Energy and Power Estimation
Linear Systems Lab
ECE 3151
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1. INTRODUCTION

This lab functions as an introduction to Matlab, more specifically the specially made functions that have been provided for the class. Additionally, the lab helps increase understanding of how to calculate energy and power. Two matlab functions were written, one for energy (myenergy.m) and the other for power (mypower.m). They were evaluated using a matlab script (Lab3_test.m) and a given function (mysignal.m). Theoretical calculations were done using the given signal to calculate the percent error of the functions.

2. RESULTS

2.1 Power and Energy Functions

The code for both power and energy are very similar. The initial values of E and P are both initially set to []. From there, the required input conditions are tested using if statements and return an error message. The first conditions tested are that **t**, the time vector, and **x**, the signal vector, are the same length. Also tested is that **t** has more than two elements. Nargin is used with if statements to determine the number of input conditions and accommodate the requirements accordingly. So, testing if **a** and **b** are within the time range and adjusting them to the maximum and minimum if they are below or above respectively. Both are calculated using intdef with the power being divided by (**b-a**). It was decided not to use myenergy within the mypower function as it ran significantly slower.

2.2 Test Script

The test script generates the values for **t, x, a,** and **b** by calling mysignal (given in the lab materials) using index 2. The resulting time vector **t** goes from -2 to 4 by increments of 0.001. The **x** signal is 3*u(t+1) - 3*r(t) + 3*r(t-1) + 3*u(t-3) while **a** and **b** are -1 and 3 respectively. The signal is plotted and the graph labeled appropriately.

From there, the power and energy are calculated using the functions above (mypower and myenergy) and displayed to the user. The results are P = 2.9989 and E = 11.9955. The theoretical values for energy and power are calculated below and used to determine the percent error in the test script.

2.3 Theoretical Calculations

The signal given is 3*u(t+1) - 3*r(t) + 3*r(t-1) + 3*u(t-3). The theoretical value for energy is calculated using the equation below with a = -1 and b = 3, the result of which is 12.0045.

$$E_{a,b} = \int_a^b |x(t)|^2 dt \qquad \text{Equation (1)}$$

The theoretical value for energy is calculated using equation (2), resulting in 3.0011.

$$P_{a,b} = {\int_a^b |x(t)|^2 dt}\Big/{b-a} \qquad \text{Equation (2)}$$

The percent error for both P and E are calculated using equation (3).

$$\%\, Error = 100\left(\frac{|Theoretical - Measured|}{Theoretical}\right) \qquad \text{Equation (3)}$$

The percent error for P is 0.074% while the percent error for E is 0.075%.

3. CONCLUSIONS

This project helped deepen understanding of power and energy calculations as well as serving as an introduction to matlab. Using the given program to compute the signal, the power was 2.9989 and the energy was 11.9955. The percent error for each assuming the signal was 3*u(t+1) - 3*r(t) + 3*r(t-1) + 3*u(t-3) was 0.074% and 0.075% respectively. The biggest issue encountered was determining what the equation of the signal was given the graphical representation. How to do so was covered in class, but not in any kind of depth or thoroughness, thus it was determined using trial and error in matlab. The primary conclusion that can be drawn from this lab is the beneficial nature of writing matlab functions to compute common equations and the small percentage of error when given appropriate input.