Electronic Devices and Circuits Lab (EE2301)
Experiment 5 : Voltage regulator

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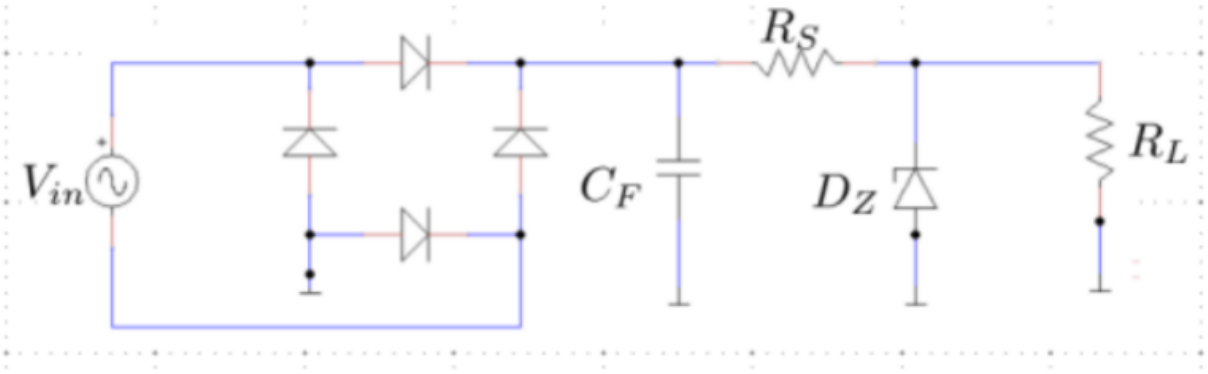
1 Aim

Our aim is to build a voltage regulator circuit using diodes,capacitors and resistances..

Voltage Regulator

A voltage regulator is a system designed to automatically maintain a constant voltage level.



Voltage Regulator circuit diagram

2 Problem statement

• Write a NgSPICE script to simulate bridge rectifier with an Low pass filter and zener voltage regulator. Use the parameters as specified according to your group. Use the input signal frequency of 50 Hz.

• Select the values of R_S and C_F appropriately such that the zener diode, D_Z , always remains in the break down regime. Justify your choice.

• Perform a transient analysis for the above circuit.

• Run the circuit with and without Zener diode and clearly show the impact on the output voltage.

• Briefly explain the working of the circuit by plotting input, filtered and regulated voltage.

• Group 1

• Given Breakdown voltage = 3V

• Load resistance R_L=750 - 1000 Ω

• Peak voltage V_p = 6V.

3 Procedure

Steps

• First we need to write spice scripts for the above circuit of voltage regulator with given values.

Finding R_S and C_F

• Now we need to find the values of C_F such that the output across capacitor has its minimum voltage value greater than breakdown voltage. we can do this by maintaining capacitance as much as required

• We need to find R_S such that it is large enough not to be a short circuit and small enough that the voltage drop across R_S is low.

• The values suitable turned out as $R_S = 500\ \Omega$ and $C_F = 100\ \mu$ F

• The above values are obtained by checking output for different values of R_S and C_F.

Transient analysis

• We need to plot the output across the load resistance with respect to time.

• Now check if the voltage is constant and equal to breakdown voltage.

With and without zener diode

• Now we need to do the same transient analysis with zener and without zener diode.

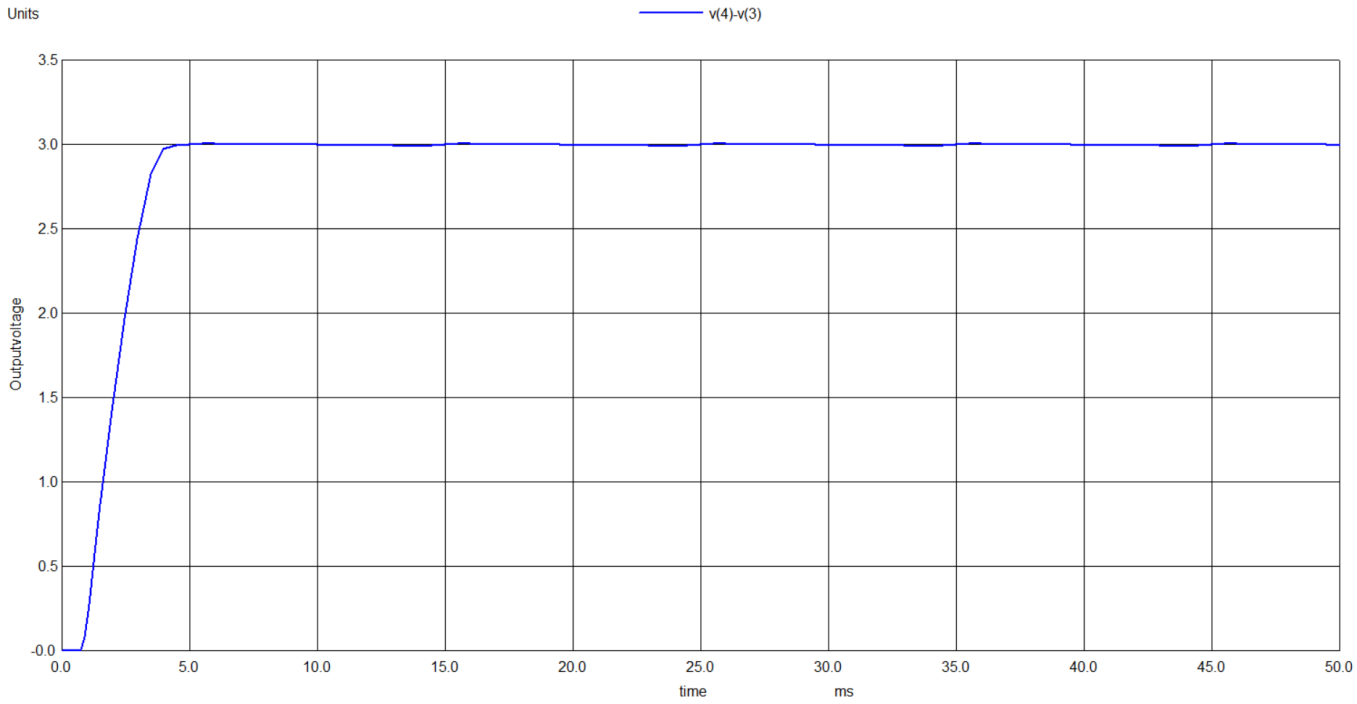
• Now we need to plot the outputs and analyse them.

Input, filter output and load output

• Now do the same transient for the circuit and plot the input , filter output and load output and analyse the circuit's output and reason it.

4 Results and observations

Voltage regulator output



Plot: Output at R_L Vs Time(ms)

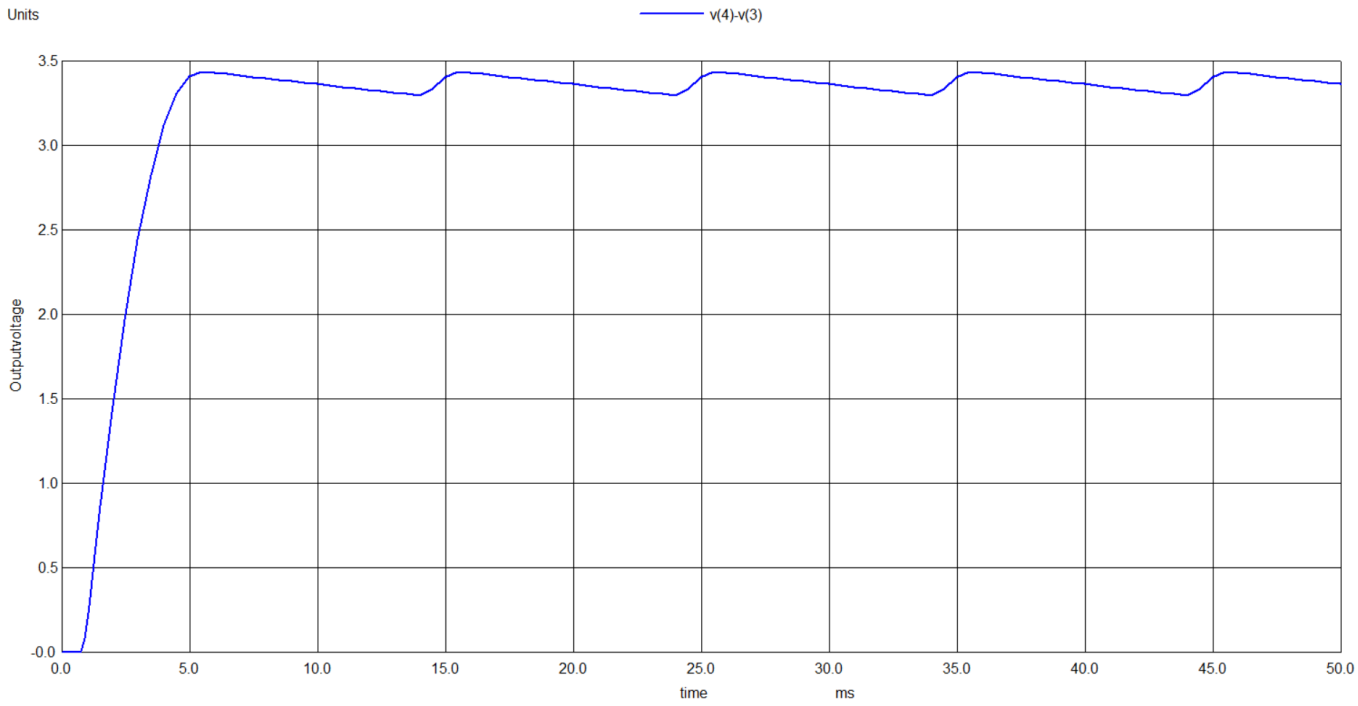
Values Used:

• V_{in} = 6 sin(2πft), f=50Hz, R_S = 500 Ω, R_L = 1.5 kΩ and C_F = 100 μ F, and Breakdown voltage is 3v.

• In the above plot we can see that the output is Constant and equal to 3V i.e. Breakdown voltage after 5ms which is what we needed.

• Now we need to plot the output without zener diode and compare.

Circuit output without zener diode



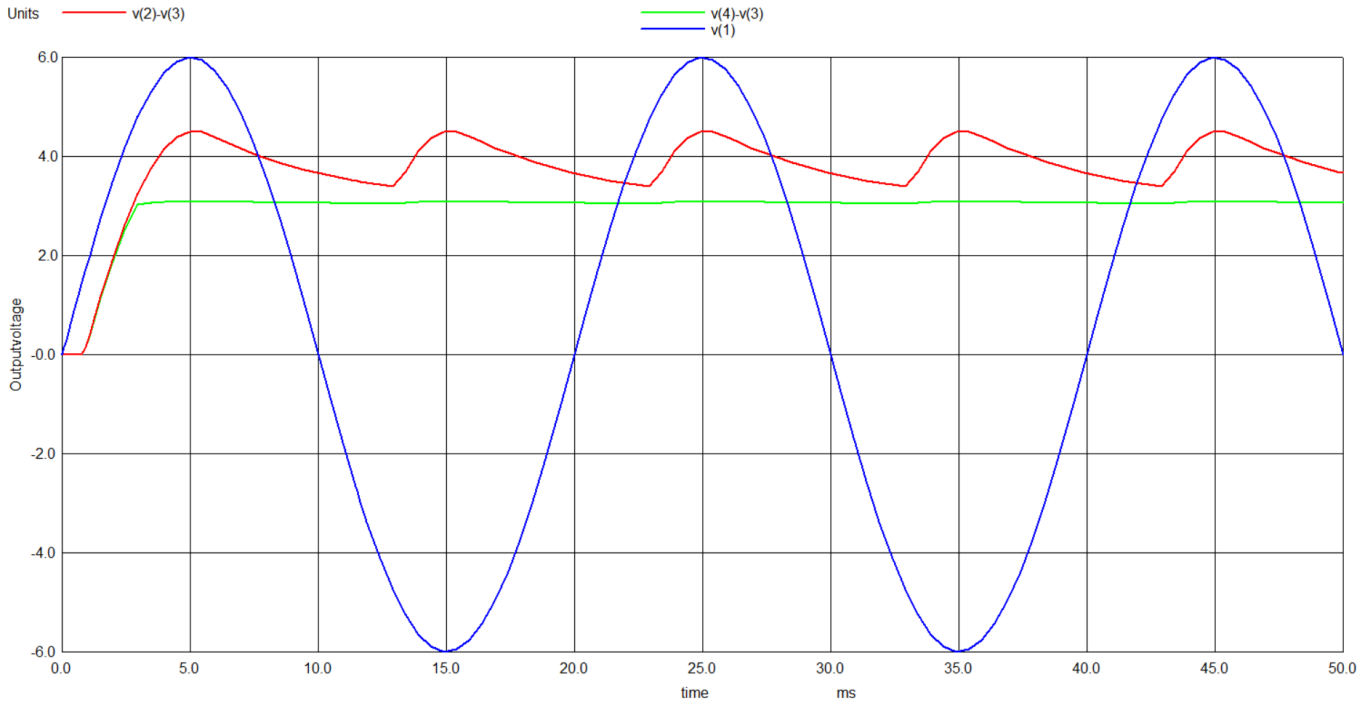
Plot: Output at R_L without zener Vs Time(ms)

• In the above plot the output increases to a point and then decreases to a some ripple voltage which is decided by the circuit elements R_S, R_L and C_F .

• It is same as the output across the capacitor with zener diode circuit but the peak voltage is different.

• The output repeats the same for every 10ms starting from 5ms.

Working of the circuit



Plot: Input, filtered and regulated voltage Vs time(ms)

• In the above the blue line represents input,the red one filtered and the green one regulated voltage.

• First the input sine wave is converted to full wave rectifier output and which intern is converted to voltage across capacitor as shown in plot because once the capacitor is charged since the T=$R_S C_F$ is the time constant which is much greater than time period of input , the voltage decrease in discharging is slow and low, so when the charging stars again its already high and easily comes to peak voltage then the same is repeated.

• Now the output across capacitor is applied to a zener diode with some change due to R_S between them,since the characteristics of zener diode are such that when voltage applied is greater than breakdown then the current is such that voltage is equal to breakdown.

• And to keep voltage across load constant we made sure that the minimum applied voltage greater than breakdown voltage.

5 Conclusions

• By using the voltage regulator we can convert AC into DC voltage using appropriate Resistors and capacitors .

• We have achieved the regulated voltage of 3V here with an input of sine wave with 6V,50Hz.

• We should also note that the resistance R_S must be less than the load .

• Now without using the zener diode the output changes significantly.

• We can also notice the effect of cut-in voltage across the capacitor output.

• Also the peak voltage decreases from input to filtered to regulated voltages due to resistances and voltage drops across them.

• The frequency of filtered output is as the twice as the frequency of input.

Thank you