Project Information

Continuum Mechanics, Spring 2010

Due 5pm, Friday May 12, 2010

The project for this course consists of two parts: the written report and the oral report. The written report (worth 80% of the project grade) may be hand written or typed and should be written so that one of your classmates can understand the material without reading any other reference(s). The length of the project should be about 10-15 type-written pages. The report should be well-organized (with an introduction putting your work into context of what we've learned in class and where it is applicable), be written using proper grammar, develop ideas logically, and be of an appropriate scope. It should be written so that your classmates can learn the topic by reading it.

Grading of Written Report

- 15 pts Scope (want enough material for a good project, but not so much that project becomes a survey with little analysis, want a topic relevant to the course). Check with me as you work on the project.
- 15 pts Length (want 10-15 pages with 1.5 space). So 10 pages double spaced is on the short side and 15 pages single spaced is on the long side.
- 10 pts References/Citation (be sure to cite all references in text and have a complete bibiography - for on-line references, try to find the author or organization that supports the website).
- 10 pts Grammar (sentences need to be constructed grammatically correct).
- 25 pts Organization (Overall does the paper have a nice flow? Is there a nice introduction, discussing what will be presented and why, and a conclusion? does the paper seem 'complete'? are sections motivated with introductory sentences?)
- 25 pts Writeup (Is it explained why you are doing what you are doing? Are there sentences between equations motivating what is being done? Analysis analysis analysis - does a result seem reasonable? If not, where could it be off?).

Grading of Oral Report

The oral report (worth 20% of the project grade) will be graded on: Organization (is the presentation well thought out?), Clarity (could the presentation be understood?), Content (is it on something of interest to this course?), Presentation (speaking clearly, visual aides). You may use the board to develop your ideas and/or a computer-generated document. If you use laptop, do *not* just copy your report. Each slide should state no more than 3 or 4 key ideas, usually expressed in incomplete sentences, and with the ideas explained in more detail verbally. The oral report should be about 30 minutes in length.

Structure of Written Report

Regarding the written report: The topic and scope of the paper is probably the most important item. Be sure that your topic covers an appropriate problem for this course (if you are not sure, check with me). Note that more is not generally better: Covering too much can leave the report sounding choppy with little or no room for motivation or analysis. This is very difficult to evaluate before you start researching/learning and this is one really good reason for discussing your choice of topic with me well before the due date.

The paper must have a **cover page** showing the title and author. It must have an **Introduction** that explains the problem and gives relevant background information. It should motivate the work (why would anyone be interested in reading this paper?). It should discuss the scope of the work : what exactly will be done in the paper?

The **main body** should explain in detail the procedures used to solve the problem and present interesting observations that you made.

1. It may contain subheadings and with each subheading a sentence or two (or three or) which should motivate and explain what it is that will be covered in the subsection and how it relates to what has been done, as well as discuss exactly what will be covered in this subsection.

2. Equations are part of a paragraph and should include appropriate punctuation.

3. Equations and pages should be numbered.

4. It is more professional to use the third person or first person plural (we) and not first person singular I or second person you.

5. Cite your references often for several reasons: It gives a reader a resource to refer to in order to learn more about the topic; it lets the instructor know if you did something original (not required); and it keeps you from getting accused of plagiarism. Plagiarism is a serious

violation of university rules and could result in expulsion from the university. Note that for a subsection you could include a statement such as The work in this section has been summarized from Dr. Littles book *The Boy and His Swan* [3]. Then additional citations within the section would only be necessary if you wanted to cite a particular equation or a direct quote.

The **Conclusion** must give a concise summary of your work.

Sample Topics

Sample topics for the project (the scope of the project will need to be discussed with me individually):

1. Heat: Derive the heat equation beginning with the conservation of energy. What are the thermodynamic definitions of specific heat? Provide specific examples of specific heat for different materials. Relate to real life (why are cooking pans made of the materials they are made of? Why does metal feel cooler than wood even when they are at the same temperature?) What are the appropriate boundary and initial conditions? Solve a sample problem with appropriate boundary and initial conditions. reference: Callen, elementary heat transfer text.

2. Wave propagation: Derive the wave equation beginning with the conservation of energy. What determines the speed at which a wave is propagated? Does a sound wave travel faster or slower in gas/liquid/solid? What are the appropriate boundary and initial conditions? Pick a simple problem and solve it. Ref: ?

3. Bulk moduli of compression. What are the thermodynamic definitions of (isothermal) bulk moduli of compressions for a liquid? for a solid? Where do they come from? Give sample values for different materials. What are the moduli for incompressible materials? Give examples of extremely compressible materials and extremely incompressible materials - what are the associated compressibility moduli? What happens in a composite material? Ref: Thermodynamics book such as Callen (for fluid), solid mechanics bood for solid, for composite material ?

4. Solid-solid interfaces: What are appropriate boundary conditions? For what sort of problems are different boundary conditions appropriate? Ref? Jaesung Lee

5. Discussion on boundary conditions between a fluid and solid. Consider both viscous and nearly inviscid flows. References: Fung, Y.C. (1997) A First Course in Continuum Mechanics. Prentice Hall. Sychev et. al. (1998) Asymptotic theory of separated flows. Cambridge University

Press. An undergraduate text on Fluid Mechanics; say Chorin, A.J. and Marsden J.E. (1979), A Mathematical Introduction to Fluid Mechanics; A more adv fluid mechanics book: e.g. White, F. M. (1974) Viscous Fluid Flow. McGraw-Hill.

6. Electrodynamics: Incorporating electric fields/ magnetic fields into momentum and energy balance. Exploit entropy inequality, what are the constitutive relations?

7. Chemical potential - Start with the field equations for each constituent and use the entropy inequality to derive the constitutive equations for diffusive (flow of a constituent relative to the bulk phase) and eventually derive Fick's law. Ref: Wyo, paper by Bennethum

8. Two-phase porous media - what are governing equations assuming an elastic solid and a viscous fluid?

9. Isotropic function theory - how can we make use of symmetries to restrict the form of the constitutive equations; show that a 4th order tensor relating two symmetric second-order tensors (strain and stress) of a fourth-order tensor must be a function of only two coefficients (the Lamé coefficients). Continue this idea by showing what an isotropic second-order and third-order tensor must look like. Discuss results by other authors which are more general, Ref: A chapter from Fung's book on Continuum Mechanics, a section from Gurtin's book on Continuum Mechanics, and a paper on Isotropic Function Theory by G. F. Smith.

10. Development of a curvi-linear coordinate system, using either cylindrical or spherical coordinates as an example. What are the basis vectors? How to define a gradient? What are the co-variant, contra-variant, and "physical" basis? References: Rebecca Brannon's GOBAG page; Malvern; D. A. Danielson, *Vectors and Tensors in Engineering and Physics*, Boulder, CO: Westview Press, 2003.

11. Development of governing equations for visco-elastic or plastic solid using the entropy inequality and an internal variable (this is an advanced topic, so should be a PhD student interested in constitutive modeling of these materials). References? I may have a text...

12. Buckingham Pi's Theorem - given a relationship between physical variables, what are the minimum number of dimensionless quantities which are needed? How is this related to non-dimensionalizing a governing equation? H. L. Langhaar, *Dimensional Analysis and Theory of Models*, John Wiley and Sons, New York, 1951; J.D.Logan, *Applied Mathematics*, John Wiley and Sons, New York, 1997; I. H. Shames, *Mechanics of Fluids*¡ McGraw-Hill Book Company, Inc., New York, 1962.

13. Other proposed topic related to this course.

Due date for written report: Wed. May 12, 2010 5pm.

Notes on Plagiarism From the UC-Denvers Academic Policies and regulations: Plagiarism is the use of another persons distinctive ideas or words without acknowledgement. The incorporation of another persons work into ones own requires appropriate identification and acknowledgement, regardless of the means of appropriation. The following are considered to be forms of plagiarism when the source is not noted:

1. Word-for-word copying of another persons ideas or words.
2. The mosaic (the interspersing of ones own words here and there while, in essence, copying anothers work).
3. The paraphrase (the rewriting of anothers work, yet still using their fundamental idea or theory).
4. Fabrication (inventing or counterfeiting sources)
5. Submission of anothers work as ones own.
6. Neglecting quotation marks on material that is otherwise acknowledged.

Acknowledgement is not necessary when the material used is common knowledge.