DYNamic SYStems

Innovative Teaching of Fourier Series using LabVIEW

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Overview

- Problem
- Previous Lab / Project Materials
- Fourier Series using LabVIEW
- Implementing New Project using LabVIEW
- Observations and Evaluations
- Summary

Problem

The application of the Fourier Series, spectral processing, the Fast Fourier Transform and filtering concepts need to be well understood

Traditional approach of mathematical equation development with homework and test problems does not appear to drive students to learn the material

Problem

FFT analyzers used in laboratory exercises end up causing students to become preoccupied with a "button-pushing" operation that clouds the purpose of the exercise

How do students become actively engaged in facilitating their own learning?

Problem

Professors strive to educate students in the most effective manner possible

The lecture-based format of teaching common in engineering education may not be the most effective manner to achieve this goal

Problem

Constructivist learning theory asserts that knowledge is not simply transmitted from teacher to student, but is actively constructed by the mind of the learner through experiences

Problem

Laboratory based projects appear to be the best vehicle for demonstrating many aspects of engineering problem solving situations

Problem:

> ***In most cases, laboratory environments are set up as "exercises" which typically have very clear, predetermined outcomes***

Problem

Students must learn to "think outside the box" and formulate solutions without a clear structure

After two weeks, people generally remember

10% of what they read

20% of what they hear

30% of what they see

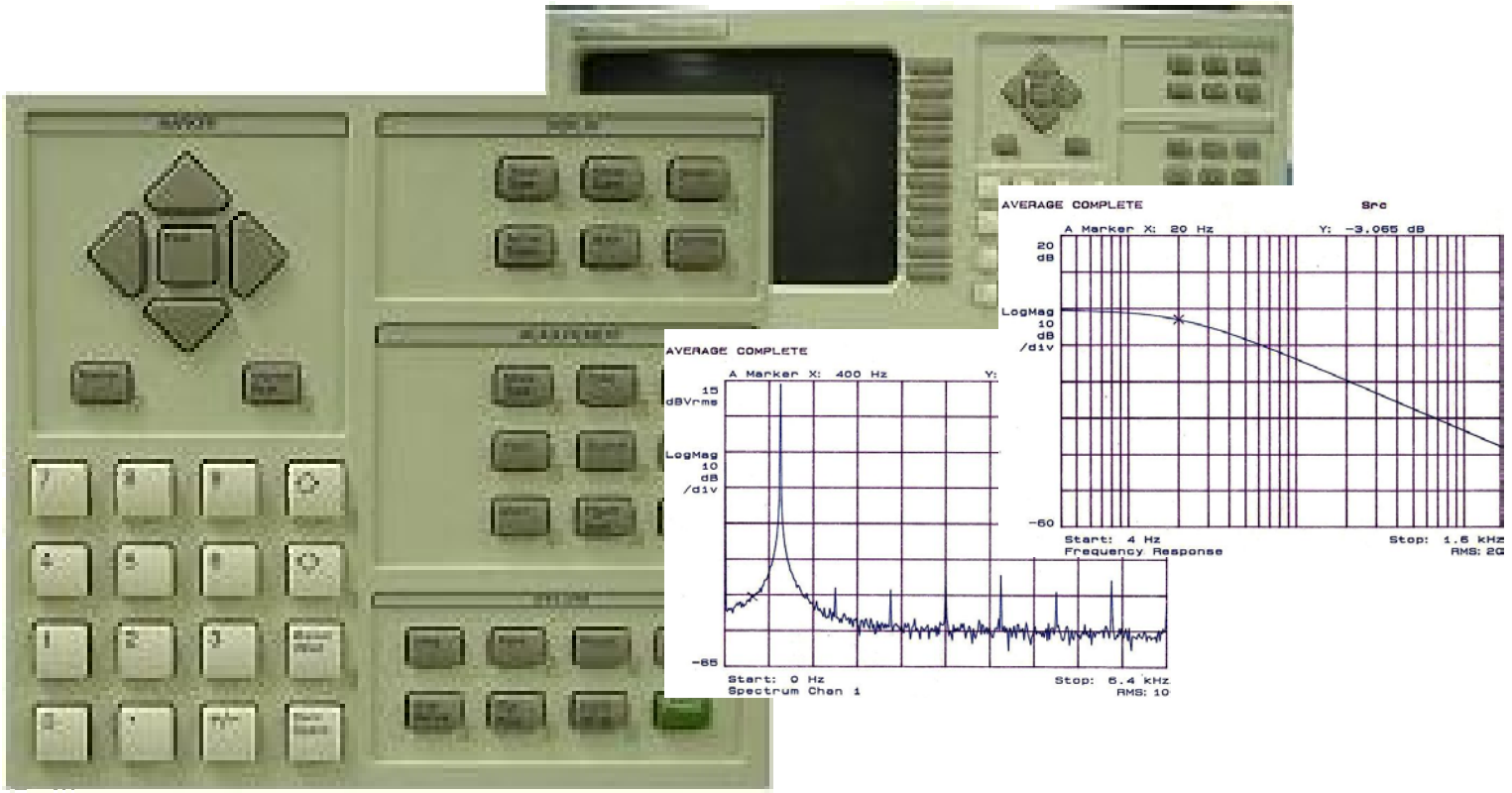
50% of what they hear and see

70% of what they say

90% of what they say and do

Previous Lab / Project Materials

Spectral Processing using a Dedicated FFT Analyzer

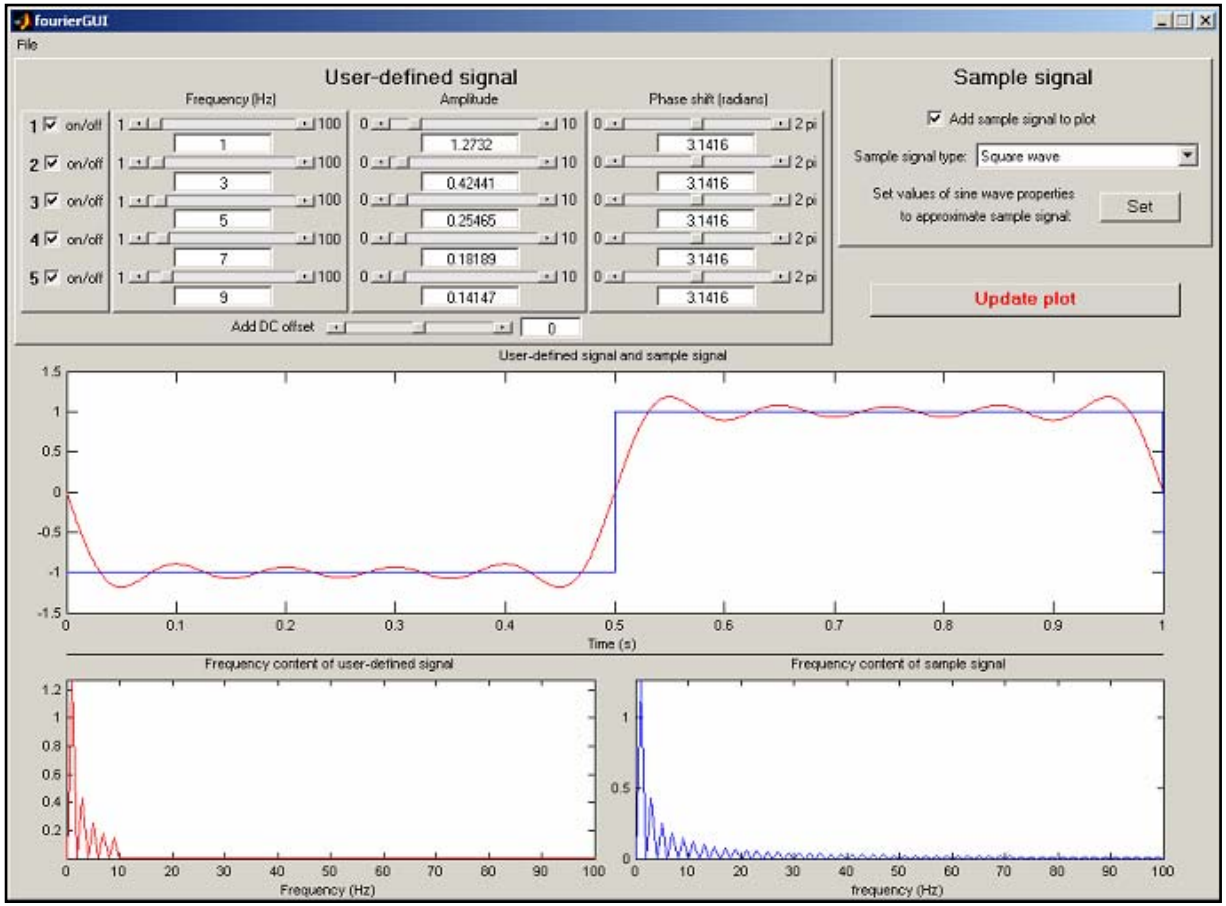


Problems using FFT Analyzer

Students blindly following specific button pushing operations to acquire the data requested

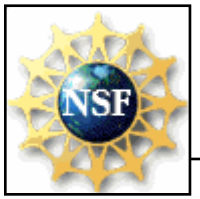
Few students go beyond the limited instructions and attempted any alternate measurements

Fourier Series Development using a MATLAB GUI



Problems using MATLAB GUI

Students used the interface to observe the resulting time trace on the screen but really didn't probe deeper into any of the more intricate aspects of the Fourier Series procedure



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Fourier Series using LabVIEW

Student-developed LabVIEW VI

Students take a simple sine wave and apply amplitude and frequency controls, the signal is shown in both the time and frequency domain

A harmonically related 2nd sine wave is then added to the sine wave in order to help clarify the concepts of harmonics that might have been misunderstood or forgotten from previous courses

Student-developed LabVIEW VI

The student is then asked to approximate a square wave in both the time and frequency domain using a summed set of 5 sine waves

The frequency and amplitude from the LabVIEW interface provide the coefficients of the Fourier Series needed to approximate a square wave

Benefit to Student

First hand understanding of the Fourier Series without ever developing a single equation of the theoretical treatment of this material

The student also gains exposure to a very powerful program, LabVIEW

Benefit to Student

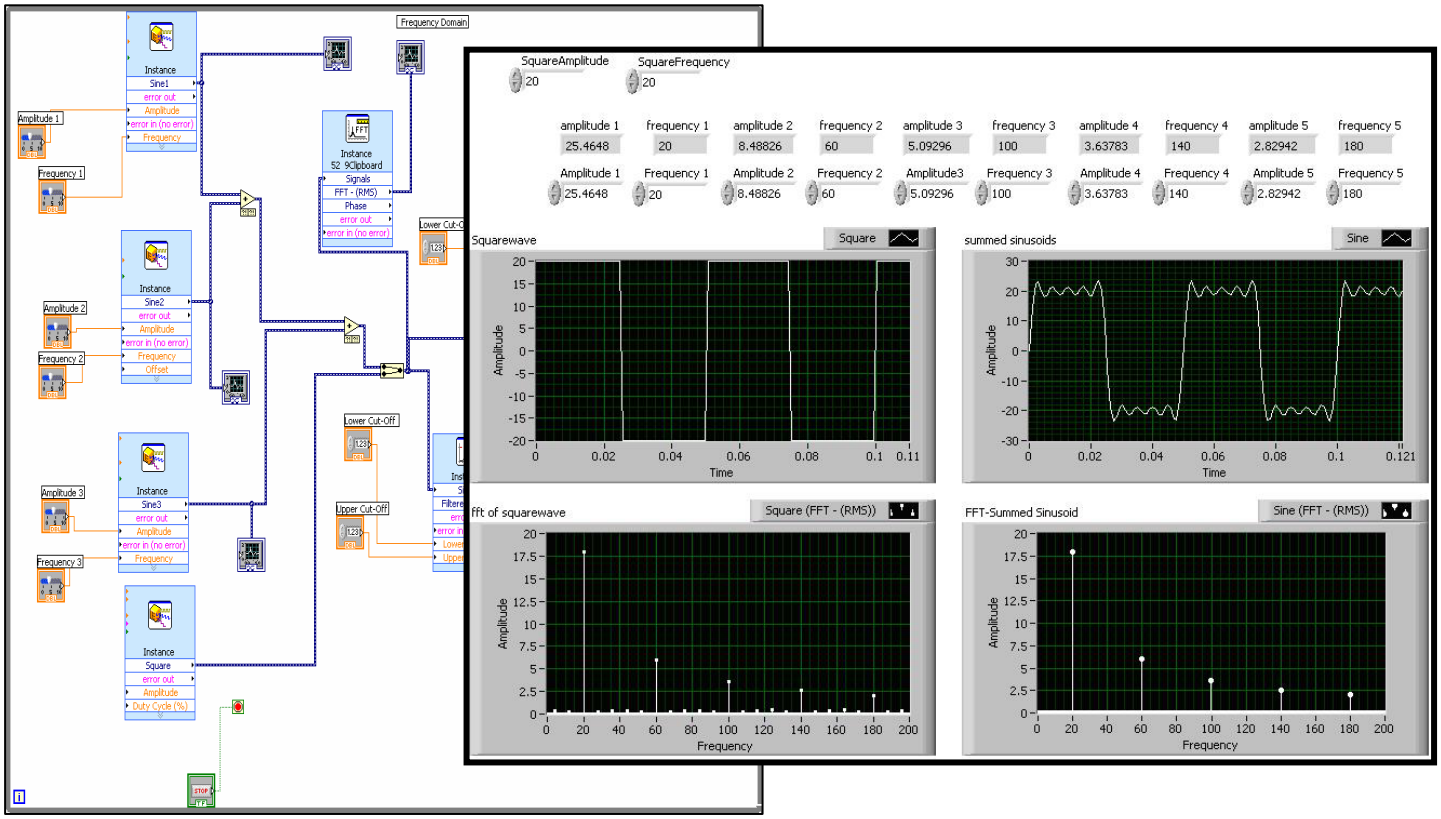
Student is forced to take ownership of the material

Sense of accomplishment upon completing project

Students drive their own experience and learn material more deeply than in previous attempts

Fourier Series using LabVIEW

Student-developed LabVIEW VI



Fourier Series using LabVIEW

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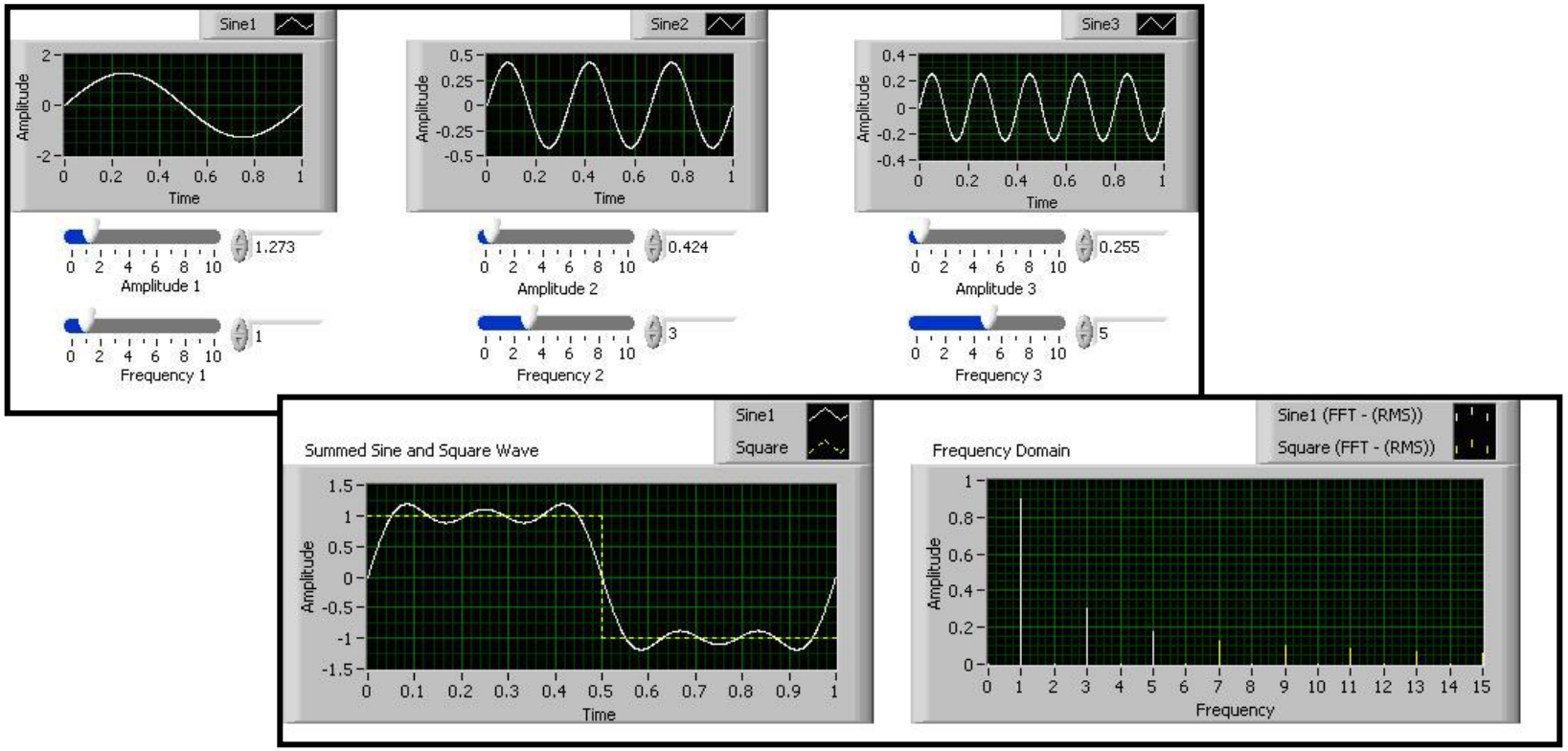
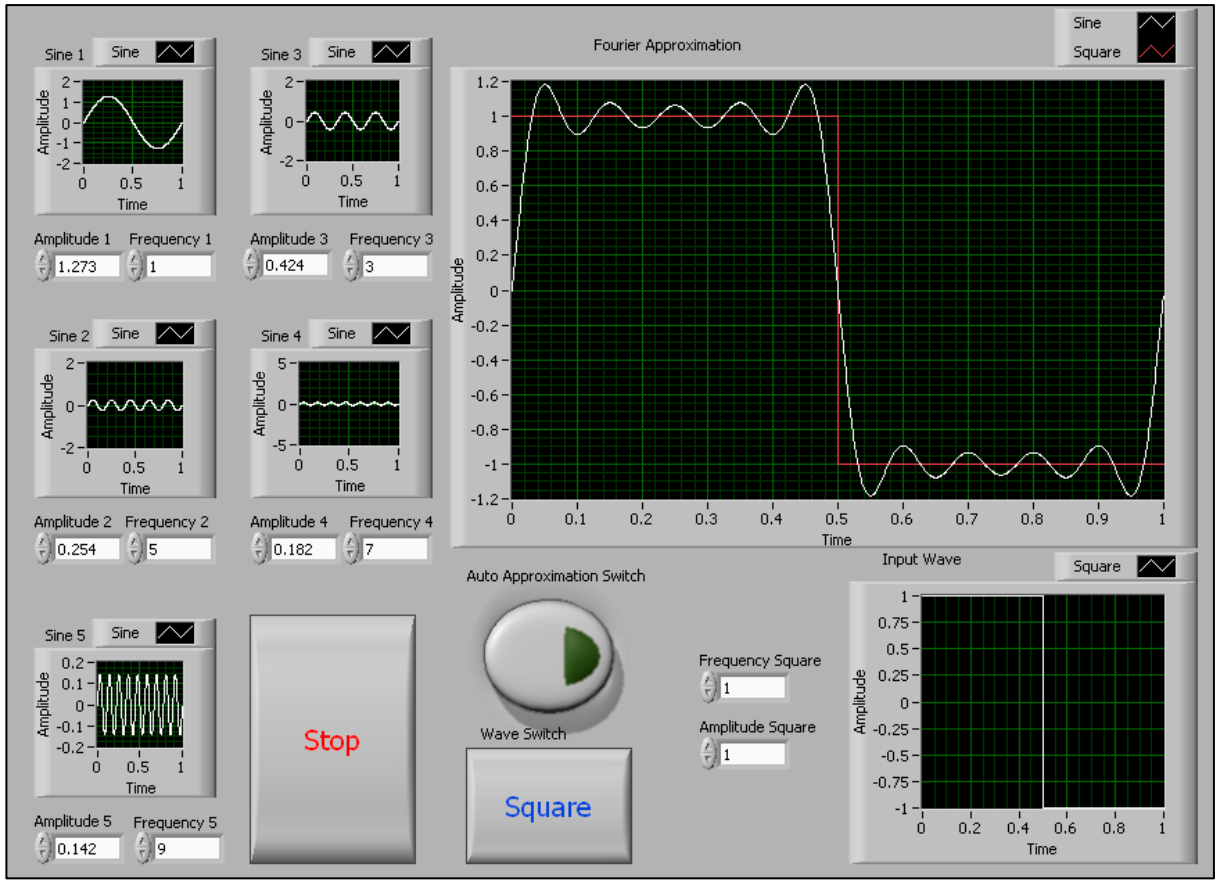


Fourier Series using LabVIEW

Student-developed LabVIEW VI



Implementing New Project using LabVIEW

Implementing New Project using LabVIEW

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Student-developed LabVIEW VI

In class assignment

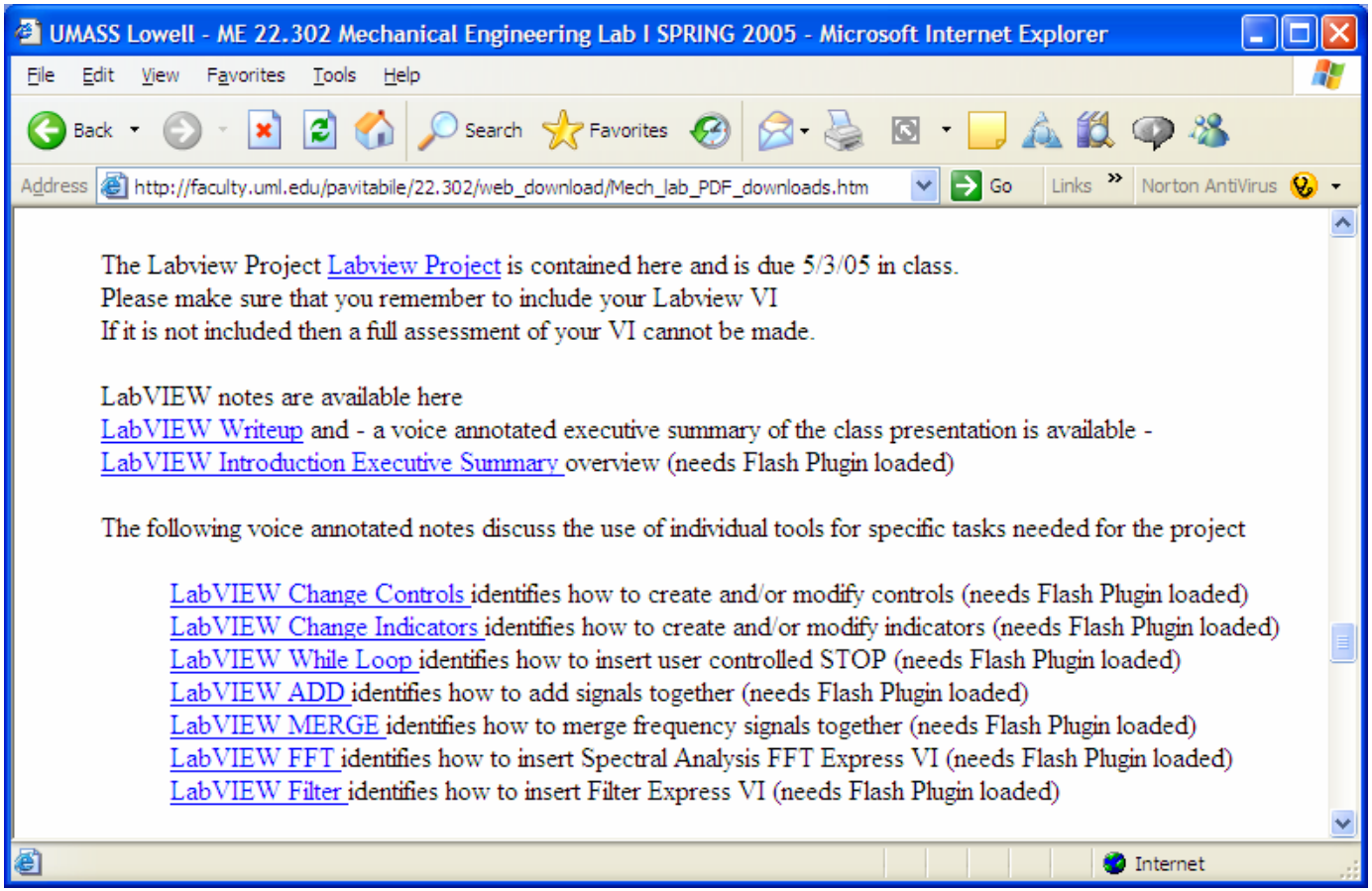
3 week period

2 hours per week

1 hour LABVIEW intro 1st week

Only features specific to project were discussed

Course Webpage with dedicated LabVIEW Section



Course Webpage with dedicated LabVIEW Section

LabVIEW Notes

- Project Overview PDF
- Voice Annotated Executive Summary of Class Notes

Course Webpage with dedicated LabVIEW Section

Project-Specific LabVIEW Voice Annotated Notes

- Change Controls
- Change Indicators
- While Loop
- Add
- Merge
- FFT / Filter

Run Example

Observations and Evaluations

FFT Analyzer and MATLAB GUI

Appeared to be well-structured and provided an excellent mode to present this complex topic

Students seemed to have trouble comprehending the general concepts necessary for future laboratory projects

Observations and Evaluations

Student Driven LabVIEW Project

Observed improvement in the overall student comprehension, understanding and retention of the material

Reasons for this improvement?

Student driven, self motivated project.

Responsibility of learning is put on the students rather than on the instructor implanting it into their memory banks

Student Response?

Students were exposed to both the laboratory based "button pushing" approach as well as the LabVIEW VI creation exercises

Students found new approach far superior

Student Response?

"Now I understand this material"

"The previous lab was a boring, fast-paced unintelligible approach to the material"

"It was not obvious to me why the lab exercise using the FFT analyzer was provided"

Summary

A new approach to teaching the Fourier series and FFT processing was presented

Earlier approaches to presenting this material utilized normal classroom lectures and laboratory exercises using stand-alone FFT analyzers

Students did not fully appreciate or comprehend the material and were reluctant to use these techniques in subsequent projects where they were clearly necessary

Summary

Students performed much better overall after "building" their own FFT Analyzer in LabVIEW and clearly identified that the material was much more "intuitively obvious" with the new approach

Students utilized the LabVIEW software to solve other problems without being coerced to utilize the available tools

Acknowledgements

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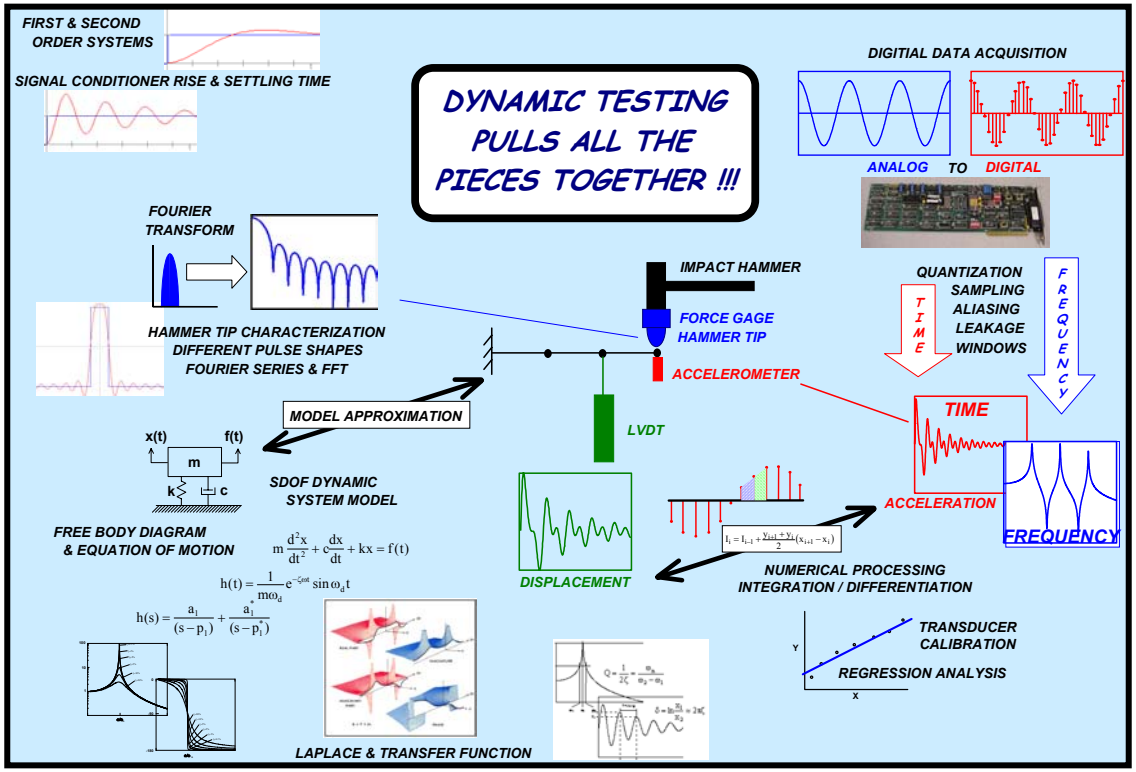
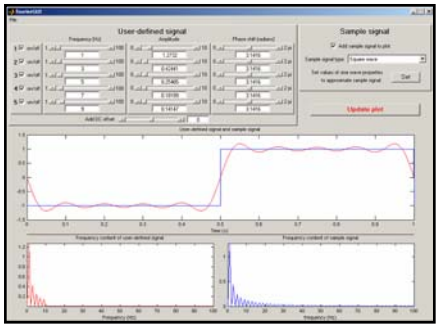
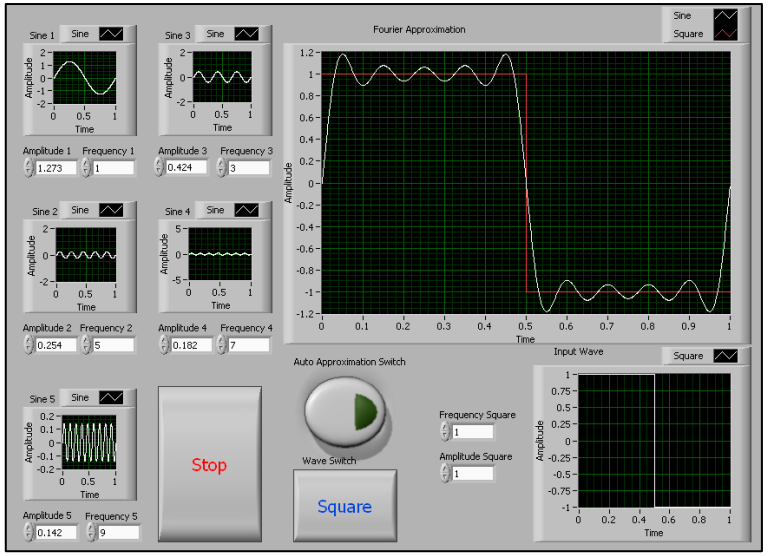
Multi-Semester Interwoven Project for Teaching Basic Core STEM Material Critical for Solving Dynamic Systems Problems



Peter Avitabile, John White, Stephen Pennell

Innovative Teaching of Fourier Series using LabVIEW





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