ME/EMA 540 – Fall 2020
Final Project

DEADLINE: **Wed. Dec. 16th 2:45 PM** – (Final exam period) A PDF of your final report of **no more than 10 pages** must be uploaded to course website in a *.zip file along with all of your measurements and your post-processing scripts (i.e. Matlab files), etc… You report may include appendices with handwritten calculations, additional supporting figures and any other materials that you wish to include; there is no limit to the size of your appendices, but the main body of your report should contain the critical information and must be less than 10 pages.

DESCRIPTION: The objective of the final project is to:

1.) Identify the fundamental dynamic modes of the walkway including the natural frequency, mode shape, and an estimate of the damping ratio.

2.) Use analysis, modeling, simulation or other calculations together with the identified modes to predict the stress in the walkway when 20 students jump simultaneously on the walkway, in tune with the first mode of vibration.

SPECIFICS FOR THIS YEAR'S OMA PROJECT: With the help of the instructors you have collected the measurements needed to perform Operational Modal Analysis on the walkway between the Engineering Research Building and the Materials Science Building. Your goal is to now use those measurements to understand how safe the walkway is. You are asked to estimate the stress in the walkway during and extreme loading event (20 students jumping in the walkway in tune with the first mode of vibration), and to compare that to the yield stress for the walkway. The following steps should help guide your work:

- Document the locations and orientations of all of the sensors used when performing your test for Setups A, B and C.
- Estimate at least two modes of vibration of the walkway from your OMA measurements using peak picking on the auto and cross-spectra. Use data from at least two setups to show the mode shapes in both vertical and lateral directions.
    - Use your identified mode shapes, natural frequencies and damping ratios to reconstruct the power spectra, and show this as a measure of the quality of your measured modal parameters.
- Create a simple model of the walkway that can be used to estimate the modes and the stress in the walkway when it vibrates in a certain mode of vibration. This can be a Ritz model which treats the walkway as a beam. Compare the identified mode shapes with those from your model. Adjust the parameters of your model until the agreement is satisfactory so that you can estimate the stress in the walkway with some confidence.
- The diagonal cross-braces seem to have modes that are largely uncoupled from those of the walkway. If those are not considered, they may invalidate your estimates for the fundamental modes of the walkway. Use the measurements from sensors on the diagonal cross-braces to estimate the natural frequencies and damping ratios of each cross brace for which measurements are available and compare them to estimate the variability in the tension of the braces. Are any of these frequencies close enough to those of the fundamental modes to contaminate your identification of those modes?