Designing a DC power supply

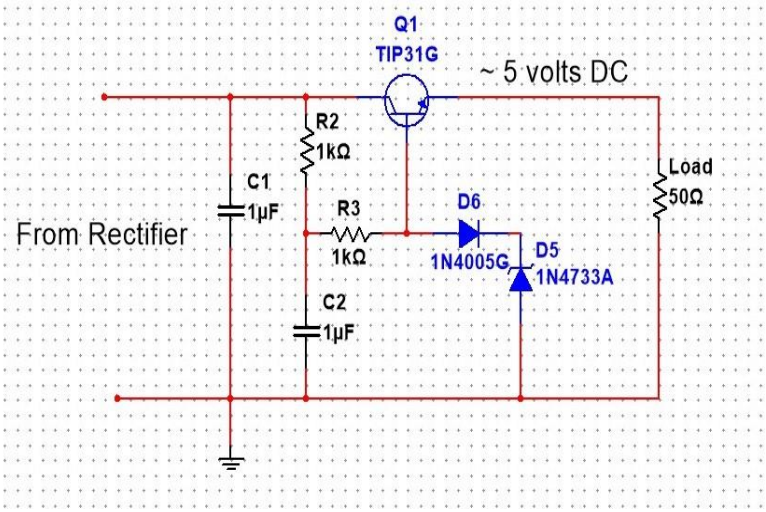
Requirements

In the Power supply lab, you are to supply a discrete set of voltages (1, 2.5, 5 one at a time) into a 50-ohm load so you have to supply at least 100 milliamps (5v/50ohms).

You have a 9v RMS 60 Hz transformer as your source and since it does not have a center tap, you need to use either a diode bridge (full wave rectifier) or a half wave rectifier and a capacitor to smooth the output.

Questions

- What will a full bridge output DC voltage be with no load? What would a half wave rectifier output DC voltage be with no load? The Use the 1N4005 power diodes available in the lab.
- What size capacitor is required?
    - The capacitor and the current load will determine the voltage "ripple". The simulation can use a current controlled current source and a resistor or a "Hall Effect" transducer to see the capacitor inrush current pulses on a scope.
    - Using too large a capacitor will result in a high in-rush current to initially charge the capacitor which can blow fuses.
    - Using too small a capacitor will let the voltage drop too low between sinusoidal peaks.
    - We must always keep the filter capacitor voltage above about 6 VDC to allow the use of a voltage regulator that sets the output voltage. This leaves at least 1 volt drop across a series regulator transistor so it can provide the asked for voltages up to 5 volts.



A Simple Series Voltage Regulator (Actually an NPN EF Amplifier)

- C1 – together with the maximum load current determines the voltage ripple at the regulator input. Calculate the needed capacitance. How does this compare to your simulation?

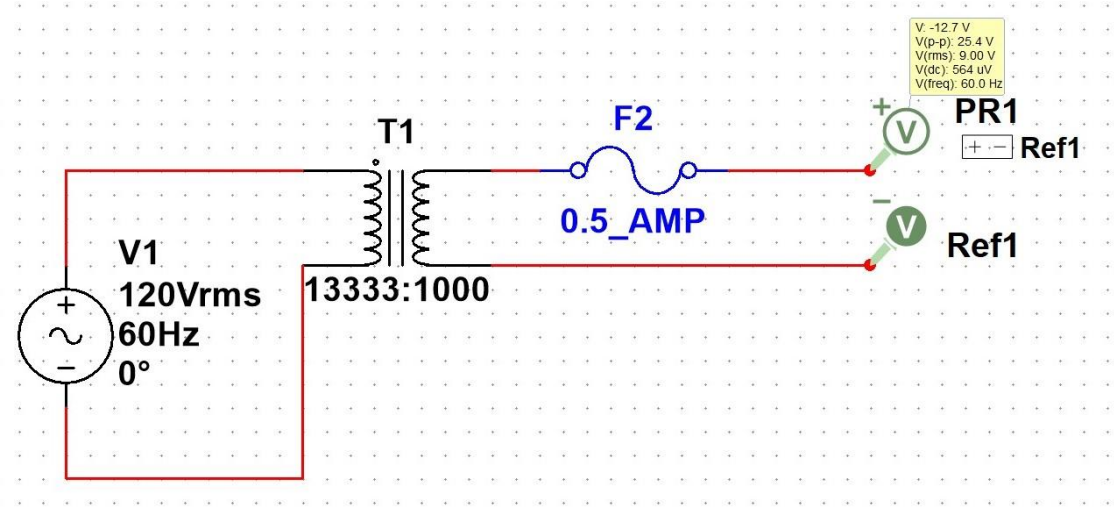
- C2 – With R1 can reduce the ripple at the regulator output by smoothing the available reference current.
- D5 – The Zener provides the main reference voltage.
- D6 – Approximately matches the Vbe voltage drop of the TIP31 series NPN transistor.
- R2, R3 – Determines the available reference current for the base current into the TIP31. The base current cannot exceed the available reference current.

What is a series voltage regulator?

- A simple NPN emitter follower using the capacitor voltage as the power supply makes a reasonable voltage regulator. Possible improvements would be a constant current source for the reference and over-current protection.
- Just make the base voltage 0.7 (a diode drop) higher than the desired output. Use a set of reference voltages and a switch to connect the desired reference to the base.

Modeling The 9V RMS AC Transformer

The transformer we have in the lab can be modeled in Multisim using a generic transformer with 13333 primary turns and 1000 secondary turns for a 13.333:1 turns ratio. Do not forget to put a fuse in the secondary circuit to protect the transformer.



A power diode full wave bridge, or a half wave rectifier connects this 9V RMS supply to the filter capacitor and series regulator.