EML 3500 Mechanical Design — Fall 2020
Prof. Ben Boesl — Exam 01

Design an Everyday Engineering Structure using a Design Matrix

Links to Course Objective: 1. Identify the state of stress and strain in a member based on axial, torsion, bending or transverse loading.
Links to ABET Outcomes: 1, 2, 3 (see syllabus for descriptions of student outcomes)

In the first module of this class we presented and investigated case studies of a typical design process. In this case a specific goal was given, and external loads and boundary conditions are known. In many cases a selection of materials that are available were known as well. We explored using a design matrix to make a more informed decision that can relate stakeholder needs to output design performance through a comparison of possible design choices.

An example of **confident** engineers that have completed an appropriate analysis on a beam structure related to the loading case. *Lunch atop a Skyscraper, 1932* Charles C. Ebbets

Now it is your turn! Your task for this exam is to consider **any** engineering design structure that may need a redesign, you will be graded on your ability to identify a unique situation that can result in improved performance over the traditional design of today. We have been focusing on structures that include beams, so your structure should include beams in some capacity. Multiple examples of engineering situations using beams and the translation of loads and boundary conditions into stress and strain can be found in the previous exams posted on CANVAS.

You can make any assumptions you need to about the typical/limiting loading cases on the engineering structure and the boundary conditions of the problem. Assume a model to translate the loading cases and boundary conditions into stress and strain, then compare that stress and strain to the strength of your potential materials. In addition, think about and include additional stakeholder considerations into your design, those additional considerations can be cost related, safety related, environmental aspects, manufacturing concerns, etc. Include all of these possible iterations into a design matrix and provide a final solution based on all of this input. You should also consider the weights of each design choice as they relate to stakeholder needs.

Submission format and instructions.
For this first exam, you will be required to submit a written document outlining your use of the design process, metrics for grading and analysis are given on the next page. You are required to turn in a .pdf file with everything that I will need to recreate your analysis. All content must be computer generated, no hand-written calculations or figures will be accepted. I will attempt to complete the design of your "best" choice on my own without any unidentified reference materials. Therefore, do not assume that I know anything outside of traditional stress and strain concepts. If you need to use a formula, include the written formula and define each term. Include example calculations so that I can follow what you did. Write out your reasoning clearly at the time that you are making it in the process of your document. Finally, summarize your thoughts and provide some next steps if you were asked to complete the design and manufacture the actual structure.

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Rubric for Exam 1 (Point values)	5 (excellent)	4 (good)	3 (acceptable)	2 (not acceptable)
Originality/ Assumptions	Problem is substantially different from examples presented in class, elsewhere in the curriculum, the book, and other common resources. While using reasoning grounded in literature and prior example, it is not a duplication or slightly altered duplication. Stakeholders are clearly identified and are comprehensive	Problem is substantially different from examples presented in class, elsewhere in the curriculum, the book, and other common resources. Reasoning has a major flaw in the assumtions or discussion that could invalidate calculations completed, or is not backed by references or literature. Stakeholders are clearly identified and but may be missing key contributors	Problem is essentially an existing example with superficial changes, such as a different forces applied or materials selected. There is little originality inherent in the problem. Stakeholders are not defined or are poorly considered.	Solution does not meet the minimum standard
Technical Profenceny	The model that is selected is a reasonable one; values that must be invented are likewise reasonable. References are included. Calculations are accurate.	Majority of calculation processes are correct, but an error(s) resulted in lower confidence in obtaining the correct outcome. References are included, but some are missing or are from poor sources	The model is chosen more for convenience than accuracy, numerical values from poor sources or are thin. May be some calculation errors. References are few or not included or not valid sources.	Solution does not meet the minimum standard
Design Matrix	Choice of design matrix is well defined and matches the needs of the problem. Quantified real values are used if at all possible, if not realistic qualitive comparisons are made. Values used are backed up by sources or proper discussion. Weighting of columns is consistent with practices layed out in the materials given in class and weighting is used when needed and responds to stakeholder needs.	Choice of design matrix is well defined and matches the needs of the problem. Minimal errors in the use of quantified real values or weighting criteria or procedures could impact the design selection, but overall the general process used was correct.	A design matirx was used, but only qualitative comparisons are made. Weighting of columns (based on stakeholder needs) was not considered, or applied incorrectly. Design alterations are omitted or were chosen for convience and were not related to overall goal of design.	Solution does not meet the minimum standard
Communication	Communication is clear, succinct, complete, organized. All elements (writing, visuals, audio, etc) contribute well to the story and are executed with proficiency and efficiency. Text and solution of the problem should be approximately 2-4 pages.	Minimal errors in presesntation of material but order and clairity are tough to follow. Material may not be presesnted efficiently, using repetative wording or including too much information when making a point.	Grammatical errors, graphical errors, other sources of unclarity obscure the meaning of the work. Method of presentation not well suited to the problem at hand.	Solution does not meet the minimum standard
Consideration of Public Health and Welfare	A discussion of appropriate saftety considerations and justification for design factors was included. Additional safety factors were considered and included in design matrix.	A discussion of appropriate saftety considerations and justification for design factors was included. Safety considerations were not included in the design matrix and not included in the discussion of design choices.	Safety and Design factors were arbitrarily chosen to be large or standard numbers and little discuss was included as to why.	Solution does not meet the minimum standard
Consideration of Economic Factors	Quantified values for economic impact were included in the design matirx and moved beyond only considering initial cost of design (i.e. included lifetime estimates, estimates of maintainence/repair costs, etc.)	Quantified values for economic impact were included in the design matirx and moved beyond only considering initial cost of design but assumptions used had a glaring flaw that weakend the analysis.	Economic aspects were limited to only assessing initial design cost. Aspects were chosen for convience and not to match stakeholder needs.	Solution does not meet the minimum standard
Exceptional Inclusion	Additonal points are possible for including a truly unique idea or solutions that goes beyond what is included in the rubric above.	Up to +5 points possible		

* Points will be distributes based on this rubric, but can be given at 0.5 increments or below 2 for complete non inclusion.

TOTAL out of 30