ECE 4670 Lab Report Grading

Lab 2: Spectrum Analysis

Points	Lab Exercise Number	Laboratory Exercise Description	Check off
		Preliminary Analysis	
10	Problem 1	**Derive theoretical** PSD of periodic pulse train	
10	Problem 2	**Derive theoretical** PSD of periodic cosinusoidal pulse train (coherent)	
10	Problem 3	**Derive theoretical** PSD of periodic autocorrelation function (Fig. 11)	
10	Problem 4	**Overlay** PSD plot of random bit stream NRZ and Manchester line coded signals in dB. Comment on the spectrum shape differences.	
		Periodic Pulse Train [F_s = 500 KHz, tau_s = 200 ns, 100 mVpp]	
5	Part a	**Measure:** Spectral line spacing (using Spectrum Analyzer, include Spectrum Analyzer Plot in report)	
5	Part a	**Measure:** Spectral line spacing (frequency)	
5	Part a	**Measure:** Zero location (at what frequencies)	
5	Part a	**Measure:** Number of spectral lines between zeros	
5	Part a	Describe any additional data that seems appropriate for comparing your theoretical calculation to the measured data (explain all).	
5	Part a	Import measured data into Jupyter notebook, display theoretical with measured data on same plot.	
5	Part a	Compare measured data to your theoretical values.	
5	Part a	Repeat all of part a above for F_s = 100 KHz and tau = 400 ns	
5	Part b	Setup pulse train with a 25% rise and fall time (set back to initial pulse train setting), take SA measurement (include captured data in report) Note: 25% of tau of 200 ns for rise and fall	
5	Part b	Comment on the change of the spectral content, is this expected? why? Consider the rise time analysis added to the sample notebook to support your comments here.	
		Periodic Cosinusoidal Pulse Train	
5	Part a	Settings: $F_0 = 5$ MHz, $T_s = 10\ \mu$s (burst 5 cycles), 100 mVpp. Measure with Spectrum Analyzer. First verify the burst signal on scope then measure using SA. Verify items 1-4.	
5	Part a	Settings: $F_0 = 5$ MHz, $T_s = 10\ \mu$s (burst 2 cycles), 100 mVpp. Measure with Spectrum Analyzer. First verify the burst signal on scope then measure using SA. Verify items 1-4.	
5	Part a	Settings: $F_0 = 5$ MHz, $T_s = 10\ \mu$s (burst 10 cycles), 100 mVpp. Measure with Spectrum Analyzer. First verify the burst signal on scope then measure using SA. Verify items 1-4.	
5	Part a	Compare measured to theory for just 5, **or** 2, **or** 10 by importing the measured data from the SA into Jupyter.	
10	Part b	Settings: $F_0 = 4$ MHz, $T_s = 5\ \mu$s (burst 5 cycles), 100 mVpp. Measure with Spectrum Analyzer. First verify the burst signal on the scope then measure using SA. Measure data from SA and include in Jupyter. Compare measured to theoretical calculation. Note the spectrum peaks shift. Are the results expected? why? Verify that the characteristic spectral nulls and line spacing remain invariant with F_0 changes.	
10	Part b	Settings: $F_0 = 6$ MHz, $T_s = 10\ \mu$s (burst 5 cycles), 100 mVpp. Measure	

		with Spectrum Analyzer. First verify the burst signal on scope then measure using SA. Measure data from SA and include in report. Compare measured to theoretical calculation. Note the spectrum peaks shift. Are the results expected? why? Verify that the characteristic spectral nulls and line spacing remain invariant with F_0 changes.	
5	Part c	Using the Python function `line_spectra_CS_dBm()` driven by pulse train Fourier coefficients, X_n, chose a value for F_0 that makes the co-sinusoidal signal non-coherent. See if you can observe the spectral line splitting apart. I want you see if a value of F_0 will make the spectral lines lapping up from the negative frequency axis to the positive frequency axis can be made to interleave the native positive frequency axis spectral lines. Your Jupyter notebook will ultimately contain a spectrum exhibiting this behavior.	
		Pseudo-Noise (PN) Sequence Generators (PRBS)	
5	Part a	Set 33600A function generator to PN = 5, 200 mVpp, verify correct PN code on scope, correct number of 1's, what should they be?	
10	Part a	Measure the spectral lines using the SA. Verify the spectral nulls, verify the line spacing. Compare to theoretical calculations.	
5	Part b	Set 33600A function generator to PN = 10, 200 mVpp, verify correct PN code on scope, correct number of 1's, what should they be?	
10	Part b	Measure the spectral lines using the SA. Verify the spectral nulls, verify the line spacing. Compare to theoretical calculations.	
		Almost Random Sequence	
5	Part c	Change the generator to PN32, which is the largest shift register length available on the 33600A. Observe the spectrum on the N9914A. As you zoom in to a single spectral lobe and then reduce the resolution bandwidth see if you can resolve the spectral lines. What is the period of this generated signal in seconds? What is the spacing of the spectral line. Include the close in lobe in your report.	
0	Part d	If not already on your function generator, load NRZ and MAN csv files, as explained in the lab reader.	
5	Part d	Select the NRZ ARB file set the sampling rate to 100 MSa/s, to insure 1 Mbps and set amplitude 100 mVpp. Capture the waveform on the scope and the spectrum on the SA. From the scope see that the pattern corresponds to $M = 63$. From the power spectrum note the location of the spectral nulls and line spacing. The general shape should match the Fourier transform results from the preliminary analysis plots of P_{NRZ}. Verify that they match.	
5	Part d	Select the MAN ARB file set the sampling rate to 100 MSa/s, to insure 1 Mbps and set amplitude to 100 mVpp. Capture the waveform on the scope and the spectrum on the SA. From the scope see that the pattern corresponds to $M = 63$. From the power spectrum note the location of the spectral nulls and line spacing. The general shape should match the Fourier transform results from the preliminary analysis plots of P_{MAN}. Verify that they match.	
180		Total Points	