Syllabus

ENMA 470 - Materials Selection for Engineering Design

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Course Description: Increasing your knowledge about materials classes, properties, limitations and applications, and teaching you the methodology of materials selection in engineering design.
"Making your stuff out of the right stuff"

Overview and scope of the course

Introduction to the CES materials selection software

Materials Intuition 101 - Typical materials-related design parameters: Easy to Hard

Design Considerations when using specific materials classes:
- Metallic alloys (Fe, Al, Cu, Ni, Zn, Mg, Ti-based)
- Polymers: polyolefins, polyesters, nylons, aramids, resins, elastomers
- Ceramics: cement, glass, nitrides, carbides, carbon-based
- Composites: GFRP, CFRP, cermets
- Natural materials: wood, rock, leather, bamboo, etc
- The weirdos: nanomaterials, active materials, amorphous metals, etc.

Processing Intuition 101: Materials issues
- Deformation processing: forming, forging, extrusion, moulding, casting
- Cutting: machining, blanking, hemming, etc
- Surface finish: painting, plating, nitriding, polishing,

Review of important "material properties": Strength, Toughness, Fatigue, Corrosion, etc

The Materials Selection Process - How to do it step by step

Basic design cases: yield before break, leak before yield, buckling, etc. Review of Area Moment of Inertia.

Cost-based decisions: strength / weight * cost, etc

Non-mechanical selection: Thermal, electronic, optical, etc

Multi-criteria

Conflicting criteria

Design for recycling / carbon footprint / energy cost / "green-ness"

Case Studies All Along The Way

Grading: 50% group projects, 20% final, 30% homework and peer review feedback. Team feedback also incorporated into project scores.

Textbook: Materials Selection in Mechanical Design, 4th edition, Ashby

Office hours: I have an open door policy - I'm in most days at 10AM and around until 6pm

Course Philosophy:

To date, you have taken a great number of materials science courses. These teach the physics and chemistry of materials on a very fundamental, and at times abstract, level. This is a materials **engineering** course, whereby I will be teaching you how to figure out what material and process combination will best suit a given application. In other words, how to make your stuff out of the right stuff.

The course starts out with a seat-of-the-pants overview of materials and processing classes. I will not be discussing the fact that steel is an alloy of Fe and C with a BCC crystal structure, etc. I will, however, be discussing how you can use heat treatment to vary a given steel's properties as part of your manufacturing process, the details of cutting and welding steel, and how to make your structure just strong enough by using shapes.

At the end of this course, you will hopefully have gained a great deal of confidence in materials selection going forward, whether that leads to a job, grad school, med school or wherever your plans take you. If not, I've failed at MY job.

Attendance is critical. Design projects will start as small ones contained within a single lecture period with small groups, and expand into projects with teams of 3 that will cover several weeks. I will make my slides available to the class so you can take notes with them, but you will NOT do well in this class unless you attend and participate. You will also get a lot more out of it.

Yes, I said teams. In your careers, no matter where you go, you will be working in teams. However, one huge difference between college teams and work teams is that the former is a one-off. You can usually get away with messing around and letting your teammates carry the ball. Not in this class. Every single report will be accompanied by a confidential appraisal sheet that you will fill out on your randomly chosen collaborators. Over time, I will know who is phoning it in and who is really in there working hard. This will constitute a large part of your grade.

Each team member will be individually graded on each project. If one team member is found to be consistently not contributing to projects up to a level expected by the other teammates, individual grades will be adjusted up and down accordingly. This has resulted in a person with an A- dropping to a C in the past.

You are lucky that the Mat Sci department is paying for an outstanding piece of software to help you in your work. Think of it as the world's most comprehensive pile of materials data with an excellent search and visualization front-end. It's called the CES EduPack, and it's on the VirtuLab server.

This class is not about reading, memorizing or theorizing. It's about doing.