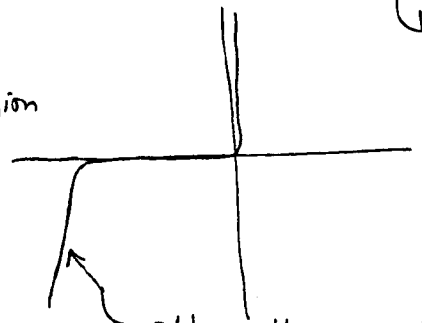
Voltage Regulator Circuits

Simple: Zener diode
operate in breakdown region

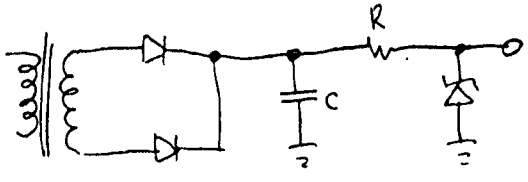


It's really exponential but think of it as a slope and DC offset. — like a battery in series with a resistor.

Purpose:

Ripple filtering

Voltage stabilization.



Design as before.

Always has some loss.

Need to choose components so the output is stable over a range of loads and supply voltages.

Example: $9\,V_{output}$, $1\,ma < I_{LOAD} < 10\,ma$

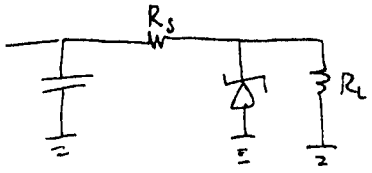
Input may be 110 – 130 volts.

$R_z \simeq 10\,\Omega$ (from data sheet)

Ripple < 1 mv.

Idea: Design it so it works with heavy load, low line. (2)

Check it with high line, Low load



Heavy load: 10ma, 9V.

Design note: — To get any ripple reduction, there must be some current in the zener.

Choose it so with heavy load, low line, it is 0.

$$R_L = \frac{V_L}{I_L} = \frac{9}{.01} = 900\,\Omega$$

Design unfiltered supply:

Usually this is done for other requirements

The bigger we make Rs, the smaller the capacitor can be.

Choose arbitrarily 5 volts across Rs.

$$R_S = \frac{5}{.01} = 500\,\Omega$$

Ripple rejection will be $\frac{10}{510} \approx .020$

So, filtered ripple is 51 mv. max.

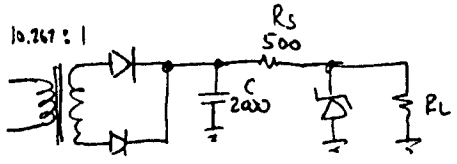
(3)

$V_{unfiltered} = 14.$

add 1V for diode → 15.

$V_{primary} = 110 * 1.4 = 154$ → Turns ratio $= \frac{154}{15} = 10.267$ (half secondary)

$$C = \frac{IT}{V} = \frac{(10ma)(8.3ms)}{50mV} = 1667\,\mu f \Rightarrow \text{use } \underline{2000\,\mu f}$$



Now, check with 130V in, 1ma load.

$$V_{sec} = \frac{(130)(1.414)}{10.267} = 17.85$$

Assume $V_D = .7 \Rightarrow V_C = 17.15$

$V_{RS} \approx 17.15 - 9 = 8.15$

$I_{RS} = \frac{V}{R} = \frac{8.15}{500} = 16.3$ ma

$P_{RS} = (V)(I) = (8.15)(16.3\,ma) = 132.9$ mw.

$I_Z = 16.3 - 1 = 15.3$

$P_Z = (V)(I) = (9)(15.3ma) = 137.7$ mw.

This is a good design for low power.

It can be inefficient for high power.