ME410 Computer Aided Engineering
Course Project Guideline

In the project you are expected to learn mostly on your own how to use a FEM package such as COMSOL. Instructors will provide as much guidance as they can for what they know in specific implementation details of COMSOL, NASTRAN and alike. As those codes are large packages, you are expected to be the expert for the solution of the specific problem you selected as a project.

Make sure that there’s enough documentation in the package for the problem you wish to solve in your project. Please note you will be responsible if your project does not work at the end. Arguments such as “we were not provided enough knowledge of the code, so we are not responsible for code not giving us good results,” or “we didn’t have enough access to computers in the undergraduate/graduate lab to solve our problems” or “computer kept crashing” Not that you would do this but similar arguments are observed in previous course projects of this courses and alike.

If the code keeps crashing, giving you errors, or if your computer keeps crashing, you are expected to work your way around these problems. For example, COMSOL has an online database of technical support for certain oddities such as getting computer crashes etc due to graphics card problems. If you identify such a problem contact the instructors.

You are almost-engineers and you are expected to prove yourselves as ones by solving problems at all levels including administrative and technical ones. In the unfortunate case of not being able to find appropriate results with a FEM code, you will be graded for your discussion, and approach.

ME410 CAE course project is a CAE-analysis-based design project, and it must contain the following elements:

1. **Product and its figures of merit.** For example a light-weight bridge that will sustain dynamic loads of 40 ton trucks, and 70 kmh winds. Its function is to sustain loads, figures of merit are: its weight, it maximum allowed static and dynamic loads, its maximum deformation under maximum loading (e.g. truck standing in the middle with a 70 kmh side wind)

2. **Background.** Appropriate literature search of similar models used for the design of similar objects. E.g. a background search for the theoretical and modeling approach used in the design of truss-bar bridges of the type you wish to model.
3. **Description of the design problem:** List of design parameters for which a parametric study will be conducted and the reasoning behind the selection of them (why are they the most important or definitive parameters of the design?). E.g. A cage-structure for the truss-bar design may be drafted by an architect, and as an engineer you make sure that appropriate beam elements are used for it to work, profile, cross-section, moment of inertia of the beams may be design parameters.

The design problem must also include crude analytical back-of-the-envelope type sketchy calculations of the most important element of the design to show a rough feasibility. For example, since the beam elements have an analytical solution, by selecting a single beam (the weakest link in your design) and showing that certain loads on this beam causes no critical deformations or stresses will be very appropriate to chose the range of I's and A's for your design.

4. **Approach.**
   a. Description of the computer model. E.g. modeling of 3D truss-bar structure with beam elements.
   b. Description of the analysis method. E.g. Static analysis under static loads, dynamic analysis.
   c. Governing equations and boundary conditions. E.g. beam equations for the truss elements, appropriate boundary conditions applied.
   d. Input variables (parametric study). E.g. loading conditions
   e. Final project report and presentation must have the validation of your results. You must provide a mesh convergence argument based on a single finest mesh run and its coarser forms to show how the results converge and supporting arguments why the mesh you chose for the design and analysis is satisfactory.

5. **Results and discussion.** This part must have the figures of merits you find appropriate for the analysis of your results and how the design is finalised. E.g. maximum deformation in the middle of the bridge and critical maximum stresses realised in the beams and junctions.

6. **Conclusion and future work.** An honest discussion of the successes and shortcomings of the project, and suggestions how it can be improved.

*Project Proposal Guidelines*

The project proposal must have an abstract for parts 1, 3 and 4, and expected results. Especially part 3 must have the emphasis. The problem must be well-defined and in the case of an existing demo in the COMSOL or a similar
package relevance of the two problems and your contributions must be clearly identified. The proposal must have the following elements:

1. Title of the project
2. Abstract/Executive summary (former as a paragraph, letter as an itemized list)
3. Description of the design problem.
4. Description of the CAE-analysis approach.
5. Expected results and merits of success.
6. Tasks: This should be a list of tasks that needs to be completed for the successful ending of the project. For example:
   - Design of the conceptual bridge: What will be the shape, span, width, number of bars used in the bridge, ...?
   - Parameterization of the design: What parameters will be optimized in the design, beam profiles, I-beams, T-Beams, L-Beams, size of the beam cross-section, widht-height...
   - Benchmark simulations: Candidate (guess) simulations for example for L, I and T beams with appropriate width and height for each cross-section.
   - Validation of benchmark simulations: Make sure you are doing the right simulations. If there’s an example somewhere which your design is based on, run the code and make sure you get the same results. Or use physical arguments supporting that you are getting reasonable results from the code.
7. Timeline: Projected completion of each task in bi-weekly units.