ee101_osc_4.sqproj

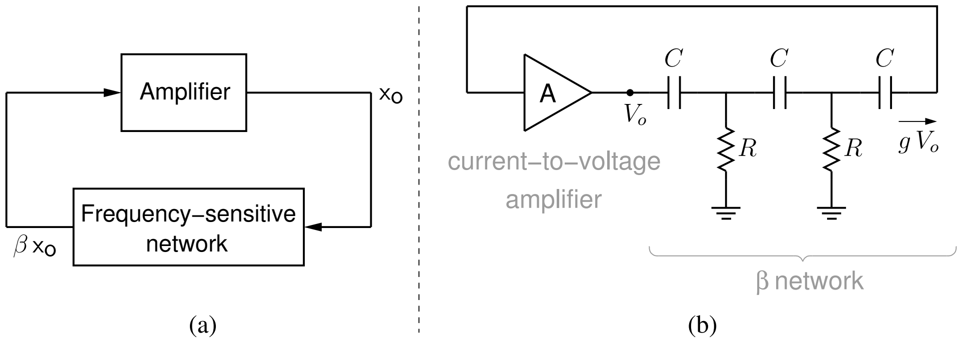

Figure 1: (a) Block diagram of a sinusoidal oscillator, (b) A specific example of the β network.

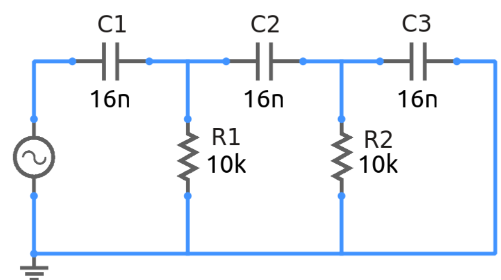

Figure 2: Circuit diagram of β network with component values.

Fig. 1 shows the block diagram of a sinusoidal oscillator based on positive feedback. It consists of an amplifier with gain A and a feedback network. In this example, the feedback network takes as input the output voltage V_o of the amplifier and produces as output a current $I_o = g\,V_o$. Note that the amplifier in this case must convert an input current to an output voltage, i.e., it should be a "current-to-voltage" or "transresistance" amplifier, and its gain will have units of resistance.

Fig. 2 shows the same β network with component values. The input to the β network is given by the voltage source, and its output is the current through the capacitor C_3. The reason for connecting C_3 to ground will become clear when we consider the complete oscillator circuit employing this β network.

The condition for oscillation is given by the Barkhausen criterion, viz.,

$$A(j\omega)\,\beta(j\omega) = 1\,. \tag{1}$$

(See `ee101/ee101_osc_3.sqproj` for an oscillator circuit using the above β network.)

Exercise Set

1. Apply the Barkhausen criterion and find the condition for oscillation, i.e., the frequency of oscillation and the condition to be satisfied by A (in Ω) for oscillations to occur (assuming A to be real).
2. Simulate the circuit and plot the magnitude and phase of β as a function of frequency. From the plots, find the numerical value of A (in Ω) that is required for the circuit to oscillate.
3. Compare the values you obtained in (1) with the simulation results.

References

1. S. Franco, *Design with Operation Amplifiers and Analog Integrated Circuits,* McGraw-Hill, 1998.
2. J. Millman and A. Grabel, *Microelectronics,* McGraw-Hill, 1988.