

INTRODUCTION:

EMEM-543 System Dynamics is an upper level required course in the Mechanical Engineering undergraduate curriculum. The class touches on concepts of electrical and mechanical system modeling, system stability, and basic frequency response. Currently the course does not cover the concept of signal filtering, but its instructors would like to include this concept. The goal of this project is to produce a prototype of a laboratory package which allows students to explore the effects of signal filtering and phase shift through audio and image processing.

This project was inspired by a past MSD project in which the design team created interactive keyboards which exhibit the effects of filtering to students at a K-12 level.

This design project is intended to produce a working prototype of a laboratory package which exhibits concepts of signal filtering and phase shift through audio and image processing.

ADMINISTRATIVE INFORMATION:

- **Project Name:** Design of Lab Hardware and Software to Teach Filtering to System Dynamics Students
- **Project Number:** P13361
- **Start / End Terms:**

Start Term	End Term
Fall 2012 (2121)	Winter 2012-2013 (2122)

- **Faculty Champion:**

Name	Dept.	Email	Phone
Dr. Vincent Amuso	EE	vjaeee@rit.edu	585.475.2165

- **Other Support:**

Name	Dept.	Email	Phone
Dr. Agamemnon Crassidis	ME	alceme@rit.edu	585.475.4730
Dr. Jason Kolodziej	ME	jrkeme@rit.edu	585.475.4313
Dr. Marca Lam	ME	mjleme@rit.edu	585.475.6871

- **Project Guides:**

Name	Email
Leo Farnand	lfarnan1@rochester.rr.com
Vincent Burolla	vabddm@rit.edu

- **Primary Customer:**

Name	Organization	Dept.	Email	Phone
Dr. Mark Kempski	RIT, KGCOE	ME	mhkeme@rit.edu	585.475.2473
Dr. Kathleen Lamkin-Kennard	RIT, KGCOE	ME	kaleme@rit.edu	585.475.6775

- **Sponsor:**

Name	Organization	Contact Info.	Type & Amount of Support Committed
Mark Smith	RIT, MSD	mwsps21@rit.edu	Financial; \$500.00

PROJECT OVERVIEW:

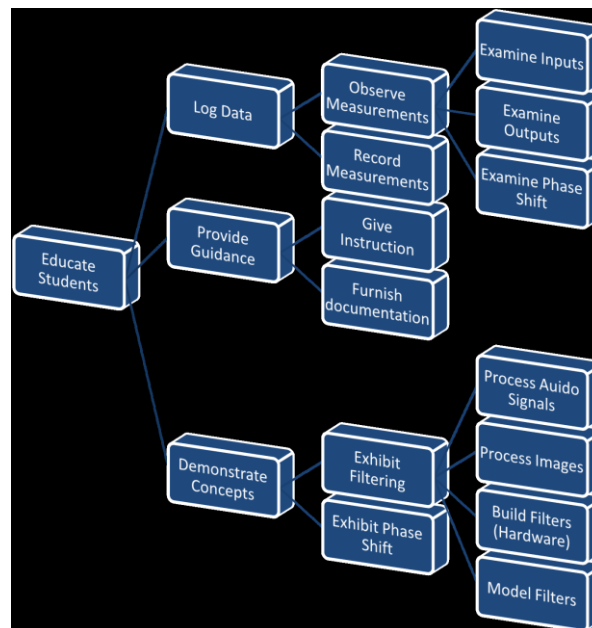
This project generates a laboratory experience that will be used as a teaching guide to introduce filters to the EMEM-543 course. The lab to be designed will introduce and demonstrate various implications of filters in engineering by focusing on three different cases. The first front is one-dimensional audio signal case. The student will have the capability of recording a waveform or using a prerecorded audio signal and will wire the included circuit board to act as a high pass, low pass or band pass filter. Through this interaction the student will be able to hear different ranges of frequencies of the signal utilizing the various filters. This method using auditory enforcement to demonstrate the implication of filtering.

DETAILED PROJECT DESCRIPTION:

- Customer Needs:

ID	Category	Description	Priority
1	Activity	Primary product function must be to educate students of EMEM-543 on electrical filters, including low, high, and band pass filters	1
2	Activity	Product must provide audio processing activities via interaction with analog electrical hardware that demonstrate the impact of design decisions on system performance	1
3	Activity	Product must provide interactive image processing activities conducted via Matlab/Simulink software	1
4	Activity	Product must provide sensory feedback that demonstrates phase shift	1
5	Activity	Product data acquisition must be conducted via Labview	3
6	Activity	Product must be engaging to students	2
7	Support	Product must include full documentation, including a preliminary lab activities manual, full bill of materials, wiring schematics, and service manuals	1
8	Support	Product hardware must be inexpensive and easily replaceable	1
9	Support	Product hardware must be easy to store, maintain, and repair	1
10	Environment	Product must be designed for execution in the System Dynamics studio classroom (GLE-2120)	3
11	Environment	Product must be designed for use during instruction (class) time	2
12	Environment	Product must be safe for all users	1

- Functional Decomposition:



- Engineering Specifications & Constraints:

Engineering Specifications

ID	CN Address	Metric	Unit	Nominal	Ideal	Comments
1	1	Level of understanding	%	70	100	Open lab quiz will measure understanding of lab activity concepts
2	6	Activity time spent doing "hands-on" work	%	50	100	This includes all lab activity except for reading the lab manual
3	6	Design possibilities/outcomes	#	8	Infinite	H/W: HPF, LPF, BPF, active, inactive, first order, second order, etc.; S/W: Blur, Edge detection, HPF, LPF, etc.
4	9	Storage footprint of hardware	in	12x12x3	6x6x2	
5	9	Maintenance time (minor)	min	10	10	Minor repair such as replacing a wire or simpler
6	9	Repair (major) time	min	90	60	i.e. replacing PCB, audio rec board, breadboard, etc.
7	10	Compatible with laboratory (GLE-2120) support equipment	Y / N	Yes	Yes	i.e. DC power supply, oscilloscope, multimeter, DAQ, computer
8	11	Lab activity duration	min	80	100	Includes reading the lab manual and performing all in lab activities
9	12	Maximum audio level @ 1 ft	dB	80	80	Hearing damage possible (but unlikely) above this level

Engineering Constraints

ID	CN Address	Metric	Unit	Nominal	Ideal	Comments
1	2	Filter topics addressed	Y / N	Yes	Yes	Filter topics such as type, cutoff frequencies, etc.
2	3	Matlab software present	Y / N	Yes	Yes	Image processing and phase distortion activities
3	4	Phase distortion software present	Y / N	Yes	Yes	
4	5	Labview software present	Y / N	Yes	Yes	For data acquisition purposes
5	7	Documentation provided	Y / N	Yes	Yes	Lab activities manual, operations/instruction manual, service manual, BOM, etc.
6	8	Stocked components used	%	75	100	Zero lead time parts
7	8	Prototype Cost	\$	500	400	Cost for product development
8	8	Reproduction cost	\$	300	100	Cost of production of one unit assuming the purchase of many units at once
9	9	Time between maintenance (minor)	Weeks	1	52	Any minor maintenance such as replacing wires, etc.

- Project Deliverables:
 - The team will deliver, for each activity:
 - A detailed design for all hardware and software to build, including proposed test plans
 - A laboratory manual which outlines the planned learning objectives and activities
 - Documentation to support the laboratory package including service and repair instructions
 - The team will submit their technical paper to one of the following: the ASEE annual conference, an ASEE regional conference (RIT is part of St. Lawrence, but other regions would work), the ASME annual conference (IMECE) or the IEEE Frontiers in Education conference.
- Budget Estimate:

Budget estimated at \$500.00 for hardware components

STUDENT STAFFING:

- Anticipated Staffing Levels by Discipline:

Discipline	How Many?	Anticipated Skills Needed
EE	3	Variable, experience with filter design and implementation
ME	1	Has taken Systems Dynamics.

Prepared by: Beth DeBartolo
 Revised by: Ethan Flow

Date: 8/8/2012
 Date: 01/18/2013