X470993

UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE

Department of Electrical Engineering

Nyquist Diagrams

INTRODUCTION

The stability of a closed-loop system can be determined by looking at its open-loop gain and phase characteristics. If the system in an open-loop configuration has a gain of one or greater at a phase shift of zero or 180 degrees at some frequency (depending on the type of feedback), then the system will be unstable when the loop is closed.

If a plot of the open-loop gain and phase versus frequency is made, stability can be readily determined. There are several ways of plotting such information. One is called a Body plot which consist of actually two plots -- one of gain and the other phase. This plot is useful when designing compensation of the system. Another method is to plot gain and phase as a polar quantity. For this plot, the gain is represented by the length of a vector from the origin of the graph and the phase is represented by the angle of the vector from zero reference. The curve resulting from the plot of the point of the vector as frequency is varied is called a Nyquist diagram.

The requirement for stability on a Nyquist diagram is that the curve not encircle the +1 (-1) point clockwise, or, stated another way, the number of counterclockwise encirclements of the +1 (-1) must equal the number of open-loop poles with positive real parts. Whether the encirclement is of the +1 or -1 depends on whether the system has positive feedback (+1) or negative feedback (-1). The frequency at which an unstable system will oscillate will lie somewhere between the frequency where the gain is one and the frequency where the phase is zero degrees (+1) or 180 degrees (-1).

ASSIGNMENT

The student is to determine and verify the stability of several systems by obtaining and analyzing open-loop gain and phase information for the systems.

REFERENCES

1. References on reserve in the library.
2. Textbooks on the subject of electronics and feedback systems.
3. Faculty with expertise in the area of electronics and feedback systems.

EXPECTED RESULTS (as a minimum)

1. Plot Nyquist diagrams using the data obtained from the three circuits in Figures 1-3 and verify the results of the stability tests.
2. Plot a gain (Bode) and a phase plot using the data obtained from the circuit in Figure 3 and verify the Nyquist diagram.

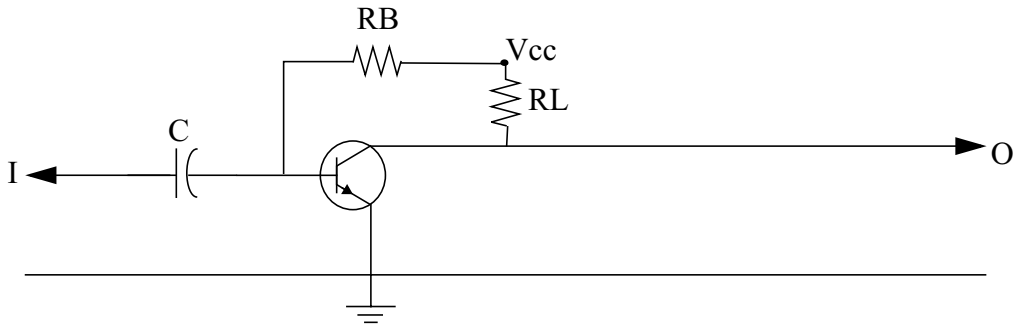

Figure 1.

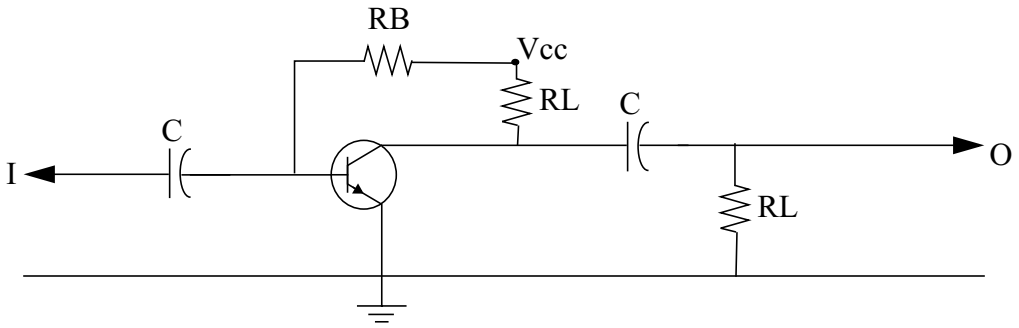

Figure 2.

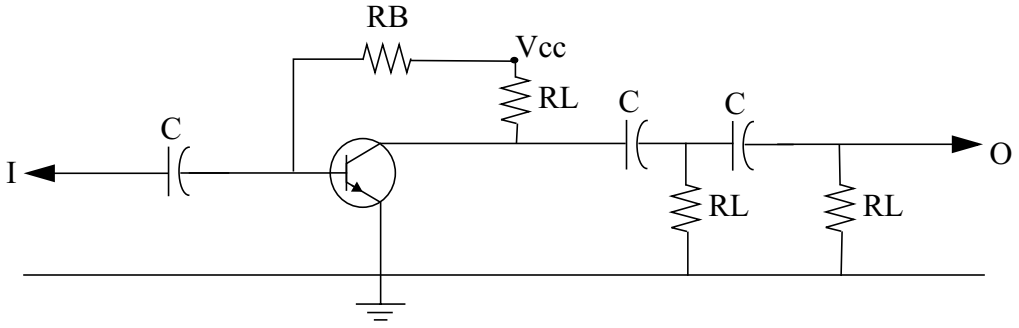

Figure 3.