EEN3096 Communications Electronics

Experiment CE1: Design of RF Class A Tuned Amplifier

Objectives

- To familiarize with the practical aspects of the design of a Class A Tuned Amplifier.
- To illustrate issues such as the choice of component, the biasing requirement and prediction of the circuit performance.

Results

(Numbering below is according to the lab sheet)
(All calculation steps must be shown clearly)

3. By measurement, R_{B1}=9.821kΩ; R_{B2}=4.65kΩ;
   By calculation, V_B=1.61V; V_E=0.91V
4. By measurement, V_C= 4.97V; V_B=1.45V; V_E=0.745V
5. Verified.
6. There is a slightly different with the measured V_B and V_E. This is due to the imperfection of those passive elements or components in the circuit. Besides, it also due to the stray capacitance and inductance effect.
7. $I_C \cong I_E$ = 4.97mA
8. $g_m \cong$ 0.191
12. Refer to the tables below:

- (With $V_{B(pp)}$ fixed to 36mV)

f/MHz	***1.0***	***2.0***	***3.0***	***4.0***	***5.0***	***5.5***	***6.0***	***6.5***	***7.0***	***8.0***	***9.0***	***10.0***
$V_{L(pp)}$/mV	70	150	160	180	340	510	660	860	960	720	460	360
$V_{B(pp)}$/mV	36	36	36	36	36	36	36	36	36	36	36	36
A_v	1.94	4.17	4.44	5	9.44	14.17	18.33	23.89	26.67	20	12.78	10

- (Without $V_{B(pp)}$ fixed to 36mV)

f/MHz	***1.0***	***2.0***	***3.0***	***4.0***	***5.0***	***5.5***	***6.0***	***6.5***	***7.0***	***8.0***	***9.0***	***10.0***
$V_{L(pp)}$/mV	160	340	520	840	920	760	620	500	420	310	230	170
$V_{B(pp)}$/mV	30	28	26	20	16.5	18	19	19	20	19	14	16
A_v	**5.33**	**12.14**	**20**	**42**	**55.76**	**42.22**	**32.63**	**26.32**	**21**	**16.32**	**16.43**	**10.63**

13. A graph is plotted by using the values in table with $V_{B(pp)}$ fixed to 36mV. This graph is shown in Figure 1.
    From this graph, the resonance frequency is 7.0 MHz. The A_v at resonance is 26.67.
    By calculation, resonance frequency ≅ 7.34 MHz.
    There is a slightly difference due to the stray capacitor and inductor.
14. Figure 2 is the input and output waveform at resonance frequency.
15. By measurement, R_L = 0.977kΩ
    By calculation, r_{ce} = 162.92Ω = 163Ω
16. By calculation, Early voltage, or collector o/p voltage, V_A = 0.81V
19. By measurement, $V_{L(pp)}$ = 780mV; A_v = 21.67
20. By measurement, R_L = 464Ω
    By calculation, A_v = 23.04

There is a slightly difference between the measured and calculated values of A_v.

21. $V_{L(pp)}$ = 1060mV; A_v = 29.44
    By measurement, R_L = 1464Ω
    By calculation, A_v = 28.01
    Again, there is a slightly difference between the measured and calculated values of A_v.
24. Maximum output voltage swing, $V_{L(pp),\ max}$ = 8000mV or 8V
    Lower voltage threshold = 600mV or 0.6V. This value is approximate to the value of V_E, which is 0.745V.
25. Clipping voltage= 1.8V

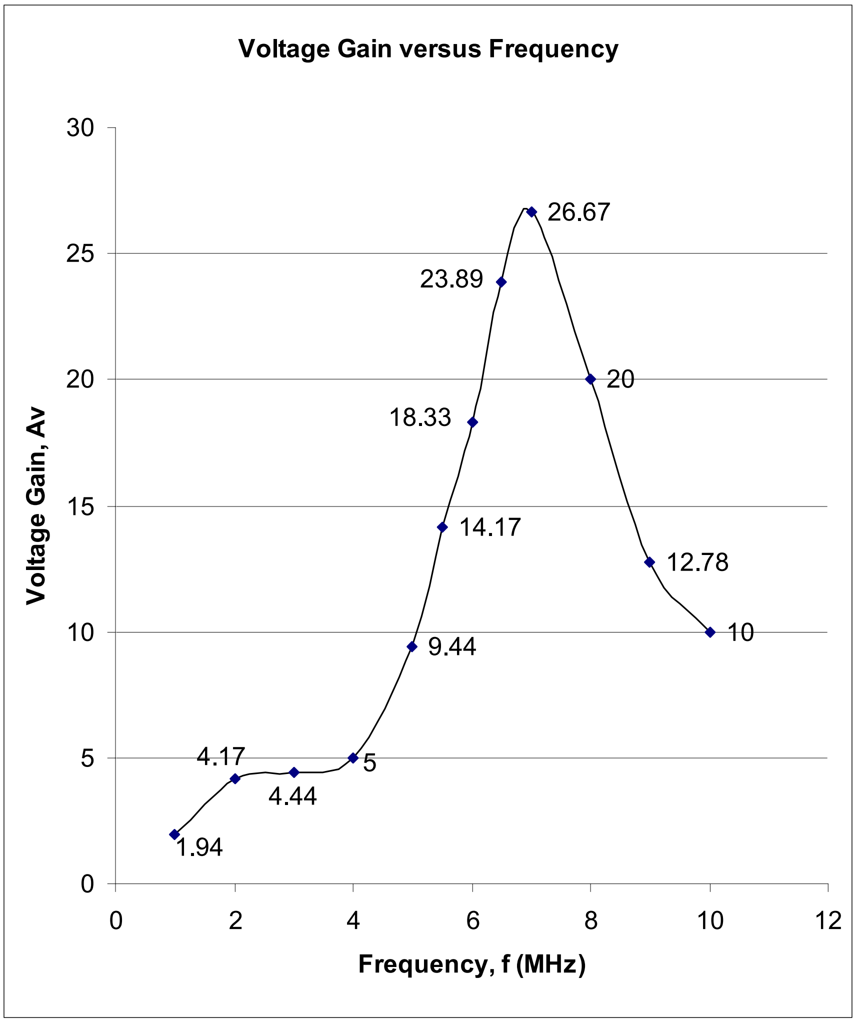

Figure 1

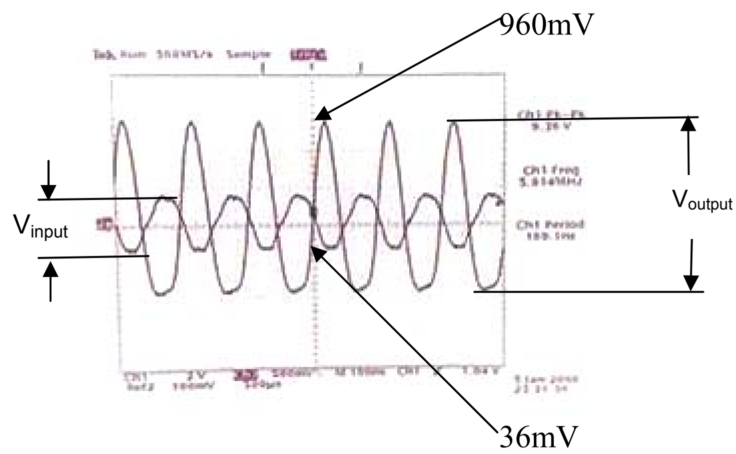

Figure 2

Discussion

Due to instrument error, there is a difficult to maintain the input voltage ($V_{B(pp)}$) with a value of 36mV. Hence, I try to do the experiment twice; once with fixed ($V_{B(pp)}$) to 36mV and once without fixed ($V_{B(pp)}$) to 36 mV. In order to maintain ($V_{B(pp)}$) with a value of 36mV, I need to keep on changing the amplitude of the function generator when its frequency changes.

Besides, due to imperfection of component and stray capacitor, the values that I measured have error, and are slightly different with the measured value.

Conclusion

A lot of thing have to be consider when design a Class A Amplifier, e.g. the operating frequency range, input signal amplitude and etc. Hybrid-model for the transistor is essentially accurate and significant within a frequency range, it provides an easier way for us to design a good amplifier. However, a capability or accuracy of the amplifier is always limited by the imperfection of those passive elements and exists of stray capacitor at high frequency and effect of those coupling capacitor and bypass capacitors.

After this experiment, I gain the basic knowledge of tuned Class A Amplifier and learn the way to design one. This experiment was proved successfully since the measured resonant frequency is approximate to the ideal value. I have designed the amplifier with fewer conductors as possible as I can with the shortest conductance paths (the wires).

Reference

Robert Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory", 6th Edition, Prentice Hall, 1996.

This lab report is prepared by Desmond Kho.