X260994

UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE

Department of Electrical Engineering

Experiment No._____Feedback Oscillators

INTRODUCTION

If the output of an active device such as a transistor amplifier is fed back into its input in the proper phase and magnitude, the device will sustain oscillations without an apparent input. In Figure l is shown a Colpitts oscillator. In Figure 2 is an AC small-signal model of Figure 1 with the indicated assumptions. The mesh equations for the circuit would be of the following form:

$$\begin{bmatrix} z11 & z12 \\ z21 & z22 \end{bmatrix} \begin{bmatrix} io \\ ib \end{bmatrix} = \begin{bmatrix} -zo\ Io \\ 0 \end{bmatrix}$$

where Io is a small current source representing noise inherent in the device.

The output current, io, would be;

$$io = \frac{-z22\ zo\ Io}{z11\ \ z22 - z21\ z12} \qquad (1)$$

If the device is to sustain oscillation (be marginally stable), the denominator of the above function must be equal to zero. Equating the real and the imaginary part of the denominator to zero, the following expressions are obtained;

$$hfe + 1 - \omega^2\ C1\ L = 0 \qquad (2)$$

$$\omega R\ (C1 + C2) - \omega^3\ L\ R\ C1\ C2 = 0 \qquad (3)$$

Solving equation (3) for frequency;

$$\omega = 0 \quad \text{and} \quad \omega = \sqrt{\frac{C1 + C2}{L\ C1\ C2}}\ \text{rad/sec} \qquad (4)$$

The circuit conditions for sustain oscillation can be obtained by substituting equation (4) into equation (2) obtaining;

$$hfe \geq C1/C2 \qquad (5)$$

PRELIMINARY

P-1. Obtain a small-signal transistor from your instructor. Determine the following specifications for your transistor from the manufacturer's data book (and/or from your instructor).

Transistor _____ NPN PNP (circle one)

Manufacturer _____

VCEmax = _____volts hfe = _____

Other information (such as pin-out, etc.).

P-2. Derive and verify the equations (2) through (5) shown in the introduction using the circuit of Figure 2.

P-2 cont'd.

P-3. Assuming L = 0.2 Henrys and C2 = 0.004 uF, determine C1 and the frequency of oscillation, fr (Hertz).

(INSTRUCTOR'S SIGNATURE_____DATE_____)

PROCEDURE

F-1. Connect the circuit of Figure 1 using the circuit parameters determined in the preliminary report and leaving one end of the inductor, L, disconnected. Use a capacitor decade box for C2 and a variable inductor for L.Make RB a fixed resistor of whatever value needed to make VCE = VCC/2.

CAUTION: DO NOT MAKE CHANGES IN THE CIRCUIT UNLESS VCC IS ZERO!

F-2. Connect the loose end of the inductor, L, and observe the oscillation across VCE using an oscilloscope.Determine the frequency of the oscillation and sketch the waveform

F-3. Vary C2 and L and record what happens.

REPORT (should contain at least the following)

R-1. Compare the frequency observed in the experiment with the frequency calculated in the preliminary report. Discuss any differences.

R-2. Discuss the waveform of the oscillation.

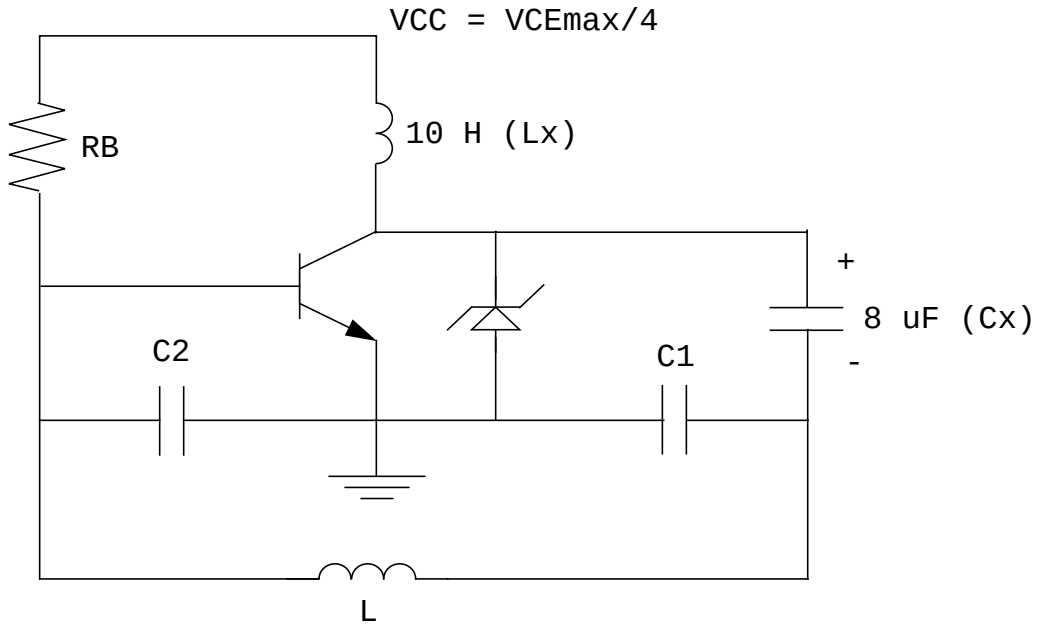

Figure 1.

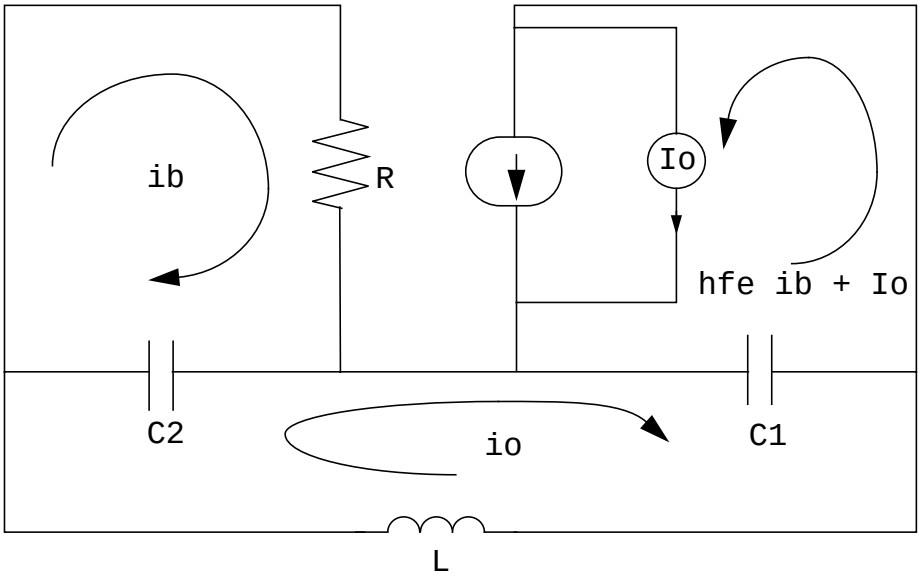

Figure 2.

$$R \cong hie \qquad \omega RLx \gg \frac{1}{hoe} \gg \frac{1}{\omega rC1} \qquad \omega rL \gg RL$$

$$hre = 0 \qquad \frac{1}{\omega rCx} = 0$$