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SUBJECT # POWER ELECTRONICS

DEPARTMENT # BEE

SEMESTER # 8^{th}

TEACHER ⤵

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QUESTION # 01

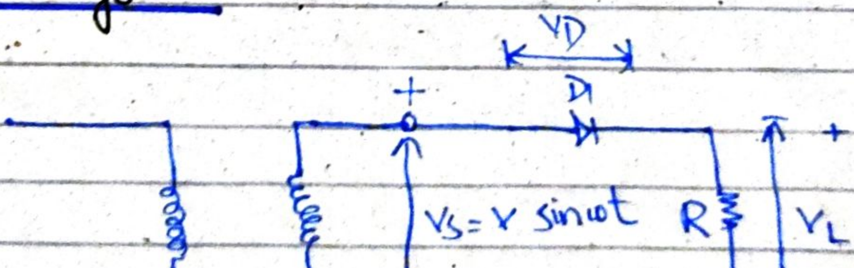
Ractifier:

It is the electronic device which is used to convert Ac into Dc. is called Rectifier.

1) 1-φ uncontrolled Half-wave Rectifier:

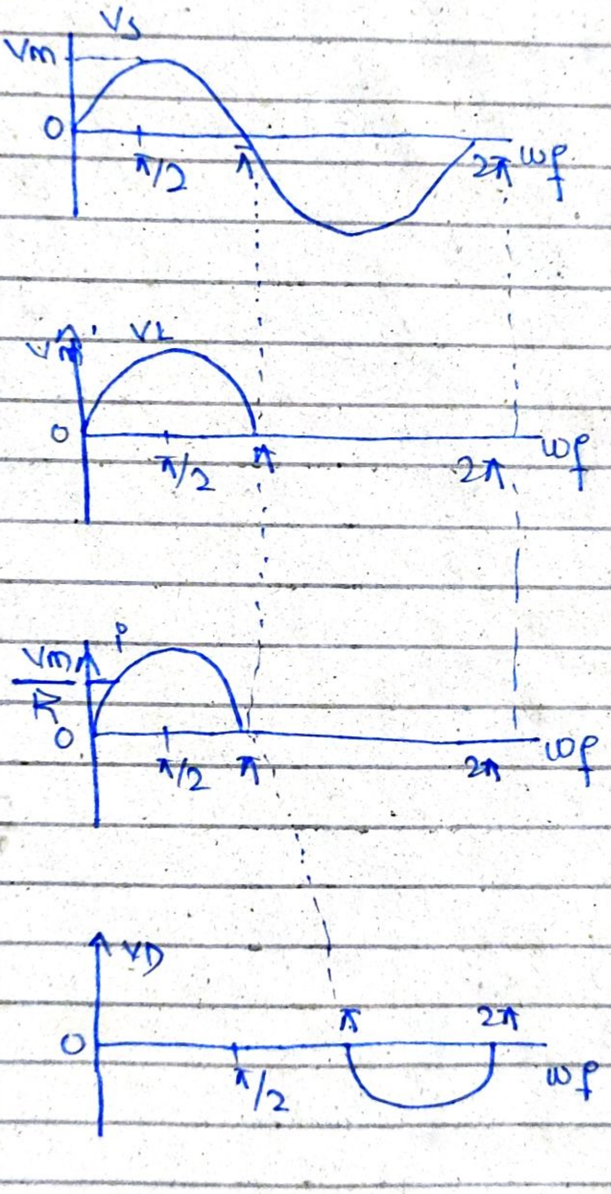
A rectifier is a circuit that convert an Ac signal in to unidirectional signal. Diodes are used commonly in rectifiers. A single phase half wave rectifiers is the simplest type is not normally used in industrial applications. However it is usefull in understanding the principle of rectifier operation.

circuit diagram:



During positive half cycle, the input voltage diode D1 is forward base and conduct and input voltage appears across the load. During the negative half cycle of the input voltage the diode is blocking conductor and output voltage is zero.

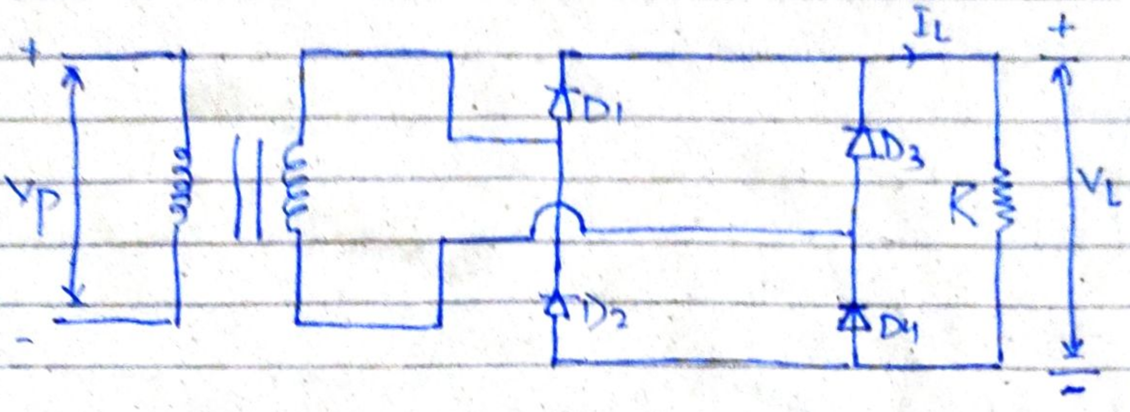
waveform :-



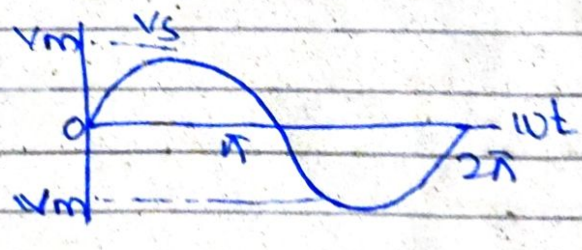
2) 1-φ uncontrolled Full wave bridge Rectifiers :

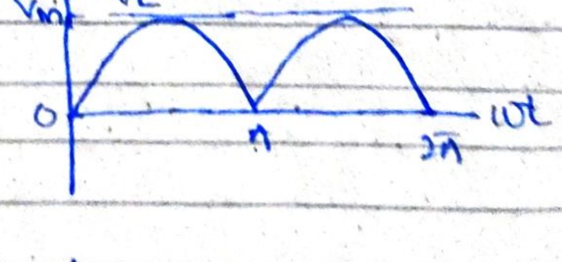
We use four diodes in bridge Rectifier circuit

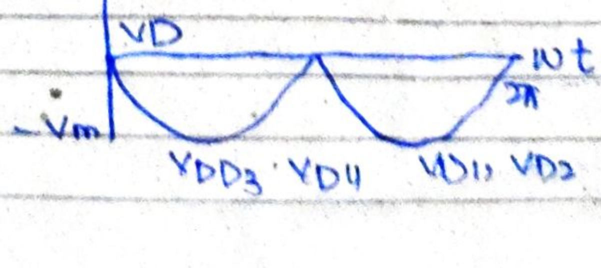
Circuit Diagram :



During postive half cycle of the input voltage the current flows through the load through diodes D1 and D2. During negative cycle Diodes D3 and D4 conducts the peak inverse voltage of a diode is Vin





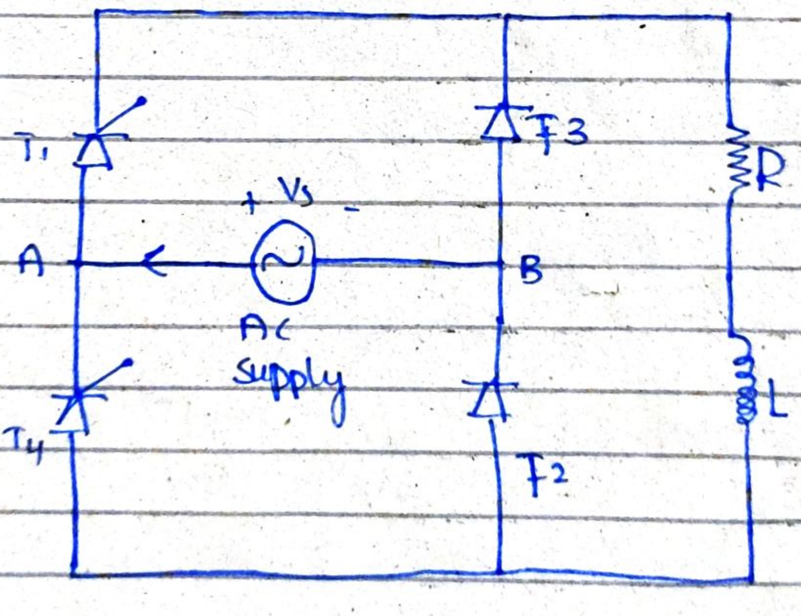


Similarities:- / Differences:

- Both uses diode
- During positive half cycle both conduct.
- During negative half cycle bridge Rectifier conduct but not conduct the half wave Rectifier.

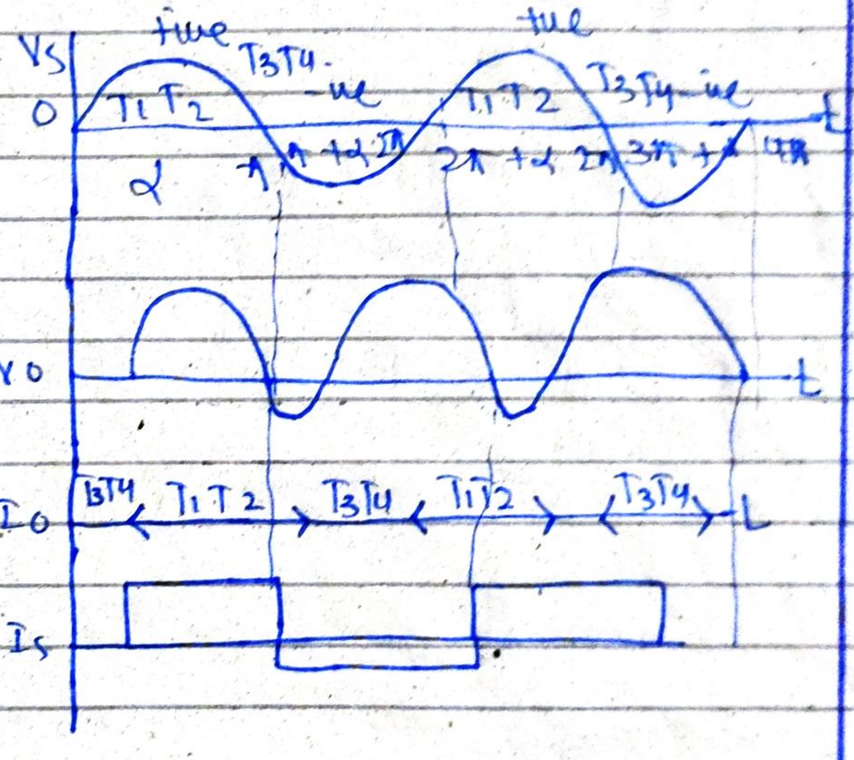
2- 1-ϕ controlled bridge rectifier:

circuit diagram:



Its function is basically subdivided into two parts positive half and negative half cycle T_1 and T_2 will become forward base. If we give gate pulse the T_1 and T_2 current will flow in the loop. During negative half cycle terminals A is negative with respect to terminal B, T_3 and T_4 will be in forward bias. If we give gate pulse to T_3 and T_4 current will flow in another loop.

Graph:



Similarities and difference:

- uncontrolled rectifiers 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.

QUESTION NO 2

Given :-

$V_m = 90V$

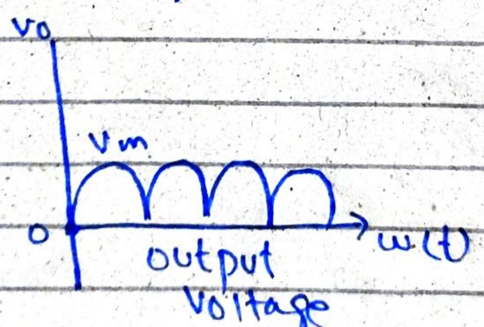
$R = 13\Omega$

$I_m = \frac{V_m}{R_L} = \frac{90}{13} = 6.29\Omega$

i)

$I_{dc} = ?$

First we will find Idc in full wave rectifier



$I_{dc} = \frac{V_m}{\pi R} = \frac{90}{3.14 \times 13} = \frac{90}{40.82}$

$= 2.204A$

$V_{DC} = \frac{V}{\pi} = 28.66$

$V_{rms} = \frac{V_m}{2} = \frac{90}{2} = 45V$

$I_{rms} = \frac{90}{2R}$

$= \frac{90}{2(13)} = \frac{90}{26}$

$I_{rms} = \boxed{3.46 A}$

1-θ Full wave tectifier can contoolled

$V_s = V_{dc} = \frac{2V_m}{\pi} = \frac{2(90)}{3.14}$

$= \frac{180}{3.14} = 57.32$

$I_{dc} = \frac{V_m}{R} = \frac{90}{13} = 6.92 A$

$V_{rms} = \sqrt{2}\, v_s$

$= \sqrt{2}(57.32)$

$= 1.41(57.32)$

$= 81.06$

$I_{Rms} = I_m/_2$

$$= \frac{6.29}{2}$$

$$I_{rms} = \boxed{3.145A}$$

Ans///

Question NO :- 3 Part (A)

Principal of Buck Converter :-

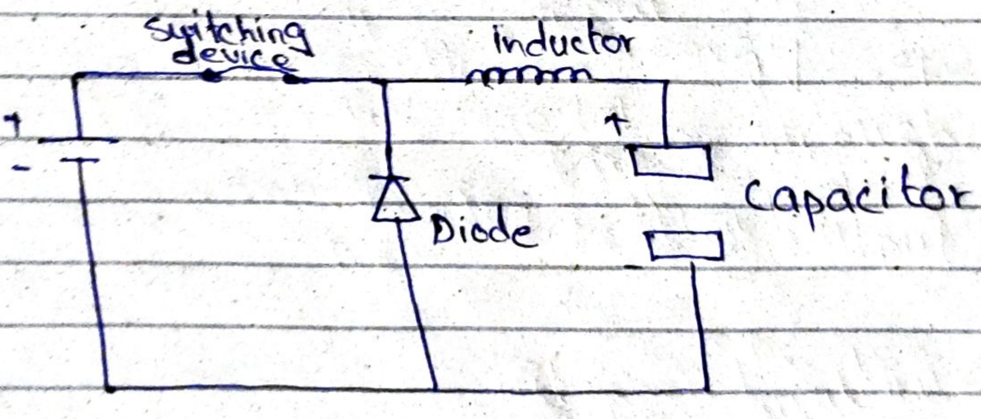
→ The main working principle of buck converter is that the inductor in the input circuit resists sudden variation in input current. when switch is ON the inductor stores energy from the input in the form of magnetic energy & discharge it when switch is closed the capacitor in the output is assumed large enough that the time constant of RC circuit, in the output stage is high. The large time compared to switching period ensures that in the steddy state a constant output voltage $V_o(t) = V_o$(constant) exists across load terminal.

Working of Buck Converter :-

The working of a buck converter into a few steps.

Step 1:-

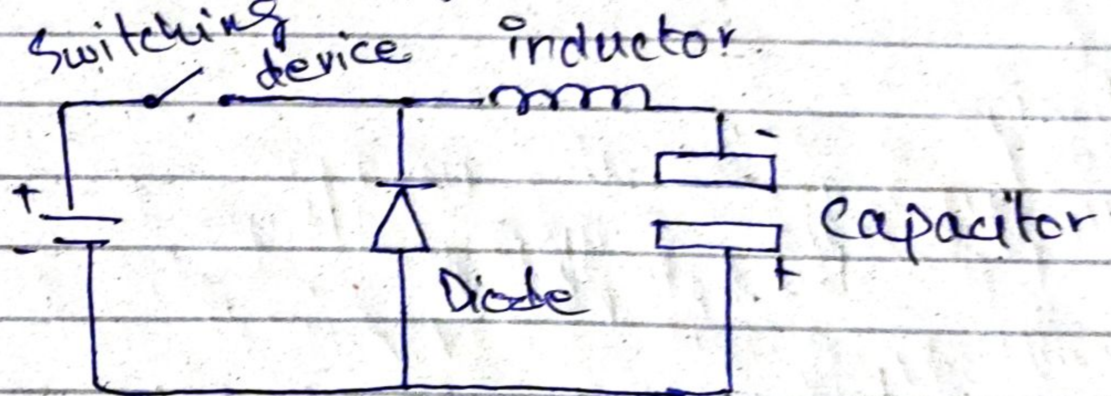
The switch ON & let current flow to the output capacitor, charging it up. Since the voltage across the capacitor cannot rise instantly & since the inductor limits the charging current the voltage across the cap during the switching cycle is not the full voltage of the power source.



Step 2:-

The switch turns OFF since the current in an Inductor cannot charge only suddenly, then the inductor creates a voltage across it.

This voltage is allowed to charge the capacitor & power the load through the diode when the switch is turned off maintaining current output current throughout the switching.



Question:- 3(B) Part (B)

Given:-

$V_{in} = 50V$

duty cycle = 90% = 0.90

$R = 13\Omega$

$f = 20kHz = 20000 Hz$

i) $V_{out} = ?$

$V_o = d(v_i)$

$= 0.90(50)$

$V_o = 45V$

(ii) $I_{out} = ?$

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

$$= \frac{45}{13}$$

$$= 3.46A$$

(iii) $I_{in} = ?$

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

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

$I_{in} = 3.84\ A$

(iv). inductor(*) = ?

$L = \frac{I_{OFF}\ LR}{2}$

As we know that

$V_o = dV_i$

$d = V_o/V_1 = \frac{45}{50}$

$d = 0.9$

$\frac{I_{ON}}{T} = 0.9$

$T_{ON} = 0.9 * T$ $T = \frac{1}{f}$

$T_{ON} = \frac{0.9}{f}$

$T_{ON} = \frac{0.9}{20(10^3)\ Hz} = 4.5\ LB$

Also from eq we have

$$\frac{I_{ON}}{I} = 0.9$$

$$\frac{I_{ON}}{0.71} = I \Rightarrow \frac{1.60fs}{0.9} = 1.78$$

now

$$I = I_{ON} + I_{OFF}$$

$$I_{OFF} = I - I_{ON}$$

$$= 1.78 - 4.5$$

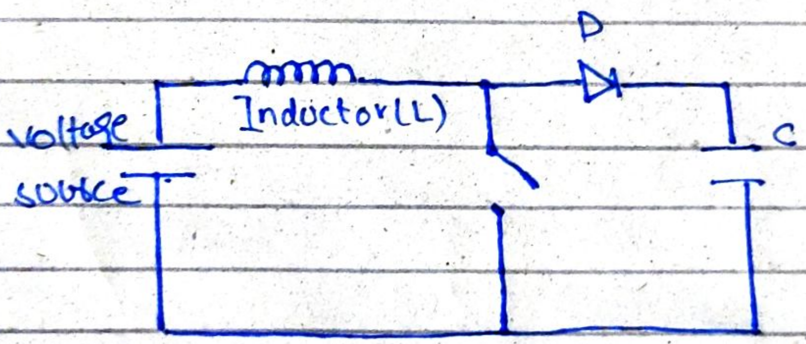
$$= -2.72$$

Question No 4:- Part (A)

Ans:-

Boost chopper:-

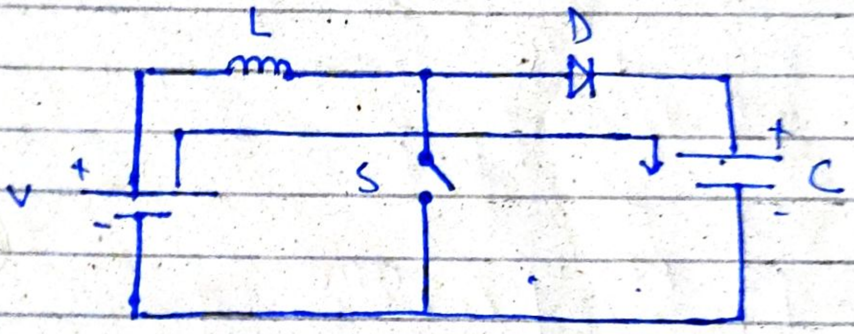
A boost converter is one of the simplest type of switch mode converter. It takes an input voltage & boost it. All consist of is an inductor, a semi conductor switch, a diode & a capacitor. It is also called as step-up converter.



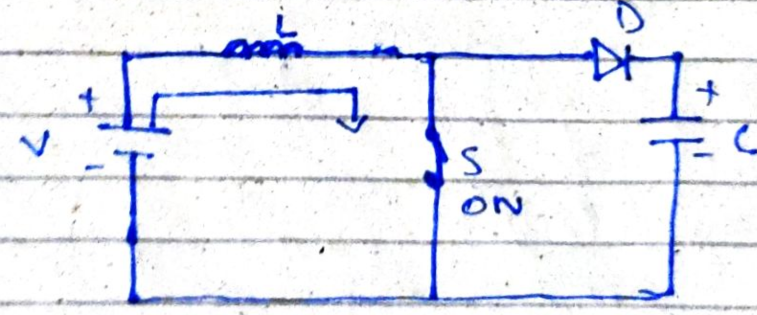
Working Principal

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 ~~source~~ 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 charge since it can't discharge through the now back-biased diode. is ON for a time t_{ON} & is OFF for a time t_{OFF}. we defined the time period, T, as : $T = T_{ON} + T_{OFF}$ & the switching frequency.

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

Now define another term duty cycle.

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

Boost converter in steady state operation for this mode using KVL.

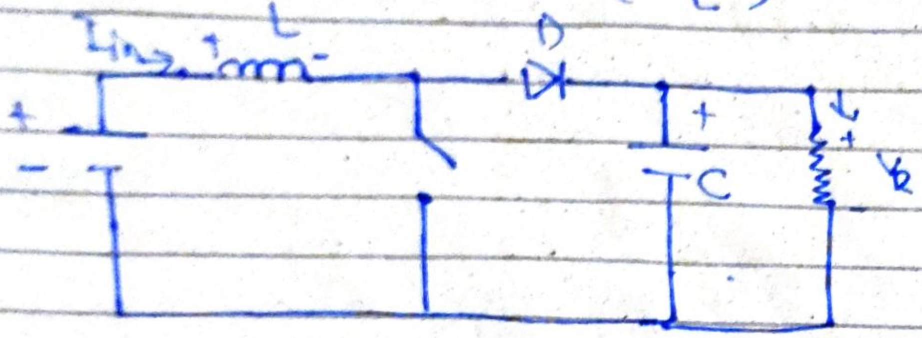
$$V_{in} = V_L$$

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

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

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 help 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 conjunction with the input source.

Analyze the circuit using KVL

Boost Converter in steady state operation for mode

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

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

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

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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Question No 4

Part (B)

Given:-

$V_{in} = 50V$
$D = 90 = 0.90$
$R = 13\Omega$
$f = 20Hz$

Finds:-

i) V_{out}
ii) I_{out}
iii) I_{in}
iv) Inductor (L)

we know that

$\Rightarrow$ i) $V_{out} = \frac{V_S}{1-D} = \frac{50}{1-0.90} = \frac{50}{0.1}$

$V_{out} = \boxed{500\ V}$

$\Rightarrow$ ii) $I_{out} = \frac{500}{13} = \frac{V_{out}}{R}$

$I_{out} = \boxed{38.46\ A}$

// Ans //

iii) $L = \frac{I_{out}}{1-D}$

$= \frac{38.46}{1-0.90} = \frac{38.46}{0.1}$

Inductor = 384.6 L

Ans

~~Inductor $= \frac{I_{out}}{1-D}$~~

~~$= \frac{384.6}{1-0.90} = \frac{384.6}{0.1}$~~

~~= 3846~~

Ans

Question NO 5:: Part (A)

Buck Boost converter

The buck boost converter is large of DC- DC that has output voltage magnitude that is either greater than its then the input voltage magnitude. It is equvalinted to a flyback converter using a single inductor instead of a transformer.

Principal of working of buck Converter,,

The main working principle of buck converter is that the induce in the input circuit result sudden variations in input current. when switch is ON the inductor store energy & discharge it when switch is closed the capacitor in the output circuit is assumed large is enough that the time constant of RC circuit in the output stage is high the large time constant compare to switching period ensure a constant output voltage

$V_o(t) = V_o$ (constant)

Question :- 5 (B)

PART B

Given:-

$V_{in} = 50$

$V_{out} = 90\% = 0.90$

$R = 13\Omega$

$f = 20kHz$

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

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

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

$$= \frac{50 + 1}{0.90 + 50} = \frac{5}{50.90} \approx 0.098$$

$$= 1.00$$

(2)

$$I_{out} = \frac{V_o}{R} = \frac{0.90}{13}$$

$$= 0.069$$

(3) $I_{in} = \frac{I_o D}{1-D} = \frac{0.069(1.00)}{1-1.00}$

$= \frac{0.069}{0}$

$= 0$

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

$= \frac{50 \times 1.00}{20,000(I_{out} - I_{in})}$

$= \frac{50}{20,000(0.069 - 0)}$

$= \frac{50}{1380} = 0.036$

* THE END *