Name : Muhammad Saqib Khalil

ID : 13342

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Submitted to : Engr. SHAYAN TARIQ JAN

Q#01

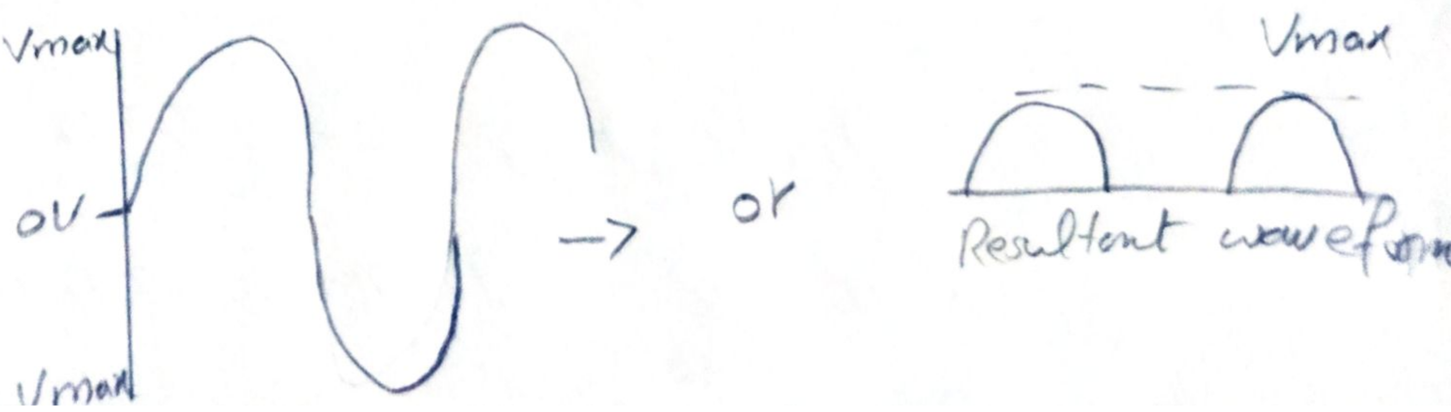
Difference between single phase half wave and full wave bridge rectifier:

① Half wave rectifier which convert only one half of the AC cycle into pulsating DC ~~which~~ while full wave rectifier is an electronic circuit which convert entire cycle AC into pulsating DC

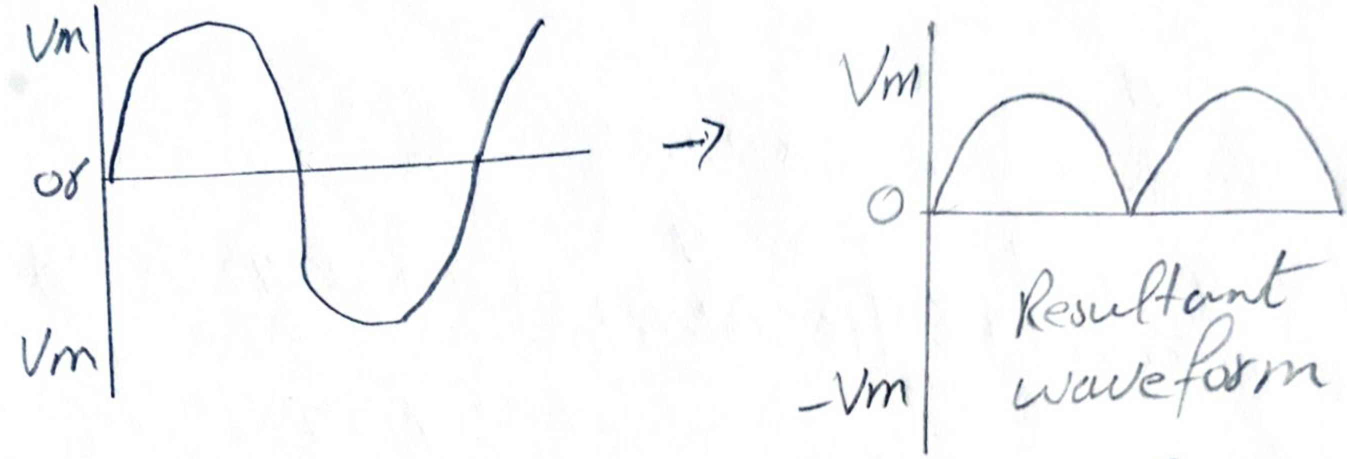
② Half wave utilize only half of AC cycle for the convertion while full have utilize full wave of AC cycle

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

4) output waveform of single phase half wave rectifier



and single phase wave bridge rectifier



5) The number of diode in half wave rectifier is 1 while in bridgh rectifier is 4.

Simillarities between single phase Half wave & full wave bridge rectifier:-

1) Peak inverse voltage of single half wave and full wave rectifier are same which is Vm & same in both rectifier

② Both Utilize the single phase for the operation.

(2) single phase uncontroll and controll rectifier difference & simillarities:-

(1) uncontroll they are naturally turn on whenever a positive voltage is applied between its terminal & when you stop by applying it negative voltage
while in controll rectifier, the conduction start at any angle in positive half cycle normally 0 to 180 degree once the conduction start can be turnon and OFF

Q#02

Given :

$Vm = 42V$

$R = 13\Omega$

Sol:

For half wave

1) Vdc :

$$\frac{Vm}{\pi}$$

where $Vm = 42V$ & $\pi = 3.14$

putting these values in eq 1

$$Vdc = \frac{42}{3.14}$$

$$Vdc = 13.37V$$

For full wave bridg

$$\frac{2Vm}{\pi}$$

putting value

$$Vdc = \frac{2(42)}{3.14}$$

$$Vdc = 26.75V$$

(2) I_{dc} :

For half wave

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

$$I_{dc} = \frac{42}{(3.14)13}$$

$$I_{dc} = \frac{42}{40.82}$$

$$= 1.028 \text{ Amp}$$

For full wave

$$I_{dc} = \frac{I_m}{\pi} \quad \text{--- (2)}$$

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

$$I_m = \frac{42}{13}$$

$$I_m = 3.23 \text{ Amp}$$

put it in eq (2)

$$I_{dc} = \frac{3.23}{3.14}$$

$$I_{dc} = 1.0286 \text{ Amp}$$

(3) V_{rms} :

For half wave:

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

$$= \frac{42}{2}$$

$$V_{rms} = 21 \text{ V}$$

For full wave

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

$$V_{rms} = \sqrt{2}\, V_s \quad \text{—— (3)}$$

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

$$= \frac{42}{\sqrt{2}}$$

$$= \frac{42}{1.414}$$

$$V_s = 29.70$$

putting value of V_s in eq (3)

$$V_{rms} = (\sqrt{2})(29.70)$$

$$= (1.414)(29.70)$$

$$\boxed{V_{rms} = 41.99 \text{ V}}$$

4) Irms : (For half wave & full wave)

For half wave

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

$$= \frac{42}{2(13)}$$

$$= \frac{42}{26}$$

$$\boxed{I_{rms} = 1.61 \text{ Amp}}$$

For full wave:

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

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

$$= \frac{42}{13}$$

$$I_m = 3.23 A$$

put value of I_m in eq (4)

$$I_{rms} = \frac{3.23}{2}$$

$$\boxed{I_{rms} = 1.615 A}$$

(5)

I would like to refer the uncontroll full wave bridge rectifier because the efficiency of the full wave bridge rectifier is better than in half wave rectifier and output frequency also gratter than half wave rectifier.

Q.3

Buck chopper:

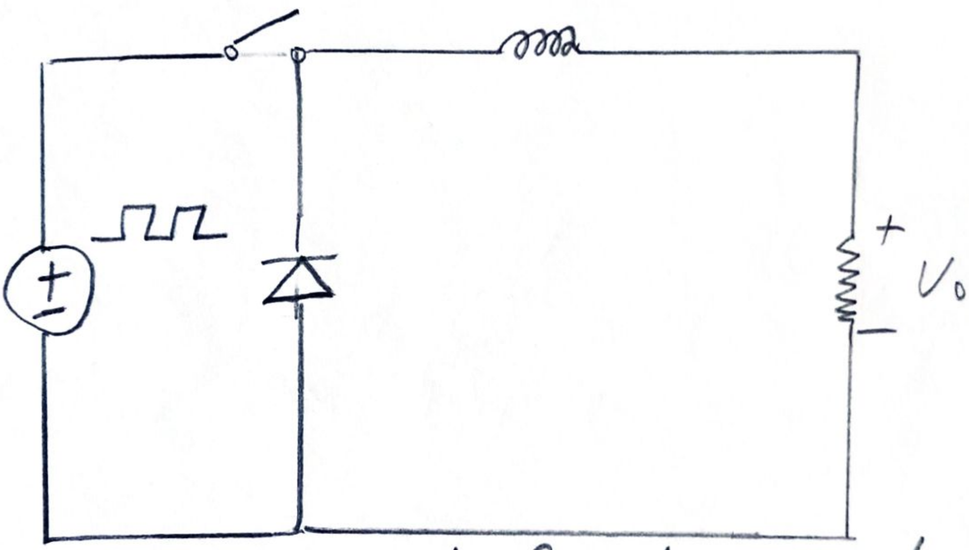
1) Output voltage is less than input voltage
2) The thyrister in the circuit acts a switch
3) when thyrister is ON. Supply voltage appear across the load
4) when thyrister is OFF, the voltage across the load will be zero
5) Practical arrangment includes on inductor L and diode which are used to eliminate current pulsation providing a smooth DC current
6) with S closed, D is off and it remain off and it remain off as long as S in ON
7) The i/p current build up exponentially and flow through L & Load
8) V_o equal to V_i
9) with S off or open, the current through I decay to zero
10) This cause inductive voltage with opposite polarity accross L.

11) V_2 forward bias diode D

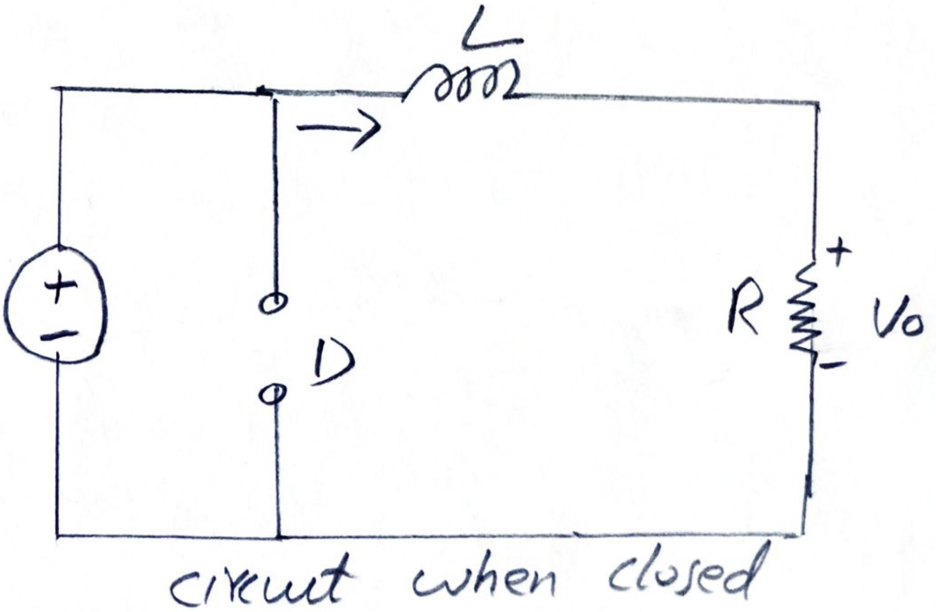
(12) Current flows through L & Load & Diode D

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.

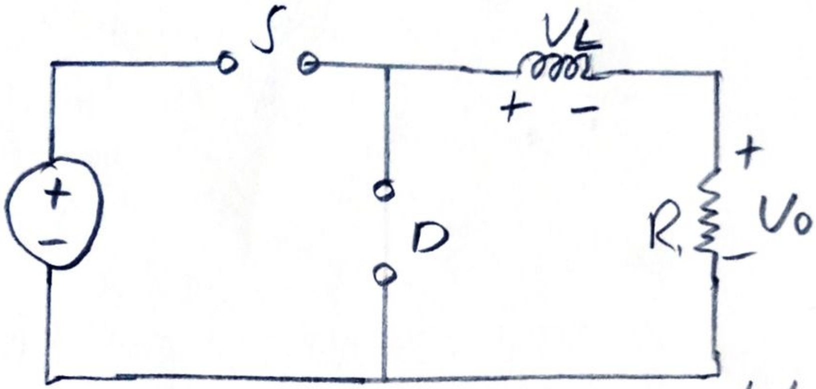


circuit of Buck converter



circuit when closed

(11)



circuit when switch is open

Given data:

$V_{in} = 50V$

$D = 42\%$

$R = 13\Omega$

$\text{Frequency } (f) = 20KHz$

1) Vout

we know that

$V_{out} = \alpha \times V_s$ OR $D \times V_s$ — (1)

Here α = Duty cycle

which $42\% = 0.42$

putting all value in eq (1)

$V_{out} = (0.42)(50)$

$\boxed{V_{out} = 21\,V}$

(12)

(2) Iout)

$$I_{out} = V_o/R$$

$$= \frac{21}{13}$$

$$\boxed{I_{out} = 1.615\ A}$$

3) Iin :-

we know that

$$I_o = \frac{I_i}{D}$$

$$I_i = I_o \times D$$

$$I_i = 1.615 \times 0.42$$

$$\boxed{I_i = 0.6783}$$

(4) Inductor:

we know that

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

Lets suppose $T_{OFF} = 0.009$

$$L = \frac{0.009}{2} \times 13$$

$$\boxed{L = 0.0585\ H}$$

Q.4

Boost chopper:-

① The output voltage is more that the input voltage by saveral 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_L jumps instantaneously to V_i but current through L increase linearly & stored energy

6) when S is open, the current collapses & energy stored in L is transfered to C through D

7) The induced voltage across the inductor reverse and adds to source voltage, Voltage increasing output voltage

8) The current that was flowing through S now flow through L, D & C to Load.

9) Energy stored in inductor is released to Load

10) when S closed again, D become reverse baise, the capacitor energy supplied the load voltage & cycle again

$V_o = V_i + V_L$

(11) V_o is always higher than V_i as polarity of inductor voltage V_L is same as V_i

12) If inductor L is very large, source current I_i is repple free & considered constant $W_{on} = V_i T_i T_{ON}$

13) Assuming c to be large enough to neglect the voltage ripple, V_o is considered constant

$$W_{OFF} = (V_o - V_i) * I_i * I_{OFF}$$

14) Since losses are neglect, the energy stored transfered during T OFF by L min be equal to energy gained during T ON $W_{ON} = W_{OFF} = V_i I_i I_{ON} = (V_o - V_i) * I_i * OFF$

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

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

Thus V_o is always greater than V_I

$\rightarrow P_i = P_o \rightarrow V_i I_i = \frac{V_o^2}{R} \rightarrow I_i = \frac{V_o^2}{V_i} * \frac{1}{R}$

$\rightarrow I_o = I_i \times \frac{T_{OFF}}{T} \Rightarrow I_o = I_i\,(1-d)$

$\rightarrow P_o = P_i \Rightarrow V_i I_i \Rightarrow \frac{V_o^2}{R} = \frac{V_i^2}{(1-d)^2} * \frac{1}{R}$

$\rightarrow I_i = \frac{V_i}{(1-d)^2} * \frac{1}{R}$

$\rightarrow I_L = \frac{I_{max} + I_{min}}{2} = I_i$

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

(15)

→ Voltage accross L is

$$V_L = V_1 = L * \frac{di}{dt}$$

$$\Delta I_1 = \frac{V_1}{L} * T_{ON} \text{ or } I_{max} - I_{min} \Rightarrow \frac{V_i}{L} T_{ON}$$

Again $I_{max} + I_{min} = 2 * I_1$

Solving

$$I_{max} = V_1 \left[\frac{1}{R(1-d)^2} + \frac{T_{ON}}{2L} \right]$$

$$I_{min} = V_1 \left[\frac{1}{R(1-d)^2} - \frac{T_{ON}}{2L} \right]$$

$$I_{p-p} = I_{max} - I_{min} = \frac{V_1 T_{ON}}{L}$$

For continous current mode

$$I_{min} = V_1 \left[\frac{1}{R(1-d)^2} - \frac{T_{ON}}{2L} \right]$$

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

Given data:

$V_{in} = 50V$

dutycycle $D = \cancel{20\%}$ 42%

Resistor $R = 13\Omega$

frequency $F = 20KHz$

1) Vout

As we know

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

$$V_o = 50\left(\frac{1}{1-0.42}\right)$$

$$V_o = 50\left(\frac{1}{0.58}\right)$$

$$\boxed{V_o = 86.20V}$$

2) Iout:

$$I_o = I_1(1-d) \quad (1)$$

First finding In

3) IN

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

$$\Rightarrow \frac{50}{(1-0.42)^2} \times \frac{1}{13}$$

$$I_{in} = \frac{50}{(5.8)^2} \times \frac{1}{13}$$

$$= \frac{50}{0.3364} \times \frac{1}{13}$$

$$= 148.63 \times \frac{1}{3}$$

$$\boxed{= 11.43\ A}$$

putting this value in eq ①

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

$$I_o = 11.43(1-0.42)$$

$$I_o = 11.43(0.58)$$

$$\boxed{I_o = 6.629\ A}$$

Q.5

Buck- Boost chopper:-

-> It combines the concept of both step-up & Step- down choppers

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

-> The output voltage polority also be reserved

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

-> when S in ON, D is reverse biose & I_D is zero

-> while S is OFF, the source is disconnected

-> The current through inductor does not change instantanously and it forward brose the diode, providing path for the Load.

-> with S= ON (T_{ON}); $W_{ON} = V_1 * I_1 * T_{ON}$

with S= OFF (T_{OFF}); $W_{ON} = V_1 \times I_1 \times T_{OFF}$

-> Ignoring losses, $W_{ON} = W_{OFF} = V_1 * I_1 * T_{ON}$

$$\Rightarrow V_1 * I_1 * T_{OF}$$

-> $V_0 = V_1 \dfrac{dt}{(I-d)T} = V_1 \dfrac{d}{(i-d)}$

(14)

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

The average output $P_i = V_1 I_1 = \left(\frac{I_{max} + I_{min}}{2}\right)$

$\times dV \Rightarrow P_0 = \frac{V_0^2}{R}$

$\rightarrow I_{max} + I_{min} = \frac{2dV_1}{R(1-d)^2} ; \quad I_{max} - I_{min} = \frac{V_s}{L} dt$

$\rightarrow I_{max} = V_1 \left[\frac{1}{R(1-d)^2} + \frac{T}{2L}\right] d$

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

For continuous current condition

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

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

$\longleftrightarrow$

Data

Vin = 50V

Vout = 42%

Resistor (R) = 13 Ω

Frequency f = 20 KHz

1) Duty cycle (D)

we know that

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

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

$$0.42 = 50.\frac{d}{(1-d)}$$

$$(0.42)(1-d) = d50$$

$$0.42 - 0.42d = d50$$

$$0.42 - 0.42d$$

$$0.42 = 50d + 0.42d$$

$$0.42 = 50.42d$$

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$$d = \frac{0.42}{50.42}$$

$$\boxed{d = 0.00833}$$

2) Iout

we know that

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

$$= \frac{2(0.00833)\,50}{13(1-0.00833)^2}$$

$$= \frac{0.833}{12.78}$$

$$I_{max} + I_{min} = 0.065A \quad (1)$$

we know that

$$I_{out} = \frac{I_{max} + I_{min}}{2}$$ putting eq (1) value in place of Imax + Imin

$$= \frac{0.065A}{2}$$

$$\boxed{= 0.0325}\ Amp$$

3) $I_i = ?$

$I_i = I_L d$

$I_i = 0.325 \times 0.00833$

$\boxed{I_i = 2.707 \times 10^{-3}}$

(4) Induction

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

putting value where $T = \frac{1}{F}$

~~L = 13 (0.00005) f t 0~~

$$L = \frac{13(5 \times 10^{-5}) \times 0.00833}{2}(1 - 0.00833)^2$$

$$= \frac{5.414 \times 10^{-6}}{2}(0.99167)^2$$

$$= (2.707 \times 10^{-6})(0.983)$$

$$\boxed{L = 2.6609 \times 10^{-5} H}$$ Answer