

# ECET 4840 Advanced Telecommunications Laboratory Exercise 5

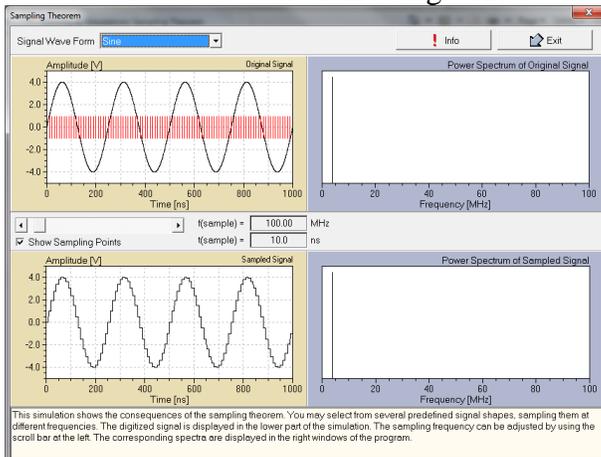
Name: \_\_\_\_\_

Due Date: \_\_\_\_\_

**Purpose:** The objective of this two-part exercise is to use a set of simulation applets to reinforce the student's knowledge of Fourier Series Analysis by varying key parameters and studying the results. In addition to graphically determining the Fourier components of several functions, simulations will be done to understand the basic concepts of sampling theory and aliasing.

## Part 2 Procedures:

1. Visit the "Learning by Simulations" site at:  
<http://www.vias.org/simulations/simusoftware/nykvist.html>
2. Read the introductory paragraph regarding the "Nyquist-Shannon sampling theorem."
3. Download the English version of the program to your desktop
4. Unzip the file
5. Run the "nykvist" application
6. You should now see the following window running:



7. Study the various sections and features of the program
8. Notice that the top section shows the original signal, whereas the bottom section shows the samples signal
9. Move the slider in the middle of the program. Notice that the number of samples (red bars) indicated on the original signal increases or decreases depending upon which direction you move the slider
10. What is the frequency (Herz) of the Sine wave (original signal)? \_\_\_\_\_
11. What should the corresponding minimal sampling rate "t(sample)" (in seconds) be for the Sine wave? \_\_\_\_\_
12. Adjust the slider until the minimal sampling rate shows in the t(sample) field.
13. How many nanon-seconds (ns) are showing in the field? \_\_\_\_\_

14. Take a screenshot of the program. What do you notice about the sample marks (red bars on original signal)?
  15. What happened to the sampled signal in the bottom section? Why?
  16. What is the value of  $f(\text{sample})$ ? \_\_\_\_\_
  17. Adjust the slider until  $f(\text{sample})$  is twice the Nyquist frequency. What is this frequency? \_\_\_\_\_
  18. Take another screenshot
  19. Describe the sampled signal. Does it look similar to the original signal?
  20. In the “Signal Wave Form” dropdown control select “Sawtooth”
  21. Repeat steps 10 through 19 for the Sawtooth function
  22. At the Nyquist frequency do the sampled Sine and Sawtooth functions look the same? Why/why not?
  23. What is the power spectrum? You may need to look this up on the Internet
  24. Describe the power spectrum of the Sawtooth function
  25. Describe the spectrum of the sampled Sawtooth function at the Nyquist frequency
- Turn in:** Create an informal report including both parts (1 and 2) and all requested data and screenshots. Be sure to include a coversheet. Staple your report in the upper left hand corner.