IQRA NATIONAL UNIVERSITY

Power Electronics

Final Assignment Spring 2020

Name: Kaleem Ullah

ID: 13170

Submitted to: Engr Shayan Tariq Jan Sir

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Question No (1)

Difference between single phase half wave and full wave bridge rectifire

① Half wave rectifire which convert only one half of AC cycle into pulsating DC while full wave rectifire is an electronic circut which convert entire cycle AC into pulsating DC

② Half wave utilize only half of AC cycle for the convertion while full have utilize full wave of AC cycle

③ Half wave is unidirectional the conduction is one direction only either convert positive or negative that why called half wave rectifire is bidirectional it convert for positive as well as negative half of the cycle.

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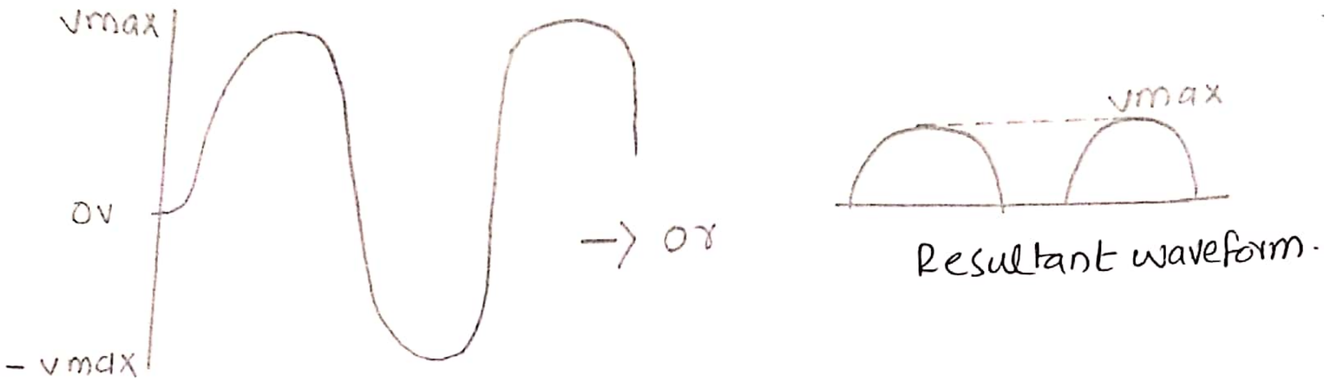
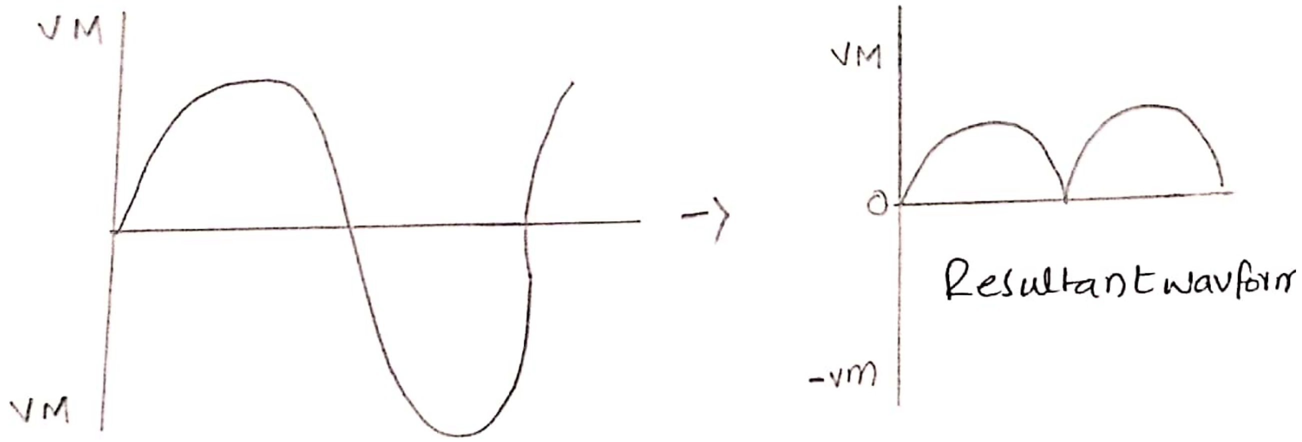
(4) output waveform of Single phase half wave



and single phase wave bridge rectifire



=> (1) Similartris between single Phase wave and full wave bridge rectifire.

(1) Peak inverse voltage of single half wave and full wave rectifire are same which is Vin and same in both rectifires.

=> Both utilize the Single phase for the operation.

(2) Single phase uncontroll and Controll rectifire difference and Similarties.

=> uncontroll they are naturally turn on whever a positive voltage is applied between its terminal and when you Stop by applying its negative voltage.

=> while in controll rectifire that Conduction Start at any angle in positive half cycle normally 0 to 180 degree once the Conduction Start can be turn on and OFF.

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Question No (2)

Given 70 v

R = 13 Ω

Solution :- For half wave

(1) vdc

$$\frac{vm}{\pi} \rightarrow (1)$$

where vm = 70V and π = 3.14

putting these values in eq (1)

$$vdc = \frac{70}{3.14}$$

vdc = 22.29

For Full wave bridg

$$\frac{2vm}{\pi}$$

putting value

$$vdc = \frac{2(70)}{3.14} \Rightarrow \frac{140}{3.14}$$

vdc = 44.58

⇒ (2) I_{dc}

For half wave

$$I_{dc} = \frac{V_m}{\pi R}$$

$$I_{dc} = \frac{70}{(3.14)13}$$

$$I_{dc} = \frac{70}{40.82}$$

$$\boxed{I_{dc} = 1.714A}$$

⇒ For full wave

$$I_{dc} = \frac{I_m}{\pi} \rightarrow (2) \quad \text{where } I_m = \frac{V_m}{R}$$

$$I_m = \frac{70}{13}$$

$$I_m = 5.3A$$

⇒ Put it in eq (2)

$$I_{dc} = \frac{5.3}{3.14}$$

$$\boxed{I_{dc} = 1.714 \text{ Amp}}$$

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⇒ (3) Vrms ⑥

For half wave

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

$$= \frac{70}{2}$$

$$V_{rms} = 35V$$

For full wave

$$V_{rms} = \sqrt{2}\, V_s \longrightarrow ③$$

As $V_s = \frac{V_m}{\sqrt{2}}$

$$= \frac{70}{\sqrt{2}}$$

$$= \frac{70}{1.414}$$

$$V_s = 49.50$$

putting value of Vs in eq ③

$$V_{rms} = (\sqrt{2})(49.50)$$

$$= (1.414)(49.50)$$

$$\boxed{V_{rms} = 70.00V}$$

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⇒ Irms : (For half wave and full wave) ⑦

For half wave

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

$$= \frac{49}{2(13)}$$

$$= \frac{49}{26}$$

$$= 1.884A$$

Irms = 1.884 Amp

⇒ For full wave

$$I_{rms} = \frac{I_m}{2} \rightarrow \text{eq } (4)$$

where $I_m = \frac{V_m}{R}$

$$= \frac{70}{13}$$

$$I_m = 5.38A$$

put values of Im in eq (4)

$$I_{rms} = \frac{5.38}{2}$$

Irms = 2.69

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(5) I would like to refer the uncontrolle full wave bridge rectrifire because the efficency of the full wave bridge rectifire is better than in half wave rectifire and out put frequency also grater than half wave rectifire.

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Question No (3)

Buck Chopper

(1) out put voltage is less than input voltage.

(2) The thyristor in the circuit acts as a switch

(3) when thyristor is ON supply voltage appear across the Load

(4) when thyristor is OFF the voltage across the Load will be zero.

(5) Practical arrangment includes on inductor L and diode which are used to eliminate current pulsation providing a smooth DC amount of current

(6) with S closed D is off and it remain OFF and it remain off as long as S in ON

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(10)

7. The i/P current buildup exponen-
-tically and flow through L and
Load

8. Vo equal to V1

9. with S off or open the current
through I decay to zero

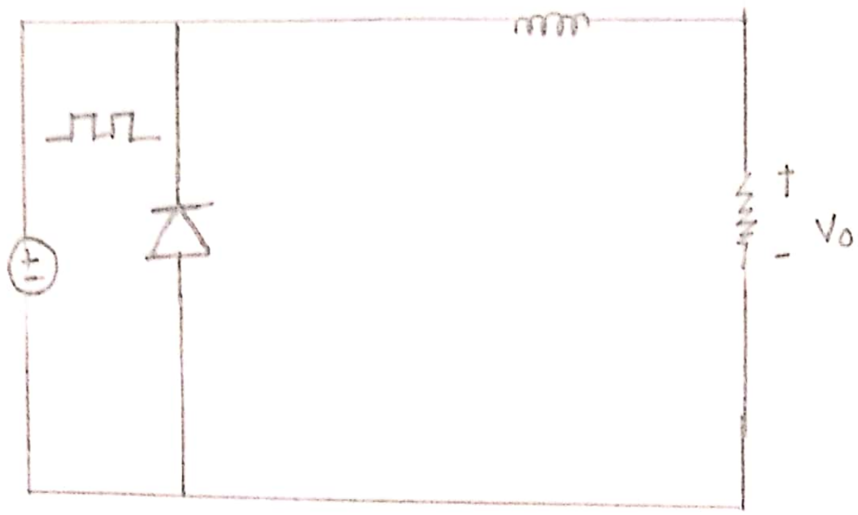
10. This cause inductive voltage
with opposite polarity across L.

11. V2 forward bias diode D

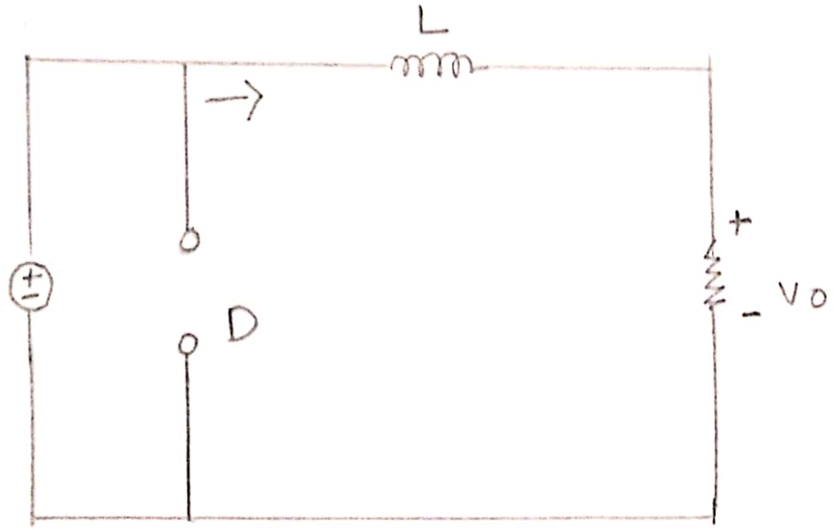
12. Current flows through L and Load
and diode D

13. This arrangment permit the use
of simple filter inductance L
to provide a satisfactorily
Smooth DC Load Current

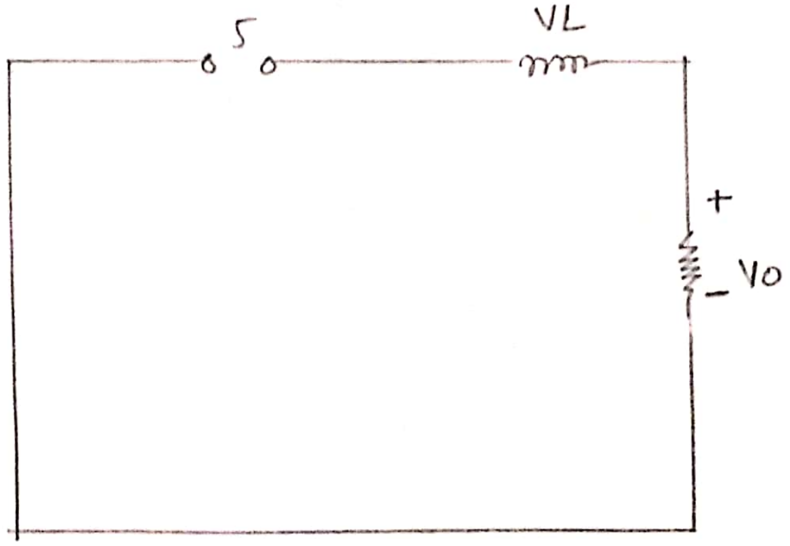
14. With high switch frequency
Smaller inductance is sufficient
to get desired output.



=> Circut of Buck Converter.



=> Circut when closed



=> Circut when Switch is open

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⇒ Given Data

vin = 50 V

D = 0.70%

R = 13 Ω

Frequency (f) = 20KHz

(1) Vout

we know that

Vout = α × Vs OR D × Vs → (1)

Here = α = Duty cycle

which 70% = 0.70

putting all value in eq (1)

vout = (0.70) (50)

Vout = 35 V

(2) I out

I out = Vo/R

$= \frac{35}{13}$

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$I_{out} = 2.69\ A$

(3) I in

We know that

$$I_o = \frac{I_i}{\alpha ORD}$$

$$I_i = I_o \times D$$

$$Fi = 2.69 \quad 0.70$$

$$I_i = 1.88\ A$$

(4) Inductor

we know that

$$L = \frac{T_{OFF}}{2} \times R$$

Let Suppose $T_{OFF} = 0.009$

$$L = \frac{0.006}{2} \times 13$$

$$L = 0.039\ H$$

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Question No (4)

Boost chopper

1. The output voltage is more that the input voltage by Serval time.
2. L is used to provide Smooth input current
3. The SCR (S) acts as the Switch which work in PWM mode.
4. with S ON the L is Connected to the supply
5. Load voltage V_2 Jumps instantaneously to V_1 but Current through L increase linearly and Stored energy
6. When S is open the Current the Current collapses and energy is Stored and L is transferd to C through D

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(7) The induced voltage across the inductor reverse and adds to Source voltage increasing output voltage

(8) The Current that was flowing through S Now flow through L, D and C to Load.

(9) Energy Stored in inductor is released to load

(10) When S Closed D become reverse baise the capacitor energy Supplied the Load voltage and Cycle again

$V_0 = V_1 + V_2$

(11) VO is always higher than VI as polarity of inductor voltage V2 is Same as V1

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(16)

(12) if inductor L is very Large Source current I1 is repple free and considered constant $W_{ON} = V_I T_i T_{ON}$

(13) Assuming C to be Large enough to neglect the voltage ripple vo is considered constant

$$W_{OFF} = (V_O - V_i) * I_i * T_{OFF}$$

(14) Since Losses are neglect the energy Stored transferred during T OFF by L min be equal to energy gained during T ON $= W_{OFF} = V_i T_i T_{ON} =$

$$= (V_O - V_i) * I_i * T_{OFF}$$

$$V_O = V_I \left(1 + \frac{T_{ON}}{T_{OFF}}\right) = V_I \left(\frac{T}{T - T_{ON}}\right)$$

$$V_i \left(\frac{1}{1 - \frac{T_{ON}}{T}}\right) = V_1 \left(\frac{1}{1-d}\right)$$

Thus vo is always greater than v1

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=> Thus vo is always greater than v1

-> $P_I = P_o$ -> $V_I I_I = \frac{V_o^2}{R}$ -> $I_I = \frac{V_o^2}{V_I} * \frac{1}{R}$

-> $I_o = I_I \times \frac{T_{OFF}}{T}$ => $I_o = I_I (1-d)$

-> $P_o = P_I$ => $V_I I_I$ => $\frac{V_o^2}{R} = \frac{V_i^2}{(1-d)^2} * \frac{1}{R}$

-> $I_I = \frac{V_I}{(1-d)^2} * \frac{1}{R}$

-> $I_I = \frac{I_{max} + I_{min}}{2} = I_I$

$I_{max} + I_{min} = 2 * I_I$

-> voltage across L is

$V_L = V_I = L * \frac{di}{dt}$

$\Delta I_I = \frac{V_I}{L} * T_{ON}$ or $I_{max} - I_{min}$

=> $\frac{V_i}{L} T_{ON}$

Again $I_{max} + I_{min} = 2 * I_I$

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=> Solving

$$I_{max} = V_I \left[\frac{1}{R(1-d)^2} + \frac{T_{ON}}{2L} \right]$$

$$I_{min} = V_I \left[\frac{1}{R(1-d)^2} - \frac{T_{ON}}{2L} \right]$$

$$I_{P-P} = I_{max} - I_{min} = \frac{V_I T_{ON}}{L}$$

For continous current mode

$$I_{min} = V_I \left[\frac{1}{R(1-d)^2} - \frac{T_{ON}}{2L} \right]$$

$$\Rightarrow \frac{1}{R(1-d)^2} = \frac{T_{ON}}{2L} \Rightarrow L = \frac{R T_{ON} (1-d)^2}{2}$$

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⇒ Given Data

Vin = 50V

duty cycle D = 0.70%

Resistor R = 13 Ω

Frequency F = 20 KHz

(1) Vout

As we know

$$Vo = Vi \left(\frac{1}{1-d} \right)$$

$$Vo = 50 \left(\frac{1}{1-0.70} \right)$$

$$Vo = 50 \left(\frac{1}{0.30} \right)$$

$$\boxed{Vo = 166.66}$$

(2) I out

$I_O = I_1 (1-d) \rightarrow (1)$

First finding Iin

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(3) I IN

$$I_1 = \frac{Vi}{(1d)^2} * \frac{1}{R}$$

$$\Rightarrow \frac{50}{(1-0.70)^2} \times \frac{1}{13}$$

$$I_{in} = \frac{50}{(0.3)^2} \times \frac{1}{13}$$

$$= \frac{50}{0.09} \times \frac{1}{13}$$

$$= 555.55 \times \frac{1}{13}$$

$$\boxed{= 42.73 \text{ A}}$$

putting this value in eq (1)

$$I_{out} = I_1 (1-d)$$

$$I_o = 42.73 (1-0.70)$$

$$I_o = 42.73 (0.30)$$

$$\boxed{I_o = 1.2.8 \text{ A}}$$

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Question NO (5)

=> Buck - Boost Chopper

-> it combines the concept of both step - up an step - down choppers

-> The output voltage is either higher or lower than input voltage

-> The switch is either an SCR or GTO or IGBT

-> when S in ON D is reverse biase and ID is zero

-> while S is OFF the source is disconnected.

-> The current through inductor doesnot change instantaneously and it forward bias the diode providing path for the load.

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→ With S = ON (TON) ; WON = VI * I1 * TON

With S = OFF (TOFF) ; WON = VI X I1 X TOFF

→ Ignoring Losses , WON = WOFF =

VI * I1 * ION

⇒ VI * I1 * TOFF

→ $V_O = V_I \frac{dt}{(I-d)T} = V_I \frac{d}{(i-d)}$

$I_L = \frac{I_{max} + I_{min}}{2}$; $I_1 = I_L d = \frac{(I_{max}+I_{min})}{2} \times d$

The average and put $P_I = V_I I_1 = \frac{(I_{max} + I_{min})}{2}$

$\times dv \Rightarrow P_o = \frac{V_o^2}{R}$

→ $I_{max} = V_I \left[\frac{1}{R(1-d)^2} + \frac{I}{2L} \right] d$

→ $I_{min} = V \left[\frac{1}{R(1-d)^2} - \frac{I}{2L} \right] di$

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(23)

⇒ For Continous Current Condition

$$I_{min} = 0 = V_1 \left(\frac{1}{R(1-d)^2} - \frac{T}{2L} \right) d$$

$$\Rightarrow L = \frac{RTd}{2} (1-d)^2$$

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⇒ Data

$V_{in} = 50\,V$

$V_{out} = 70\%$ 0.70

Resistor (R) = 13 Ω

Frequency f = 20 KHz

① Duty cycle (D)

we know that

$$\frac{V_o}{V_I} = \frac{-D}{1-D}$$

$$V_o = \frac{V_i d}{(1-d)}$$

$$0.70 = \frac{50\,d}{(1-d)}$$

$$(0.70)(1-d) = d50$$

$$0.70 - 0.70d = d50$$

$$0.70 = d50 + 0.70d$$

$$\Rightarrow 50.7d$$

$\Rightarrow \quad 50.7d = 0.70$

$d = 0.0138$

(2) I out

we know that

$$I_{max} + I_{min} = \frac{2dvi}{R(1-d)^2}$$

putting values

$$\Rightarrow \frac{2(0.0138)(50)}{13(1-0.0138)^2}$$

$$\Rightarrow \frac{2(0.0138)(50)}{13(0.97)^2}$$

$$\Rightarrow \frac{1.38}{12.23}$$

$I_{max} + I_{min} \Rightarrow 0.11$ Ampere (A)

⇒ (3) $I_i = I_L \times d$

$\Rightarrow 0.11 \times 0.0138$

$\Rightarrow 0.0015 A$

(4) Inductance

$$L = \frac{RTd}{2} (1-d)^2$$

putting values

$$L = \frac{13(5\times10)^{-5}}{2} \times (1-0.0138)^2$$

$$L = \frac{13(5\times10^{-5})}{2} \times (0.97)$$

$$\boxed{L = 0.00031 H}$$ Answer:-

Thank You