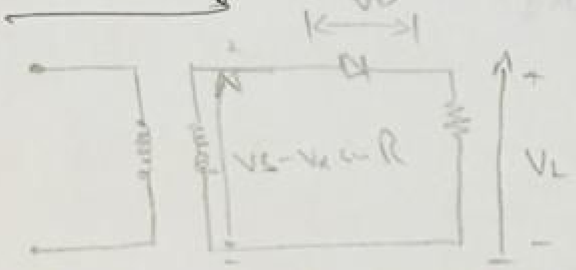
Q 1 Rectifier:

It is the eletronic devices which is used to Convert AC into DC is Called Rectifier. -

① 1-Φ uncontrolled Half wave Rectifier.

A rectifer is a circuit that convert an ac signal in to unidirectional signal Diodes are used Commonly is rectifier A single phase halfwave rectifier is the simplest types is not normally used in industrial Applications However It is useful in under standing the principle of rectifier operation.

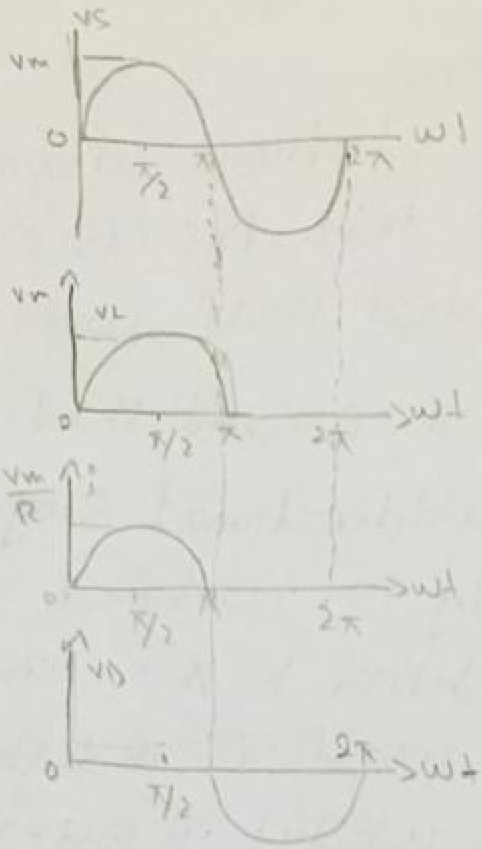
Circuit Diagram



During positive half cycle the input voltage diode D1 is forward base and conducts and input voltage appear across the load

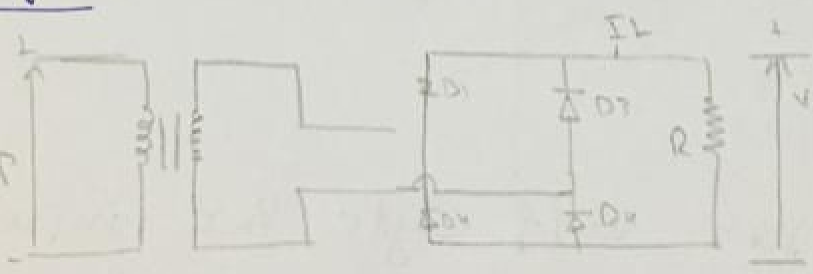
During negative half cycle of the input ~~voltage~~ voltage the diode in ~~bad~~ blocking condin and output voltage is zero

Wavform

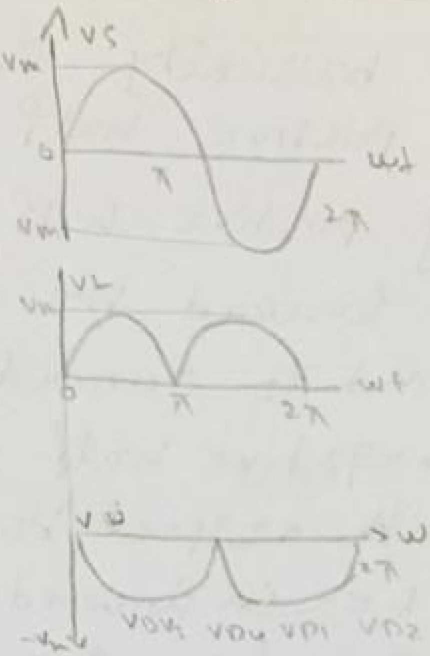


1- (i) uncontrolled full wave bridge Rectifier
we use four diodes in bridge Rectifier circuit.

Diagram



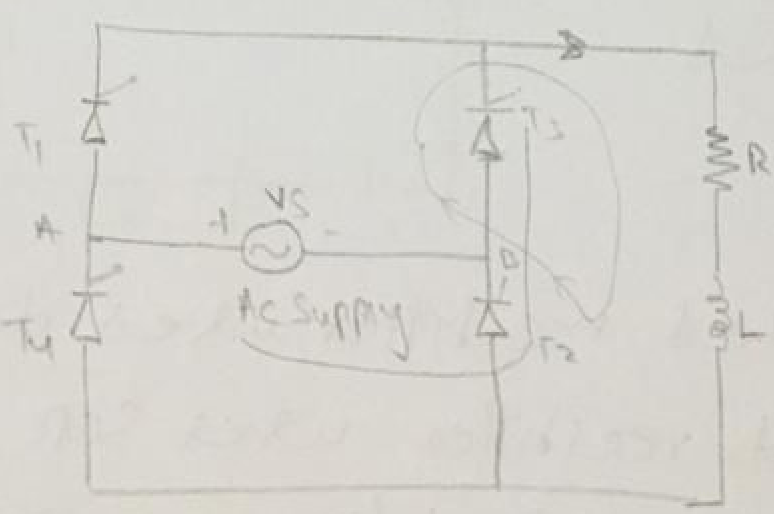
During positive half cycle of the input voltage the current flows through the load through diods D1 and D2 During negative cycle Diodes D3 and D4 conduct the peak inverse voltage of a diode is vm.



Similarities and differences
Both uses diode
- During positive half cycle both conduct
- During negative half cycle bridge Rectifier conduct & not conduct the half wave Rectifie

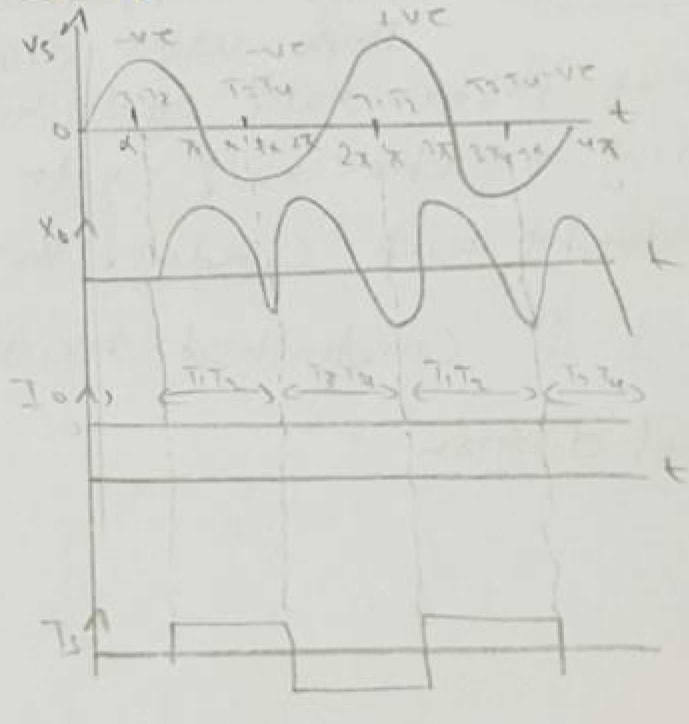
2 - 1-Φ controlled bridge rectifier

Circuit diagram



Its function is basically subdivided in to two parts positive half and negative half cycle. During positive half cycle T1 and T2 will become forward bias. If we give gate pulse T1 and T2 currents will flow in the loop. During negative half cycle Terminal A is negative with respect to Terminal B. T3 and T4 will be in forward bias. If we give gate pulse to T3 and T4 current will flow in another loop.

Graph



Similarities and difference

- Uncontrolled rectifier uses diodes
- Controlled rectifier uses SCR
- In controlled Rectifier we control the output by using the gate pulse.

When we give gate pulse than it trigger otherwise not.

Q = 02

Solution

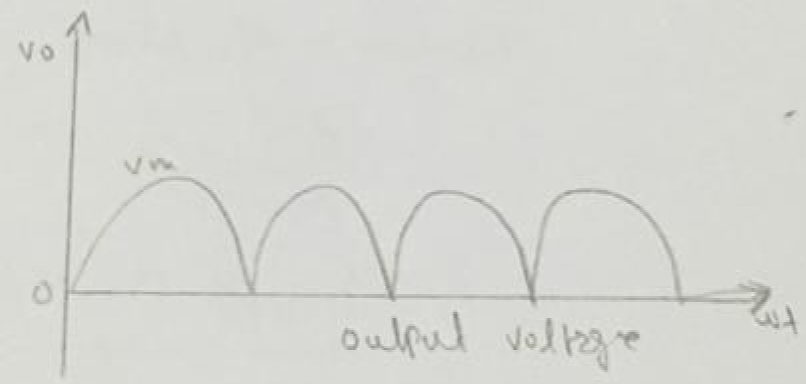
$V_m = 40V$

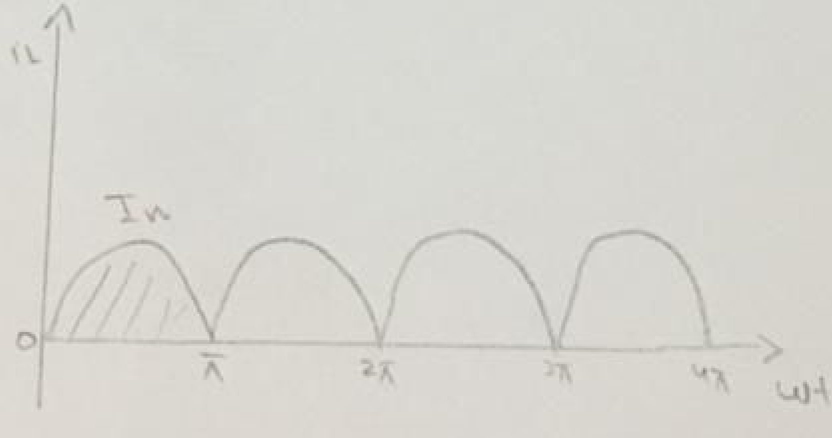
$R_L = 11\Omega$

$I_m = V_m / R_L$ $\quad 40/11 = I_m$ 3.6 A

(1) $I_{dc} = ?$

First we will find I_{dc} in full wave rectification





I_{dc} = area under the load current over full cycle / period of the cycle

$$I_{dc} = \int_0^{\pi} \frac{I_m \sin \omega t \, d(\omega t)}{\pi}$$

$$I_{dc} = \frac{I_m}{\pi} \int_0^{\pi} \sin \omega t \, d(\omega t)$$

$$I_{dc} = \frac{I_m}{\pi} \left[-\cos \omega t \right]_0^{\pi}$$

$$I_{dc} = \frac{I_m}{\pi} \left[-\cos \pi - (-\cos 0) \right]$$

$$I_{dc} = \frac{I_m}{\pi} \left[1 + 1 \right]$$

$$I_{dc} = \frac{2 I_m}{\pi}$$

Now put the value

$$I_{dc} = \frac{2(3.5)}{3.14}$$

$$I_{dc} = 0.79\,A$$

$$V_{dc} = \frac{V_m}{3\pi}$$

$$V_{dc} = \frac{340}{3.14}$$

V_{dc} 1[illegible]0.07 V

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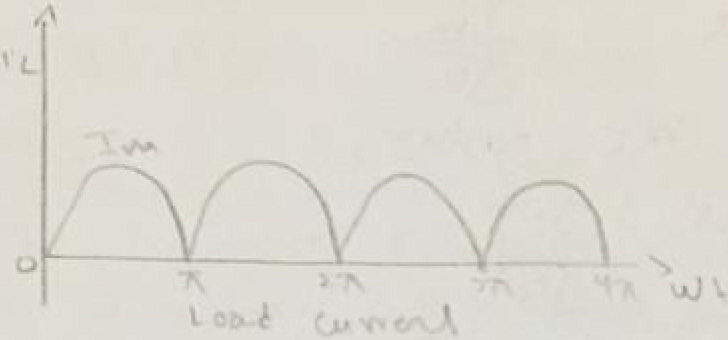
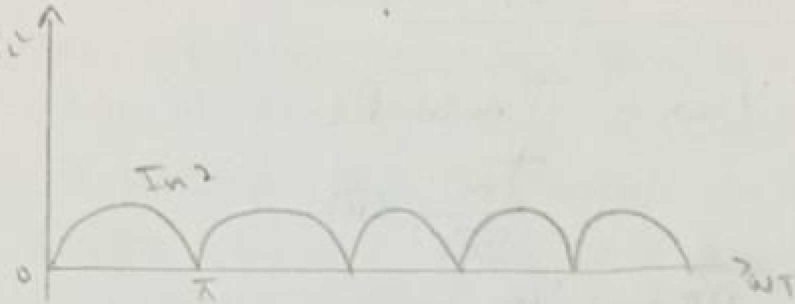
(3) Irms?



Load current



$$I_{rms} = \sqrt{\frac{\text{area of the square of load current over full cycle}}{\text{Period of square wave form}}}$$

$$I_{rms} = \sqrt{\int_0^{\pi} \frac{I_m^2}{2\pi} \sin^2 \omega t \; d(\omega t)}$$

$$I_{rms} = \sqrt{\frac{I_m^2}{2\pi} \int_0^{\pi} (1 - \cos 2\omega t) d(\omega t)}$$

$$I_{rms} = \sqrt{\frac{I_m^2}{2\pi} \left[\omega t - \frac{\sin 2\omega t}{2}\right]_0^{\pi}}$$

$$I_{rms} = \frac{I_m^2}{2\pi} \left[\pi - \frac{\sin 2\pi}{2} - 0 + \frac{\sin 2(0)}{2}\right]^{1/2}$$

$$I_{rms} = \sqrt{\frac{I_m^2}{2\pi} + \pi}$$

$I_{rms} = \frac{I_m}{\sqrt{2}}$

Putt the value

$I_{rms} = \frac{2.5}{\sqrt{2}}$

$I_{rm} = 1.76A$

Ans $V_{rms} = I_{rms} * R_L$

$\frac{I_m}{\sqrt{2}} * R_L$

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

Putt the value

$V_{rms} = \frac{40}{\sqrt{2}}$

$V_{rms} = 44V$

And Vdc?

$V_{dc} = I_{dc} * R_L$

$\frac{2I_m * R_L}{\pi}$

$V_{dc} = \frac{2V_m}{\pi}$

putt the value

$V_{dc} = \frac{2(40)}{3.14}$

$V_{dc} = 30V$

Q3

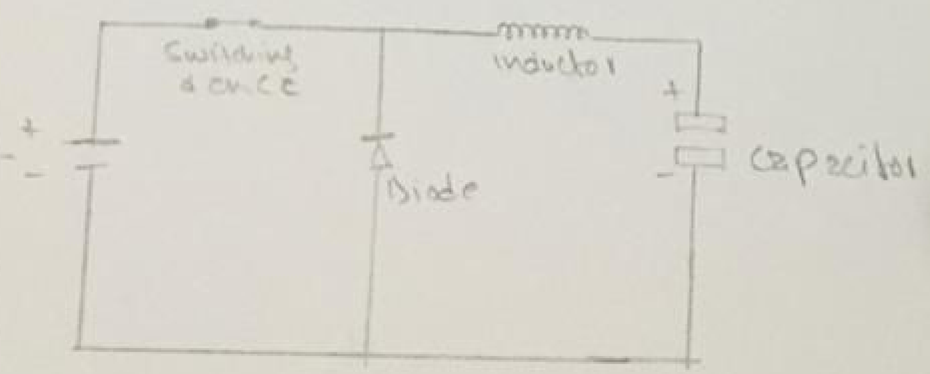
Principle of Buck converter

→ the main working principle of Buck converter is that the inductor in the input current resists sudden variations in input current when switch is ON the inductor stores energy from the input in the form of magnetic energy and discharge it when switch is closed the capacitor in the output is assumed large enough that the time constant of RC circuit in the output stage is high. the large time constant compared to switching period ensures that in steady state a constant output voltage Vo(t) = Vo (constant) exists across load terminals.

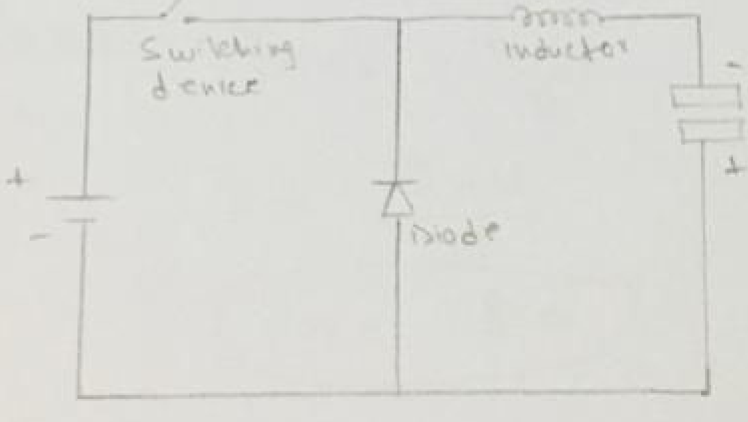
Working of Buck converter.

The working of a buck converter into a few steps

Step 1: The switch on and lets current flow to the output capacitor charging it up since the voltage across the capacitor cannot rise instantly and since the inductor limits the charging current. the voltage across the cap during the switching cycle is not the full voltage of the Power Source



Step 2 The switch turns off since the current in an inductor cannot change suddenly. the inductor creates a voltage across it this voltage is allowed to charge the capacitor and power the load through the diode when the switch is turned off. maintaining current output current throughout the switching cycle



Q3 = Part 2

Date $V_{in} = 50V$

duty cycle = $d = 40\% = 0.40$

Last digits of ID (11440)

$R = 11\,\Omega$

First digits of ID (11440

$f = 2\,kHz = 2000\,Hz$

(1) Vout = ?

$V_o = d(V_i)$

$= (0.40)(50)$

$V_o = 20V$

(2) Iout

$I_{out} = \frac{V_o}{R}$

$I_o = \frac{20V}{11}$

$I_o = 1.81A$

(3) Iin = ?

$I_{in} = \frac{V_1}{R}$

$I_{in}\ \frac{50}{11}$

$I_{in} = 4.54A$

(4) Inductor (L) = ?

$L = \frac{T_{OFF}}{2} \times R$ — (1)

As we know that

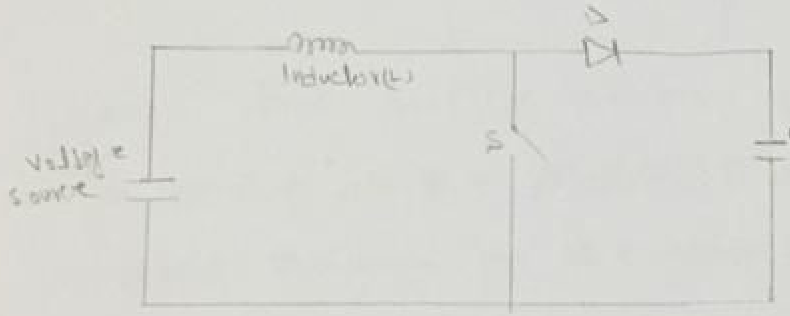
$V_o = dV_1$

$d = V_o/V_1 = \frac{20}{50} = 0.4$

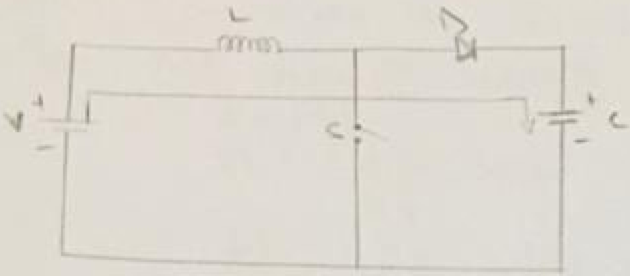
Q4

Boost Chopper:

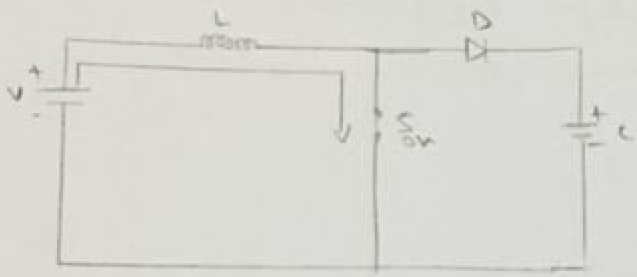
A boost Chopper is one of the simplest types of switch mode converter. It takes an input voltage & boost it. All consist of is an inductor & semi conductor switch, a diode & a capacitor. It is also called as step-up Converter.



Principle The main working principle of boost converter is that the inductor in the input circuit resists sudden variations in input current. When switch is off the inductor stores energy in the form of magnetic energy & discharges it when switch is closed. The capacitor in the output circuit is assumed large enough that the time constant of RC circuit in the output stage is high.



The output capacitor is charged to the input voltage minus one diode drop.



When the switch is on our signal source goes high turning on the MOSFET. All the current is diverted through to the MOSFET through the inductor. The output capacitor stays charged since it can't discharge through the now back-biased diode.

S on for a time ton & is off for a time toff we define the time period T, as T = Ton + Tof & the switching frequency

$$f_{switch} = \frac{1}{T}$$

Now define another term duty cycle

$$D = \frac{T_{ON}}{T}$$

Boost converter in steady state operation for this mode using KVL

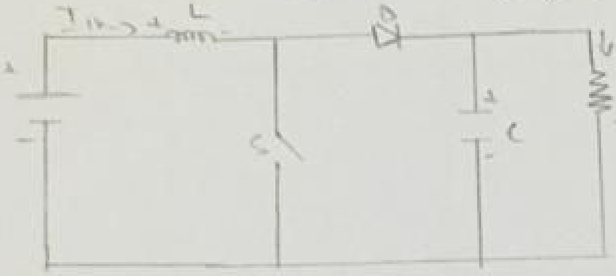
$$V_{in} = V_L$$

$$V_L = L\frac{di_L}{dt} = V_{in}$$

$$\frac{di_L}{dt} = \frac{\Delta i_L}{\Delta t} = \frac{\Delta i_L}{DT} = \frac{V_{in}}{L}$$

Since the switch is closed for a time $T_{ON} = DT$ we can say that $\Delta t = DT$

$$(\Delta i_L)_{closed} = \left(\frac{V_{in}}{L}\right) DT$$



In this mode the polarity of the inductor is reversed. The energy stored in the inductor is released & is ultimately dissipated in the load resistance & this helps to maintain the flow of current in the same direction through the load & also step-up the voltage as the inductor is now also acting as a source in conjuction ~~with also acting as a source~~ with the input source.

Analyze the circuit using KVL

Boost converter is steady state operation for mode 2 using KVL

$$V_{in} = V_L + V_O$$

$$V_L = L\frac{di_L}{dt} = V_{in} - V_O$$

$$\frac{di_L}{dt} = \frac{\Delta i_L}{\Delta t} = \frac{\Delta i_L}{(1-D)T} = \frac{V_{in} - V_O}{L}$$

Since the switch is open for a time $T_{OFF} = T - T_{ON} = T - DT = (1-D)T$ we can say that

$$\Delta t = (1-D)T$$

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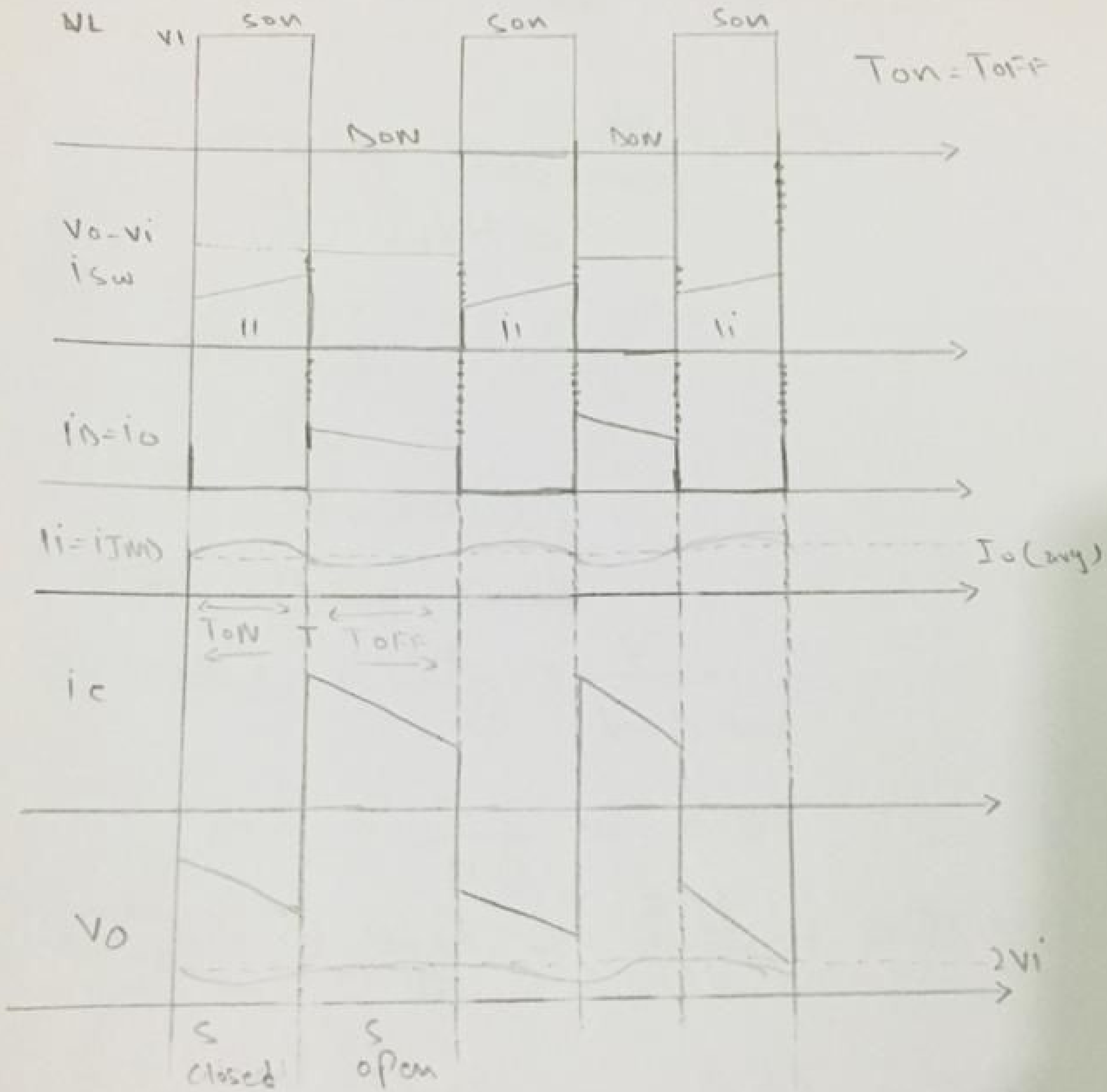


Q4 Part B)

$V_m = 50V$

$D = 40$

$R = 11\Omega$

Switching frequency

$f = 20Hz$

Find
(1) Vout
(2) Iout
(3) Iin
(4) Inductor (L)

We know that

(1) $V_{out} = \frac{V_S}{1-D} = \frac{5}{1-(0.40)}$

$= \frac{5}{0.6} = 8.33$

(2) $I_{out} = \frac{V_{out}}{R} = \frac{8.33}{11} = 0.75A$

(3) $I_{in} = \frac{I_{out}}{1-D} = \frac{0.75}{1-D} = \frac{0.75}{1-0.40}$

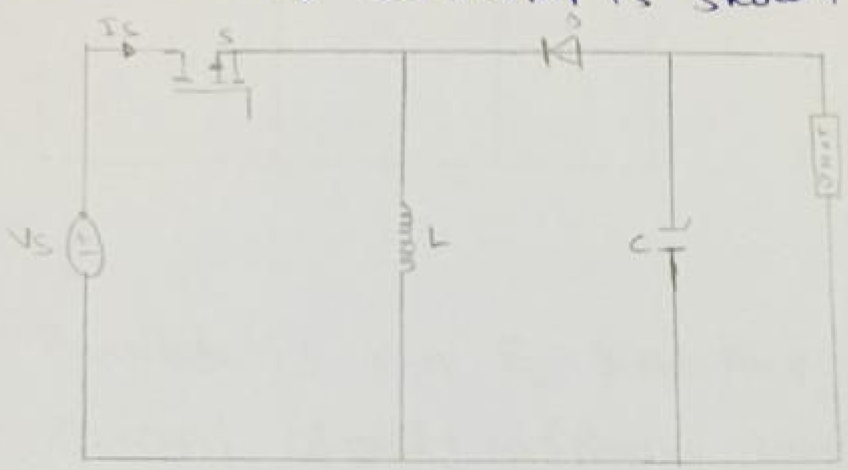
$= \frac{0.75}{0.6}$

$= 1.25I$

Q5] Buck-Boost Choppers:

A buck-Boost converter which can operate as a DC-DC step-down upon the duty cycle, D.

Buck-Boost converter is shown below



The input voltage source is connected to a solid state device. the second switch is used is a diode the diode is connected in reverse to the direction of power flow from source to capacitor & the load & the two are connect in parallel as shown in the figure above.

The controlled switch is turned on & off by using pulse width modulation. PWM can be time based or frequency based. Time based is mostly used for DC-DC converters it is simple to construct & use. frequency remain constant in this type of PWM modulation.

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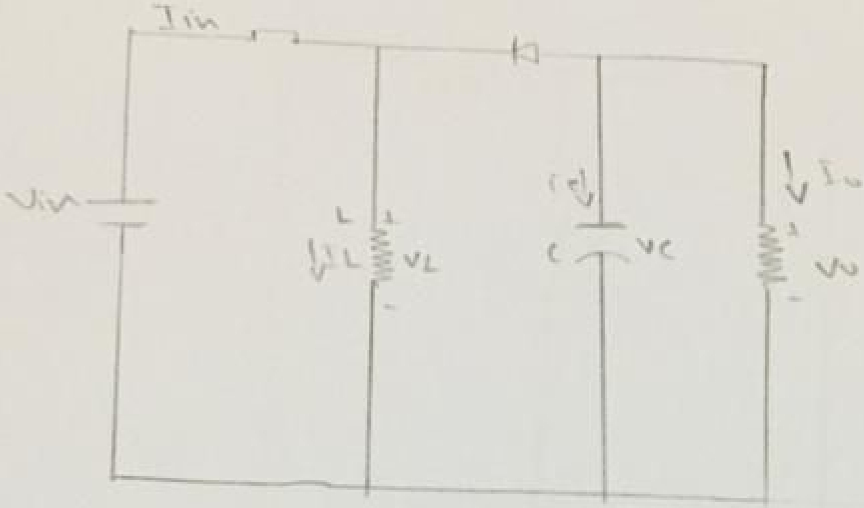
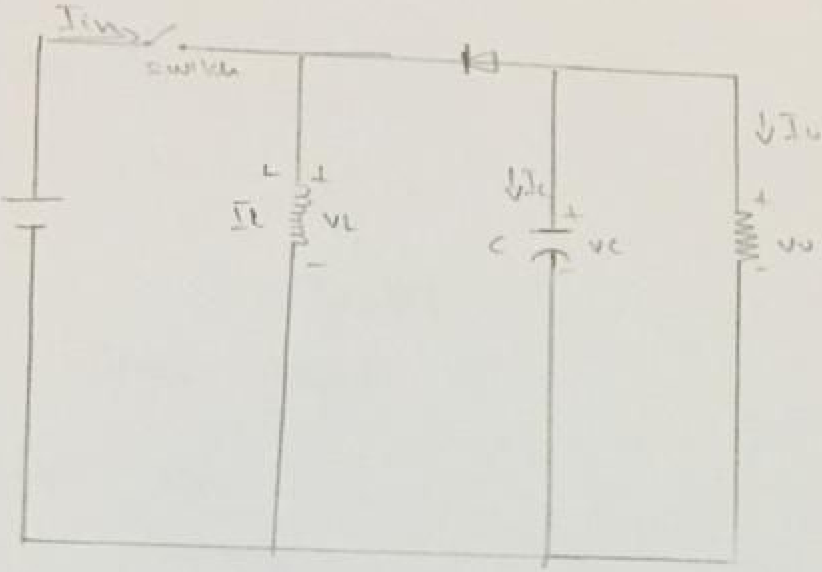
Mode 1: Switch is on. Diode OFF



This switch is on & therefore represents a short circuit ideally offering zero resistance to the flow of current so when the switch is on all the current will flow through the switch & the inductor & back to the DC inpu source. The inductor stores charge during the time the switch is on & when the solid state switch is off the polarity of the inductor revers so that current flows through the load & throu the diode & back to the inductor. So the direction of the current remain same.

MODE II · Switch is off. Diode is ON



In this mode the polarity of the inductor is reversed & the energy stored in the inductor is released. So the current through the inductor cannot abruptly change the diode must carry the current so it commutates & begins conducting. Energy is transfered from the inductor to the capacitor resulting in a decrasing inductor current & a voltage across the resistor with the opposite polarity compared to vin

During steady state the circuit is said to operate

(1) In discontinous conduction mode if the inductor current reaches zero.

(2) In continous conduction mode if the inductor current never reaches zero.

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Q 5 Part B

Given Data. $V_{in} = 50V$

$V_{out} = 40\%$

$R = 11$

$f = 20Hz$

Sol We know that

(1) $1-D = \frac{-V_{in}}{V_o - V_{in}}$

$-D = \frac{-V_{in} - 1}{V_o - V_{in}}$

$D = \frac{50V + 1}{0.40 + 5}$

$D = 9.44$

(2) $I_{out} = \frac{V_o}{R} = \frac{0.40}{11}$

$I_{out} = 0.03A$

(3) $I_{in} = \frac{I_o D}{1-D} = \frac{0.03 \times 9.44}{1-9.44}$

$I_{in} = 0.896A$

(4) $L = \frac{V_{in} \times D}{f \times \Delta I} = \frac{50 \times 9.44}{20}$