EE230: Homework-2
Unregulated DC Power Supply

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1 Overview of the experiment

1.1 Aim of the experiment

1. Understanding the problems associated with increasing the capacitor value in an unregulated powersupply so as to reduce the ripple.
2. Understanding the limits of performance of a Zener regulator
3. Understanding a BJT based series voltage regulator to appreciate the basic blocks of an IC voltage regulator.

1.2 Methods

We start by creating a netlist for each circuit, simulating on Ngspice and exporting the values to a python script to plot them using Matplotlib.

2 Design

3 Simulation results

3.1 RC Integrator

3.1.1 Code snippet

3.1.2 Simulation results

RC_Integrator_1.png

RC_Integrator_3.png

RC_Integrator_4.png

RC_Integrator_5.png

RC_Integrator_6.png

3.2 RC Differentiator

3.2.1 Code snippet

3.2.2 Simulation results

RC_Differentiator_1.png

RC_Differentiator_3.png

RC_Differentiator_4.png

RC_Differentiator_5.png

RC_Differentiator_6.png

3.3 RC Lowpass Filter

3.3.1 Code snippet

3.3.2 Simulation results

RC_Lowpass_Filter.png

3.4 RC Highpass Filter

3.4.1 Code snippet

3.4.2 Simulation results

RC_Highpass_Filter.png

3.5 RC Bandpass Filter

3.5.1 Code snippet

3.5.2 Simulation results

RC_Bandpass_Filter.png

3.6 RLC Bandpass Filter

3.6.1 Code snippet

3.6.2 Simulation results

RLC_Bandpass_FiIter.png

4 Experimental results

4.1 RC Integrator

$\tau = RC = 10K\Omega \cdot 0.1\mu F = 1ms$ The circuit is simulated for pulsewidth T, where $T = \{10\tau, 5\tau, \tau, 0.5\tau, 0.1\tau, 0.01\tau\}$

4.2 RC Differentiator

$\tau = RC = 10K\Omega \cdot 0.1\mu F = 1ms$ The circuit is simulated for pulsewidth T, where $T = \{10\tau, 5\tau, \tau, 0.5\tau, 0.1\tau, 0.01\tau\}$

4.3 RC Lowpass Filter

The Transfer Function is

$$G(s) = \frac{1}{1 + sRC}$$

The 3db frequency is expected to be

$$f_{3db} = \frac{1}{2\pi} \cdot \frac{1}{RC} = 159.16Hz$$

The experimental value follows it quite closely.

4.4 RC Highpass Filter

The Transfer Function is

$$G(s) = \frac{sRC}{1 + sRC}$$

The 3db frequency is expected to be

$$f_{3db} = \frac{1}{2\pi} \cdot \frac{1}{RC} = 159.16Hz$$

The experimental value follows it quite closely.

4.5 RC Bandpass Filter

The Transfer Function is

$$G(s) = \frac{1}{3 + sRC + \frac{1}{sRC}}$$

The peak frequency is expected to be

$$f_{peak} = \frac{1}{2\pi} \cdot \frac{1}{RC} = 159.16Hz$$

The lower and higher frequencies are expected to be

$$f_L = \frac{\sqrt{13} - 3}{2} \cdot \frac{1}{2\pi} \cdot \frac{1}{RC} = 48.189Hz$$

$$f_H = \frac{\sqrt{13} + 3}{2} \cdot \frac{1}{2\pi} \cdot \frac{1}{RC} = 525.67Hz$$

The experimental values are

$f_L = 49.33Hz$,$f_H = 532.9Hz$ with $f_{peak} = 162.1Hz$ and peak amplitude = -9.5 db

They follow theoretical values follows it quite closely.

4.6 RLC Bandpass Filter

The Transfer Function is

$$G(s) = \frac{R}{R + sC + \frac{1}{sL}}$$

The peak frequency is expected to be

$$f_{peak} = \frac{1}{2\pi} \cdot \frac{1}{\sqrt{LC}} = 5.032KHz$$

The lower and higher frequencies are expected to be

$$f_L = \frac{1}{2\pi} \cdot \frac{\sqrt{(RC)^2 + 4LC} - RC}{2LC} = 1.46KHz$$

$$f_H = \frac{1}{2\pi} \cdot \frac{\sqrt{(RC)^2 + 4LC} + RC}{2LC} = 17.37KHz$$

The experimental values are

$f_L = 1.448Hz$,$f_H = 17.339Hz$ with $f_{peak} = 5.035KHz$.

They follow theoretical values follows it quite closely.

5 Experiment completion status

All the sections were completed