

EE 463 Term Project 1

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# Introduction

Today, computers, televisions and mobile phones have become indispensable in our lives. We can't think of a life without them. So how do we get the energies of these devices?

In many power electronics applications, the input power is 50 - 60 AC power from the mains and is converted to DC in the application. Diode rectifiers can be used in industry where there is no control voltage required or in applications where power transmission is not required. In diode rectifiers, the power flow is only one way from mains to load. Diode rectifiers are preferred in DC power supply, AC motor drives and many other areas.

In this Project covers that single phase rectifier under different type loads

…….. to be continued.

Q1)

In this question discrete time step calculations in the simulation of a single-phase uncontrolled rectifier that is feeding a resistive load (R=100Ω) is performed. Simulation results with step size 1.5 msec, 10 µsec and 1 µsec can be observed in Figure 1, 2, and 3, respectively.

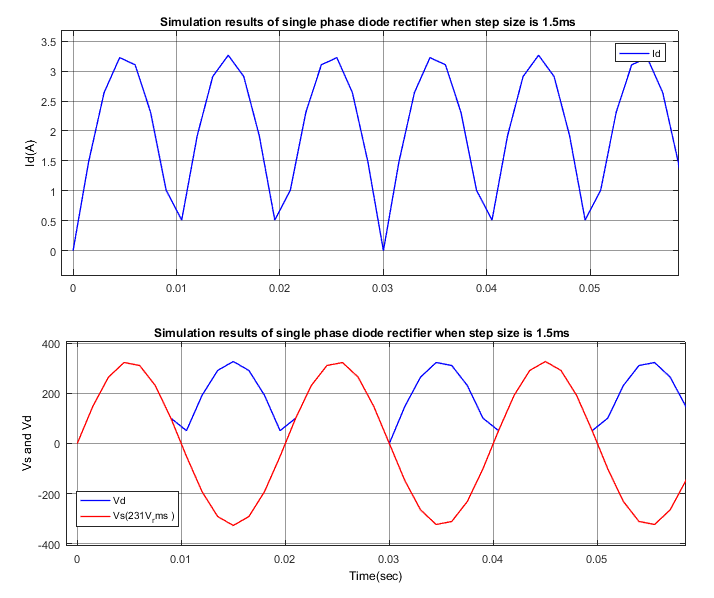
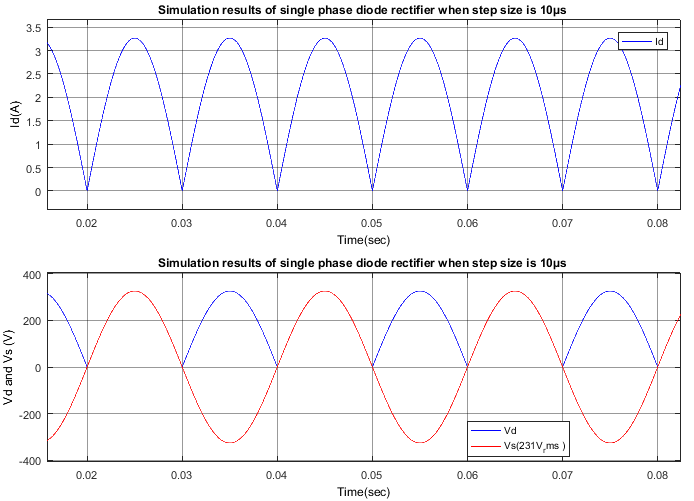
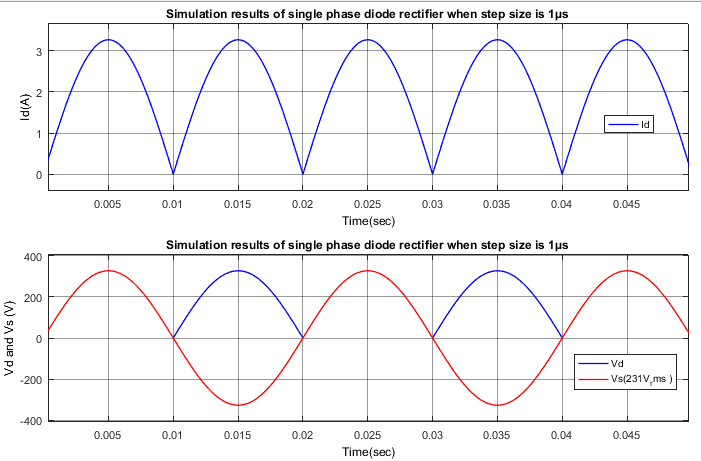


Figure 1



**Figure 2**



**Figure 3**

Q2.2)

**Q2.2)**

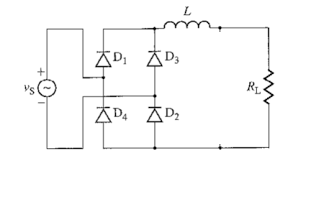
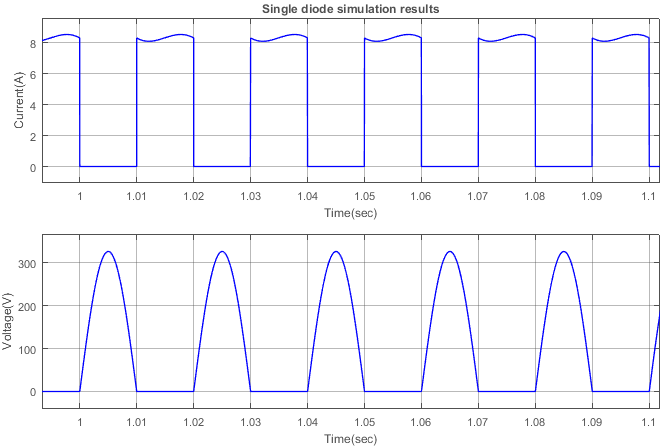


Figure 4

In Figure 4 when Vs in its positive cycle D1 and D2 is on so the current passing them is equal to Iline and voltage drop of them is equal to zero since the diodes are ideal; whereas the voltage drops on D3 and D4 are equal to Vs

In figure 5, the plots showing voltage drop and the current passing through on a single diode in steady state is shown. For simulation we used the third load in part 2.1.



*Figure 5: Voltage drop and the current passing through on a single diode in steady state*

To select a practical diode for an application several parameters should be considered such as absolute ratings and how they change with temperature rise, thermal parameter, static electrical parameters to evaluate conduction loss, and dynamic parameters to evaluate switching losses. However, for this particular circuit frequency of the grid is 50 Hz which makes some dynamic parameters such as forward & reverse recovery time and switching losses insignificant. A general purpose diode with standard recovery time should be sufficient.

From Figure 5, the peak voltage drop on diodes is 326.6V whereas Vav is 104V whereas, the maximum repetitive current passing is 8.5A and Iav is 4.158A.

To choose a discrete diode limiting factors will be maximum repetitive peak voltage (Let’s look for a diode with 400V) and If(av) (Let’s look for a diode with 5-6 Amps). We can use 6A4 diode for $0.176 from Micro Commercial Components ( <http://www.mccsemi.com/up_pdf/6A05-6A10(R-6).pdf> ) or S5GC diode for $0.15 from Diodes Incorporated (<https://www.diodes.com/assets/Datasheets/ds16007.pdf> ).

To choose a single-phase diode rectifier module we should look for 9-9.5 Amp output rectified output current and again similar maximum repetitive peak voltage values under standard purpose single phase bridges section. Note that I searched for 10Amps because there were less options in 9Amps. We can use MP10 04G-G for $1.61 or GBU 1004-G for $1.33 (<http://www.comchiptech.com/admin/files/product/GBU10005-G%20Thru402044.%20GBU1010-G%20RevC.pdf> )from Comchip Technology (<http://www.comchiptech.com/admin/files/product/MP10005G-G%20Thru242784.%20MP1010G-G%20RevC.pdf> )

Obviously, buying four discrete diodes is a cheaper solution. From maximum ratings points of view using discrete diodes is a better selection as well. Also, by using discrete devices we can increase the surface area, this could be useful to decrease thermal rise. However, the power modules are normally assembled in relatively small area to save space and this is the main advantage of the modules.

## Q2.3)

From Figure 6, we can see that VRRM of the 100Ω load is 327V according to this Iload is in phase with Figure 6 and peaks at 3.27A; therefore, we need to find the required capacitance for output voltage ripple smaller than 65V.

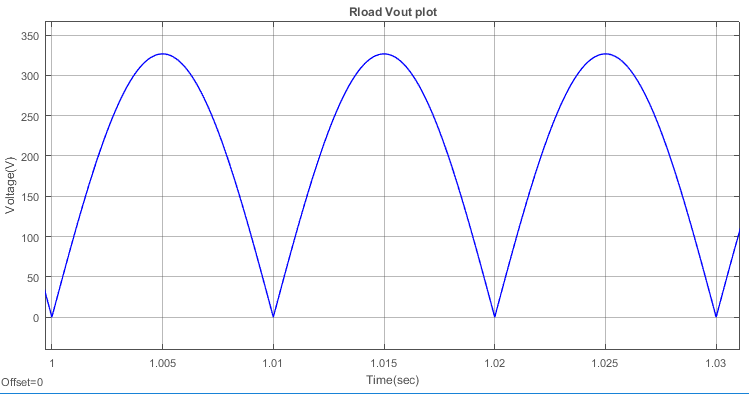


Figure 6: Vout of 100Ω load

To choose the required capacitance time constant should be significantly longer than the time interval between the successive peaks of the rectified waveform (1). When the ripple is small compared to the output peak voltage it behaves (2) where Iload is the maximum load current.

(1)

According to (2), for approximately 50V ripple C should be 654μF which makes τ 6.5 times the time interval between successive peaks of the rectified waveform. In figure 7, you can observe the output waveforms, note that ripple is approximately 40V. Then, an aluminum electrolytic capacitor whose working voltage is above 305V should be looked for. I chose 620μF capacitor from Cornell Dubilier Electronics with call number CGS621T300R2L. (<https://media.digikey.com/pdf/Data%20Sheets/United%20Chemi-Con%20PDFs/U36D%20Series.pdf> )

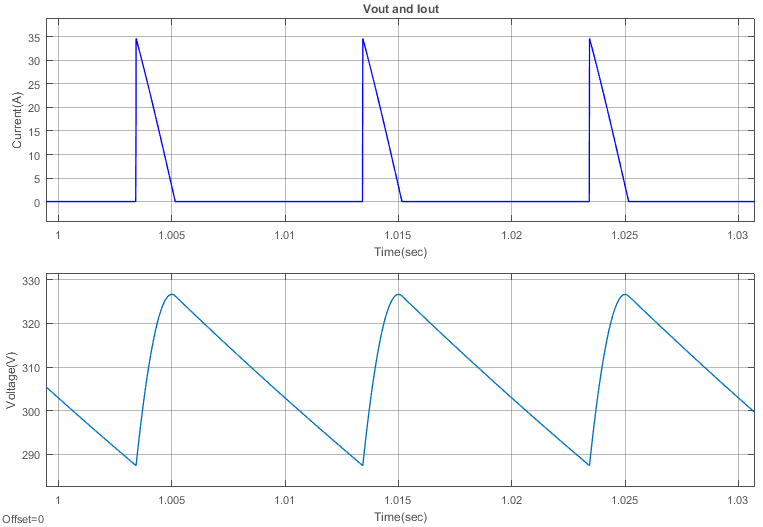


Figure 7:  *Voltage drop and the current passing through the load in steady state*

# Q3)