Project Overview

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1 Condition of Oscillation

The Condition of oscillation is given by the Backhausen criteria which states that the loop gain of the positive feedback network must be 1 for sustained oscillations.

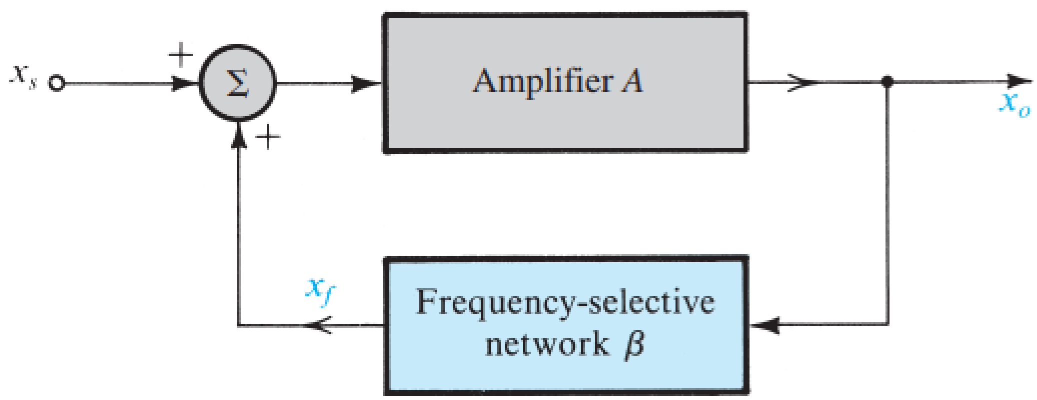

Figure 1: Block diagram of a Positive feedback network

$$Transferfunction = x_0/x_s = \frac{A\beta}{1 - A\beta} \tag{1}$$

Let

$$D(s) = 1 - A\beta$$

So for the system to be unstable

$$A\beta \geq 1$$

$$Therefore, D(s) \leq 0$$

2 Design Overview

2.1 Amplifier

I have used the common emmiter configured BJT (Bipolar Junction Transistor) as the amplifier. I am going to use the BJT 2N2222 NPN transistor manufactured by NXP Semiconductors for this Simulations. As due to heating effect if used in

$$A\beta = 1$$

condition the amplitude will decay with time. So it has to be operated during the condition

$$A\beta > 1$$

.

As we set in unstable mode the oscillations will rise so need to limit the amplitude,

Fortunately BJT has inherent amplitude stabilization as hfe decreases for larger ic.

h_{FE}	DC current gain	I_C = 0.1 mA; V_{CE} = 10 V	35	–	
		I_C = 1 mA; V_{CE} = 10 V	50	–	
		I_C = 10 mA; V_{CE} = 10 V	75	–	
		I_C = 150 mA; V_{CE} = 1 V; note 1	50	–	
		I_C = 150 mA; V_{CE} = 10 V; note 1	100	300	
h_{FE}	DC current gain	I_C = 10 mA; V_{CE} = 10 V; T_{amb} = –55 °C			
	2N2222A		35	–	
h_{FE}	DC current gain	I_C = 500 mA; V_{CE} = 10 V; note 1			
	2N2222		30	–	
	2N2222A		40	–	

Figure 2: NPN 2N2222 Datasheet Important Data

From the datasheet , the h_{FE} of the transistor 2N2222 increases upto i_c = 150 mA, after that it decreases upto 30 at i_c = 500mA for a constant V_{ce}. Here increase of i_b results in increase of i_c which results in decrease of h_{FE} value that implies decrease of gain.

The value of h_{FE} can be measured at DC operating point by dividing the value of i_c and i_b at that operating point.

Whereas decrease in i_c results in inc of hfe which increases the gain.

This stabilizes the amplitude to a particular limit.
The amplitude limiter characteristics can be realized by operating the amplifier at its desired DC operating Point and passing a ramp signal as input. The output curve can be measured from the output terminal.

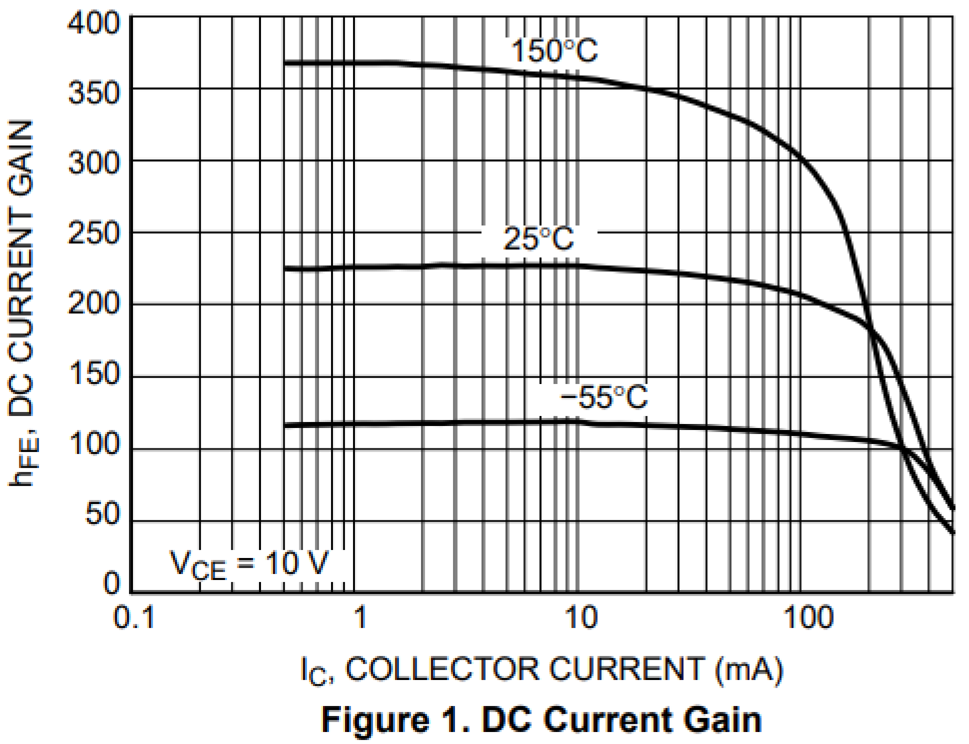

Figure 3: NPN 2N2222A Datasheet plot of h_{FE} vs i_c

2.2 Selection of β network circuit

As the Common Emitter Amplifier is an inverting amplifier which means that along with amplification it also shifts the phase by 180 degrees, I had to choose a β network such that it also creates a phase difference of 180 degrees so that the Loop gain is in phase of one another.

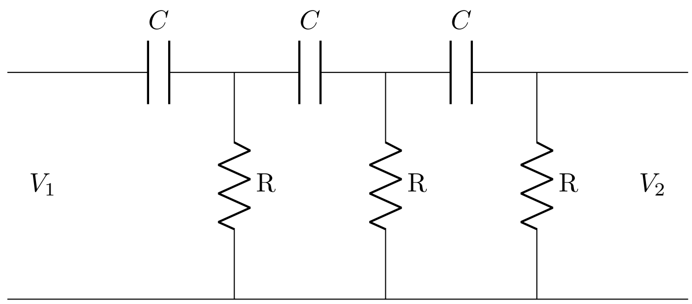

Figure 4: RC phase shift network Circuit

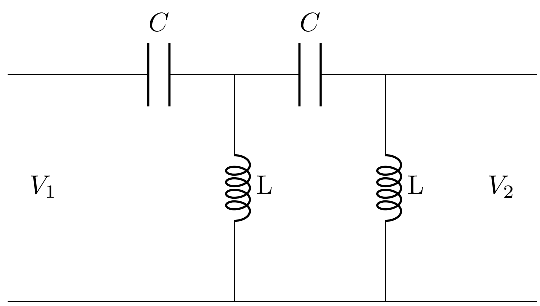

Figure 5: LC network Circuit

- For low frequency applications typically ranging from 10 Hz to 1 KHz the cascaded RC network is used as it provides the phase difference of 180 degrees at a particular frequency.

- For high frequency applications , all the way upto some Megahertz the LC network is used. It provides phase difference of 180 degrees at some particular frequency.