakdown

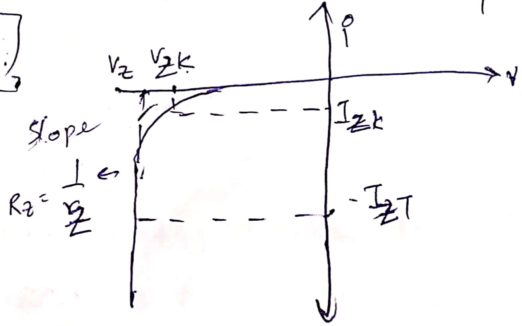
Modelling Zener diode :

r_Z = incremental resistance or dynamic resistance.



$$\boxed{V_Z = V_{Z0} + I_Z r_Z}$$





Q) A 6.8 V Zener diode in the circuit is specified to have $V_Z = 6.8V$ at $I_Z = 5mA$. $R_Z = 20\Omega$ $I_{ZK} = 0.2mA$
The supply voltage is normally 10V, and can vary by 1V. (9-11V).

Q) a) Find Output Voltage V_o (with no load), with V_s at its normal voltage.

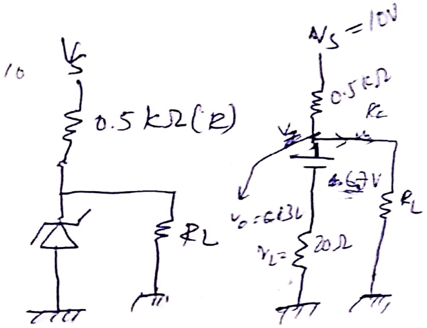
$V_Z = V_{Z0} + I_Z R_Z$

$6.8 - 5\times10^{-3}\times2\times10^{1} = V_{Z0}$.

$6.8 - 10^{-1} = V_{Z0}$

$6.8 - 0.1 = V_{Z0}$

$\boxed{6.7V = V_{Z0}}$



$I = \frac{10-6.7}{500+20} = 6.35mA$

$\therefore V_o = 10 - 0.5k\Omega(6.35mA)$

$V_o = 6.63V$.

Q) b) Find the change in voltage V_o for change $\pm 1 V_s$.

Line regulation:

$$\boxed{\Delta V_o = \Delta V_s \times \frac{r_z}{R + r_z}}$$

$= (\pm 1) \times \frac{20}{500+20} = \pm 1 \times \frac{20}{520} = \pm 38.5 mV/V$

Q) c) Find change in output voltage resulting from a load resistance R_L that draws a current of $I_L = 1 mA$. Hence find the Load Regulation $= \frac{\Delta V_o}{\Delta I_L}$?

$\Delta V_o = r_z \Delta I_Z$

$= 20 \times 1mA = -20 mV/mA$

Qd) Find the change in V_o where $R_L = 2k\Omega$.

Soln =

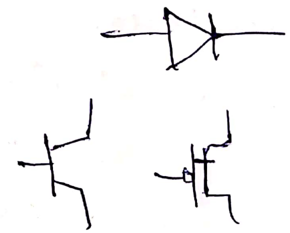
Qe) Find the value of V_i when $R_1 = 0.5k\Omega$

Qf) What is min value of R_1 for which diode still operate?

Q3) Consider Zener diode fig shown in.f Assume $V_Z = 12V$. and $R_Z = 0$. a) Calculate the zener diode current and Power dissipated in zener for $R_L = \infty$. b) What is value of R_L such that current in zener $\frac{1}{?}$ of the current, supplied by 40V source. c) Determine the power dissipated in zener diode for (b).

Sol:

4/02/2020 **Transistors**



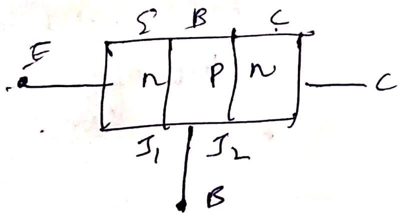
→ Refers to transfer resistance
Two types of transistors:
① Bipolar junction transistor.
② Field Effect transistor:
③ these devices are 3 terminal semi-conductor devices.

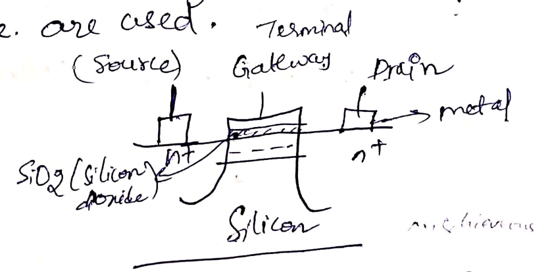
BJT It is a bipolar device (Bipolar Junction Transistor)
For the purpose of conduction both the type of carriers (electrons and holes) are used. It is a current controlled device.

→ Compared to a ~~mosphet~~, MOSFET, this device is faster and size of BJT is relatively ~~small~~ large compared to a MOSFET.

MOSFET → voltage controlled device.
Uni-polar device. For the purpose of conduction either $e^{\ominus}$ (or) holes alone are used.

Structural diagrams.





Nchannel MOSFET.
(NMOS)

Biasing (Proper amount of input voltage should be given to the corresponding output voltage)

Doping conc^n of Emitter 10^{19} cm^{-3}
" Base 10^{15} cm^{-3}
" collector 10^{17} $/cm^3$

→ Bipolar Junction Transistors is not a symmetrical device
→ Doping conc^n of Source & drain regions are same in case of a MOSFET (∵ symmetrical device).

SiO_2 (Insulator)

MOSFET has all classification of materials.

→ the gate terminal is a metal (conductor)

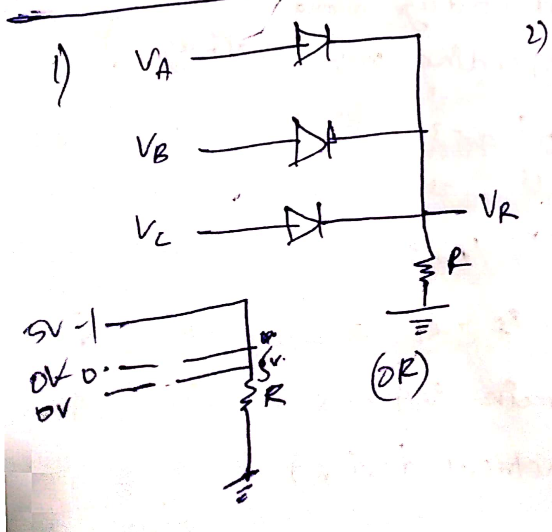
→ In between semi-conductor (silicon) and gate terminal there is silicon dioxide (SiO_2) which is insulator.

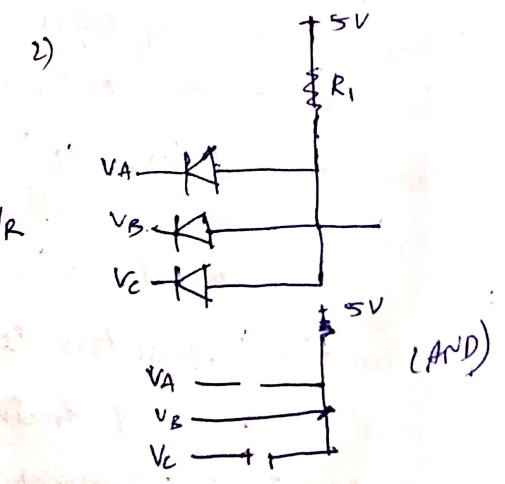
→ Input resistance of a bipolar transistor (p-n junction) is in the order of few kilo Ohms. On the other hand input resistance of a MOSFET is infinity (Silicon dioxide insulator) in order of Mega ohms ($M\Omega$)

→ ∴ MOSFET is voltage controlled device.

Modes of operation of BJT:

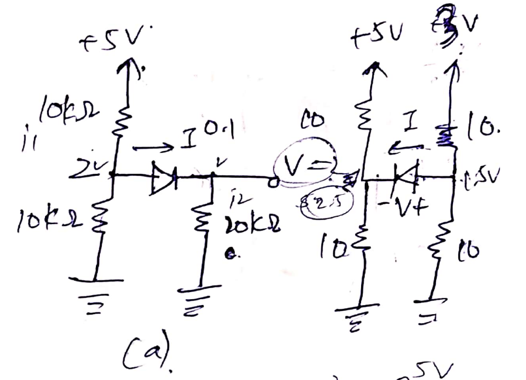
	Emitter Base J	Collector Base J	Mode
	FB	FB	Saturation (so much current)
	FB	RB	Active (Amplifier)
	RB	RB	Cut-off
(not in use) ✗	RB	FB	Reverse active.





Ideal ~~diode~~ diode circuit:

- Assuming that diodes in the circuits of Fig. are ideal, utilize thevenin's theorem to simply the circuits and thus find the values of the labeled currents and voltages.



(a) Diode is on,

10kΩ and 20kΩ ||

$10 + R_{eq} = \frac{20}{3}$

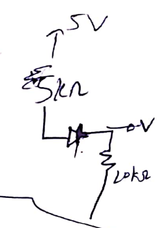
$R_{eq} = \frac{50}{3}$

$5 - i\left(\frac{50}{3}\right) = 0$

$5 = i\left(\frac{50}{3}\right)$

$\boxed{I = 0.3mA}$

$5 - 10(0.3) = \boxed{2V}$



(b)

$I = 0$

$5 - 10$

$\frac{V-5}{10} + \frac{V-0}{10} = 0$

$2V = 5$

$V = 2.5$

$5 - 10i - 10i = 0$

$\frac{5}{20} = i$

$\boxed{I = 0.25A}$

$5 - 10 \times 0.25$

$5 - iR = 0$

$5 = iR$

$5 = i$

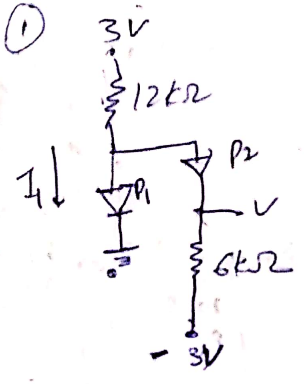
$\frac{V-3}{10} + \frac{V-0}{10} = 0$

$2V = 3$

$V = 1.5V$

- Assuming that diodes in circuits are ideal. Find values of labeled voltage and current.

(1)



(2)

Terminal char. of diodes $\quad I = I_s \left(e^{V/nV_T} - 1 \right)$

$V_T = 0.0862\,(273 + T^{\circ})$ mV $\qquad V = V_T \ln \frac{I}{I_s}$

- ~~After~~ At what forward voltage does a diode conduct a current equal to $10{,}000\, I_s$? In terms of I_s, what current flows in the same diode when its forward voltage is 0.7V?

Ans: $V = 0.273V$

- A diode fed with a const current $I = 1mA$ has a voltage $V = 690\ mV$ at $20^\circ C$. Find the diode voltage at $-20^\circ C$ and at $+85^\circ C$

Soln $V = 0.473 mV$

Zener diode Problem

- A 9.1V zener diode exhibits its nominal voltage at a test current of 20mA. At this current the incremental resistance is specified as 10. Find V_{Z0} of the zener model. Find the zener voltage at a current of 10mA and at 50mA.

S/t : $V_{Z0} = 8.9V$ $V_Z = 9.0V$ (10mA) and $V_Z = 9.4$ (50mA)