**EEE 117 Laboratory**

**Instructor: Mike Saghaimaroof**

**Work in Progress. Will be done by Saturday Night. - Luis**

**Pictures will be uploaded Friday night as I am at parents and not at my apartment for break. Thanks.**

**Lab 4: Low Pass Filter Analysis & Simulation**

**Lab Report by Luis Rivera**

**Lab Session: Monday (6 PM - 9 PM)**

**Due Date of Lab: 3/28/2016**

**Date(s) of the lab: 3/7/2016 & 3/14/2016**

**Lab Partners: Huy Nguyen, Joel Pankito**

**Introduction:**

In this lab, we were to become familiar with a low pass filter provided to us by our lab instructor. From the given circuit we were to find the value of the resistor and capacitor in order to find the phase angles with changing frequencies and see when the phase shift was about 45 degrees which we learned told us the 3dB loss in voltage which was the objective for the lab. Using this information we also needed to become familiar with PSPICE or Multisim Simulations in order to find the DC analysis, AC analysis and Transient analysis of the given circuit.

**Purpose:**

For this lab we needed to become somewhat experts with the tools to analyze our pre-constructed circuit. We were expected to have a good understanding of using the oscilloscope in order to get an accurate depiction of the phase angle and also have an idea of how a low pass filter would behave with a low frequency of about 100 hz and then with a much higher frequency at about 1,000,000hz. This was a two week lab with the first week being all about getting the values using the oscilloscope and then plotting the values in excel in order to get a bode plot while also solving for all of the values required to move onto week 2 which is comparing our values with the ones using the simulation software, which in our case was multisim simulations.

**Discussions and Results:**

**Week One Low Pass Filter Circuit Analysis:**

For the first week, we needed to use the pre-constructed circuit given to us by our instructor which looks like the circuit provided below. We used the multimeter instrument to measure the resistor and capacitor value which gave us our RC value needed to the circuit.

|  |  |
| --- | --- |
| Resistor Value | Capacitor Value |
| 10090Ω | 472 pF |

These values were compared by multiple lab groups as we first had trouble understanding if our capacitor value was supposed to be this low but we also had trouble as we misread the value as being 472 nF which is 1000x greater than the actual value which caused a huge discrepancy with our data which was fixed before we left lab. Below is a simplified table with some values we used while the end of the lab report will have the full table with every value tested.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Frequency(Hz) | ⍵ (rad) | Vin (RMS) | Vout (RMS) | Mag (Vo/Vin) | ⍵RC | Phase Angle ° |
| 100 | 628.32 | 1 V | 0.9634 V | 0.9634 V | -0.003 | -0.17 ° |
| 1000 | 6283.2 | 1 V | 0.9636 V | 0.9636 V | -0.03 | -1.714° |
| 5000 | 31.415k | 1 V | 0.93936 V | 0.93936 V | -0.15 | -8.51° |
| 10k | 62.831k | 1 V | 0.9017 V | 0.9017 V | -0.30 | -16.66° |
| 15k | 94.247k | 1 V | 0.87948 V | 0.87948 V | -0.422 | -24.17° |
| 20k | 125.663k | 1 V | 0.78715 V | 0.78715 V | -0.54 | -30.9° |
| 33.5k | 210.486k | 1 V | .629693 V | 0.629693 V | -0.787 | -45.07° |
| 50k | 314.159k | 1 V | 0.48231 V | 0.48231 V | -0.98 | -56.24° |
| 100k | 628.318k | 1 V | .268431 V | 0.268431 V | -1.248 | -71.52° |
| 500k | 3141.592k | 1 V | 0.05508 V | 0.05508 V | -1.504 | -86.176° |

In order to find these values, we used excel but in order to make sure they were correct we needed to do some math instead of just blindly following values. The frequency was given to us based on the function generator we used with the circuit which ranged from 100 hz all the way up to 1,000,000 hz and the multimeter was constantly feeding in 1 V Peak to Peak while we used the multimeter to see what our output voltage through the capacitor while the frequencies changed.

To find ⍵ (rad), we multiplied our frequency by 2𝜋

Our Magnitude was just our Vout divided by Vin-> (Vout / Vin) which always resulted in the value being the output voltage as we always divided by 1

To find our ⍵RC we needed to use the provided Resistor and Capacitor values which we 10.090kΩ and 472pF and our ⍵ was constantly changing due to changing frequency but for 100 Hz, we would multiply those values together then take the negative arctan to get our phase angle in radians.

-tan-1 (628.3185307 \* 10090 \* (472 x 10-12))

=-2.99235 x 10-3 rads

Once we had that value we could then convert to our phase angle in degrees by multiplying by 180/𝜋

(-2.99235x 10-3)\* (180/𝜋)

= -0.17°

This value correlates to our calculated value through excel and is close to what our oscilloscope showed which means our measurements were correct. We were unable to get an exact value through the oscilloscope as the values were flickering with constant different results, our instructor explained that we were much better off seeing if we were within a certain ballpark of about 5-10 degrees as the oscilloscope was rather unstable with values.

From the Results we can see that around the 33.5k frequency range, the phase angle hits about -45° which is the angle we are looking for as that tells us that our Vout has seen a 3 dB loss which also translates to a ⍵RC value of ±0.707