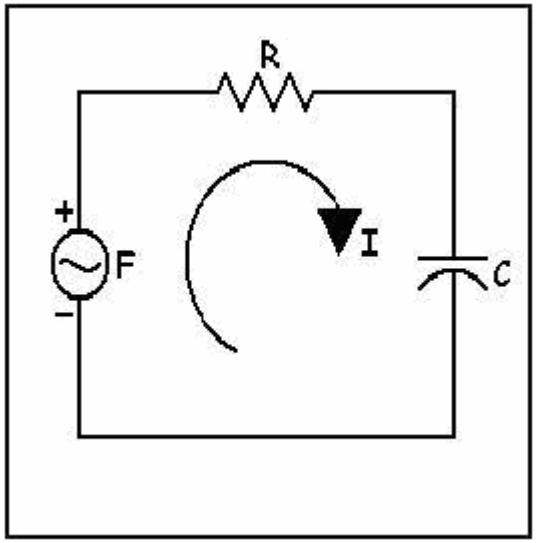
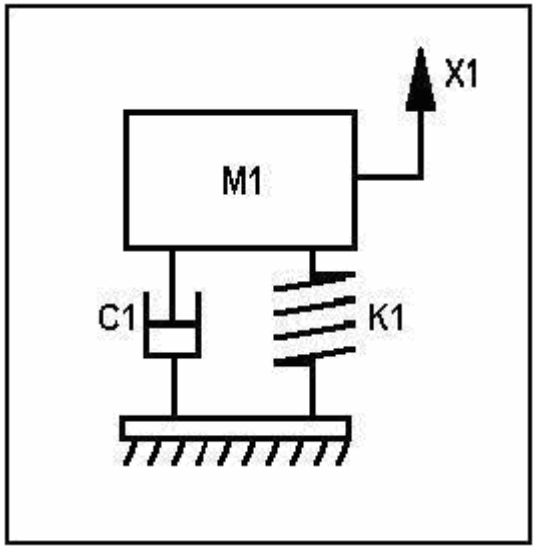
DYNamic SYStems

Development of Visualization Tools for Response of 1st and 2nd Order Dynamic Systems





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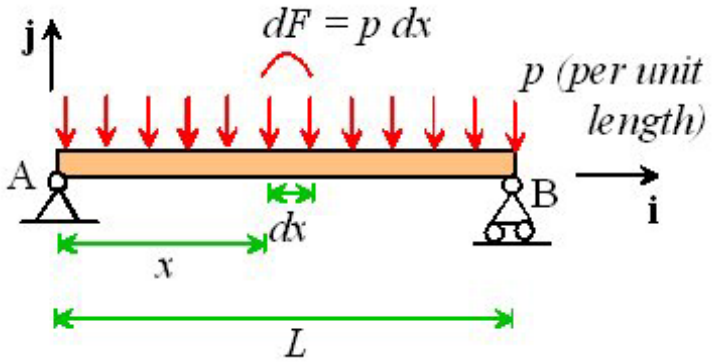
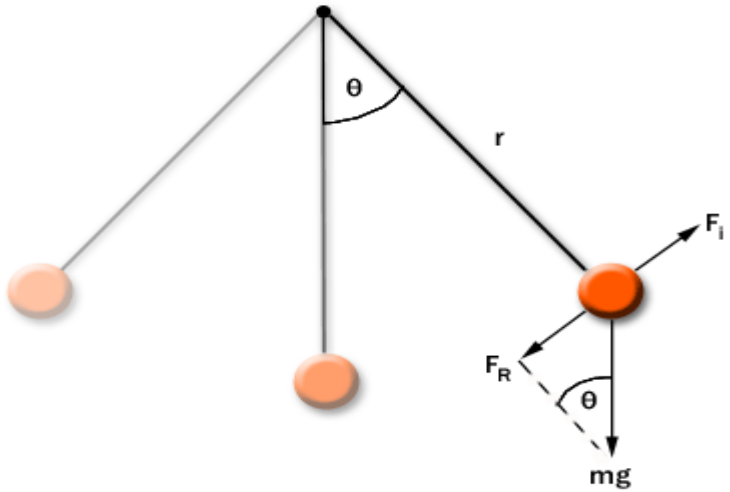
Objectives of this lecture:

- General Course Content Leading to Dynamic Systems
- Effectiveness of Course Prerequisites
- How can MATLAB and LabVIEW Visualization Tools Reinforce Student Understanding
- 1st Order System Characterization
- 2nd Order System Characterization
- Student's Response to GUIs
- Summary

Course Content

- Courses such as statics, strength of matl's etc. focus on static strength and fatigue yet don't explain how these dynamic loads are created
- Most dynamics courses consider only rigid body dynamics





Course Prerequisites

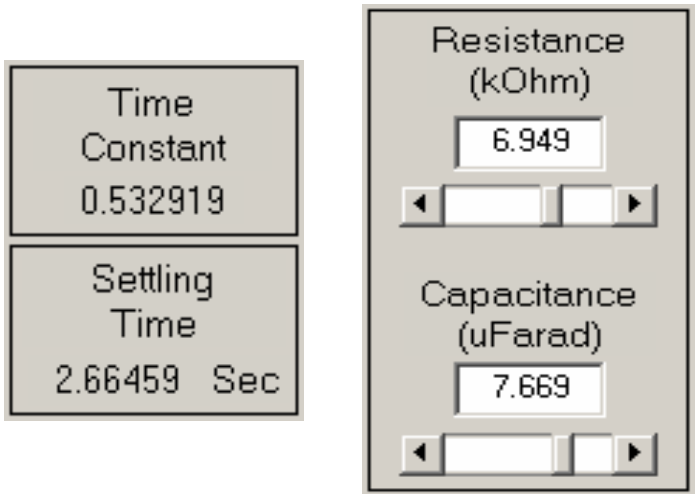
- Common prerequisites for dynamic systems courses include statics/dynamics and differential equations
- These courses involve complex numbers, relationships of exponentials and sines/cosines, solutions of 1st and 2nd order differential equations, Laplace transforms, Fourier Series, etc.
- The problem is that the student may not connect these core STEM concepts with practical examples or even be able to remember the material

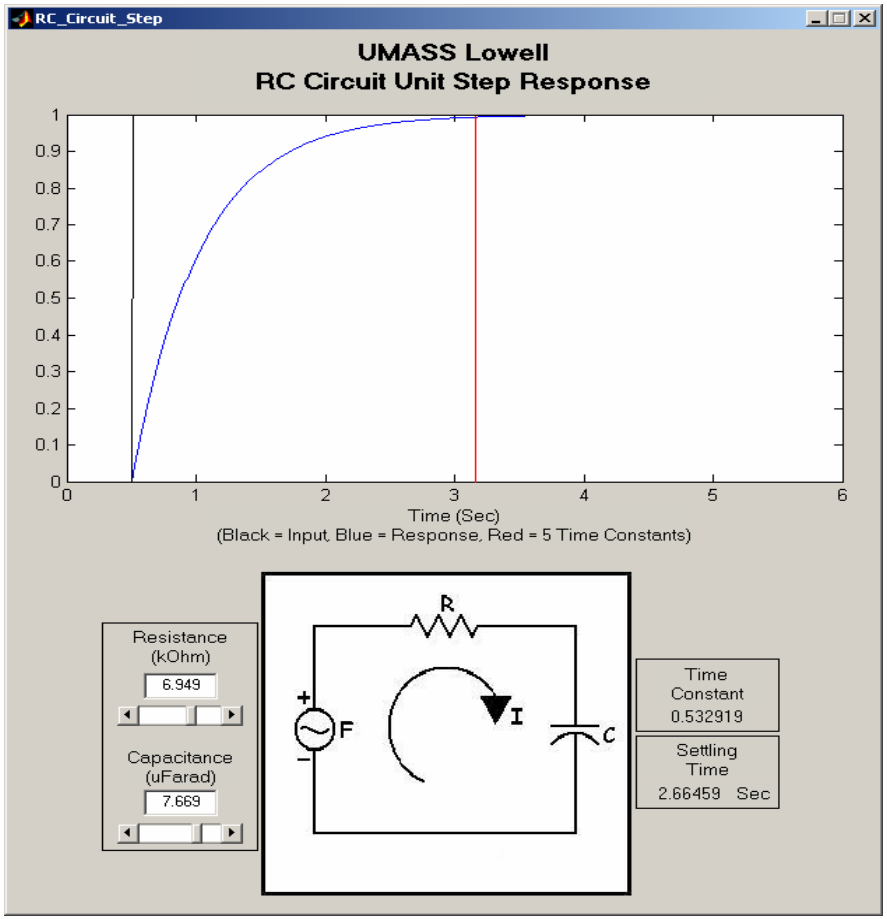
Visualization Tools

- How can MATLAB and LabVIEW Visualization Tools Reinforce Student Understanding
- Graphical User Interface (GUIs)
  - Visual examples
  - Students move at their own pace
  - Effectively reinforce core concepts
- Link between previously introduced concepts and their application

1st Order System Characterization

- MATLAB GUI for first order response
- This GUI allows for the variation of resistor and capacitor values and shows the effect on the system step response





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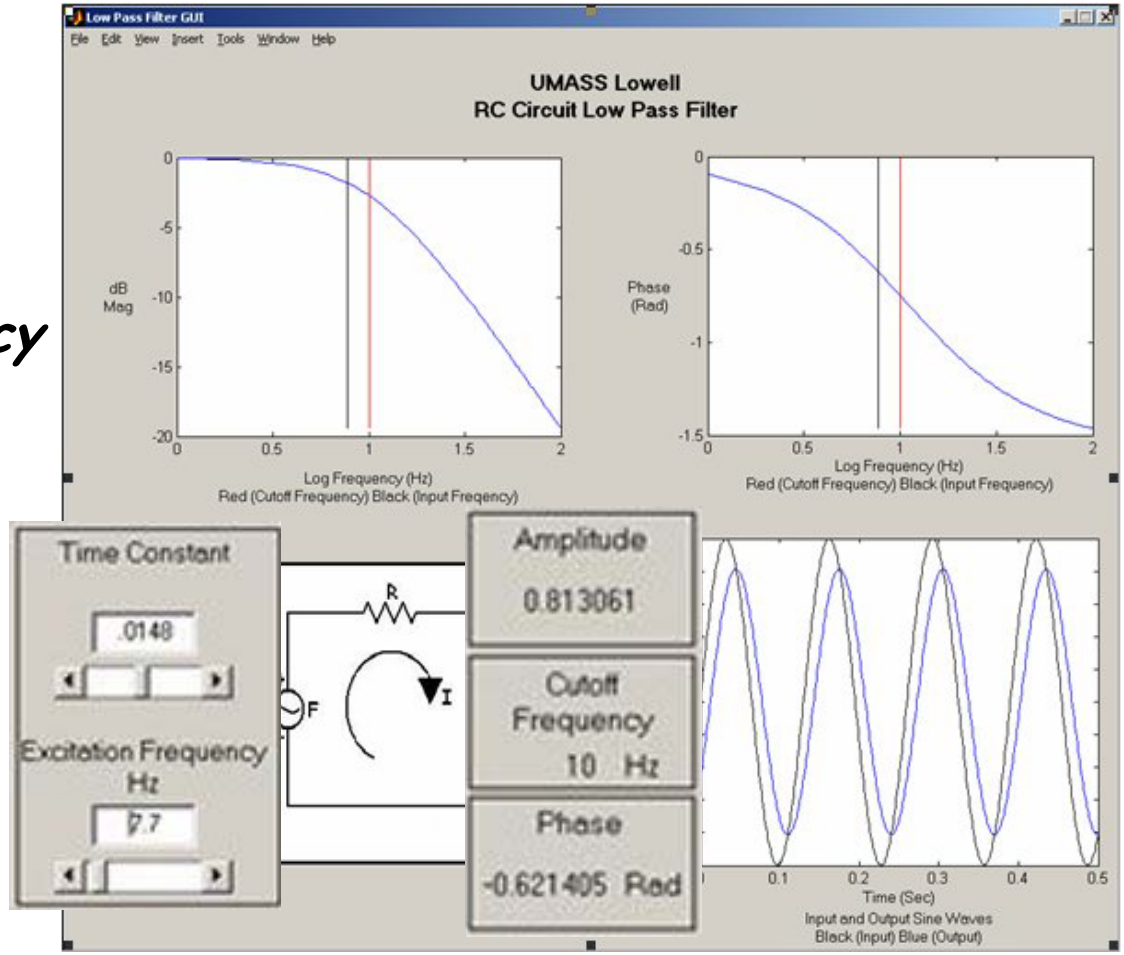
1st Order System Characterization

DYNamic SYStems

- MATLAB GUI for RC low-pass filter

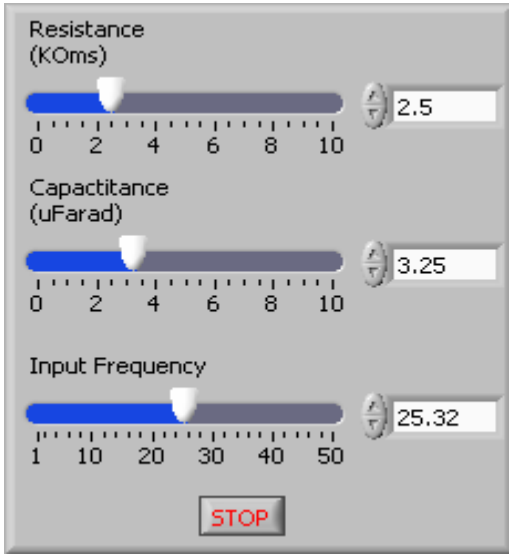
- Student controls
  - Time constant
  - Excitation frequency
- Output
  - Time response
  - Phase shift
  - Amplitude
  - Cutoff frequency

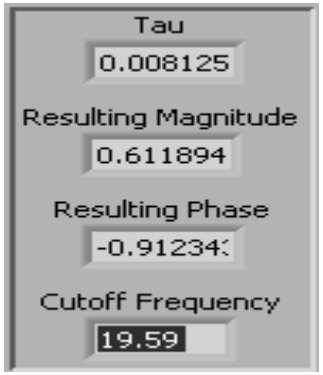


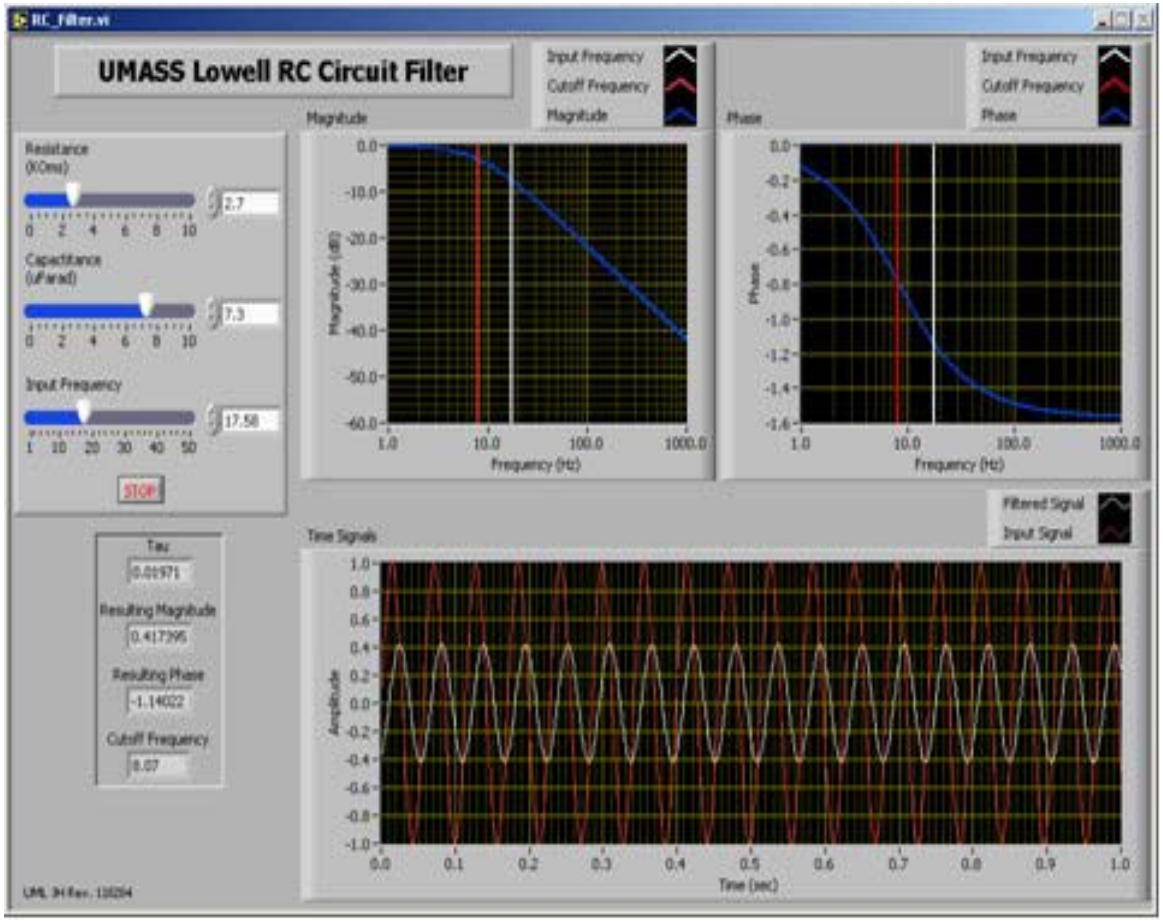
1st Order System Characterization

DYNamic SYStems

- LabVIEW GUI for RC low-pass filter







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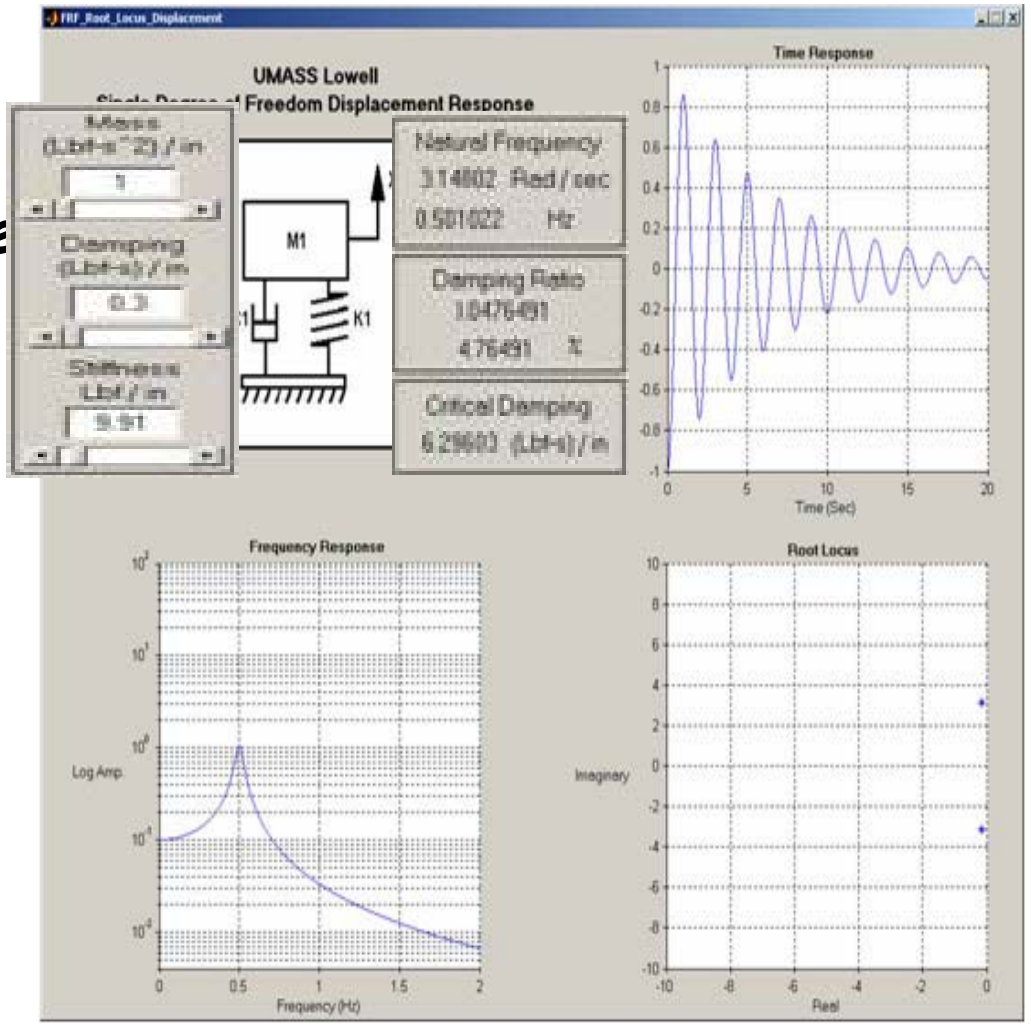
2nd Order System Characterization

- *Abundant in engineering and form a cornerstone of knowledge*
- *Several GUIs were developed for 2nd order response in both Matlab and LabVIEW*
- *Response of 2nd order systems studied based on the step function, impulse, or initial conditions*
- *Matlab and LabVIEW GUIs were developed for each of these response conditions*

2nd Order System Characterization

- SDOF System
- Displacement Response
- Input
- Mass, Damping, Stiffness
- Output
- Natural frequency, Damping Ratio, Critical Damping
- Time Response, Frequency Response, Root Locus



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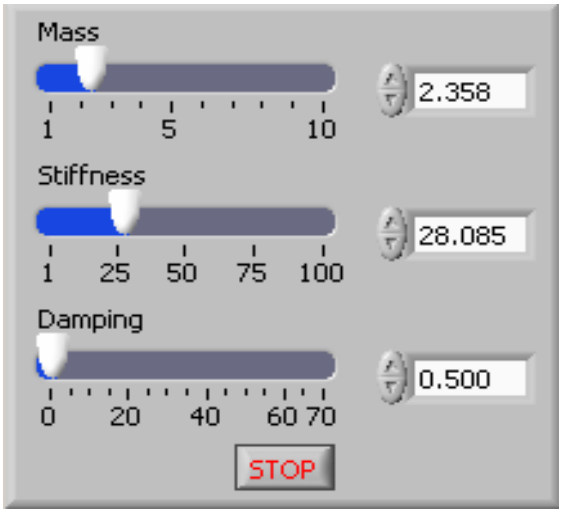
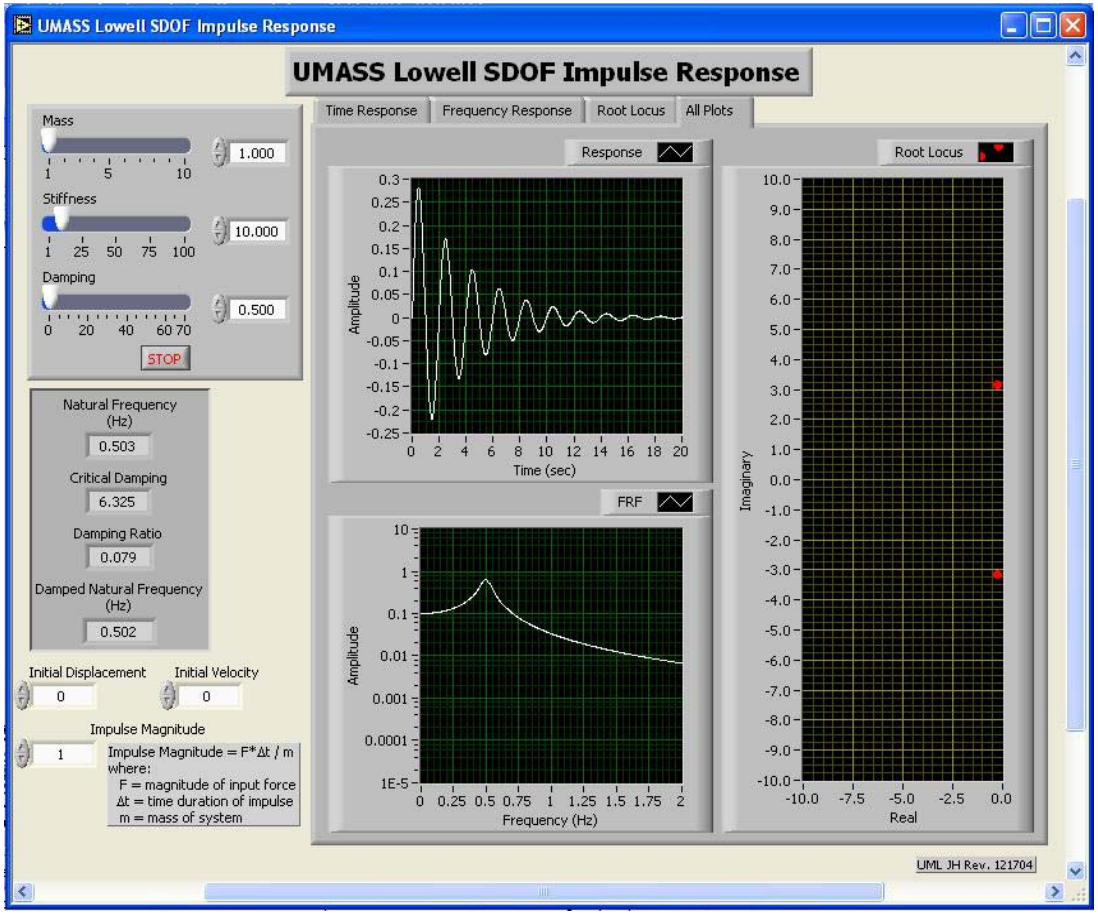
2nd Order System Characterization

LabVIEW SDOF Impulse Response





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Course Implementation

DYNamic SYStems

GUIs have been implemented throughout the Mechanical Engineering curriculum as of the past few years. So far courses include:

- Ordinary Differential Equations
- Mechanical Engineering Laboratory
- Dynamic Systems

Material is available online

http://dynsys.uml.edu

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Students Response

DYNamic SYStems

Well over 75% of the students strongly felt that the GUIs helped to further their understanding of filtering characteristics

90% of the students indicating that there was a distinct benefit in using the GUIs to better appreciate this material

over 50% felt that the GUI was essential in their understanding of the material; close to 25% felt that it partly augmented their understanding

Summary

It has become evident that students have difficulty retaining the tools required to adequately learn and understand 1st and 2nd order systems

The visualization tools developed allow for a greater understanding of system characteristics and their response during excitation

Student response was very strong concerning the need of the GUI to help foster a deeper understanding of this material

Acknowledgements

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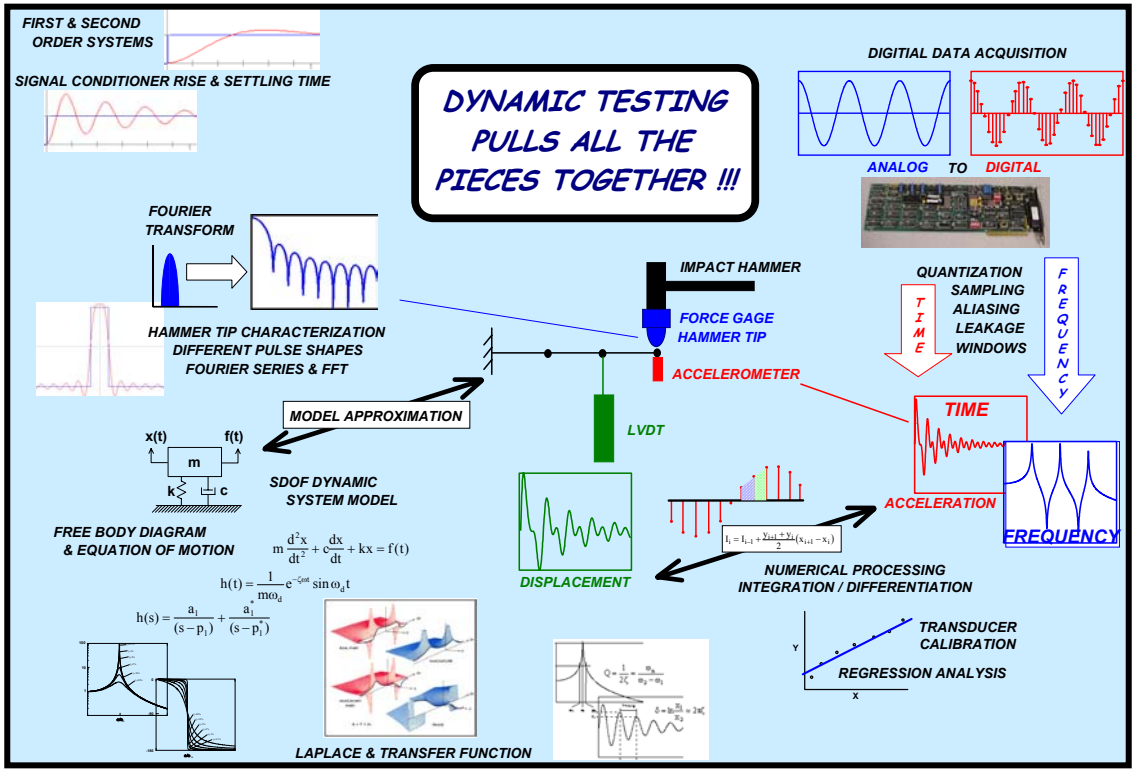
Multi-Semester Interwoven Project for Teaching Basic Core STEM Material Critical for Solving Dynamic Systems Problems



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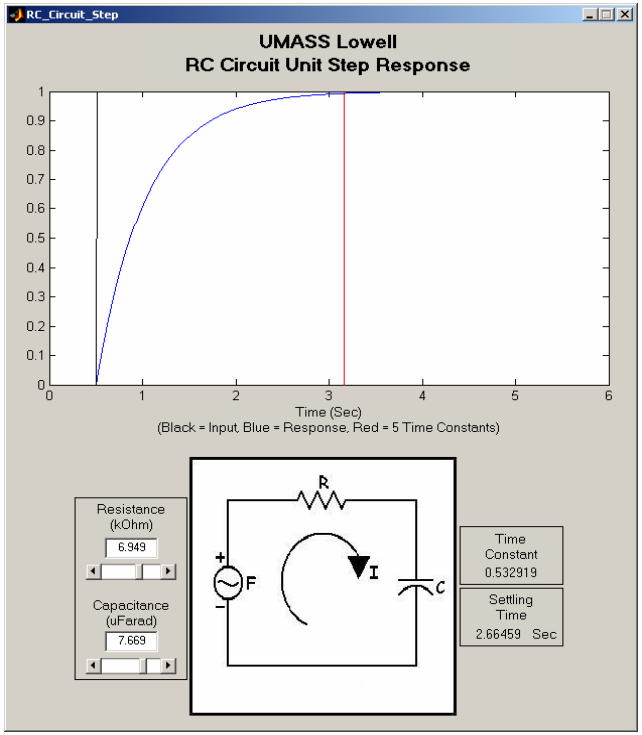

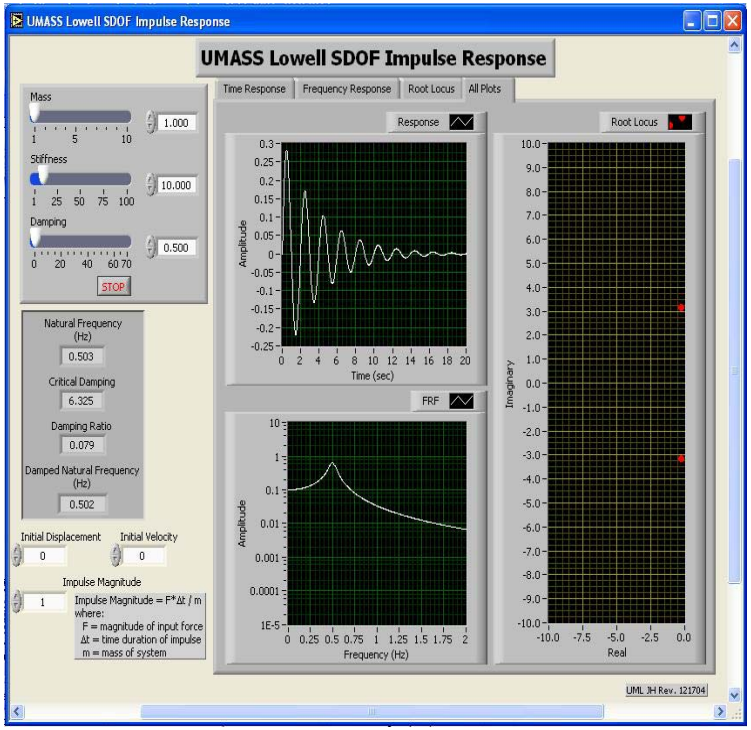

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