INDIAN INSTITUTE OF SCIENCE, BENGALURU

DEPARTMENT OF ELECTRONIC SYSTEMS ENGINEERING

DESIGN FOR ANALOG CIRCUITS

LABORATORY REPORT

ASSIGNMENT 6

VOLTAGE REGULATOR

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Contents

List of Figures

1 Voltage Regulator

1.1 Aim

To design the voltage regulator circuit for the given specifications and observe its simulation waveforms.

1.2 Schematic

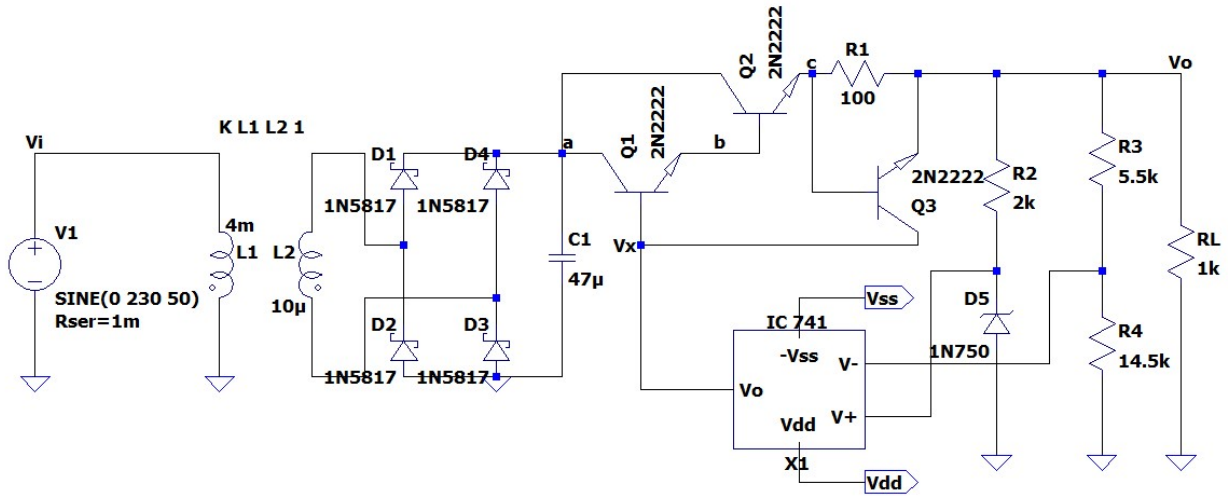

Figure 1: LTSpice Schematic of voltage regulator

1.3 Component Selection

Output voltage V_o is desired to be 6 V DC. Input provided is 230 V, 50 Hz sinewave (amplitude).

- 4mH and 10uH coupled inductors are used to model a 20:1 transformer.
- 1N750 zener diode with reverse breakdown voltage rating of 4.7 V is used.
- Voltage at inverting terminal of op-amp is $V_o R_4/(R_3 + R_4)$. At steady state op-amp is in virtual ground, so this voltage is equal to 4.7 V, so the feedback gain should be 0.783. $R_4 = 14.5k\Omega$ and $R_3 = 5.5k\Omega$ is chosen, which gives a feedback gain of 0.725. A slightly lower value is chosen, as zener voltage will fall below $4.7k\Omega$ due to its series resistance.
- R_2 is chosen as $2k\Omega$ to limit zener current to 0.7 mA.
- Voltage drop across R_1 is $3V_{BE}$=1.8 V. A 100Ω resistor is used.

1.4 Transient Simulation results

Figure 2 below shows the output and input voltage waveforms. A output voltage of 6.018 V is obtained.

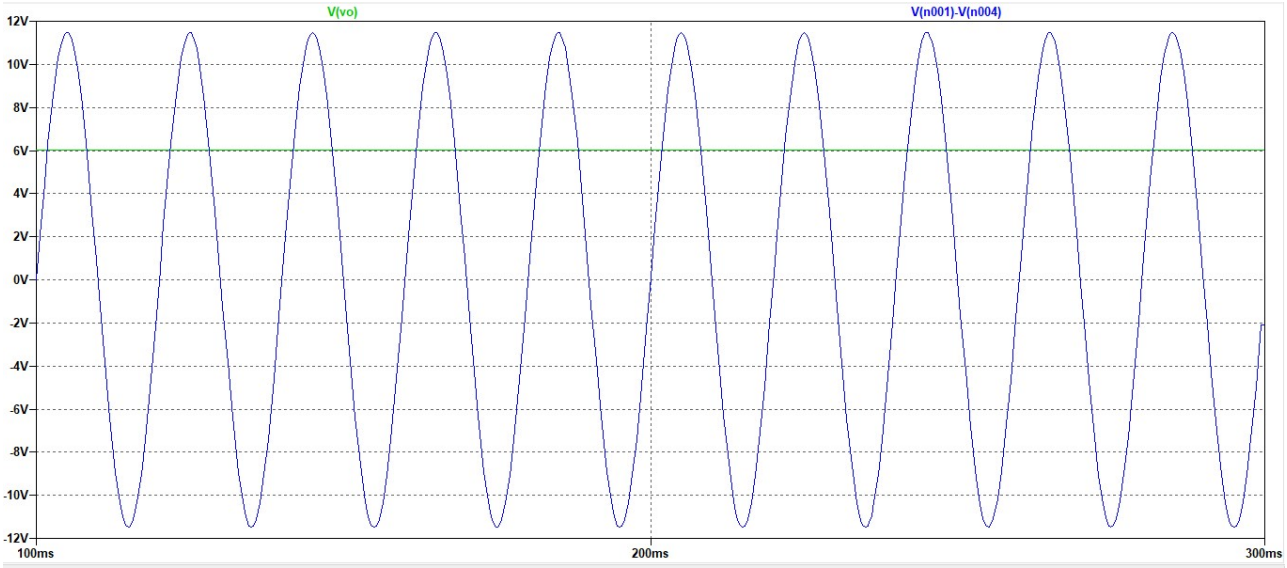

Figure 2: Transient simulation results of voltage regulator

2 DC regulated power supply

2.1 Aim

To design the regulated dc power supply and observe its simulation waveforms.

2.2 Schematic

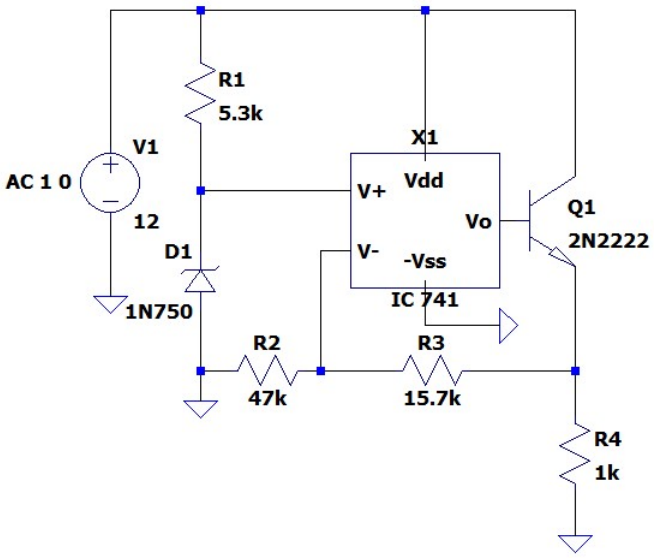

Figure 3: LTSpice Schematic of regulated DC power supply

2.3 Component selection

- 1N750 zener diode with reverse breakdown voltage rating of 4.7 V is used.
- Voltage at inverting terminal of op-amp is $V_o R_2/(R_3 + R_2)$. At steady state op-amp is in virtual ground, so this voltage is equal to 4.7 V, so the feedback gain should be 0.783. $R_2 = 47k\Omega$ and $R_3 = 15.7k\Omega$ is chosen, which gives a feedback gain of 0.75. A slightly lower value is chosen, as zener voltage will fall below $4.7k\Omega$ due to its series resistance.
- R_1 is chosen as $5.3k\Omega$ to limit zener current to 1 mA.

2.4 Transient Simulation results

Figure 4 on the next page shows the output and input voltage waveforms. A output voltage of 6.011 V is obtained for a 12 V DC input.

2.5 Noise performance

Figure 5 on the next page shows the noise attenuation versus frequency of the Dc regulated power supply. 30.6 dB attenuation is obtained for noise below 10 kHz.

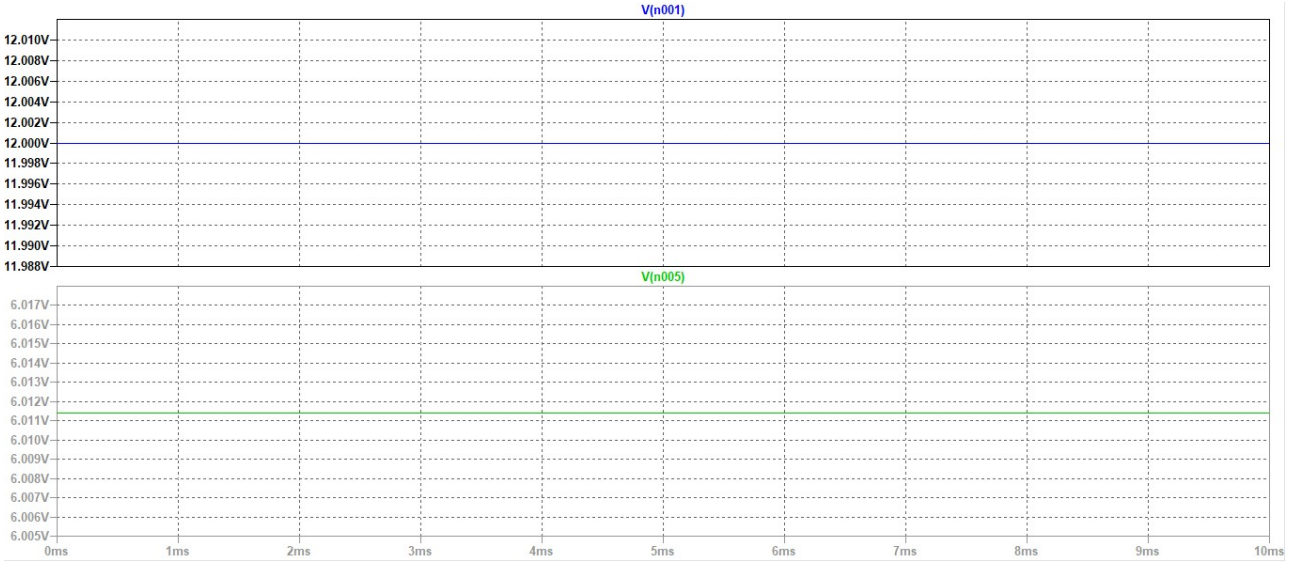

Figure 4: Transient simulation results of DC power supply

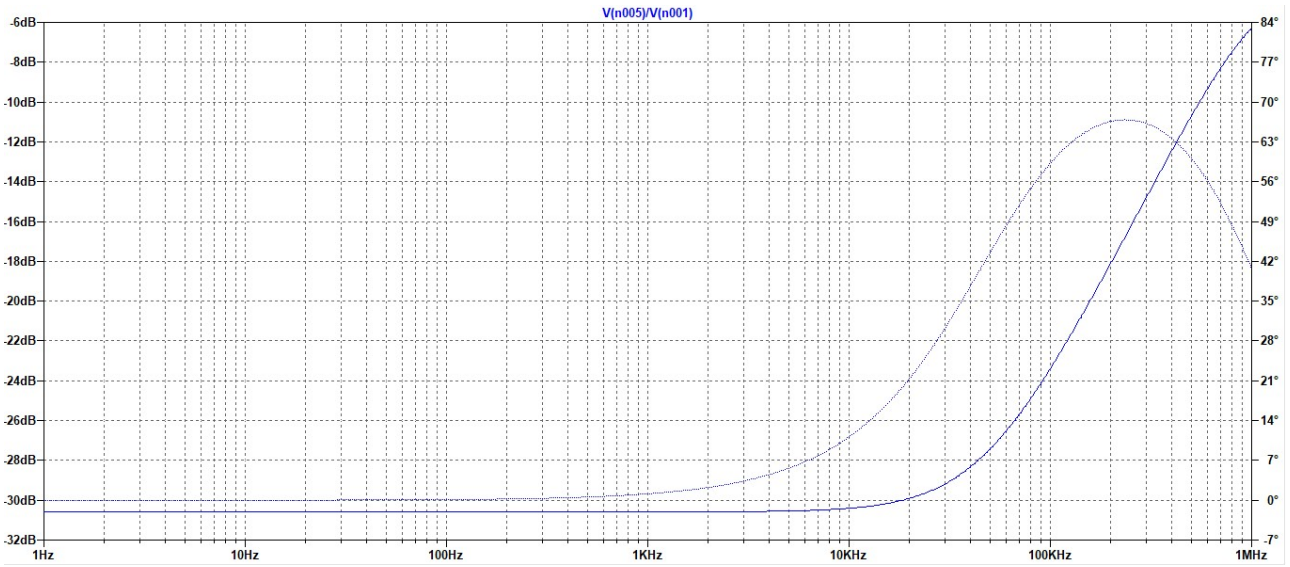

Figure 5: Noise attenuation versus frequency of DC power supply

3 Conclusion

- The voltage regulators provide stable DC voltage to the load from a noisy DC voltage, so they are used to supply loads sensitive to voltage change.
- The linear regulators have good noise immunity at the expense of poor efficiency, due to significant power loss in the series pass element (a BJT in the circuits simulated in this assignment). Higher the voltage drop across the series pass element, lower is the efficiency.
- Switching regulators are used in place of linear regulators where higher efficiency is required, but they have lower noise immunity. Also, switching regulators can be designed to obtain a regulated output voltage which is higher than the input voltage.