Q.2 a. Why high frequency signals are not rectified by ordinary diodes but are rectified by Schottky diodes ?

b. What are the reverse current carriers? Why is the reverse current in a silicon diode much smaller in comparable to germanium diode?

Answer:

Q: No. (a) when a schottky diode is fosward biased free electrons on- n-side gain enough energy to travel to larger orbit. Because of this, the free electrons just cross the junction and enter the metal producing a large fosward current. Since metal has no holes, there is no charge storage around the junction and the reverse recovery time is zero hence the schottky diode is switched off at once when it is reverse biased. Because of this fact schottky diode can easily reactify signals of frequency above 300 MHz without distortion.

(b) when pn junction is reverse biased, the junction capacitance become very high and practically no current flows through the circuit. However in actual practice a very small current flows in the circuit (appx 1μA) This current is called reverse current. which is due to minority carriers.

After the knee voltage (ie. potential barrier of the junction 0.3V for GE and 0.7V for Si diode) the foswaed current rises abruptly. At reverse bias, the reverse current increases slightly with the increase in voltage because of minority carriers for Si diode the maximum value of reverse current is as low as 1μA However for GE diode the max. value of reverse current is about 100 μA.

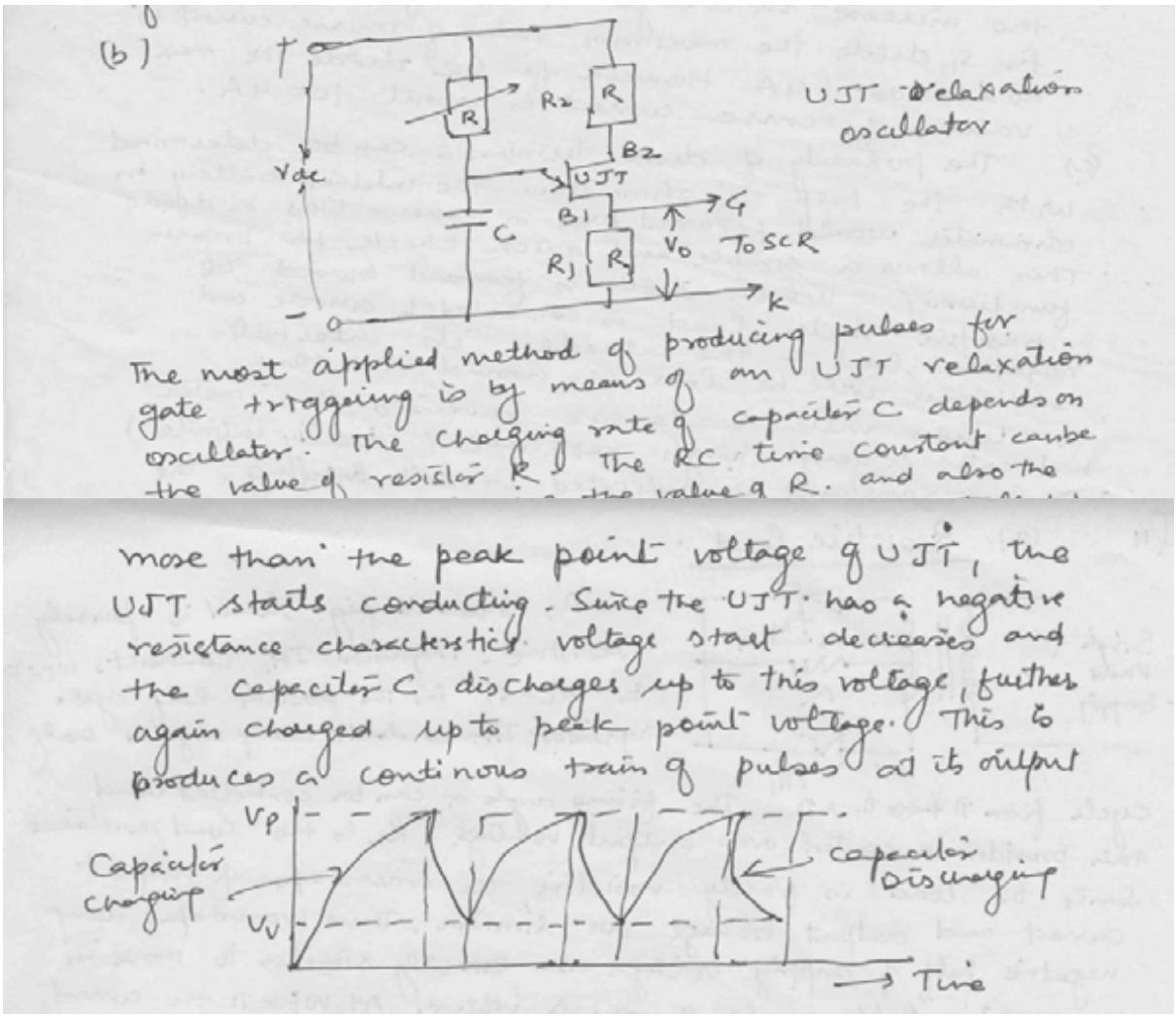
terminals can be determined

c. Explain briefly how power loss occurs in transistor switch with the help of circuit diagram.

Answer: Page Number 8 from Text Book

Q.3 a. Explain operation of UJT as a relaxation oscillator.

Answer:



b. Draw and explain V-I characteristic of a power MOSFET.

Answer: Page Number 53, 54 from Text Book

Q.4 a. Why is pulse triggering generally preferred for thyristors?

b. Explain the difference between holding current and latching current of a thyristor.

c. A dc supply of 100V feeds an inductance of 10H through a thyristors. Find the minimum width of the gate pulse so that the thyristors is triggered. It is given that the latching current of thyristor is 80 mA.

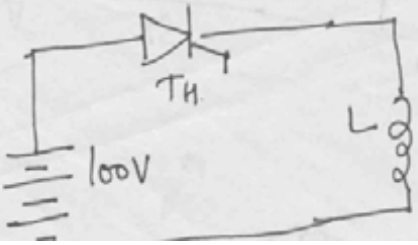
Answer:

Q: 3 (a) A power electronics circuit has a number of thyristors connected in series and parallel. They have to switched on at proper instant in certain sequence. This can be done by a train of high frequency pulses applied at proper instants through a logic circuit A pulse transformer is used for isolation. b In this method gate losses are very low because the drive is discontinous.

(b) (i) holding current(I_h) It is the maximum anode current at which the thyristor can continue conducting. If anode current becomes less than holding current thyristor is turned off. This current is in mA range.

(ii) Latching current(I_L) When a gate current is applied to a thyristor, the anode current starts increasing. Latching current is the minimum anode current to keep the thyristor in conducting state after the gate pulse is removed. This current is about two to three times holding current.

(c)



As per ckt

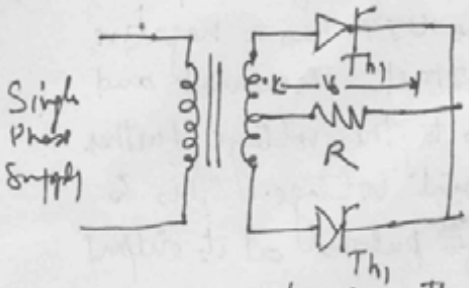
$100 = L\frac{di}{dt}$

$i = \frac{100}{L}t = 10t$

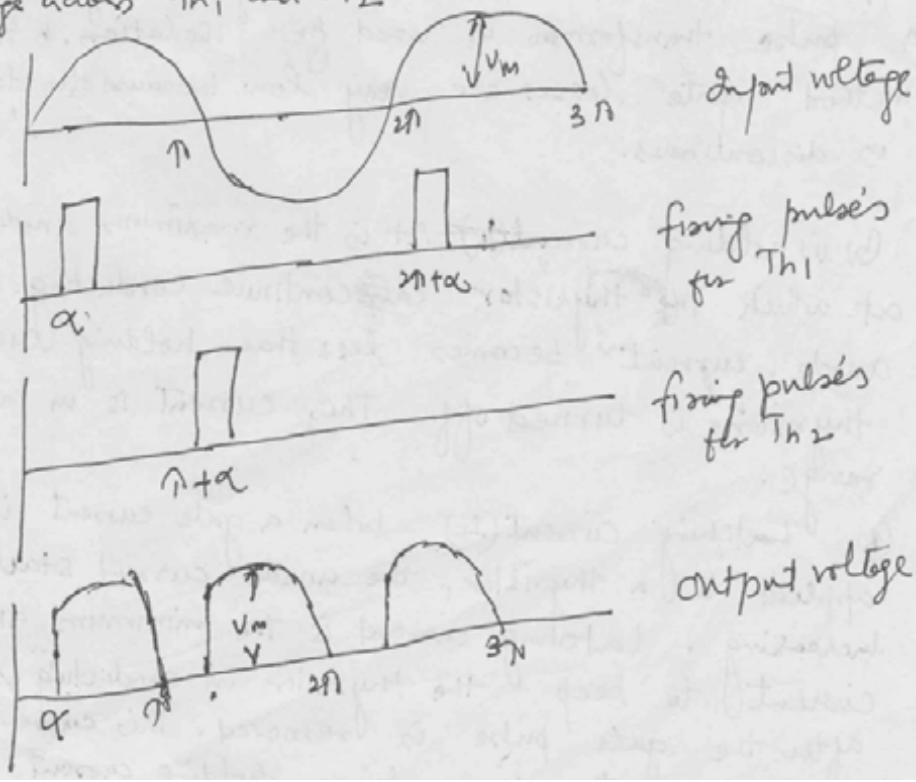
Q.5 a. Explain the working of single phase full wave controlled rectifier with purely resistive load, using a centre tapped transformer feeding. Draw the voltage and current waveforms.

Answer:

Q.N (a) Resistive load :

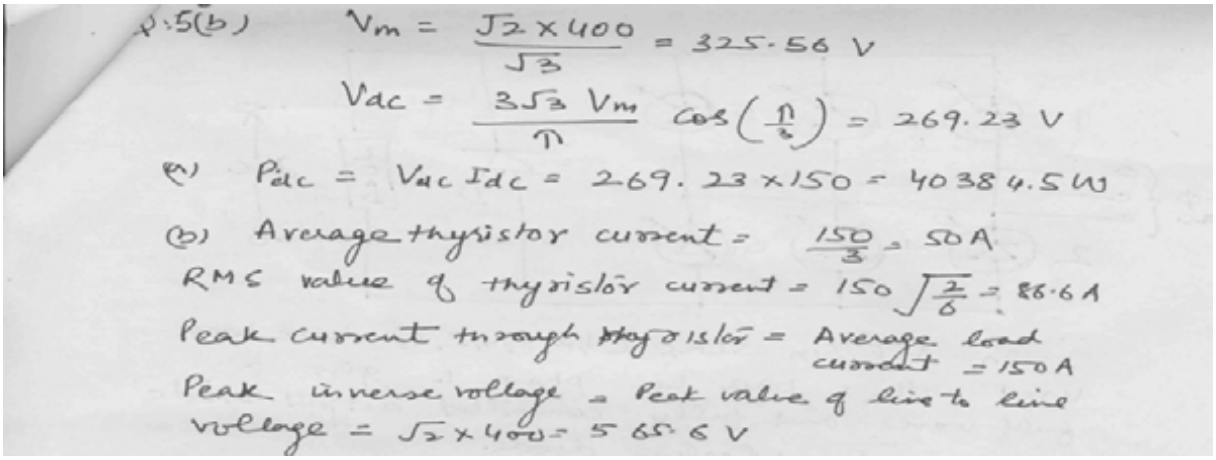


As shown in fig load is purely resistive. Thyristor Th_1 conducts $\omega t = 0$ to $\omega t = \pi$ in the positive half cycles thyristor Th_2 conducts during negative half cycle from $\pi + \alpha$ to 2π. The firing angle α can be controlled and this provides a control over output voltage. R_L is the load resistance Since the load is purely resistive the waveshapes of output current and output voltage are similar. These waveshapes during negative half of supply voltage are exactly similar to those in the positive half cycle of supply voltage. At $\omega t = \pi$ the current through Th_1 becomes zero. Immediately thereafter the supply voltage reverses and reverse voltage applied Th_1. Therefore thyristor Th_1 is turned off by natural commutation. Similarly Th_2 is turned off by natural commutation at $\omega t = 2\pi$ The waveshapes of input voltage firing pulses, output voltage and voltage across Th_1 and Th_2



b. A three phase full converter is fed by 400V 3phase 50 Hz supply. The average load current is 100 A and load is highly inductive. If the firing angle is $60^{0.}$ Find (i) output power P_{dc} (ii) average, rms and peak current through thyristors and (iii) peak inverse voltage.

Answer:



Q.6 a. Draw the circuit of three phase half-wave controlled rectifier with an inductive load and a Freewheeling diode. Explain its working.

Answer: Page Number 229-230 from Text Book

b. A three-phase half-wave controlled rectifier is connected to a 220V source. If the delay angle is 45^{o} and the load resistance R = 10Ω find
   (i) the average output voltage
   (ii) the average output current
   (iii) the average SCR current
   (iv) the SCR RMS current

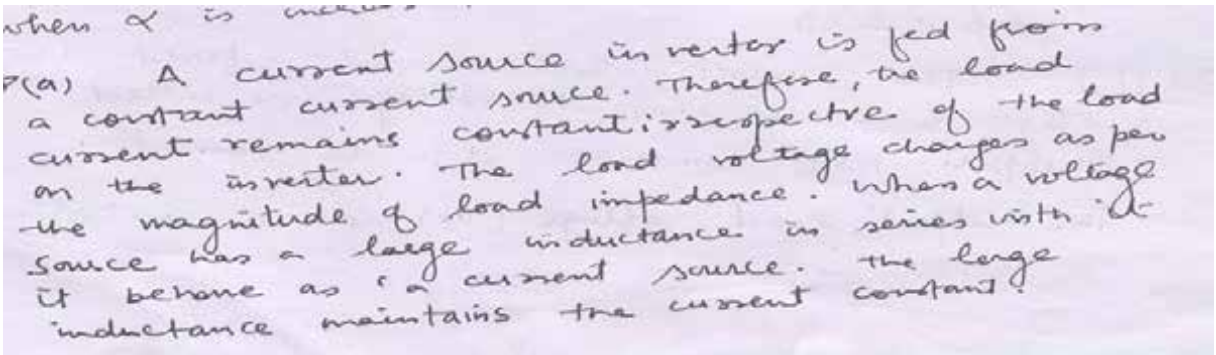
Answer: Page Number 229 from Text Book

Q.7 a. Why should a current source inverter have a large inductance in series with the Source?

b. A series inverter circuit has an inductor of 10 mH, a capacitor of 47 μF connected in series with load resistance of 5 Ω. Calculate (i) the resonance frequency and (ii) the time period of oscillation.

c. Explain the working of Half bridge voltage source Inverter.

Answer:



(b) $L = 10mH \quad C = 47\mu F \quad R = 5\Omega$

Resonance frequency is given by

$$f_T = \sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}} = \sqrt{\frac{1}{10\times10\times47\times10^{-6}} - \frac{(5)^2}{4(10\times10^{-3})^2}}$$

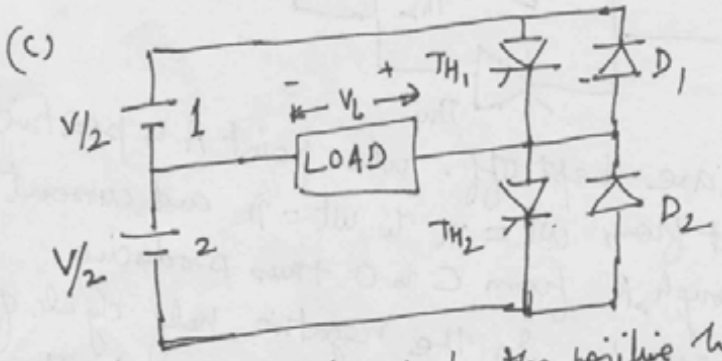
$$= \sqrt{2.1\times10^6 - 0.063\times10^5} = \sqrt{2.037\times10^6}$$

$$f_T = \sqrt{203.7\times10^4} = 14.27\times10^2 = 1427\,Hz$$

Time period of oscillations $= \left(\frac{\pi}{f_1}\right) = \left(\frac{3.14}{1427}\right)$ sec.

$= 2.2\times10^{-3}$ Sec. $= 2.2$ m sec.

(c)



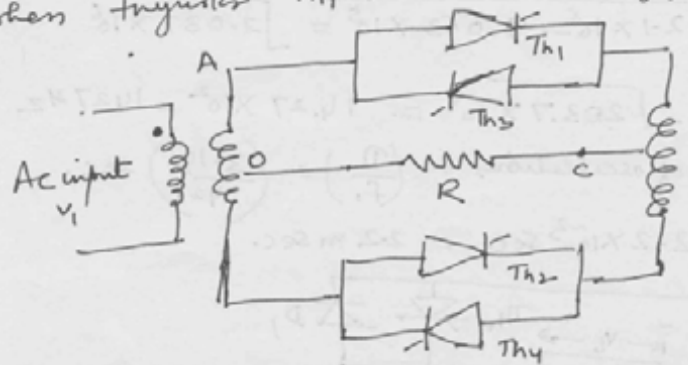
Thyristor T_{H_1} is triggered for the positive half cycle of output. The load is supplied by battery 1. The current flows through the load from positive to negative terminal and get positive half of output waves. The conduct for the period of $0 < t < \frac{T}{2}$ and the output voltage is $+\frac{V}{2}$ At $t = \frac{T}{2}$, Thyristor T_{H_1} is turned off and T_{H_2} is turned ON. for the duration $\frac{T}{2} < t < T$ thyristor T_{H_2} conducts and battery 2 supplies the load. and get negative half of output wave. The output voltage waveform is rectangular. The gate pulses for T_{H_1} and T_{H_2} is shown in fig. Diode D_1 and D_2 provide freewheeling operation and ductive or capacitive. for pure

Q.8 a. Explain the operation of a single phase cycloconverter with the help of input output voltage waveforms.

b. Explain the operation of static AC switch and list out its uses in power electronics.

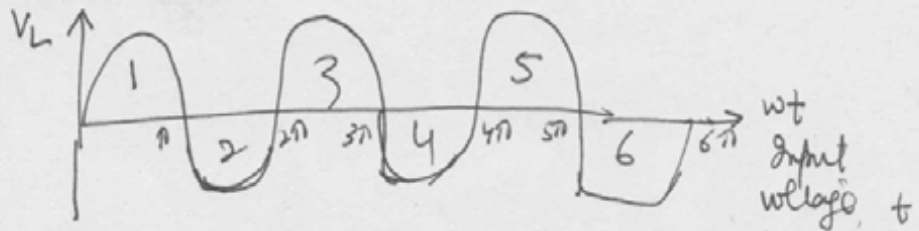
Answer:

Q1. In Single phase cycloconverter thyristors Th_1 and Th_2 from the positive group and produce positive half wave of the circuit output. Thyristors Th_3, Th_4 form the negative group and produce negative half wave of the output when thyristors Th_1 and Th_2 be triggered at $\angle\alpha$ while

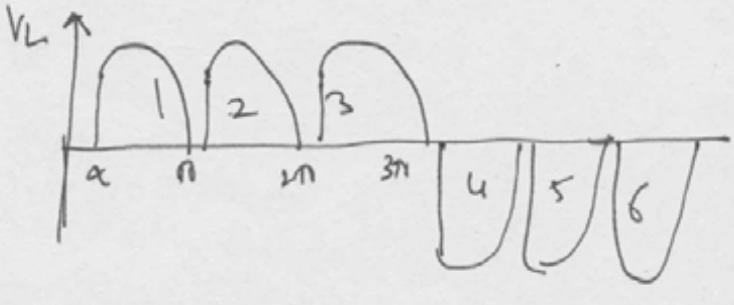


while Th_3, Th_4 are kept off. when point A is positive Th_1 will conduct from $\omega t = \alpha$ to $\omega t = \pi$ and current will flow through R from C to O thus producing positive half wave 1. In the negative half cycle of input when B is positive (with respect to O). Th_2 will conduct from $(\pi+\alpha)$ to 2π and current will flow through R again from C to O. In the next positive half cycle Th_1 will conduct from $(2\pi+\alpha)$ to 3π and current will again flow from C to O These three half waves will constitute the positive part of the output wave

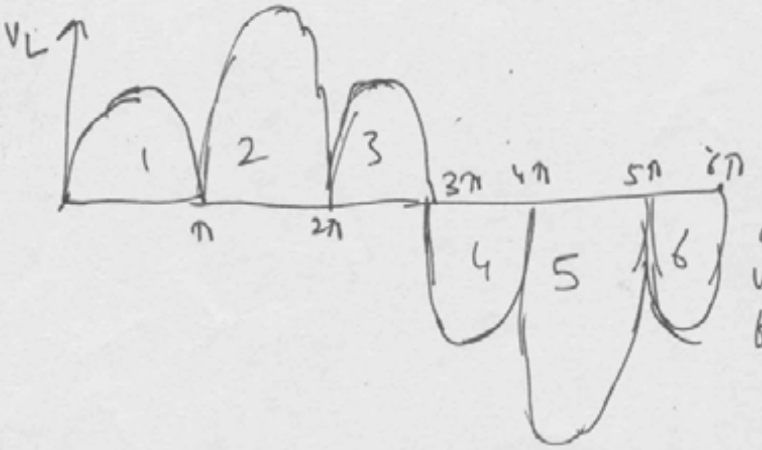
Then thyristors Th_3 and Th_4 are gated Th_1, Th_2 will turn off due to natural commutation In the fourth half wave O is positive and Th_3 will conduct causing current through R from O to C. In the fifth half wave O is positive and Th_4 will conduct causing current through R again from O to C In the sixth half wave O is positive and Th_3 will conduct causing current through R again from O to C This complete one cycle of output wave. The above repeated in subsequent cycle.



Input voltage & frequency

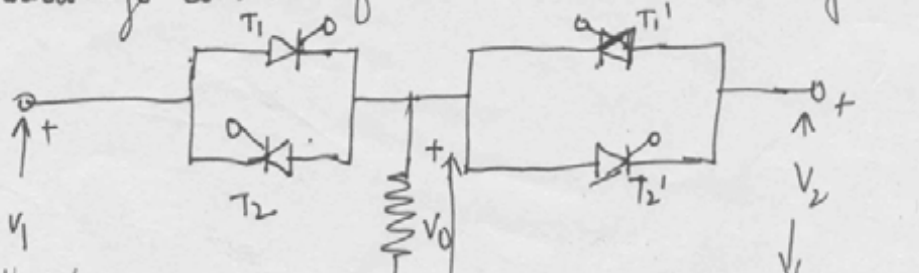


output voltage frequency $f/3$



Improved output waveform frequency $f/3$

Q The Static switches can be used for bus transfer from one source to another, it is sometimes required to switch the load from the normal source to an alternative source in case of (1) unavailability of normal source and (2) undervoltage condition of normal source. when thyristor T_1



Q.9 a. Draw the circuit of step-down chopper. Explain its operation for the ON state and OFF state. List out the industrial application of DC choppers.

Answer: Page Number 273-274 from Text Book

b. A DC buck chopper operates at a frequency of 1KHZ from a 100V DC source supplying a 10Ω resistive load. The inductive component of the load is 50 mH. If the average output voltage is 50V, find
(ii) the ON Period (T_{ON})
(iii) the RMS value of the load voltage and
(iv) the average value of the load current

Answer: Page Number 279 from Text Book

Text Book

Power Electronics for Technology, First Impression (2006), Ashfaq Ahmed, Purdue University - Calumet, Pearson Education.