Name ≠ Asad Shoaib Khalil

ID ≠ 13095

Subject ≠ Power electronics

Teacher ≠ Engr. Shayan Tariq Jan.

Paper ≠ Power electronics

Date ≠ 27-6-2020.

Scanned with CamScanner

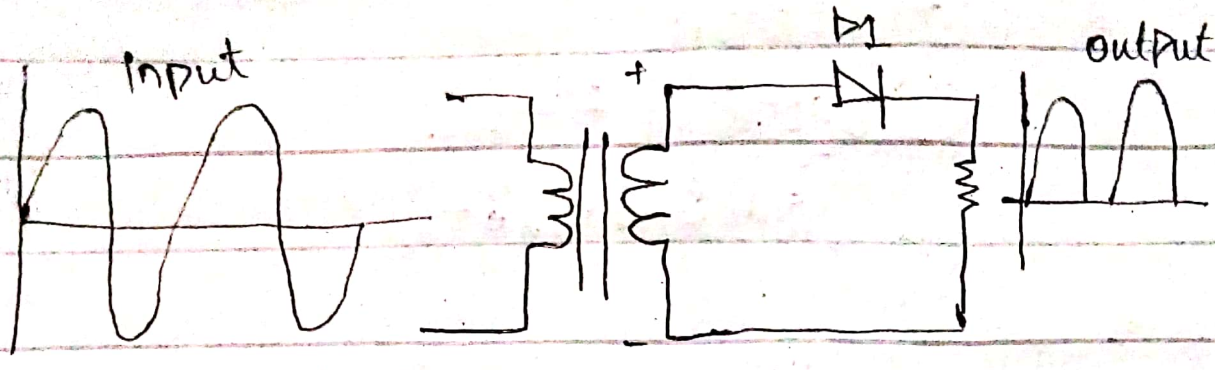
Question # 1

Answer:-

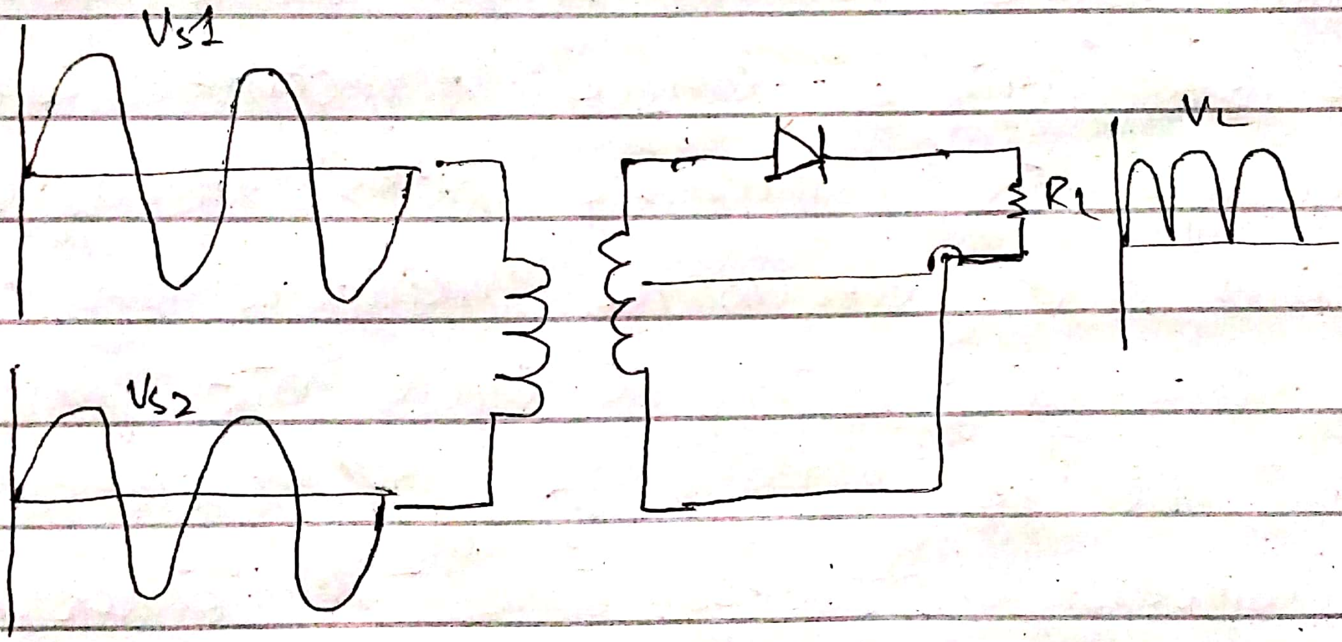
Difference b/w Half & full wave Rectifier:-

A half wave Rectifier & full wave Rectifier have significant difference. A rectifier convert AC voltage into Pulsating DC Voltage. A half wave rectifier is an electronic circuit which converts only one-half of the AC cycle into pulsating DC. It utilizes only half of AC cycle for the conversion process. One the other hand full wave rectifier is an electronic circuit which converts entire cycle of AC into Pulsating DC. The half wave Rectifier is unidirectional; it means it will allow the conduction in one direction only. that's why it can convert positive half only or negative half only into DC Voltage. This is the Reason that it is called Half wave Rectifier. While full wave Rectifier is bi-directional, it conducts for positive half as well as negative half of the cycle. Thus, it is termed as full wave rectifier.

Scanned with CamScanner



Half wave rectifier.



Full wave Rectifier.

Scanned with CamScanner

Part (2).

Basic rectifier circuits several type of rectifier are available: single phase & three phase, half wave & full wave, controll & uncontrolled etc. for a given application, the type used is determined by the requirements of that application. In general the types of rectifiers are

(1) **Uncontrolled Rectifier:-** Provide a fixed dc output voltage for a given AC supply where diodes are used only.

(2) **Controlled Rectifier:-** Provides an adjustable dc output voltage by controlling the phase at which the devices are turned on. Where thyristors & diodes are used.

Scanned with CamScanner

Question # 2.

Answer:-

Solution:-

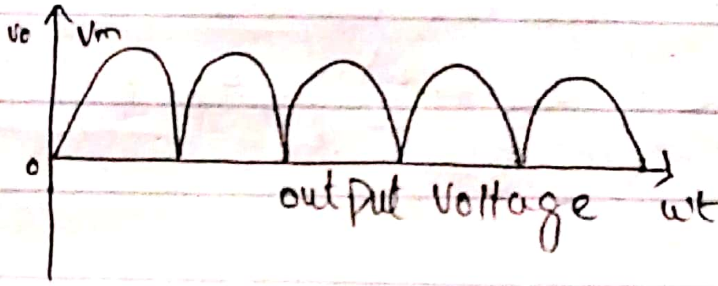
$V_m = 95\ V$

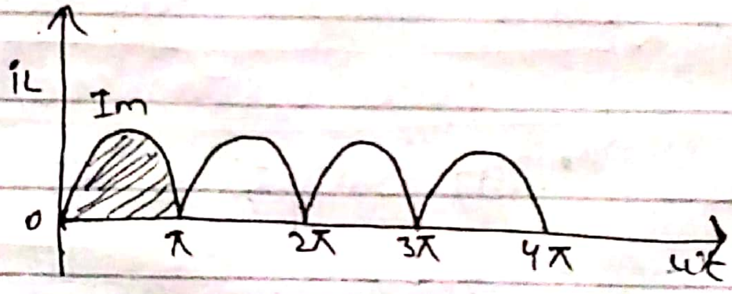
$R_L = 13\ \Omega$

$I_m = V_m / R_L = 95/13 = I_m = 7.3\ A.$

(i) $I_{dc} = ?$

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





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

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

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

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

Scanned with CamScanner

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

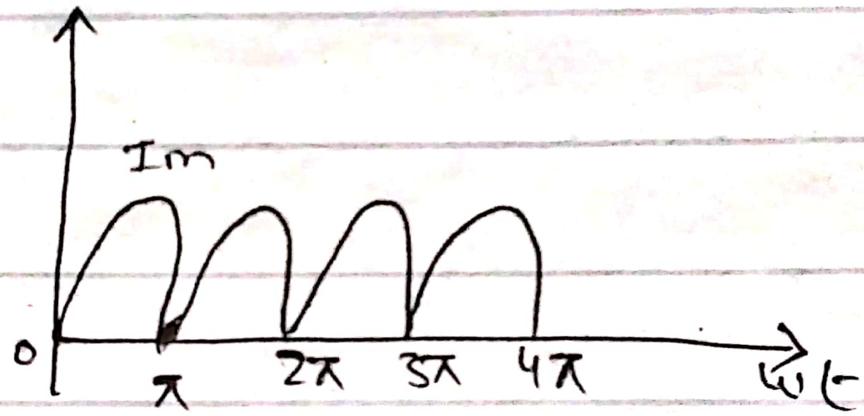
$$I_{dc} = \frac{I_m}{\pi}\{1+1$$

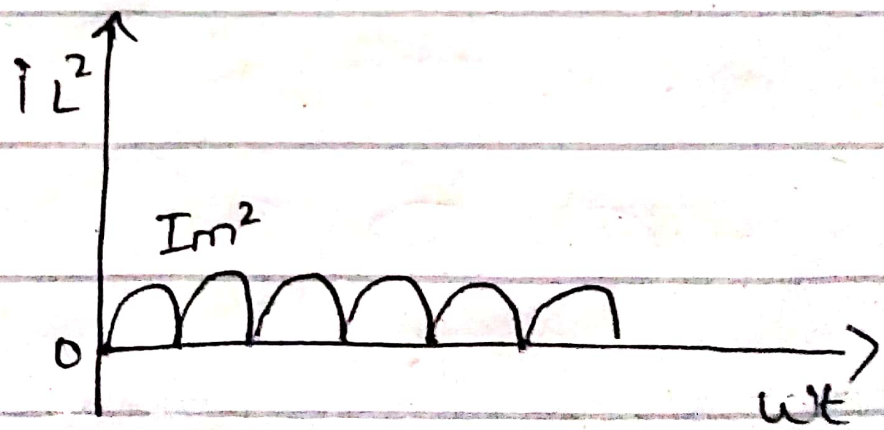
$$I_{dc} = \frac{I_m}{\pi}[1+1].$$

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

Scanned with CamScanner

(3) $I_{rms} = ?$





Scanned with CamScanner

Now

$$I_{rms} = \sqrt{\frac{\text{area of square of load current over full cycle}}{\text{period of the squared waveform}}}$$

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

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

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

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

Scanned with CamScanner

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

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

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

putt the values

$$I_{rms} = \frac{7.3}{\sqrt{2}} \Rightarrow 5.16$$

$$\boxed{I_{rms} = 5.16\ A}$$

And $V_{rms} = I_{rms} \times R_L$

$$= \frac{I_m}{\sqrt{2}} \times R_L$$

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

putt the value

$$V_{rms} = \frac{95}{\sqrt{2}}$$

$$\boxed{V_{rms} = 67V}$$

Scanned with CamScanner

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

$$V_{dc} = \frac{95}{3.14} = 30.$$

$$V_{dc} = 30V.$$

Scanned with CamScanner

(5):- half wave uncontrolled rectifier is better & effective.

Scanned with CamScanner

Question #3.

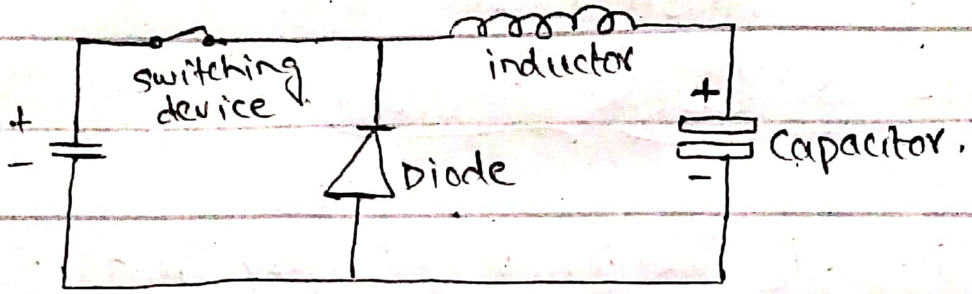
Answer:-

Principles of Buck converter:-

The main principle of Buck Converter is that the ~~Converter~~ 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 discharge it when switch is closed. The capacitor in the output is assumed large eneough that the time constant of Rc circuit in the output stage is high. The large time constant compared to switching circuit ensures that in steady state a constant output voltage $V_o(t) = V_o$ (constant) exists across load terminals.

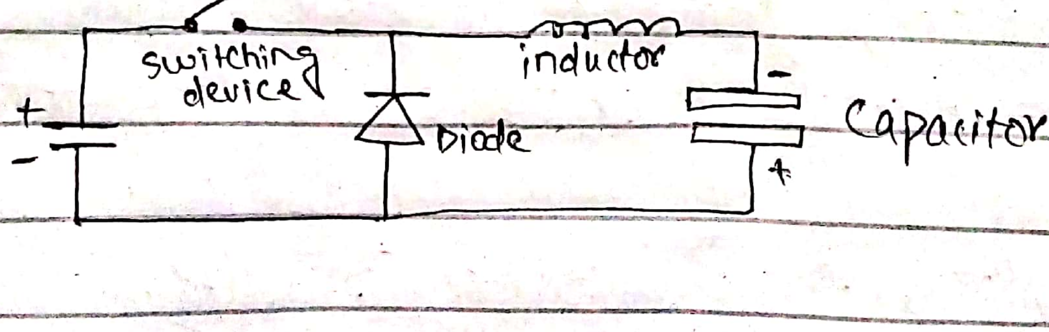
Working of Buck Converter:-

Step 1:- The switch on and lets current flow to the output capacitor, changing it up. Since the voltage across the capacitor cannot rise instantly and since the inductor limits the changing current. the voltage across the cap during the switching cycle is not the full voltage of power source.



Step 2:-

The switch turn off since the current in an inductor cannot charge suddenly. the inductors areates 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.



Scanned with CamScanner

Question # 3.
Numerical
Answer:-

Given Data :- $V_{in} = 50V$.
duty cycle = 95% = 0.95
$R = 13\ \Omega$
$f = 20kHz = 20000\ Hz$.

(i) $V_{out} = ?$

$$V_o = d(V_i).$$
$$= (0.95)(50)$$
$$\boxed{V_o = 47.5\ V.}$$

(ii) $I_{out} = ?$

$$I_{out} = \frac{V_o}{R}$$
$$I_o = \frac{47.5}{13}$$
$$\boxed{= 3.65\ A.}$$

$I_{in} = ?$

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

Scanned with CamScanner

(iv) Inductor (L) = ?

$$L = \frac{T_{off}}{2} \times R \quad \text{—(i)}$$

As we know that

$$V_o = dV_i$$

$$d = \frac{V_o}{V_i} = \frac{47.5}{50} = 0.95$$

(*)
$$\frac{T_{ON}}{T} = 0.95$$

$$\frac{T_{ON}}{T} = \frac{0.95}{f}$$

$$T_{ON} = \frac{0.95}{20(10^3)Hz} = 4.75\mu s$$

Also from eq (*) we have.

$$\frac{T_{ON}}{T} = 0.95$$

$$\frac{T_{ON}}{0.95} = T \Rightarrow \frac{4.75}{0.95} = 5\mu$$

Now

$$T = T_{ON} + T_{OFF}$$

$$T_{OFF} = T - T_{ON}.$$

$$T_{OFF} = 5\mu s - 4.75 = 0.25\mu s$$

$$\boxed{T_{OFF} = 0.25\mu s}$$

Now put this value in eq (1) we get.

$$L = \frac{0.25}{2} \times 13 = 1.6\mu H.$$

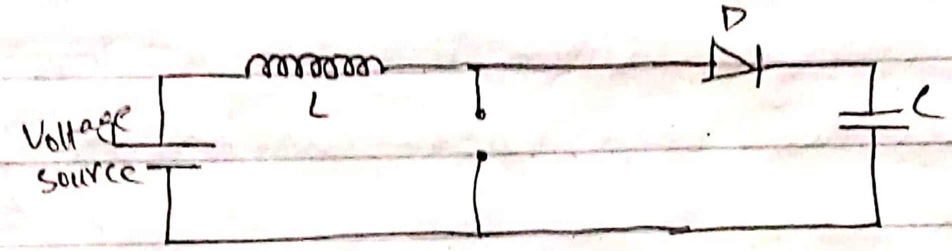
Scanned with CamScanner

Question # 4.

Answer:-

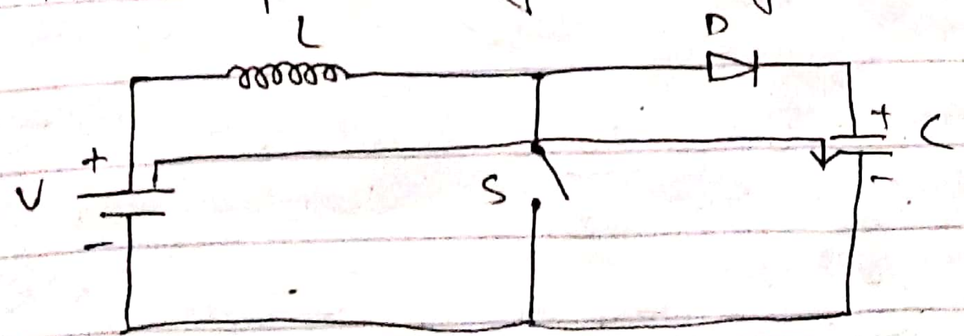
Boost chopper:-

A boost chopper is one of the simplest type switching anode converter. It takes an input voltage & boost it. All consist of an inductor, a semiconductor switch. A diode & a capacitor. It is also called as step up converter.



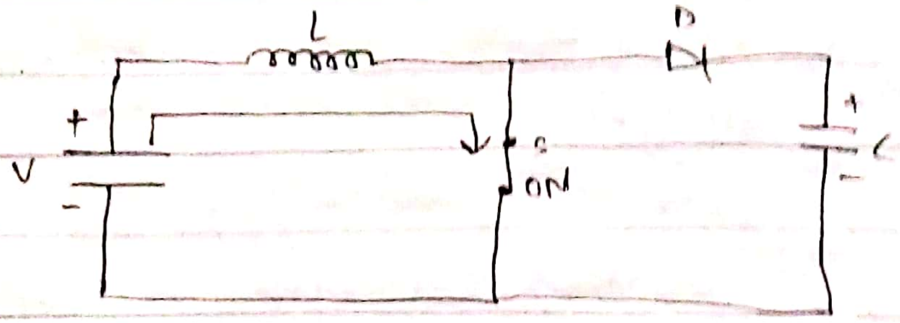
Working principle:-

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. & discharge its when switch is closed. The capacitor in the output circuit is assumed large enough that time constant of Rc circuit in the output stage is high.



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

Scanned with CamScanner



When the switch is ON. Our signal source goes high turning on the MOSFETs. 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. is ON for a time t_{on} & is OFF for t_{off}. We define the time period T, as $T = T_{ON} + T_{OFF}$ & 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 anode using KVL.

$$V_{in} = V_L$$

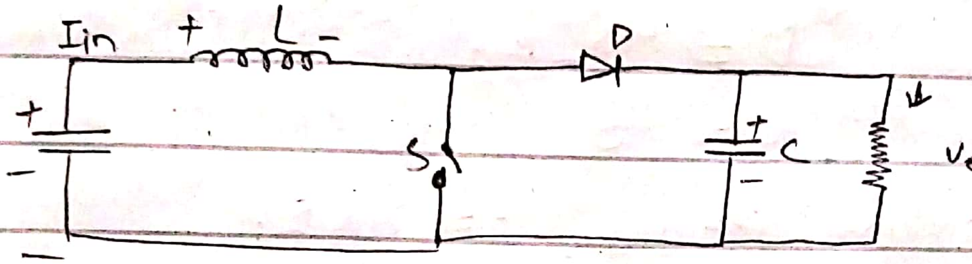
$$V_L = L\frac{di}{dt} = V_{in}$$

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

Scanned with CamScanner

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

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



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 & step up voltage as the inductor is now also acting as a source. Analyze the circuit 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

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

Scanned with CamScanner

(4)

Numerical Part:-

Given Data:-

$V_{in} = 50V$.

$D = 95\%$

$R = 13$

Switching frequency $f = 20KHZ$.

find:-

(i) $V_{out} = 0.95 \times 50 = \boxed{47.5V}$

(ii) $I_{out} = \frac{V_o}{R} = \frac{47.5}{13} \Rightarrow \boxed{3.6A}$

(iii) $I_{in} = DI_o = 0.95 \times 3.6$
$= \boxed{3.42A}$

(iv) Inductor (L) =

$L = \frac{T_{OFF}}{2} \times R$ —(i)

As we know that.

$V_o = dV_i$

$d = \frac{V_o}{V_i} = \frac{47.5}{50} = 0.95$.

$\frac{T_{ON}}{T} = 0.95$

$\frac{T_{ON}}{T} = \frac{0.95}{f} \Rightarrow \frac{0.95}{20(10^3)} = \boxed{4.75 \ell 6}$

Scanned with CamScanner

Also from eq (*)

$$\frac{T_{ON}}{T} = 0.95$$

$$\frac{T_{ON}}{0.95} = T \Rightarrow \frac{4.75}{0.95} = 5\,\mu s$$

Now.

$$T = T_{ON} + T_{OFF}$$

$$T_{OFF} = T - T_{ON}$$

$$T_{OFF} = 5\,\mu s - 4.75 = 0.25\,\mu s$$

$$\boxed{T_{OFF} = 0.25\,\mu s}$$

Now put these values in eq (i)

$$L = \frac{0.25 \times 13}{2} = \boxed{1.6\,\mu H}$$

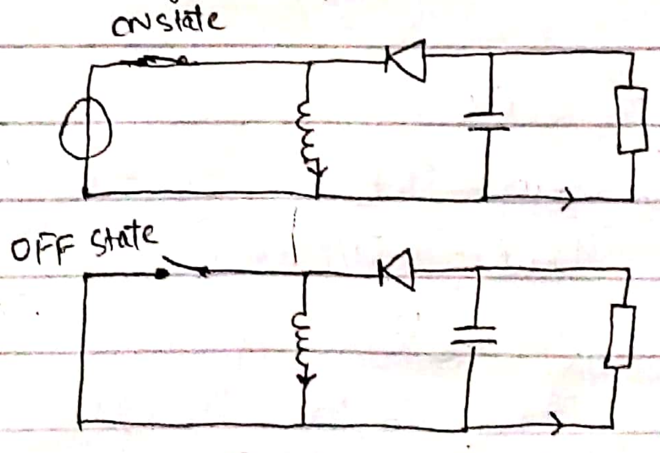
Scanned with CamScanner

Question # 5

Answer:-

Buck Boost Converter:-

It is a type of DC to DC converter and it has a magnitude of output voltage. It may be more or less than equal to the input voltage magnitude. The buck boost converter is equal to the fly back circuit and single inductor is used in the place of the transformer. There are two types of converter in it. That are buck converter & the other one is boost converter. These converters can produce the the range of output voltage than the input voltage.



Buck Boost Converter.

Working Principles of Buck Boost Converter:-

The working operation of the DC to DC converter is the inductor in the input resistance has the unexpected variation in the input current. If the

Scanned with CamScanner

Switch is ON then the inductor feed the energy from the input & stores energy of magnetic energy. If the switch is closed it discharge the energy. The output circuit of the capacitor is assumed as high sufficient than time constant of an RC circuit is high on the output stage.. The huge time constant is compared with the switching period & make sure that the steady state is a constant output voltage $V_0(t) = V_0$ (constant) and present at the load terminal.

Scanned with CamScanner

Numerical Part :-

Solution:- (i) Duty cycle.

$$1-D = \frac{-Vin}{Vo - Vin}$$

$$-D = \frac{-Vin - 1}{Vo - Vin} \Rightarrow \frac{Vin + 1}{Vo + Vin}$$

$$= \frac{50V + 1}{0.95 + 50} = \boxed{1.0009}$$

(ii) $I_{out} = \frac{Vo}{R} = \frac{0.95}{13}$

$$I_{out} = \boxed{0.073\ A}$$

(iii) $Vin = I_o R$

$$= 0.073 \times 13$$

$$\Rightarrow \boxed{0.949\ A}$$

(iv) Inductor (L) =

$$L = \frac{Vin \times D}{f \times \Delta I}$$

$$= \frac{0.949 \times 1.0009}{20KHz \times 0.073} = \frac{0.94}{1.46}$$

$$L = \boxed{6.43\ KHz.}$$

Scanned with CamScanner