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Internal Assessment Test 1 – Sept. 2019

Sub:	POWER ELECTRONICS				Sub Code:	15EC 73	Branch:	ECE	
Date:	07-09-2019	Duration:	90 min's	Max Marks: 50	Sem/Sec:	VII C &D			OBE

Answer any FIVE FULL Questions

		MARKS	CO	RBT
1	Give the characteristics features of following devices with symbols **i) IGBT ii)** TRAIC **iii)** MOSFET **iv)** MCT **v)** LASCR	[10]	CO1	L1
2	Explain the various methods to turn ON an SCR.	[10]	CO4	L2
3	Explain control characteristics of SCR, BJT, MCT and GTO.	[10]	CO1	L1
4	Mention and explain the different types of power electronic converter systems.	[10]	CO1	L1
5	a) Define power electronics and mention its different applications. b) Explain gate characteristics of SCR.	[05+05]	CO1	L1
6	Using the two transistor model,explain how a small gate current can turn on an SCR.	[10]	CO1	L1

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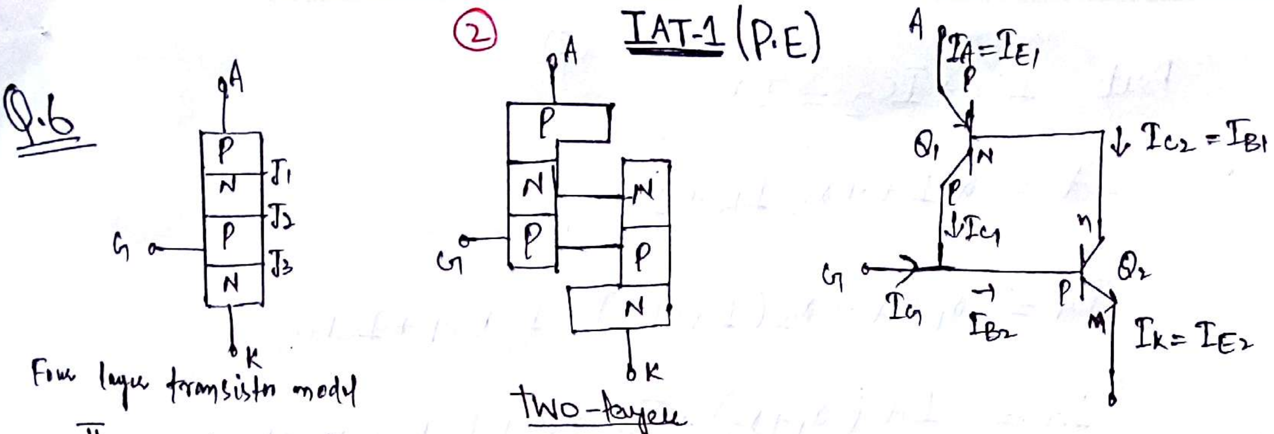
② IAT-1 (P.E)

Q.6



The operation of a thyristor can be explained with the help of two transistor model as shown in fig ⓑ. The middle two layers are splitted into two seperate parts because of this the two transistors are found.

Transistor Q1 is PNP and Q2 is NPN.
These transistors are in CB configuration

In general relationship between collector current, Emitter current, leakage current.

$$I_C = \alpha I_E + I_{CBO}$$ → Leakage current.

where $\alpha = \frac{I_C}{I_E}$

For transistor Q1

$$I_{C1} = \alpha_1 I_A + I_{CBO1} \quad -①$$

↳ CB current gain

Similarly for Q2

$$I_{C2} = \alpha_2 I_K + I_{CBO2} \quad -②$$

Adding ① and ② we get

$$I_{C1} + I_{C2} = \alpha_1 I_A + \alpha_2 I_K + I_{CBO1} + I_{CBO2}$$

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But $I_{C1} + I_{C2} = I_A$

$\therefore$ $I_A = \alpha_1 I_A + \alpha_2 I_K + I_{CBO1} B_{O2}$

$I_A = \alpha_1 I_A + \alpha_2 (I_A + I_G) + I_{CBO1} + I_{CBO2}$

$I_A = I_A(\alpha_1 + \alpha_2) + I_G \alpha_2 + I_{CBO1} + I_{CBO2}.$

$I_A (1 - (\alpha_1 + \alpha_2)) = I_G \alpha_2 + I_{CBO1} + I_{CBO2}$

$$I_A = \frac{\alpha_2 I_G + I_{CBO1} + I_{CBO2}}{1 - (\alpha_1 + \alpha_2)}$$

$(\alpha_1 + \alpha_2 = 1)$ $\quad$ $I_A \to \infty$

Q5

a) Power electronics is a technology associated with efficient conversion and control of electrical power or energy using semi-conductor devices.

Applications of Power Electronics

(i) Home appliances:→ Refrigerators, washing machines, fans etc.

(ii) Games and Entertainment:→ Toys, TV and Projectors etc.

(iii) Commercial:→ Advertising, battery chargers, computers, photo copiers etc.

(iv) Automotive:→ Alarms & security system, electrical vehicle etc.

(v) Medical:→ Laser power supplies, Medical instrumentation etc.

Q.5

b)

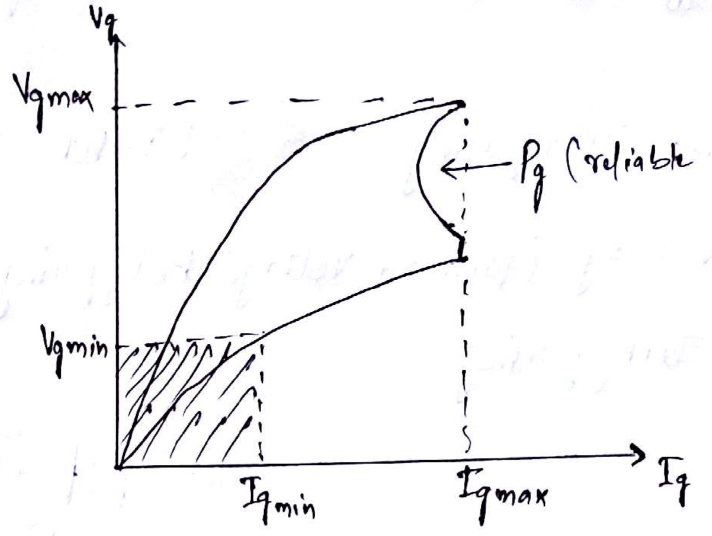


Fig. shows the gate characteristics of a Thyristor (SCR)

Here +ve gate to cathode voltage (Vg) and +ve gate to current (Ig) represents dc values.

For a particular characteristics it has been spread b/w two curves i.e 1 and 2.

This spread is due to difference in low doping levels of P and N layers.

Curve 1 represents lowest voltage values and curve 2 represents the highest possible voltages.

Vg(min) and Ig(min) are the minimum gate voltage and gate current below which the thyristor region is in off condition.

Vg(max) and Ig(max) are the max. gate voltage and gate current without damaging the SCR.

Pg is the constant gate power.

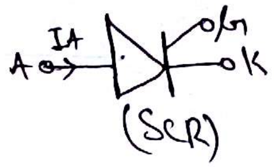
For reliable turn ON the Ig and Vg should be in the shaded area.

Q2 The different turn ON- Methods of an SCR are as:→

① High temp. triggering ② Light triggering.

③ High voltage (forward voltage) triggering ④ dv/dt triggering

⑤ Gate triggering.



High temp. triggering :→ If the temp. of the thyristor is high, there is an increase in the no. of electron hole pair that increases leakage current.

The increase in current causes α_1 and α_2 to increase so $(\alpha_1+\alpha_2)$ may tend to unity & thyristor may be turned ON.

Light triggering :→ If light is allowed to strike, the gate to cathode junction of the thyristor, the electron hole pair increases and causes the SCR to turn ON.

High Voltage :→ If the forward anode-to-cathode voltage is greater than forward breakdown voltage i.e $V_{AK} > V_{BO}$, sufficient leakage current flows and causes the SCR to turn ON.

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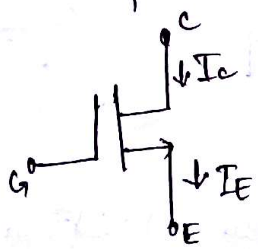
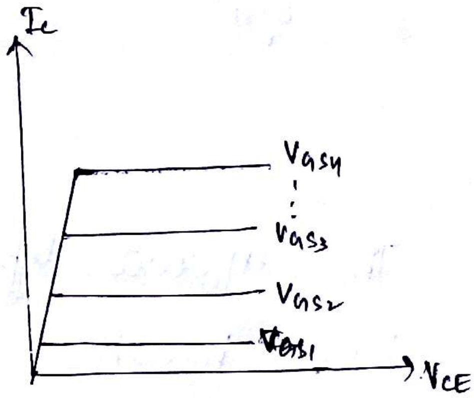
$\frac{dv}{dt}$ triggering :- If the rate of rise of anode-cathode voltage is high, the charging current of the capacitive junction may be sufficient enough to turn ON the SCR.

Gate triggering :- If a thyristor is in forward bias. By applying gate pulse b/w gate to cathode, will cause the SCR to turn ON.

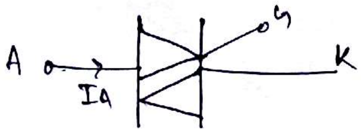
Q1 (i) IGBT

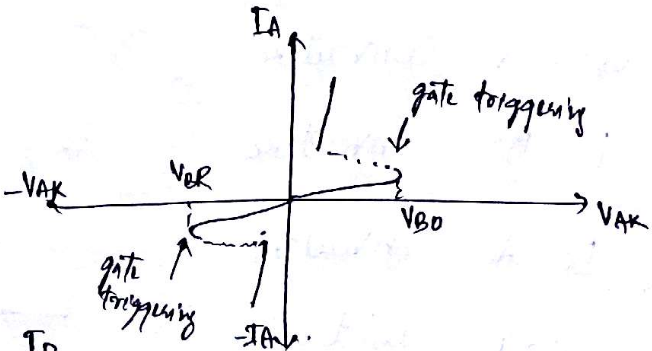
Symbol ~~input~~ Characteristics



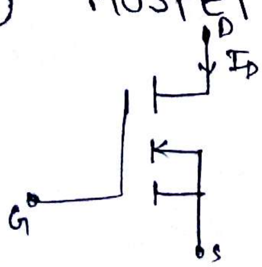


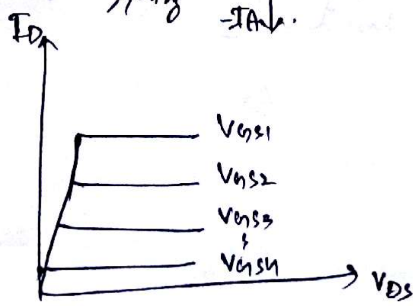
(ii) TRAIC



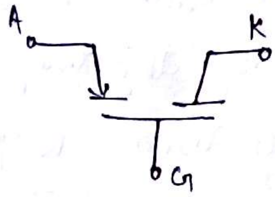


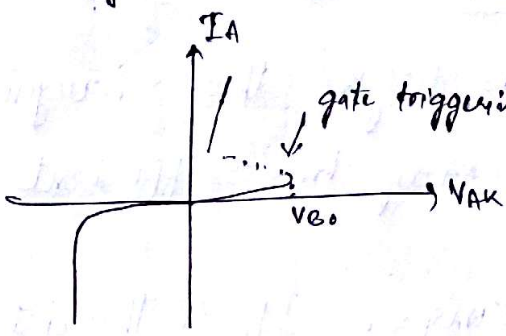
(iii) MOSFET



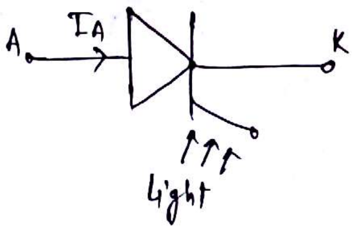


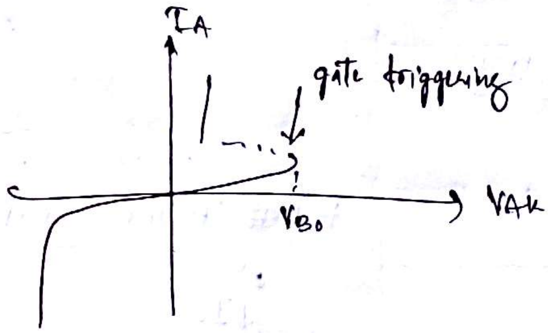
(iv) MCT → Mos Controlled Thyristor





(v) LASCR → Light Activated Silicon Controlled Rectifier:

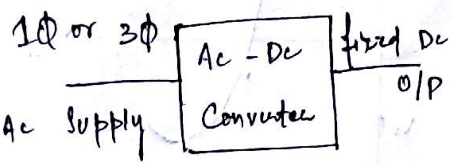


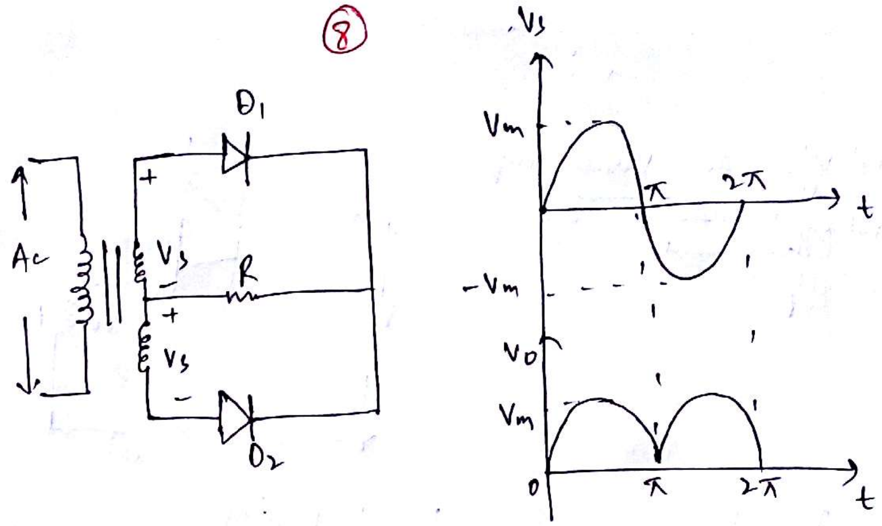


Q4. The different types of Power Electronics Converter are:-

1. Diode Rectifier
2. Ac-Dc Converter
3. Ac-Ac Converter
4. Dc-Dc Converter
5. Dc-Ac Converter
6. Static switches

(a) Diode Rectifier

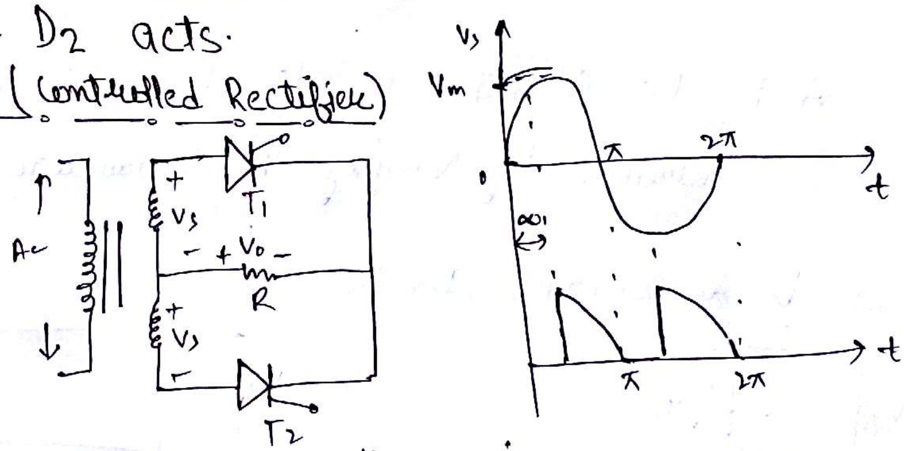




A diode Rectifier Circuit converts Ac Voltage into fixed Dc Voltage as shown in fig. The input voltage to the rectifier Vi could be either single phase or 3 phase.

During +ve half cycle, Diode D_1 acts while in -ve half cycle Diode D_2 acts.

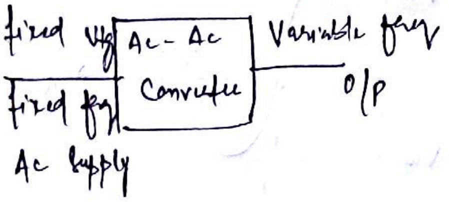
(b) Ac-Dc Convertor (Controlled Rectifier)

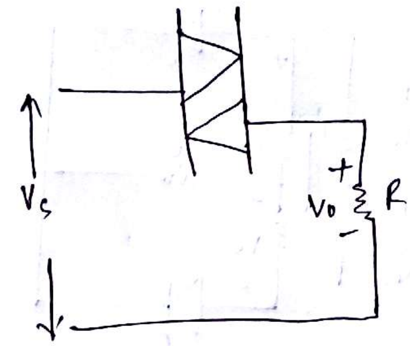


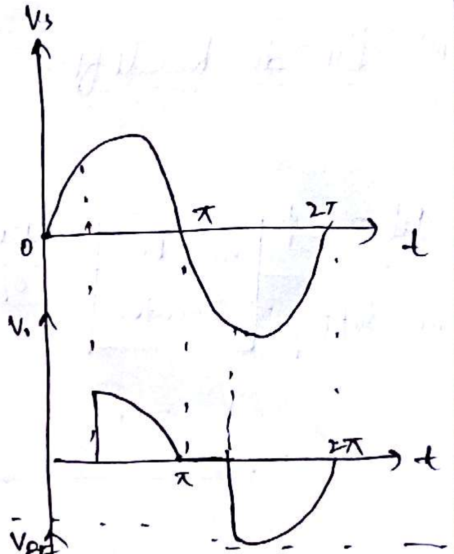
Input voltage is available from the main source, O/P of the convertor is variable dc O/P. Controlled rectifier mainly uses SCR's. The average value of the o/p voltage can be controlled by varying the firing angle 'α'.

(c) Ac-Ac Convertor (AC Voltage Controller)

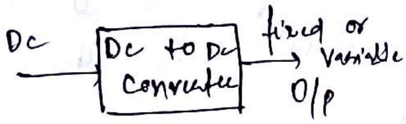
The input Voltage to the Convertor is 1Φ or 3Φ fixed Ac Voltage. O/P is an variable ac voltage

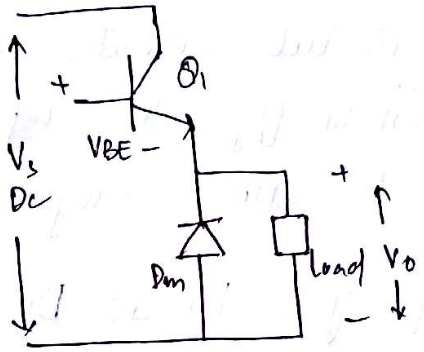


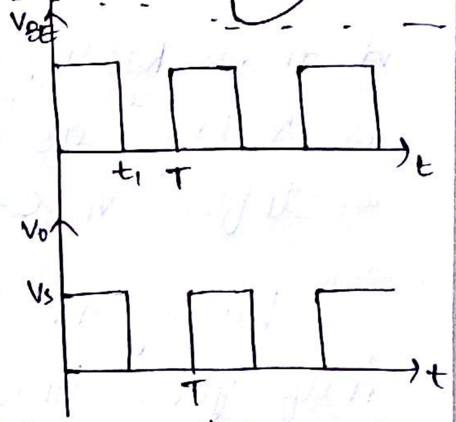




(d) DC – DC Convertor [DC Choppers]

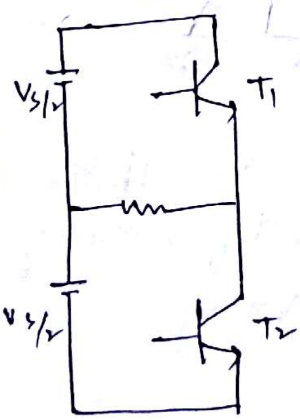


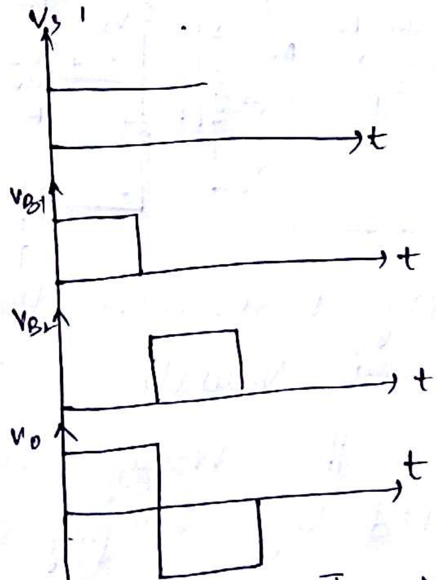




A DC-DC Convertor is also known as a Chopper. The avg. o/p is controlled by varying the conduction time 't1' of transistor Q1.

(e) DC-AC Convertors [Inverters]



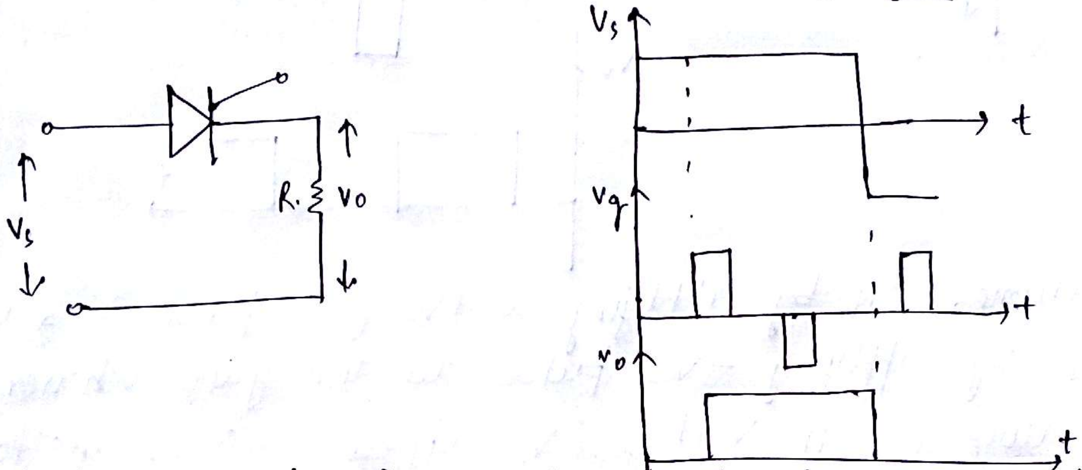


A DC-AC Convertor is also known as an Inverter. I/P to the inverter is fixed DC vtg. Usually obtained from battery. Inverters are used whenever mains are not available.

(f) Static switches :- Since the power devices can be used as static switches. The supply to these switches could be either AC or DC and the switches are called as AC static switches or DC static switches.

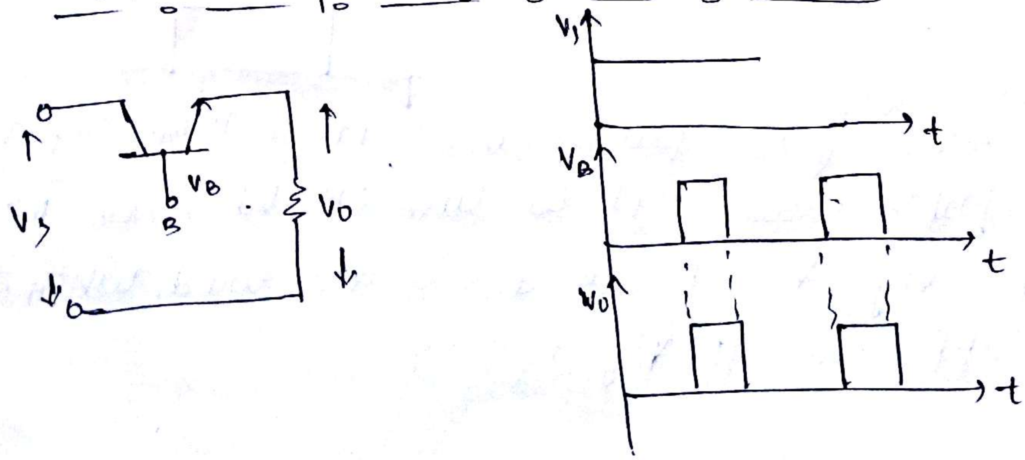
Q.3

1) SCR :- Silicon Controlled Rectifier



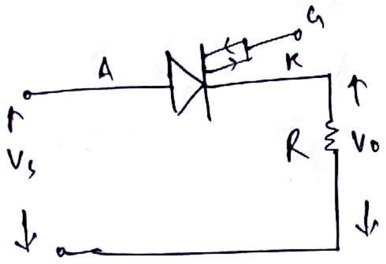
A thyristor (SCR) can be made to conduct by applying +ve pulse to gate, when it's anode voltage is more than it's cathode voltage. Once a thyristor starts conducting, it behaves like a closed switch and it becomes insensitive to gate signal. The thyristor can be turned off by applying a reverse bias vtg i.e $V_{AK} \leq 0$

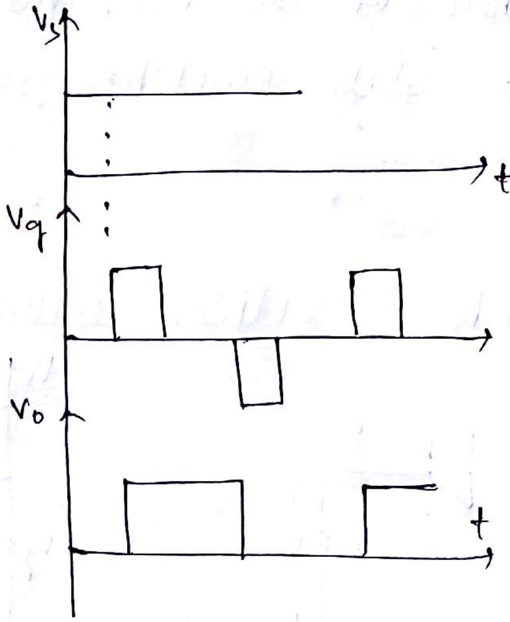
11) BJT :- Bipolar Junction transistor



Power transistor can be turned on by applying a signal to it's base and as soon as the base current is removed, BJT is turned off.

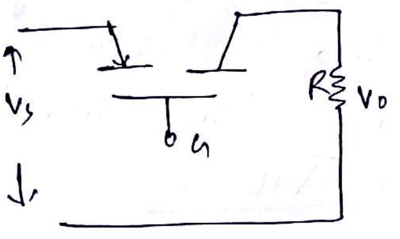
iii) GTO :→ Gate Turn off

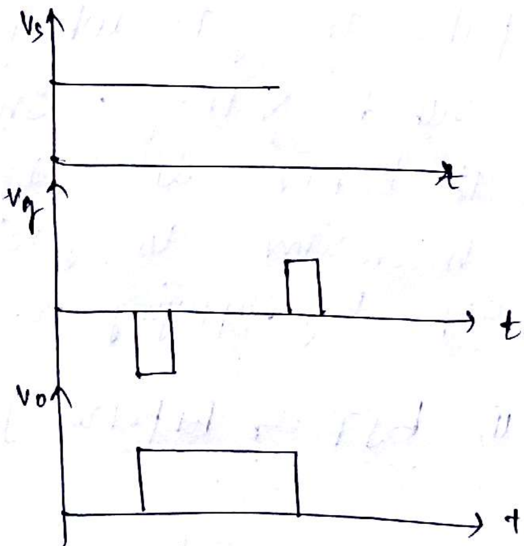




GTO is turned ON by applying a +ve gate pulse and is turned OFF by applying -ve pulse to the gate. Whenever GTO is turned ON voltage Vs appears across the load, when the device is off, O/P vtg is zero.

(iv) MCT :→ Mos Controlled thyristor:





In MCT, a +ve gate pulse causes it to turn OFF and a -ve gate pulse causes it to turn ON. Whenever MCT is turned, the vtg Vs appears across the load, when the device is OFF, the O/P vtg is zero.