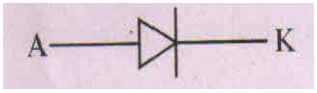
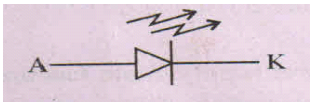
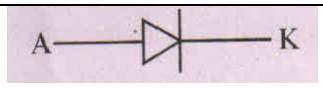
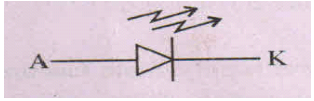
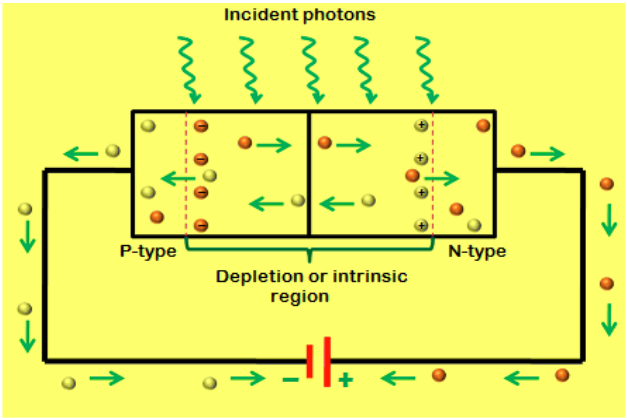
Important suggestions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skills)
4) While assessing figures, examiner may give credit for principle components indicated in a figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1	**Attempt any FIVE of the following :** **10 Marks**
a)	**Name the components of following symbols :** **(i)**  **ii)** 
Ans	**i)**  **: Semiconductor Diode** **(1 Mark)** **ii)**  **: Light Emitting Diode** **(1 Mark)**
b)	**Define the term 'Ripple factor' for rectifier.**
Ans	**Ripple factor**: The ratio of RMS value of ac component present in the waveform to the dc component in the waveform is called as ripple factor. **(2 Marks)** OR The unwanted AC components present in output waveform of a rectifier is called as ripple factor
c)	**State relation between emitter current (I_E), Base current (I_B) • and collector current (Ic) of BJT.**
Ans	$I_E = Ic + I_B$ **(2 Marks)** $I_E = (1+\beta) I_B$
d)	**Write three terminal voltage regulator IC for obtaining : (i) + 5V (ii) —12V**
Ans	**(i) Terminal voltage regulator IC for obtaining : + 5V : IC 7805** **(1 Mark)** **(ii) Terminal voltage regulator IC for obtaining : - 12V : IC 7912** **(1 Mark)**

e)	**'Germanium diode knee voltage is lower than silicon diode knee voltage.' Justify.**
Ans	**Justification:** **(2 Marks)** The band gap between conduction and valence band for Germanium (0.66eV) is less as compared to Silicon (1.11eV).Hence less energy is required to start conduction in Germanium diode.
f)	**Define the term 'Load Regulation'.**
Ans	**Load Regulation** : **(2 Marks)** Load regulation is the ability of a power supply to maintain a constant output voltage irrespective of any changes in load current. $$Load\ regulation = \left(\frac{V_{NL} - V_{FL}}{V_{FL}} \right) \times 100\%$$
g)	**Draw symbol and write truth table of EX-OR gate.**
Ans	**Symbol and truth table of EX-OR :** **(1 Mark for symbol & 1 Mark for Truth table)** *Exclusive-OR gate*  A B Output 0 0 0 0 1 1 1 0 1 1 1 0
Q.2	**Attempt any THREE of the following :** **12 Marks**
a)	**State working principle of photo diode. List out its three applications.**
Ans:	**Diagram of photo diode :** **(1 Mark)** 

Working principle of photo diode : **(2 Marks)**

When photons of energy greater than 1.1 eV hit the diode, electron-hole pairs are created. The intensity of photon absorption depends on the energy of photons – the lower the energy of photons, the deeper the absorption is. This process is known as the inner photoelectric effect.

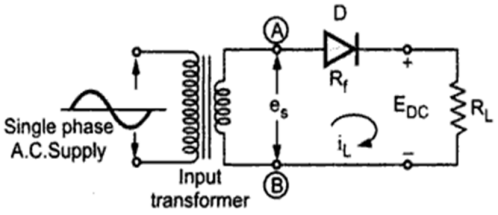
If the absorption occurs in the depletion region of the p-n junction, these hole pairs are swept from the junction - due to the built-in electric field of the depletion region. As a result, the holes move toward the anode and the electrons move toward the cathode, thereby producing photocurrent.

Applications principle of photo diode : **(1 Mark)**

Cameras, Medical devices, Smoke detector, Optical communication devices, Position sensors, Bar code scanners, Automotive devices, Surveying instruments

b) Sketch circuit diagram and input, output waveform of Half wave rectifier. State its efficiency.

Ans: **Half wave Rectifier (Circuit) :-** **(Circuit - 2 Mark)**



Waveform: **(Waveform - 1 Mark)**

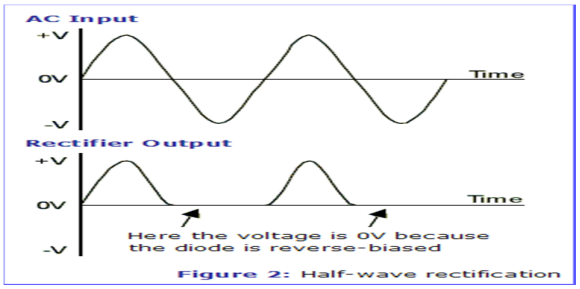


Figure 2: Half-wave rectification

Efficiency : 40.6 % **(1 Mark)**

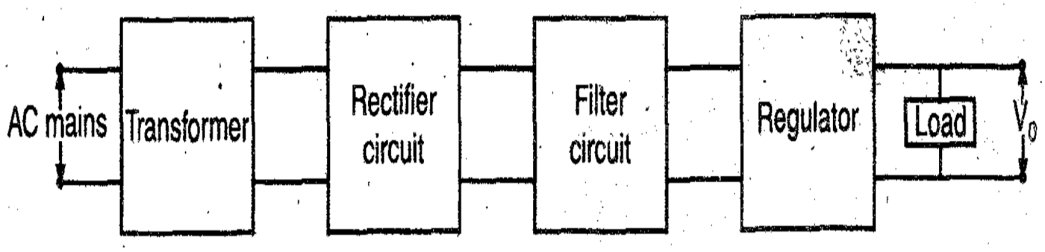
c) Compare BJT common base configuration with common collector configuration on the basis of (i) Current gain (ii) Voltage gain (iii) Input impedance (iv) Output impedance

Ans: **Comparison :** **(4 Marks)**

Parameter	Common Base	Common Collector
Current gain	Low (About 1)	High (1+β)
Voltage gain	High	1
Input impedance	Low	High
Output impedance	High	Low

d) Sketch block diagram of D.C. regulated power supply. State functions of each block.

Ans: **Diagram :** **(2 Mark)**



Functions of each block: **(2 Mark)**

1) Transformer:

It Converts an AC input source to AC required output without changing frequency. The transformer is step up or step down transformer.

2) Rectifier:

It is a circuit which is used to convert AC into pulsating DC. A rectifying diode is used.

3) Filter:

It is a circuit used to convert pulsating DC into pure DC. A inductor and capacitors are used as filter

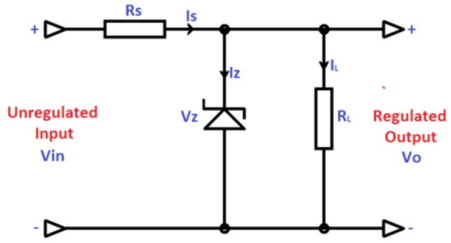
4) Voltage regulator:

An unregulated DC voltage is converted into regulated DC voltage. IC 78XX & 79XX series are used as regulator.

Q.3	Attempt any THREE of the following : 12 Marks
a)	**Explain with circuit diagram operation of zener diode as a voltage regulator.**

Ans:

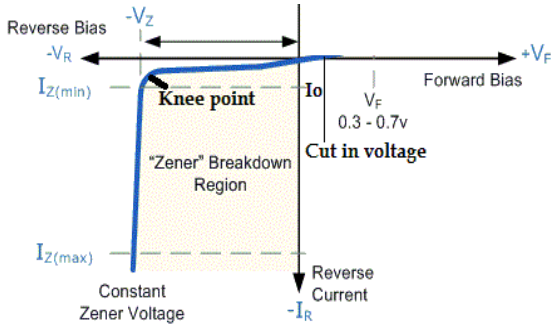
Diagram of zener diode as voltage regulator: **(2 Mark)**



Working: **(2 Mark)**

Zener Diodes are widely used as Shunt Voltage Regulators to regulate voltage across small loads. Zener Diodes have a sharp reverse breakdown voltage and breakdown voltage will be constant for a wide range of currents. Thus we will connect the zener diode parallel to the load such that the applied voltage will reverse bias it. Thus if the reverse bias voltage across the zener diode exceeds the knee voltage, the voltage across the load will be constant.

Characteristics :



b)	**State type of feedback used for oscillator circuit. Explain Barkhausen criteria.**

Ans:

Type of feedback used for oscillator circuit : Positive feedback **(1 Mark)**

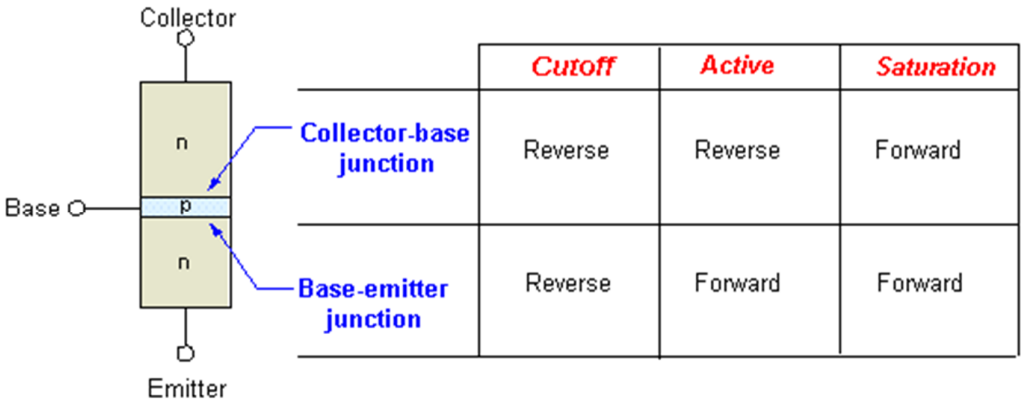
Barkhausen's criterion is a necessary condition for oscillation: **(3 Marks)**

It states that if A is the gain of the amplifying element in the circuit and $\beta(j\omega)$ is the transfer function of the feedback path, so βA is the loop gain around the feedback loop of the circuit, the circuit will sustain steady-state oscillations only at frequencies for which:

1. The loop gain is equal to unity in absolute magnitude, that is, $|\beta A| = 1$ and
2. The phase shift around the loop is zero or an integer multiple of 2π.

c) State condition for both junction to operate BJT in cut off state, Active state and saturation state.

Ans: **(4 Marks)**



	Cutoff	Active	Saturation
Collector-base junction	Reverse	Reverse	Forward
Base-emitter junction	Reverse	Forward	Forward

d) Name the type of rectifier for each of following feature : (i) Highest rectifier efficiency (ii) Highest form factor (iii) Two diode rectifier circuit (iv) PIV = 2Vm.

Ans: **(4 Marks)**

(i) Highest rectifier efficiency : Center tapped & Bridge full wave Rectifier

(ii) **Highest form factor** : Center tapped & Bridge full wave Rectifier

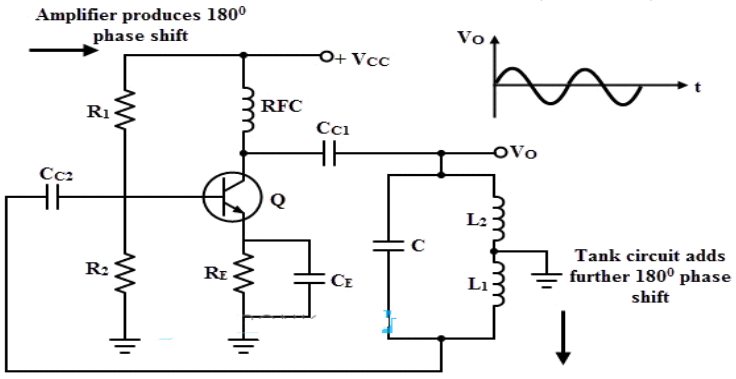
(iii) **Two diode rectifier circuit** : Center tapped full wave Rectifier

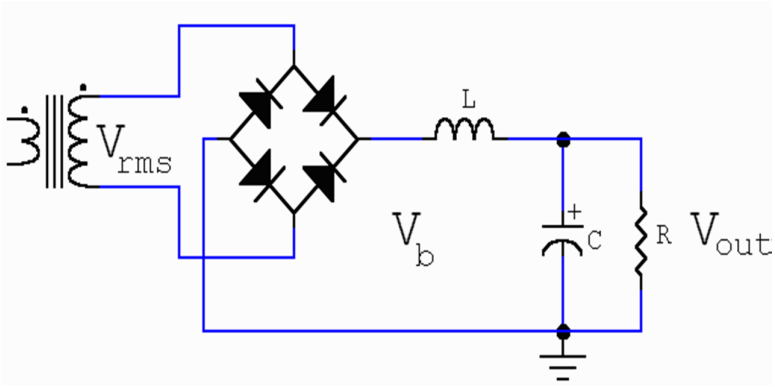
(iv) **PIV = 2Vm** : Center tapped full wave Rectifier

Q.4 A) Attempt any THREE of the following : 12 Marks

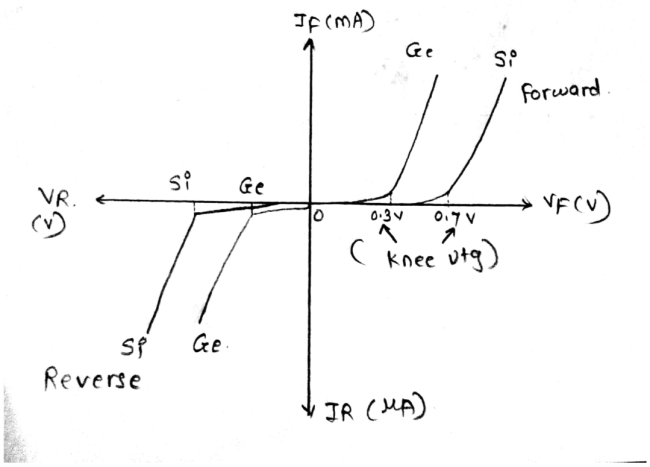
a) Sketch circuit diagram of Hartely oscillator. State expression for frequency of oscillation

Ans: **Circuit Diagram** **(3 Marks)**



	Expression for frequency of oscillation: **(1 Mark)** $$f = \frac{1}{2\pi\sqrt{L_T C}}$$ where: $L_T = L_1 + L_2 + 2M$
b)	**Sketch circuit diagram of bridge rectifier with LC filter. State function of each component.**
Ans:	**Circuit diagram :** **(2 Marks)**  **Components and its function: :** **(2 Marks)** 1. Transformer- An electrical device which transfers electrical energy from one electric circuit to other, without changing the frequency. The energy transfer takes place with change in voltage and current. 2. Rectifier- Convert AC into pulsating DC. 3. Inductor- Blocks AC components of rectified output and only pass DC components. 4. Capacitor- It bypasses AC components if any and gives DC to load.
c)	**In a common base configuration, the emitter current is 1 mA. If the emitter circuit is open, the collector current is 50 microA. Find total collector current. Assume a (Alpha) = 0.92.**
Ans:	**Given Data :** $I_{E=}$ 1mA I_{CBO}=50 µA, α= 0.92 Using Equation: **(4 Marks)** $I_C = \alpha I_E + I_{CBO}$ $I_C = (0.92 \times 1mA) + 0.05$ mA. I_C = 0.97 mA.

d)	**Sketch and label V-I characteristics of P-N junction diode. Write steps to calculate dynamic forward bias resistance.**
Ans:	**V-I characteristics of P-N junction diode :** **(2 Marks)**

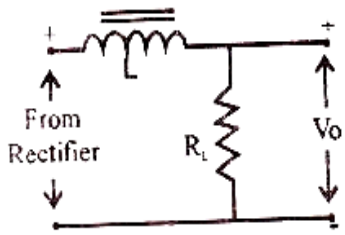


Dynamic forward bias resistance:- **(2 Marks)**

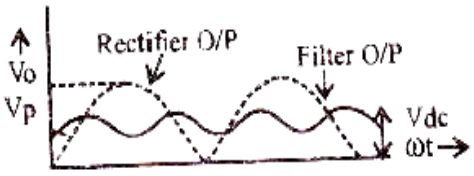
Dynamic resistance is defined as the ratio of change in voltage to the change in current. It is denoted as r_f.

$$rf = \frac{\text{Change in voltage}}{\text{Change in current}}$$

e)	**Explain operation of series inductor filter and find out its ripple factor.**
Ans:	**Circuit diagram of series inductor filter :** **(2 Marks)**



a) Inductor Filter



b) Waveforms

Operation of Series Inductor Filter : **(1 Mark)**

A high value of inductor is connected in series with load. Then the combination is connected across the rectifier. The Inductive reactance is directly proportional to

frequency. Therefore for AC contents inductor offers high opposition, and hence block the AC signals. For DC signal, freq.is zero .X_L=0.i.e.inductor acts as a short ckt. Thus all DC signals from rectifier are given to load.

Applying KVL to the series inductor ckt.

$V_0=V_R$ - I* X_L

For DC input F=0 and X_L=0.Therefore $V_0=V_R$. Thus DC components reach to load.

For AC input Freq.is high, X_L is high, I* X_L drop is high, therefore V_0 is small as compared to V_R.

Inductor opposes change in current through it. So, current waveform is made smooth.

This filter operates properly and effectively for higher values of currents. Hence increase in current reduces ripple factor.

Ripple Factor:- $RF = \frac{R}{3\sqrt{2}\omega L}$ **(1 Mark)**

Q.5 **Attempt any TWO of the following :** **12 Marks**

(a) **A transistor is connected in common emitter (CE) configuration with collector supply Vcc of 8V. Voltage drop across resistance RC connected in series with collector is 0.5 V. The value of RC is 800 ohm. If alpha (α) equal to 0.96, calculate : (i) Collector-emitter voltage (ii) Collector current (iii) Base current**

Ans: **Given data** :

Vcc = 8V Rc = 800 Ω α= 0.96 V_{RC} = 0.5 V.

By using Equations

(i) Collector-emitter voltage : **(2 Marks)**

$\mathbf{V_{CE} = V_{CC} - I_C R_C}$

$\mathbf{V_{CE}}$ **= 8 – 0.5 = 7.5 V**

(ii) Collector current : **(2 Marks)**

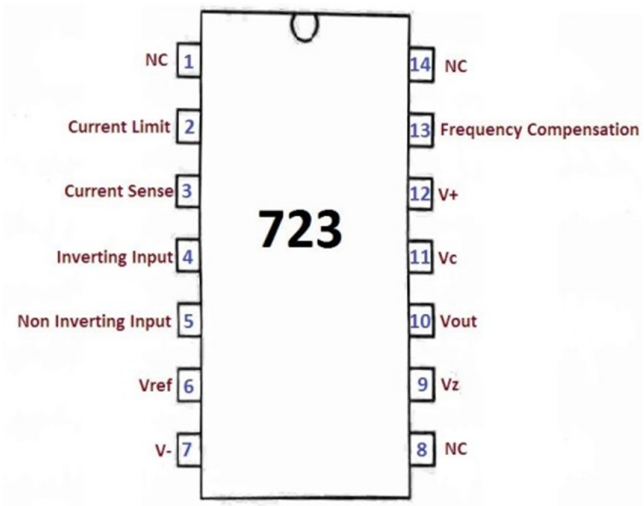
$$I_C = \frac{V_{CC} - V_{CE}}{R_C}$$

$$= 0.625\ mA$$

(iii) Base current : **(2 Marks)**

$$I_B = \frac{I_C(1-\alpha)}{\alpha}$$

= 26.04 µA

b)	**Sketch pin configuration of IC 723. State functions of each pin. Sketch circuit diagram for obtaining 6V output d.c. regulated voltage using IC 723.**
Ans:	**(Configuration : 2 Mark, Function : 2 Marks & Diagram : 2 Marks)** **1) Pin configuration of IC 723 :** **(2 Mark)**  **2) Functions of each pin**:- **(2 Marks)** **V+ and V-:** These are the supply voltage terminals of the IC. V+ is the positive terminal and V- is the negative terminal. **Non Inverting Input:** This is the non-inverting input of the error amplifier whose output is connected to the series pass transistor. Reference voltage or a portion of it is given to the non-inverting input. **Inverting Input:** This is the inverting input of the error amplifier whose output is connected to the series pass transistor. Usually output voltage or a portion of it is given to the inverting input. This makes the output voltage constant. **V_{ref}:** It is the reference voltage output of the IC. It is the output of voltage reference amplifier. Its output voltage is about 7.15V. **V_{out}** : It is the output terminal of the IC. Usually output voltage ranges from 2 to 37V. This pin can provide up to 150mA current. **Current Limit:** It is the base input of the current limiter transistor. This pin is used for current limiting or current fold back applications. **Current Sense:** This is the emitter of current limiting transistor. This terminal is used with current limiting and current fold-back applications.

Vc : This is the collector input of the series pass transistor. It is usually directly connected to the positive supply voltage if an external transistor is not used.

Freq. Comp: Frequency Compensation : This pin is used to connect a capacitor which bypasses high frequency noises. It is the output of error amplifier. The capacitor is connected between this pin and inverting input of the error amplifier. The prescribed value of this capacitor varies for different types of regulators.

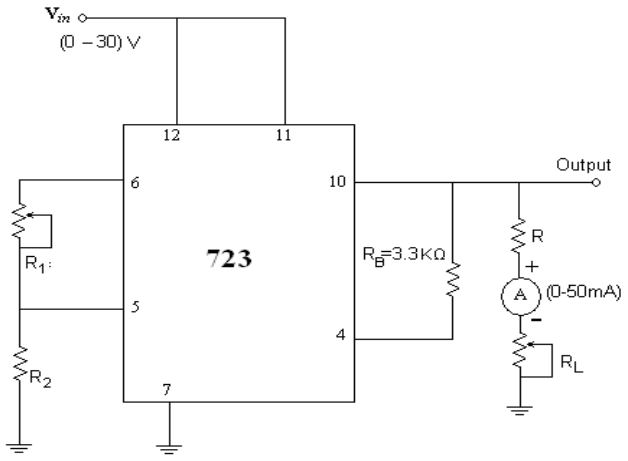
Current Sense: This is the emitter of current limiting transistor. This terminal is used with current limiting and current fold-back applications.

Vc: This is the collector input of the series pass transistor. It is usually directly connected to the positive supply voltage if an external transistor is not used.

Freq. Comp: Frequency Compensation: This pin is used to connect a capacitor which bypasses high frequency noises. It is the output of error amplifier. The capacitor is connected between this pin and inverting input of the error amplifier. The prescribed value of this capacitor varies for different types of regulators.

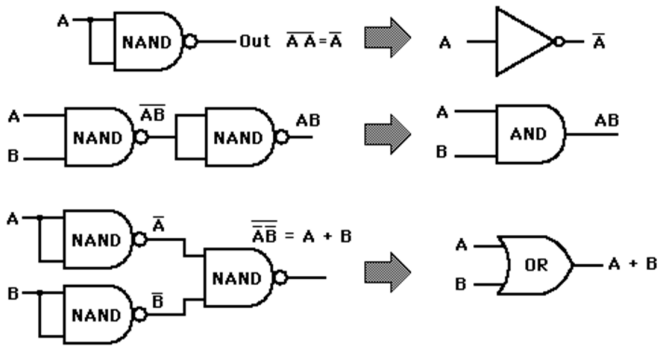
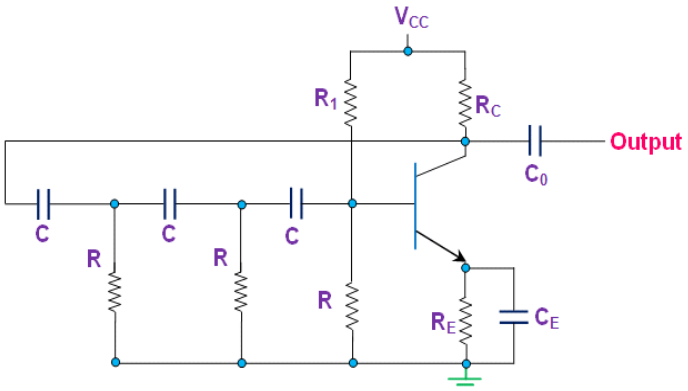
Vz: It is the anode of the zener diode whose cathode connected to the output terminal. It is usually used for making negative regulators.

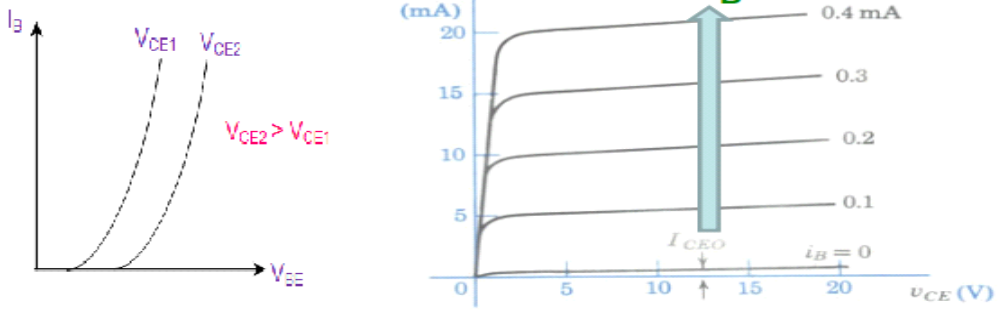
3) Circuit diagram for obtaining 6V output d.c. regulated voltage using IC 723 **(2 Marks)**



Expression $V_{out} = V_{ref} * (R_2 / R_1+R_2)$

Assume any value of R_2, R_1 can be calculated.

c)	**Implement the fundamental logic gates 'OR gate', 'AND gate', 'NOT gate' using only NAND gates.**
Ans:	**Fundamental logic gates 'OR gate', 'AND gate', 'NOT gate' using only NAND gates:** **(6 Marks)** 
Q.6	**Attempt any TWO of the following : 12 Marks**
a)	**Sketch circuit diagram of RC phase shift oscillator. If value of capacitor C = C_1 = C_2 = C_3 = 5 pF and frequency of oscillation is 800 Hz, calculate value of resistor R, (R = R_1 = R_2 = R_3).**
Ans:	**Circuit diagram of RC phase shift oscillator** **(3 Marks)**  or equivalent circuits **Given data :** fo= 800 Hz and C = 5 pF Using Expression for frequency of oscillation $$f_o = \frac{1}{2\pi(\sqrt{6})CR}$$ **(1 Marks)**

	Putting values in above equation **R = 16.24 MΩ** **(2 Marks)**
b)	**For common emitter configuration sketch input Characteristics for two different values of V_{CE} and output characteristics for two different values of I_B. Write formula for input resistance and output resistance.**
Ans:	**(Input characteristics 2 Marks & Output characteristics 2 Marks)** **Input characteristics** **Output characteristics**  $r_i = \frac{\Delta V_{BE}}{\Delta I_B}$ **…..for V_{CE} = constant** **(1 Mark)** $r_o = \frac{\Delta V_{CE}}{\Delta I_C}$ **…..for I_B = constant** **(1 Mark)**
c)	**Perform following number system conversion :** **(i) $(589)_{10}$ = ( )$_2$** **(ii) $(101101)_2$ = ( )$_{16}$** **(iii) $(413)_8$ = ( )$_2$** **(iv) $(5AF)_{16}$ = ( )$_{10}$** **(v) $(AC8)_{16}$ = ( )$_2$** **(vi) $(106)_8$ = ( )$_{10}$**
Ans:	**(1 Mark for each)** **(i) $(589)_{10}$ = (1001001101)$_2$** **(ii) $(101101)_2$ = (2D)$_{16}$** **(iii) $(413)_8$ = (100001011)$_2$** **(iv) $(5AF)_{16}$ = (1455)$_{10}$** **(v) $(AC8)_{16}$ = (101011001000)$_2$** **(vi) $(106)_8$ = (70)$_{10}$**

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