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ID 13172

Subject Power electronics

Final

Submitted to

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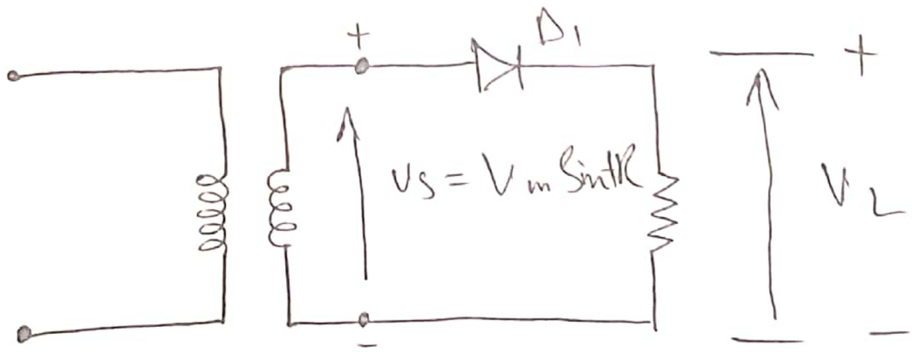
Q 1:

(i) 1-θ Uncontrolled Half wave Rectifier:

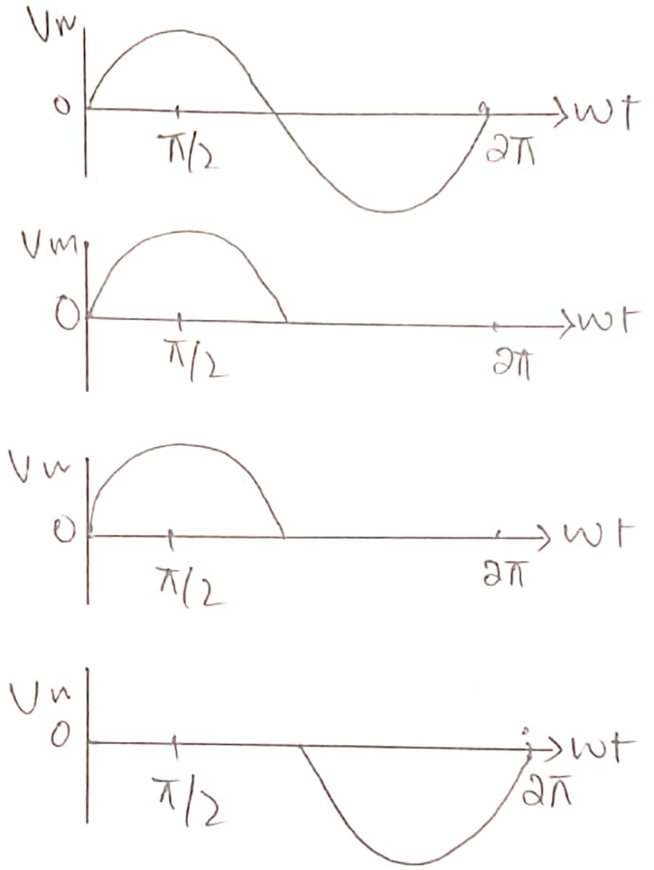
A rectifier is a circuit that convert an AC signal in to undirectional signal Diodes are used commonly in rectifiers A Single phase half wave rectifier is the simplest type and not used in industrial application. It is useful in under standing the principle of rectifier operation.



During +ve half cycle the input voltage diode D1 is forward biased and conducts. Input voltage appear across the load.

During -ve half cycle the input voltage the diode in blocking consider and output voltage is zero.

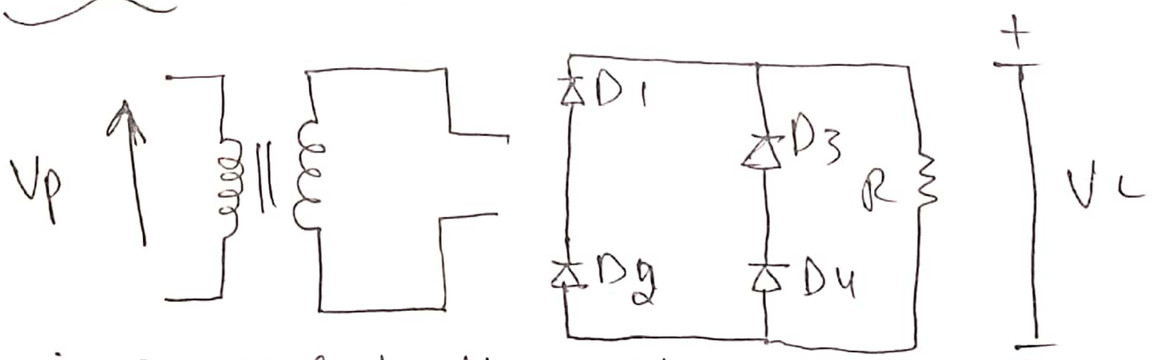
wave form:



1-θ uncontrolled Full wave bridge rectifier:

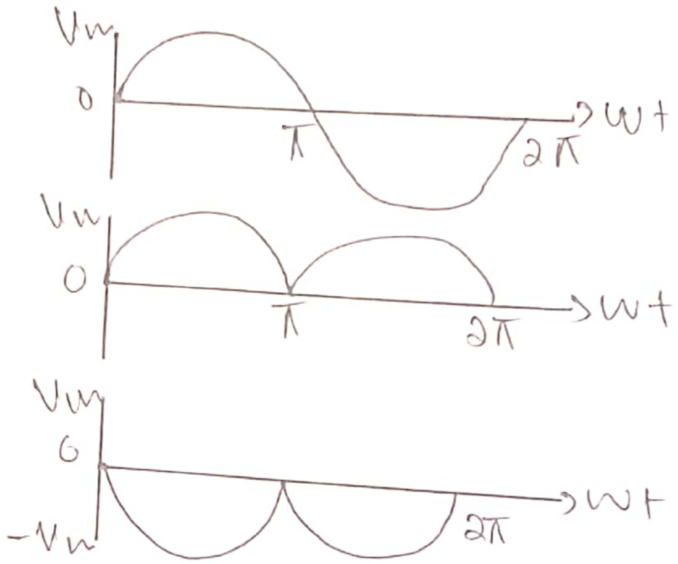
we use four diodes in bridge rectifier circuit.

Circuit diagram:



During +ve half cycle of the input voltage the current flows through the load through D_1 and D_2

During -ve half cycle diode D_3 and D_4 conducts. The peak inverse voltage of a diode is V_m.



Similarites and differences:

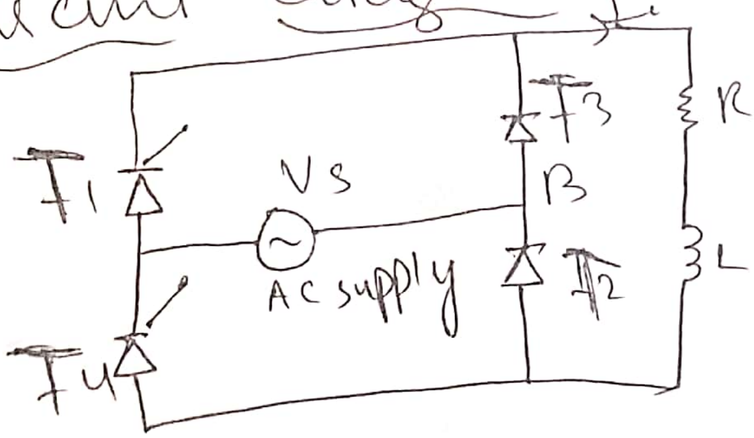
-> Both uses diodes.

-> During +ve half cycle both conducts.

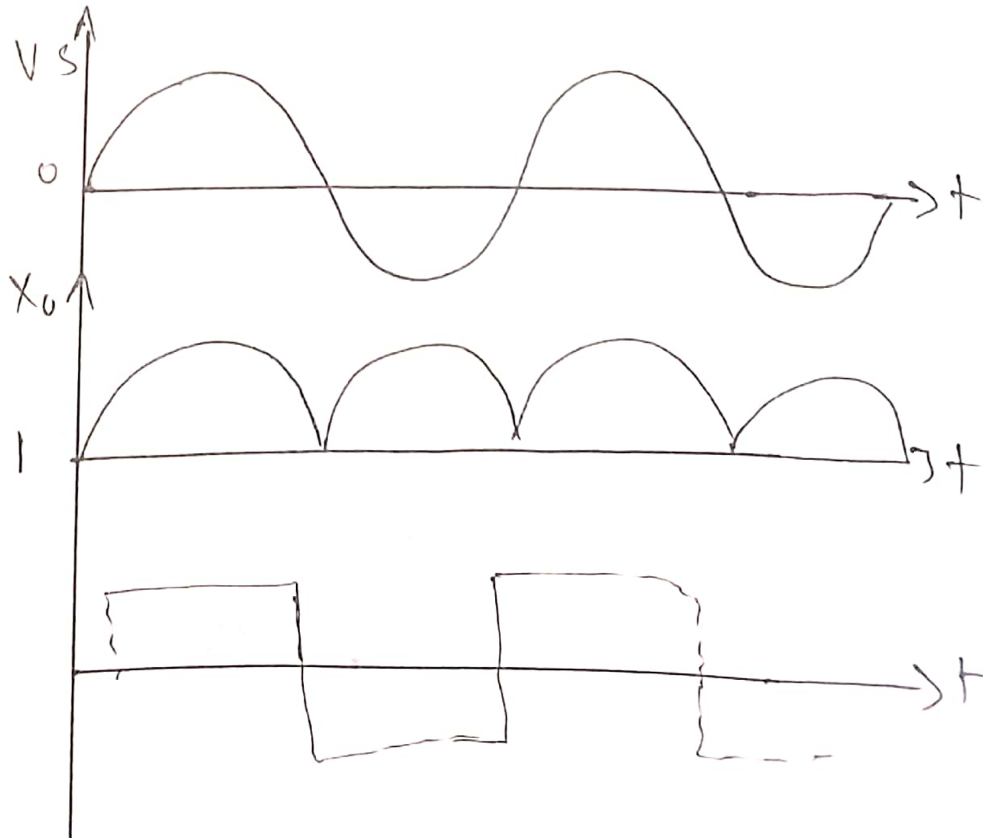
-> During -ve half cycle bridge rectifier conduct but not conduct the half wave rectifier.

1-Φ controlled bridge rectifier:

circuit diagram:



Its function is basically in to two parts +ve half cycle and -ve half cycle. During +ve half cycle T_1 and T_2 will become forward biased. T_1 and T_2 ~~circuit will~~ give current will flow in the loop. During -ve half cycle terminal A is negative with respect to terminal B. T_3 and T_4 will also in forward bias. If we give gates pulse to T_3 and T_4 current will flow in another loop.



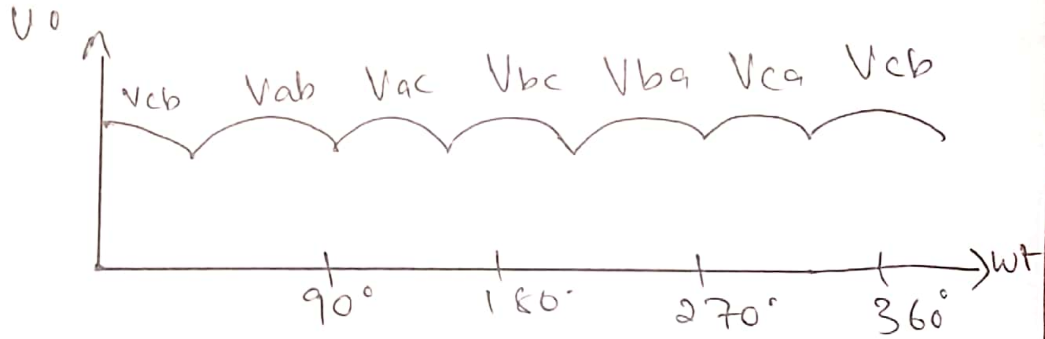
Uncontrolled bridge rectifier:

-> Two series diode are always conducting while four diodes are blocking.
-> One of the conducting diodes is odd numbered while the other is even numbered.
-> Each diode conducts 120°.
-> Current flows out from the most +ve source terminal through an odd numbered diode through the load followed by the even numbered diode and then back to the most -ve source terminal.
-> Output has less ripples and the diodes are numbered in accordance to their conductance.
-> The bridge uses both the +ve and -ve halves the i/p voltage.
-> Upper set of diodes consitutes the +ve group while the lower set constitutes the -ve.

-> Transformer Primary - Secondary is in Delta - star configuration.

-> The diode with the most +ve voltage will be conducting.

__Wave form:__



__Similarities and differences:__

-> Uncontrolled rectifier uses diodes.

-> Controlled rectifier use SCR.

-> The controlled rectifier we control the output by using the gate pulse.

-> When we give gate pulse then it trigger otherwise not

Q2:

$V_m = 72V$

$R = 13\Omega$

(i) $V_{rms} = \frac{V_m}{2} = \frac{72}{2} = 36V$

(ii) $I_{rms} = \frac{V_m}{2R} = \frac{72}{2(13)} = 2.7A$

(iii) $I_{dc} = \frac{V_m}{\pi R} = \frac{72}{(3.14)(13)} = 1.763$

(iv) $V_{dc} = \frac{V}{\pi} = \frac{72}{3.14} = 22.9v$

$V_s = V_o = V_{dc} = \frac{2V_m}{\pi} = \frac{2(72)}{3.14} = 45.85v$

$I_{dc} = \frac{V_m}{R} = \frac{72}{13} = 5.53 A$

$V_{rms} = \sqrt{2} V_s = \sqrt{2} \times 45.85 = 64.84v$

$I_{rms} = I_m/2 = 1.763/2 = 0.8815 A$

1-θ full wave rectifier (uncontrolled)

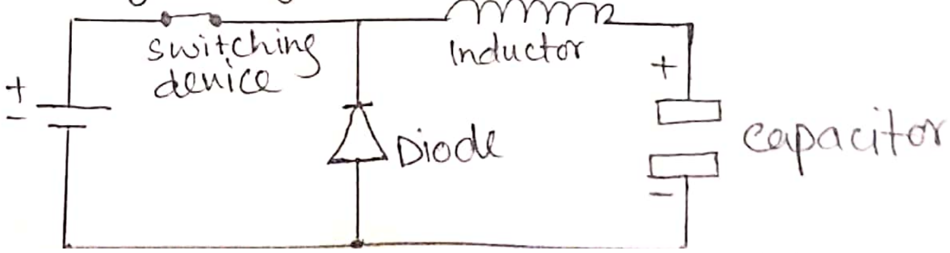
Q3:- Principle of Buck converter:

-> The main working principle of Buck converter is that the inductor in the input circuit resists sudden variations in input current. When switch is ON the inductor stores energy from the input in the form of magnetic energy and discharges 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 $V_o(t) = V_o$ (constant) exists across load terminals.

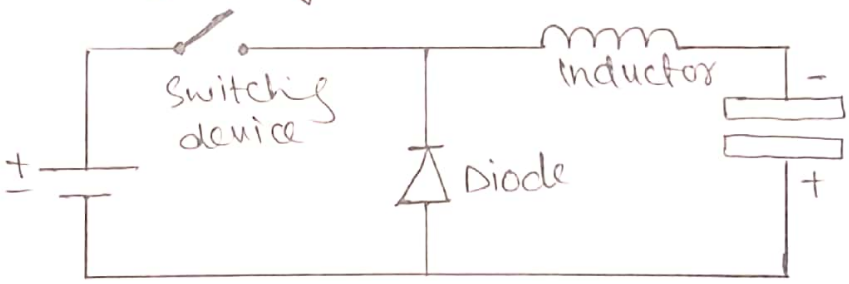
Working of Buck converter:

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.



Q 3: numerical

(ID 13172)

Given data

$V_{in} = 50V$

duty cycle $d = 72\%$

$R = 13\Omega$

$f = 20kHz = 20000\,Hz$.

Find (i) V_{out} (ii) I_{out} (iii) I_{in}

(iv) Inductor L

(i) $V_{out} = ?$

we know that

$V_{out} = DV_s$

$V_{out} = 72\% \times 50 = 0.72 \times 50$

$V_{out} = 36\ V$

(ii) $I_{out} = \frac{V_o}{R} = \frac{36}{13}$

$I_{out} = 2.769\ A$

(iii) $I_{in} = \frac{V_i}{R}$

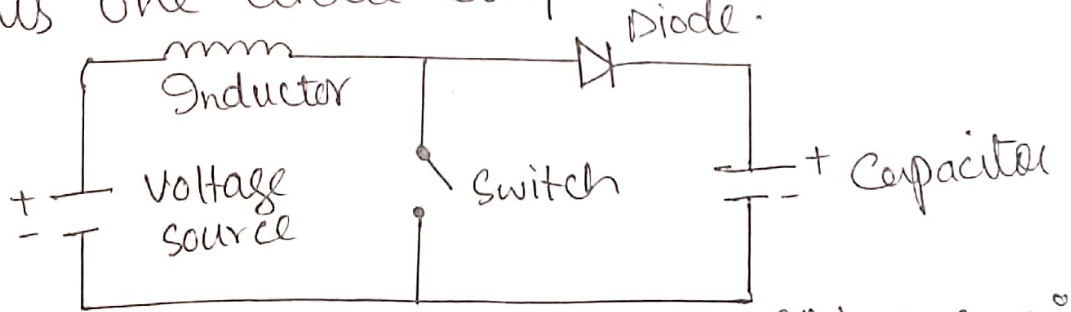
$I_{in} = \frac{50}{13} = 3.84\ A$

Q 4 :- Principle of Boost converter:

-> The main working principle of boost converter is that the inductor in the input circuit resists sudden variation in input current. When switch is OFF the inductor stores energy in the form of magnetic energy and 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 large time constant compared to switching period ensures a constant output voltage Vo(t) = Vo(constant).

Working of Boost converter:

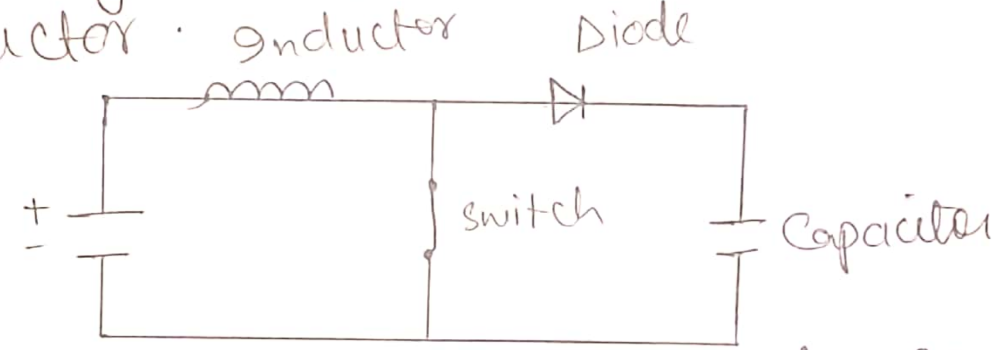
Step 1: Here nothing happens. The output capacitor is charged to the input voltage minus one diode drop.



Step 2: To turn the switch ON our signal source goes high, turning on the MOSFET. All the current is diverted through the induct
Note that the output capacitor stays

Charged since it can't discharge through the now back-biased diode.

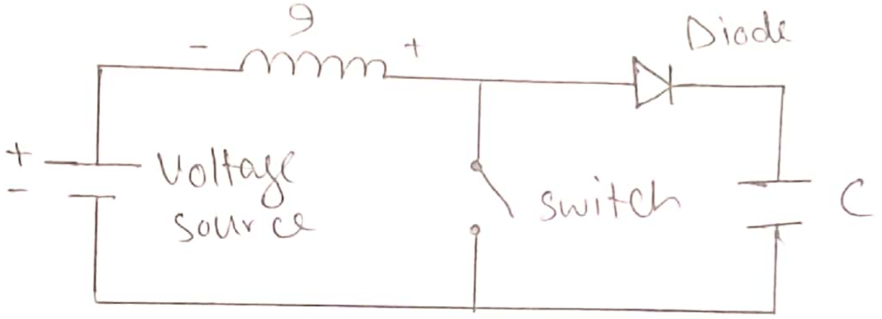
The power source isn't immediately short circuited, since the inductor makes the current ramp up relatively slowly. A magnetic field builds up around the inductor.



Step 3: The MOSFET is turned off and the current to the inductor is stopped abruptly.

The Inductor doesn't like sudden changes in current. So it does not like the sudden turning off of the current. It responds to this by generating a large voltage with the opposite polarity of the voltage originally supplied to it using the energy stored in the magnetic field to maintain that current flow.

The output capacitor is now charged to a higher voltage than before, which means that we have stepped up a low DC voltage to a higher one.



Q 4: Numerical

Given data (ID 13172)

$V_{in} = 50V$

$D = 72\%$

$R = 13\,\Omega$

Switching frequency = 20 KHz

Find (i) Vout (ii) Iout (iii) Iin

(iv) Inductor L

(i) $V_{out} = \frac{V_s}{1-D} = \frac{50}{1-0.72} = \frac{50}{0.28}$

$$V_{out} = 178.571 V$$

(ii) $I_{out} = \frac{V_{out}}{R} = \frac{178.571}{13}$

$$I_{out} = 13.73626 A$$

(iii) $I_{in} = \frac{I_{out}}{1-D} = \frac{13.73626}{1-0.72}$

$= \frac{13.73626}{0.28}$

$$I_{in} = 49.0580 A$$

Q 5:- Principle of Buck Boost Converter:

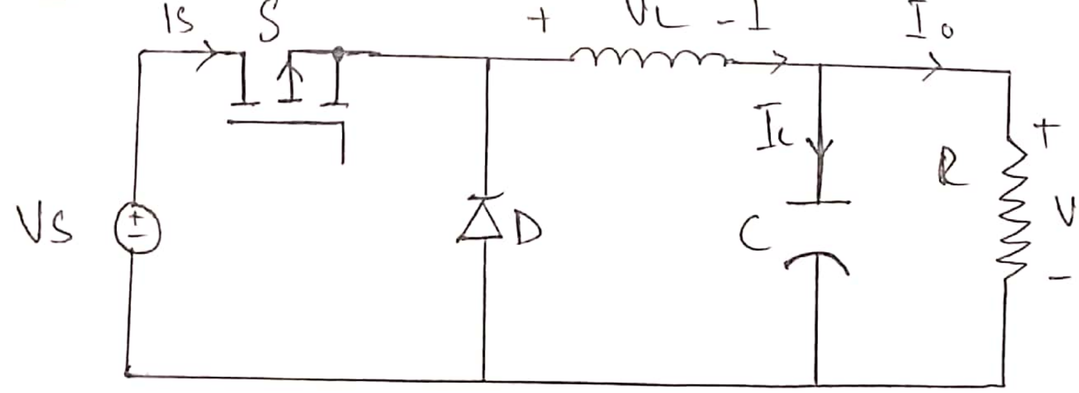
The main principle of Buck Boost converter is that the inductor in the input circuit resists sudden variation in input current. When switch is ON the inductor stores energy from the input in the form of magnetic energy and discharges it when switch is closed. The capacitor in the output circuit is assumed large enough that the time constant of RC circuit in the output stage is high.

→ Buck Boost converters are used in self-regulating power supplies.

Working of Buck Boost converter:

There are two types of working in the Buck boost converter.

(i) Buck converter working.

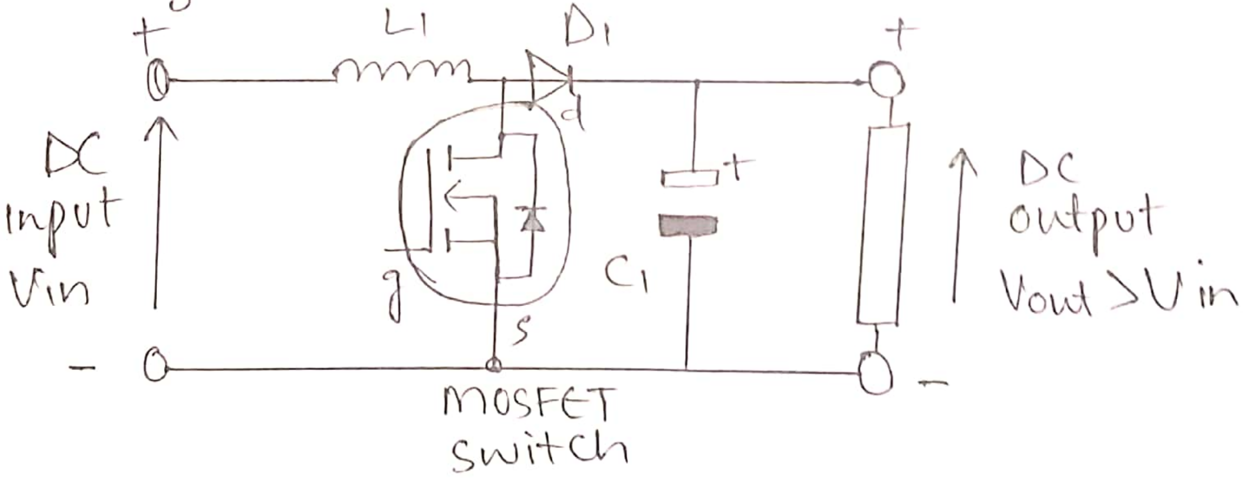


The following diagram shows the working operation of the buck converter, In the buck converter first transistor is turned ~~on~~ ON and second is switched off due to high square wave frequency. The Inductor L is the initial source of current. If the first transistor is OFF by using control unit then the current flow in the buck operation. The magnetic field of the inductor is collapsed and the back emf is generated ~~~~ collapsing field turn around the polarity of the voltage across the inductor. The current flow in the diode D2, the load and the D1 diode will be turned ON.

The discharge of the L decreases with the help of the current. During the first transistor is on one state the charge of the accumulator in the capacitor The current flows through the load and during the off period keeping Vout reasonably. Hence it keeps the minimum ripple amplitude and Vout closes the value of Vs.

(ii) Boost converter working:

In this converter the first transistor is switched ON continually and for the second transistor the square wave of high frequency is applied to the gate terminal. The second transistor is in conducting when the on state and the input current flow from inductor L through second transistor.



By charging the capacitor C the load is applied to the entire circuit in the ON state and it can construct earlier oscillator cycles. During the ON period the capacitor C can discharge regularly and the amount of high ripple frequency on the output voltage.

The approximate potential difference is given by the equation

$V_S + V_L$

During the off period of second transistor the inductor L is charged and the capacitor C is discharged. Inductor produce back e.m.f & the values are depending up on the rate of charge of current of the second transistor switch.

The polarity of voltage across inductor L has reversed.

The input voltage gives the output voltage and atleast equal to or higher than the input voltage.

The Diode D_2 is in forward biased and the current applied to the load current and it recharges the capacitors to $V_S + V_L$ and it is ready for the second transistor.

Q 5: numerical

(ID 13172)

Given

$V_{in} = 50V$

$V_{out} = 72\%$

$R = 13\Omega$

$f = 20KHz$

(i) $D = ?$

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

$$= \frac{50-1}{0.72+50} = 1.00552$$

(ii) $$I_{out} = \frac{V_o}{R} = \frac{0.72}{13} = 0.05538A$$

(iii) $$I_{in} = \frac{I_o D}{1-D} = \frac{0.5538 \times 1.00552}{1-1.00552}$$

$$= \frac{0.5568}{-0.00552}$$

$$= -100.87$$

(iv) $L = \frac{V_{in} \times D}{f \times \Delta I}$

$= \frac{50 \times 1.00552}{20{,}000(I_{out} - I_{in})}$

$= \frac{50.276}{20{,}000(0.055 - (-100.87))}$

$= \frac{50.276}{20000(100.925)}$

$= \frac{50.276}{2018000}$

$L = 0.000024$