Department of Electrical Engineering
Assignment
Date: 27/06/2020

Course Details

Course Title:	Power Electronics	**Module:**	
Instructor:	Engr Shayaan	**Total Marks:**	50

Student Details

Name:	Idrees Iqbal	**Student ID:**	13171

Note: Plagiarism of more than 20% will result in negative marking.
Similar answers of students will result in cancellation of the answer for all parties.

Q1.	Rectifiers are common circuits used in most electronic devices. There are multiple types of rectifiers used now a days. Explain in detail what are the similarities and differences between: 1. 1 – φ Uncontrolled Half Wave Rectifier and Full Wave Bridge Rectifier 2. 1 – φ Uncontrolled Rectifier and Controlled Rectifiers (Bridge Rectifier).	CLO 2 Marks 10
Q2.	A AC voltage of Vm = (Last 2 digits of ID) V has to be delivered to a Resistive DC load of R = (First 2 digits of ID) ohms. The load and source are connected through 2 types of 1 – φ Uncontrolled rectifiers (Half Wave and Full Wave Bridge) and data is collected. Find the following for both rectifiers: 1. Vdc 2. Idc 3. Vrms 4. Irms 5. Which rectifier do you think is better and why.	CLO 2 Marks 10
Q3.	The Buck chopper is a type of DC-DC converter. Explain in detail the principals and working of Buck converter when the switch is open and closed. The buck converter is connected to a DC source voltage of Vin = 50V. The duty cycle is D = (Last 2 digits of ID) %, load of R = (First 2 digits of ID) ohms and switching frequency of 20kHz. What will be the 1. Vout 2. Iout 3. Iin 4. Inductor (L)	CLO 3 Marks 10

Q4	The Boost chopper is a type of DC-DC converter. Explain in detail the principals and working of Boost converter when the switch is open and closed. The boost converter is connected to a DC source voltage of Vin = 50V. The duty cycle is D = (Last 2 digits of ID) %, load of R = (First 2 digits of ID) ohms and switching frequency of 20kHz. What will be the 1. Vout 2. Iout 3. Iin 4. Inductor (L)	CLO 3 Marks 10
Q5	The Buck-Boost chopper is a type of DC-DC converter. Explain in detail the principals and working of Buck converter when the switch is open and closed. The Buck-Boost converter is connected to a DC source voltage of Vin = 50V. The Output voltage Vout = (Last 2 digits of ID) %, load of R = (First 2 digits of ID) ohms and switching frequency of 20kHz. What will be the 1. Duty Cycle (D) 2. Iout 3. Vin 4. Inductor (L)	CLO 3 Marks 10

Name Idrees Iqbal ID 13171 Submitted To · Engr. Sajjad

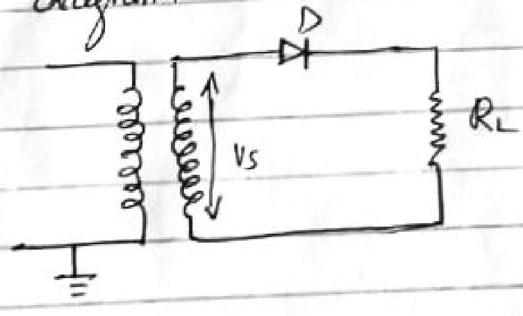
Ans)1 Half Wave Rectifier.

The crucial difference between half wave and full wave rectifier is that halfwave rectifier Convert only one-half cycle of the ac input supplied into pulsating dc signal.

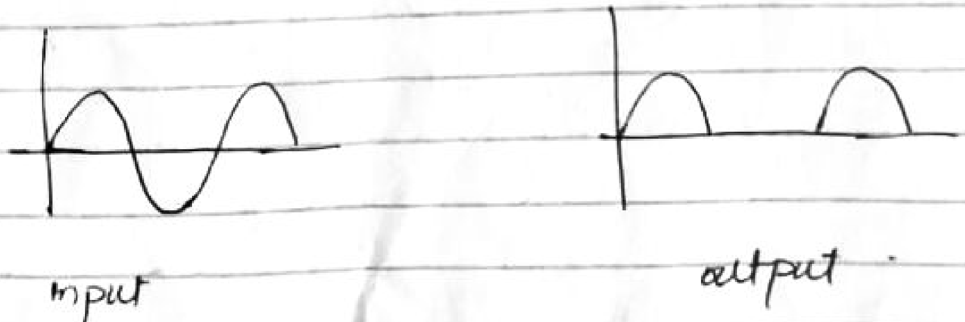
Another major difference the two is that the rectification efficency of half wave rectifier is Somewhat less compared to the full wave rectifier

the half wave passes only one half of the half at the applied input signal and block the other when the positive half of the input is passed then nagative half is blocked and vice-versa.

Circuit diagram

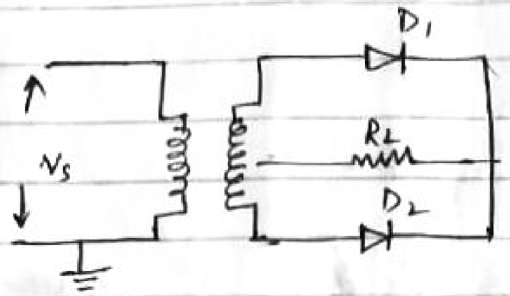


it is composed of an ac source, a diode, a step-down transformer and a resistor that serves load.



Full wave Rectifier:-

A full wave rectifier is a that is a circuit that has the ability to pass both the halves of the applied input signal. Ac input signal is converted into pulsating dc by the full wave rectifier.



it consist of step down transformer along with 2 diodes connected with resistor (load)

when positive half on the input is applied to the circuit then it causes diode D_1 to get forword bias there by allowing the flow of the current through it Hence the signal appears at the load.
at the same time the positive half reverse bias the diod D2. There by condition does not take place through it. Hence no any output is achived at the load

Due to the negative half cycle diode D_2 will now be forword biased and now start condition due to which current flows through it and hence appears at the load.

input output

Parameters	Half wave	Full wave
* Number of diode used in circuit	1	2 or 4
* Maximum efficiency for rectification	40.6%	81.2%
* Basic ripple frequency	f	2f
Ripple factor	More	less
voltage regulation	Good	Batter as compared to half wave
Tranformer utilization factor	0.287	0.693
Peak inverse voltage	Maximum value of supplied input	Twice the maximum of supplied
Peak factor	2	1.414
form factor	I_{max}/π	$2I_{max}/\pi$
Tranformer core saturation	possible	Not possible

Q2 $V_m = 71$

$R = 13$

Find V_{DC}, I_{DC}, V_{rms}, I_{rms}

(i) $V_{DC} = ?$

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

$$V_{rms} = \frac{V_m}{2} = 4.5V$$

$$I_{rms} = \frac{V_m}{2R} = \frac{71}{2(13)} = \frac{71}{26}$$

$$= 2.73A$$

$$I_{dc} = \frac{V_m}{\pi R} = \frac{71}{(3.14)(13)} = \frac{71}{40.82}$$

$$\boxed{I_{dc} = 1.73}$$

1-Q Full bridge rectifier

$$V_s = V_o = V_{dc} = \frac{2V_m}{\pi} = \frac{2(71)}{3.14}$$

$$= \frac{142}{3.14}$$

$$\boxed{V_{dc} = 45.22V}$$

$$I_{dc} = \frac{V_m}{R} = \frac{71}{13} = 5.46A$$

$$\boxed{I_{dc} = 5.46A}$$

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

$$= \sqrt{2}(45.22V)$$

$$= 63.76$$

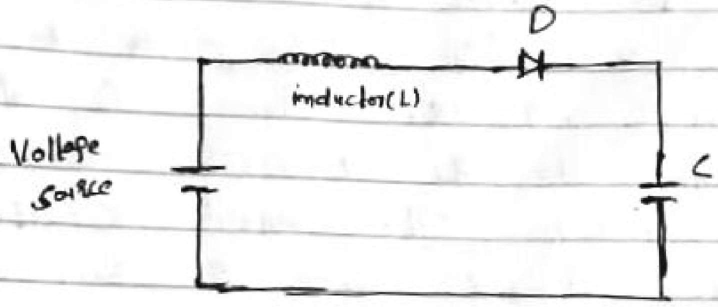
$$I_{rms} = \frac{I_m}{2} = \frac{5.46}{2}$$

$$\boxed{I_{rms} = 2.73}$$

Ans) No 3

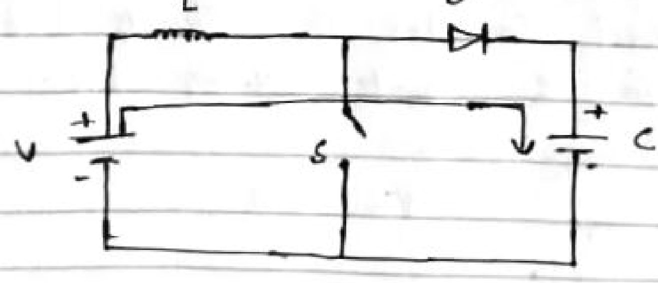
Boost Chopper.

A boost Converter is one of the Simplest types of Switch mode Converter It takes 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.

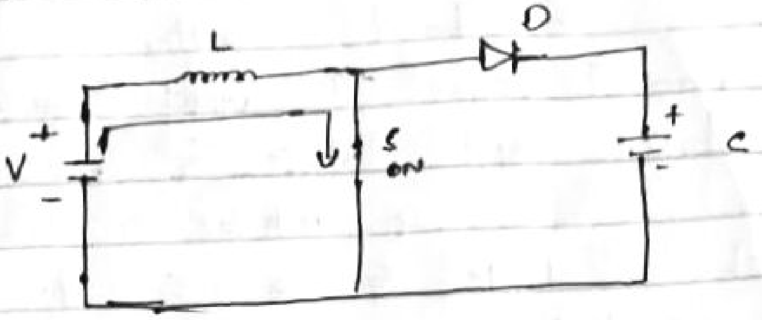


Working principle :

The main Working principle of boost Converter is that the inductor in the input Circuit Resist Sudden Variations in input Current. When Switch is off. the Inductor Stores energy in the form of magnetic energy & discharge 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 directed 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 a time t_{off}. We define the time period, T, as $T = T_{ON} + T_{off}$ & the 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 mode using KVL.

$$V_{in} = V_L$$

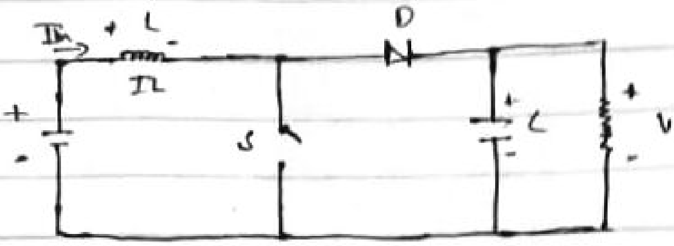
$$V_L = L\frac{di_L}{dt} = V_{in}$$

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

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 helps 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 2 using KVL.

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

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

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

Since the switch is open for a time $T_{OFF} = T - T_{ON} = (1 - D)T$ we can say that

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

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(10)

$V_{in} = 50\,V$

$D = 71$

$R = 13\Omega$

Switching frequency

$f = 20\,Hz$.

find

(1) V_{out}

(2) I_{out}

(3) I_{in}

(4) Inductor (L)

we know that

(1) $V_{out} = \frac{V_s}{1-D} = \frac{50}{1-0.71}$

$= \frac{50}{0.29}$

$= 172.41\,V$

(2)

$I_{out} = \frac{V_{out}}{R} = \frac{172.41}{13}$

$= 13.26\,A$

(3) $I_{in} = \frac{I_{out}}{1-D} = \frac{13.26A}{1-D}$

$= \frac{13.26A}{1-0.71}$

$= \frac{13.26}{0.29}$

$= 45.72\,I$

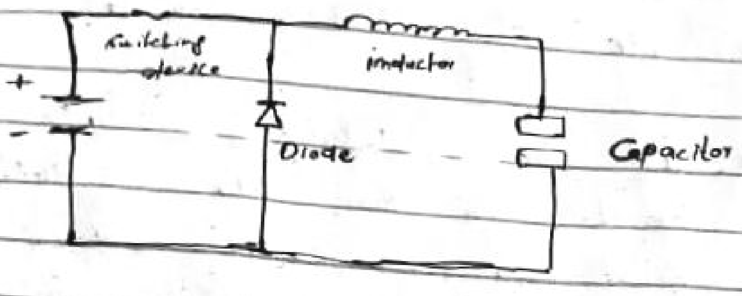
Ans) 4 **Principle of Buck Converter**

The main Woking principle of Buck Converter is that the inductor in the input circuit resist sudden Variations 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 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 Convertor

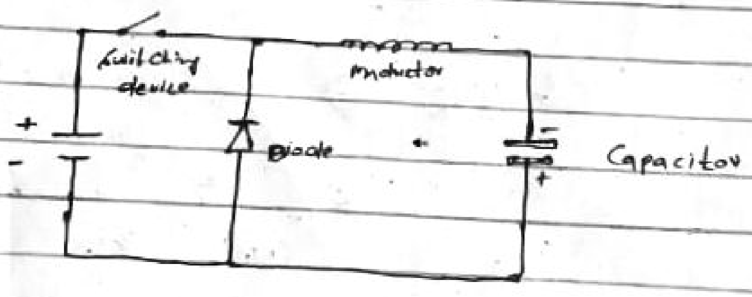
The Woking of a buck Convertor into a few steps.

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 charge Current. the Voltage across the Cap during the switching cycle is not the full Voltage of the power source



Step 2:

The switch turn 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



Ans (4) Problem Solution:

Data

$V_{in} = 50V$

duty cycle $= d = 72\% = 0.72$

↳ Last digits of ID (13272)

$R = 13\Omega$

↳ First digit of ID (13272)

$f = 20\ kHz = 20000\ Hz$

(i)

$V_{out} = ?$

$V_o = d(v_i)$

$= (0.71)\ (50)$

$V_o = 35.5V$

(ii)

$I_{out} = ?$

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

$I_o = \frac{35.5v}{13}$

$I = 2.73A$

(iii) $I_{in} = ?$

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

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

$I_{in} = 3.84A$

(iv) Inductor (L) = ?

$L = \frac{T\,oF}{2}\,R \rightarrow eq\ ①$

AS We Know that

$V_o = dv_i$

$d = v_o/v_i = \frac{35.5}{50} = 0.71$

(A) $\frac{T_{ON}}{T} = 0.71$ ∴ $d = \frac{T_{on}}{T}$

$T_{ON} = 0.71 * T$ ∴ $T = \frac{1}{f}$

$$T_{ON} = \frac{0.71}{20(10^3)\ HZ} = 35.5 \mu s$$

Also from equation (A) we have

$$\frac{T_{ON}}{T} = 0.71$$

Now

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

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

$$T_{OFF} = 50 \mu s - 35.5 \mu s = 15 \mu s$$

$$T_{OFF} = 15 \mu s$$

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

$$L = \frac{15 \mu s}{2} \times 13 = 97.5 \mu H$$

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Ans) 5) Buck Boost Converter -

The buck bost converter is a type of DC-DC that has output voltage magnitude that is either gratter than or less than the input voltage magnitude. it is equvalonted to a flyback converter using a single inductor instead of a transformer

principles and working of buck Converter.

The main working principle of buck converter is that the induce in the input circuit result suddin varaitions in input current. when switch is ON the inductor store energy in the form of magnitude energy and 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)

Q5 Example

$V_{in} = 50v$.
$V_{out} = 00.71\% = 0.71$
$R = 13$.
$f = 20$ KHZ.

(1) Duty Cycle $d = ?$

We Can't find the duty cycle because

(16)

Q No 5 Example

(4)

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

$$L = \frac{50 \times 1.0057}{20 \times 10^3 \times (I_{out} - I_{in})}$$

$$L = \frac{50.285}{20000(0.054 - (-9.52))}$$

$$L = \frac{50.285}{9.574}$$

$$L = 5.252$$ ← Ae

(17)

(b) Q. 5

$V_{in} = 50$

$V_{out} = 71$

$R = 13$

$f = 20\ KHZ$

(1) Duty Cycle = ?

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

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

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

$$D = \frac{50V + 1}{0.71 + 50}$$

$$= \frac{50 + 1}{50.71}$$

$$= 1.0057$$

(2) $I_{out} = \frac{V_o}{R} = \frac{0.71}{13}$

$= 0.054$

(3) $I_{in} = \frac{I_o D}{1 - D} = \frac{0.054 \times 1.00057}{1 - 1.0057}$

$$= \frac{0.0543}{-0.0057}$$

$$= -9.52$$