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

Course Details

Course Title: Power Electronics **Module:** ______
Instructor: SIR SHAYAN TARIQ **Total Marks:** 50

Student Details

Name: RAFI UD DIN **Student ID:** 12401

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

0Q4	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

Q No 1

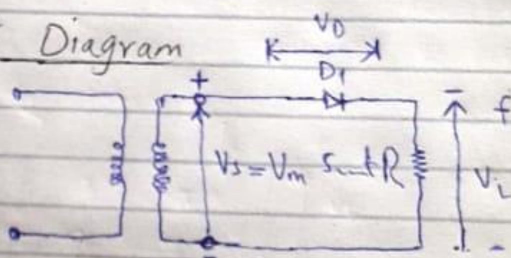
Rectifier

It is the electronic device which is used to convert AC into DC is called Rectifier.

1- ① Uncontrolled Half Wave Rectifier

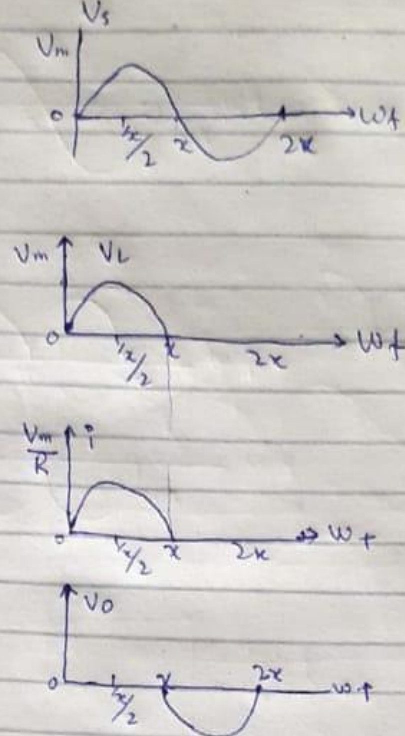
A Rectifier is a circuit that convert an ac signal into Unidirectional signal. Diodes are used commonly in rectifier. A single phase half wave rectifier is the simplest type is not normally used in industrial applicati However, it is useful in understanding the principle of rectifier.

Circuit Diagram



During positive half cycle the input voltage, diode D_1 is forward base and conduct. An input voltage appear across the load. During negative half cycle the input voltage the diode in blocking and output voltage is zero.

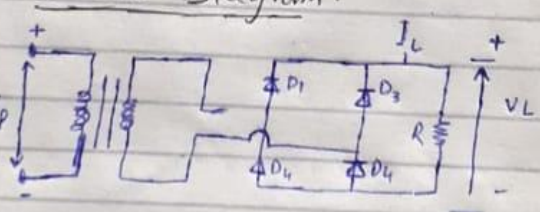
Waveform



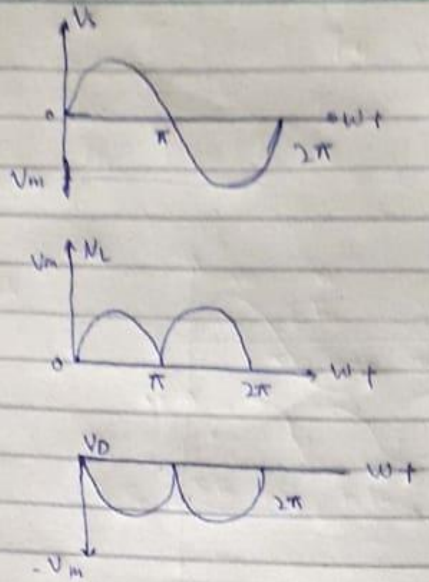
1) 1- Φ Uncontrolled full wave bridge Rectifier

We use four diodes in bridge Rectifier circuit.

Circuit Diagram.



During positive half cycle of the input voltage the current flows throught the load, through diode D_1 and D_2. During negative cycle diode D_3 and D_4 conducts the peak inverse voltage of a diode is V_m.

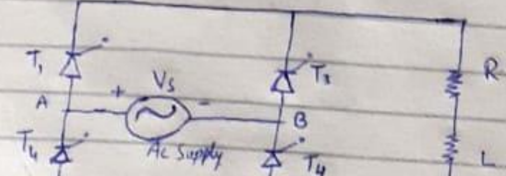


Similisaties. ad differences

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

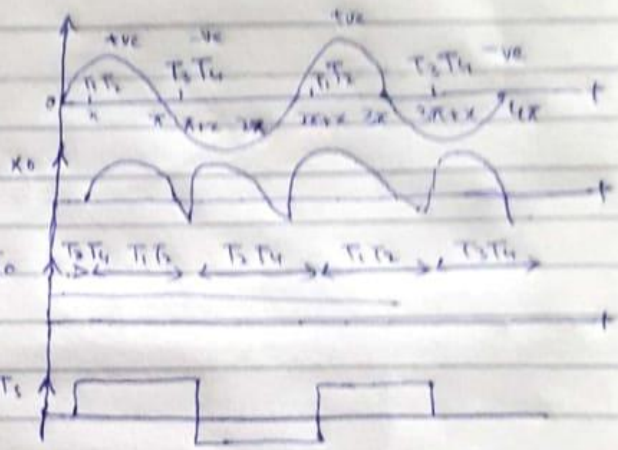
2. 1-Φ Control bridge Rectifier

Circuit Diagram



Its function is basically subdivided into two parts, positive half and negative half cycle. During positive half cycle T1 and T2 will become forward. If we give gate pulse to T1 and T2 current will flow in the Loop. During negative half cycle 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 rectifier uses diodes
- Control rectifier uses SCR
- In control rectifier we ~~use~~ control the output by using the gate pulse. when we give gate pulse than it trigger otherwise not.

Q No 2

Sol:- $V_m = 01$
$R = 12$

we know that
for half wave

1) V_{dc}

$$\frac{V_m}{\pi} \longrightarrow (1)$$

$V_m = 01$, $\pi = 3.14$

So

$$\frac{01}{3.14} = 0.318V$$

For full wave

$$\frac{2V_m}{\pi}$$

$$\frac{2(01)}{3.14} = 0.636V$$

2) I_{dc}

for half wave

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

$$= \frac{01}{3.14(12} = 0.026A$$

For full wave

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

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

$$= \frac{01}{12} = 0.83A$$

So

$$I_{dc} = \frac{0.83}{3.14} = 0.264\ A$$

3) V_{rms}

for halfwave

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

$$\frac{01}{2} = 0.5\ V$$

For full wave

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

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

$$= \frac{01}{\sqrt{2}} = 0.707V$$

$$V_{rms} = \sqrt{2}\,(0.707)$$

$$V_{rms} = 0.99\ V$$

4) I_{rms}

for half wave

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

$$= \frac{01}{2(12)} = 0.041\ A$$

For ful wave

$$\frac{I_m}{2} \rightarrow (1) \quad \text{where} \quad I_m = \frac{V_m}{R}$$

$$= \frac{01}{12} = 0.083\ A$$

put in (1)

$$\frac{I_m}{2} = \frac{0.083}{2} = 0.0415A.$$

5) I would like to refer the uncontrol full wave bridge rectifier because the effiency of the full bridge rectifier is better than half rectifier and output frequency also greater then half wave rectifier.

QNo 3:-

Principle of working of buck converter.

The main working principle of buck converter is that the indicator in the input cirut resist sudden variation in the input current when switch is ON. The indicator store energy in the form of magnetic energy and discharge it when the switch is closed the capacitor is the output circuit is assumed Large enough that the time constant of Rc circuit in the output stage is heigh The Large time conctant compare to switching period ensure a constant output voltage

$V_o(t) = V_o(\text{constant})$

Data:- 12401

$V_{in} = 50V$

$D = 01$

$R = 12$

frequency = 20KHz

① V_{out}

$V_{out} = D\alpha V_s \longrightarrow ①$

α = Duty cycle

01% = 0.01 put in ①

$(0.01)(50) = 0.5V$

2) Iout

$$I_o = \frac{V_o}{R}$$

$$\frac{0.5}{12} = 0.051A$$

3) I_{in}

we know that

$$I_o = \frac{I_1}{\alpha \text{ or } D}$$

$$I_1 = I_o \times \alpha$$

where α is a duty cycle

$$I_1 = 0.051A \times 0.01$$

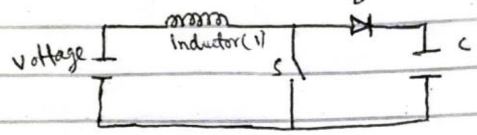
$$I_{in} = 0.00051A$$

4) Inductor.

Q No 4

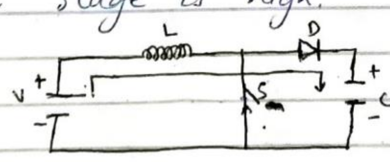
Boost converter:

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

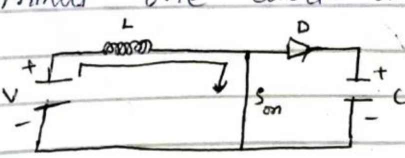


Working Principle:

The main working principle of main converter is that the indutor in the input circuit resist sudden variations in input current. When switch is off the inductor stores energy in the form of megnatic energy and discharges it when switch is closed. The capacitor in the output circuit is assumed large enough that the time constant of R.C 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 charged since it can't discarge through the now back-biased diode.

The switch is ON and therefore represents a short circuit ideally offering zero resistance to the flow of current. Let us say the switch 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 $T_{switch} = \frac{1}{T}$

Now define another term duty cycle,

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

Boost convertor is steady state operation for This made using KVL

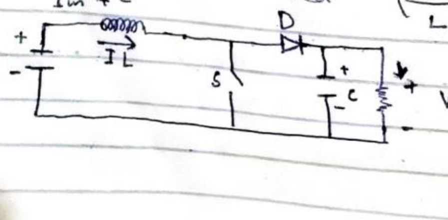
$$V_{in} = V_L$$

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

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

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 indutor is released and is ultimately dissipated in the load resistance, & this helps to maintain the flow of current in the same direction through the Load and also step up the voltage as the inductor is now also acting as a source is conjuoction with the input source.

Anaylise the circuit using KVL

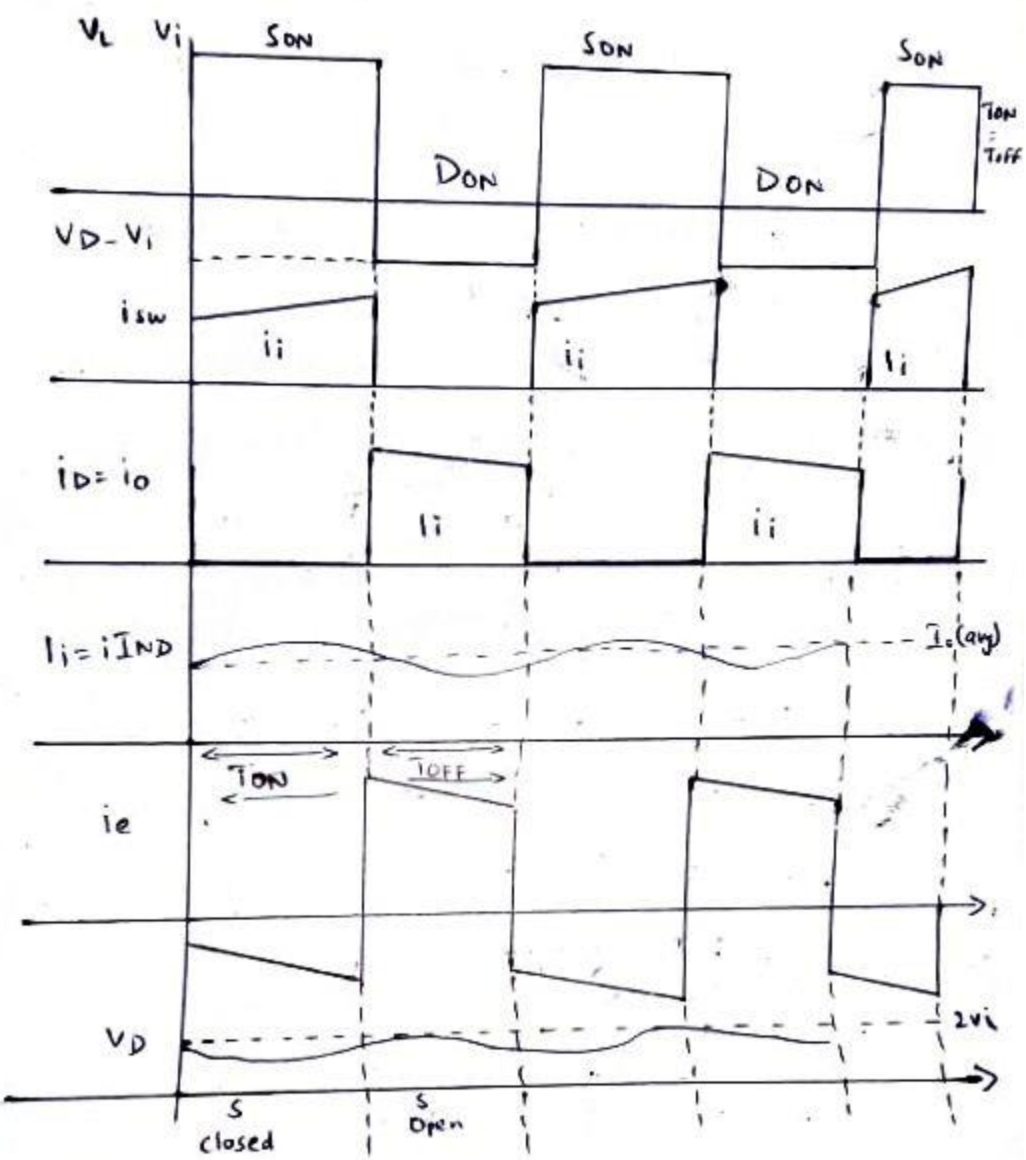
Boost convertor is steady state operation for made 2 using KVL

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

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

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

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



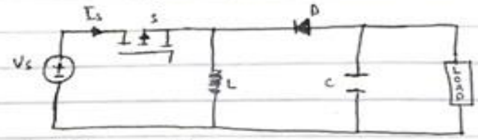
VL
Vi
SON
DON
TON = TOFF
VD-Vi
isw
ii
iD= io
Ii = iIND
Io(avg)
TON
TOFF
ie
VD
2vi
S closed
S Open

Q NO 5

Buck - Boost Choppers

A buck boost converter which can operate as a DC-DC step-down upon the duty cycle, D.

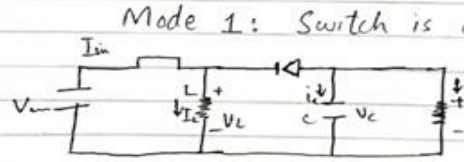
Buck-Boost Converter is shown below



The input voltage source is converted to a solid state device. The second switch is used a diode. The diode is connected, in reverse to the direction of power flow from source, to a capacitor and the Load and the two are connected in parallel as shown in the figure above.

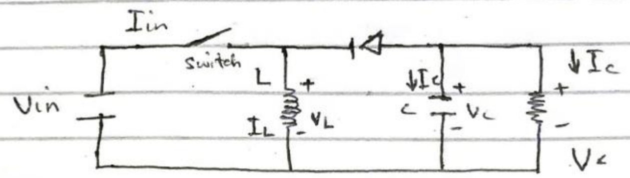
The controlled switich is turned ON and OFF by using pulse with modulation. PWM can be time based or frequency based. Time based is mostly used for DC-DC converters. It is smple to construct and use. Frequency remain constant in this type of PWM modulation.

Mode 1: Switch is ON, Diode OFF



The switch is ON and therefore represent a short circuit ideally offering zero resistance to the flow of current. So when the switch is ON all the current will flow through the switch and and the inductor and back to the DC input source. The inductor stores charge during the time the switch is ON & when the solid state switch is OFF the polarity of the inductor reverses, so that current flows through the load and through the diode and back to the inductor. So the direction of the current remain same.

MODE II. Switch is OFF, Diode is ON



In this mode the polarity of the inductor is reversed and the energy stored in the inductor is released. So the current through the inductor cannot abruptly change the diode must carry the current so it commulates and begins conducting. Energy is transformed from the indutor to the capacitor resulting in a decreasing inductor current and a voltage across the resister with the opposite polarity compared to Vin.

During steady state the circuit is said to operate.

1- In discontinuous ~~condition~~ conduction mode if the inductor current reaches zero.

2- In continuous conduction mode if the inductor current never reaches zero.

Data:-

Vin = 50V

Vout = 0.1%

Resistor = 12

frequency = 20kHz

① Duty Cycle

$$\frac{V_o}{V_1} = \frac{-D}{1-D}$$

$$V_o = \frac{+V_1 d}{1-d}$$

$$0.01 = +50 \frac{d}{1-d}$$

$(0.01)(1-d) = 50d.$

$0.01 = 50d + 0.01d$

$0.01 - 0.01 = 50d$

$0.01 = 50.0.01d$

$$\frac{0.01}{(50)(0.01)} = 0.000002.$$

2 ///

Iout

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

$$I_{max} + I_{min} = \frac{2(0.000002)(50)}{12(1-0.000002)^2}$$

$$= \frac{0.0002}{11.99} = 1.66^{-5}$$

$$I_{out} = \frac{I_{max} + I_{min}}{2}$$

$$\frac{1.66^{-5}}{2} = 0.039\ A$$

3) $Ii = ?$

$$I_i = I_{cd}$$

$$= 0.039 \times 1.66^{-5}$$

$$= 0.0030\ A.$$