Semester in Review

24-370 - Spring 2011
Professor Steve Collins

Reminders and Announcements

• Project 3 Reports due May 5th at midnight
• HW 9... cancelled
• Course Evaluations
  – How administration makes course decisions
    • Consider the value (learning/work)
  – The only way my teaching is evaluated
  – Additional written feedback greatly appreciated
    • Include anything you like, regardless of questions
What you have learned

- **Technical basis**
  - Analytical and numerical analyses
  - Basic optimization techniques
- **Practical knowledge**
  - Useful parts, materials, sources, and tools
  - Design processes and techniques (iteration)
- **Intuition for machine and robot design**
  - Hands-on experience
  - Useful creativity

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What you have learned

- **Sketching**
  - Quick concept generation
  - Detailed spatial communication
- **Simple models**
  - Simplest abstraction that captures phenomena
- **Check yourself:**
  - What is the simplest model of a wrench?
What you have learned

• CAD modeling (SolidWorks)
  – Creating parts and features
  – Assembling components

• Creating engineering drawings (SolidWorks)
  – Orthographic and isometric projections
  – Dimensioning

• CAD analysis (SolidWorks)
  – Stress analysis in components
  – Stress analysis in assemblies, e.g. contact
  – (thermal analysis...)

What you have learned

• Failure analysis
  – Simple stresses
  – Bending stresses
  – Contact stresses
  – Buckling
  – Fatigue
  – Ductile vs. brittle failure

• Check yourself:
  – Fatigue analysis?
  – Improved designs?
### What you have learned

**Material selection**
- Key mechanical properties
  - E.g. ultimate & yield strength, density, elasticity
- Available materials
  - E.g. 7075 Aluminum, 440C Stainless Steel
- Where to find these
  - Selection charts, Matweb

**Check yourself:**
- Material for small, complex, high-strength part?
- Material for large, simple, high-stiffness part?

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### What you have learned

**Principles for assembly**
- Joints only where necessary for motion, assembly
- Tolerances and stacking
- Perfectly constrained solutions

**Types of assembly elements**
- Rigid joints: fasteners, welds, clamps
- Articulating joints: plain, ball and roller bearings

**Check yourself:**
- Rigid joint: Normal, friction or shear loading?
- Articulation: Linear or rotational joint?
What you have learned

• Kinematics of assemblies
  – Spatial position through geometry

• Kinetics of assemblies
  – Gearing and torque, velocity

• Dynamics of assemblies
  – Forces for acceleration
  – Forces for rotational acceleration (centripetal)

• Check yourself:
  – Dynamic loading on a cam shaft?
  – Output torque vs. gear ratio R?

What you have learned

• Catalog component selection
  – Motivations
  – Components available and prominent sources
  – Key properties and methods of analysis

• Check yourself:
  – Gear analysis: property most influences strength?
  – Wire rope: minimum drum diameter estimate?
  – What properties are important in encoders?
### What you have learned

- **Electric motor analysis**
  - Key properties
  - Underlying dynamical models
  - Simple steady-state methods
  - Numerical simulation in Matlab

- **Check yourself:**
  - What are key properties for: Powering tasks? Torque-production tasks?
  - How do induction and rotor dynamics differ?
  - Why does back-EMF matter?

### What you have learned

- **Design for manufacture**
  - Common processes and their properties
  - Selection process

- **Cost analysis**
  - Simple models of manufacturing cost
  - Tools for estimation

- **Check yourself:**
  - When might you use injection molding?
  - When should you use sand casting?
  - How would you estimate the cost of a seam?
What you have learned

• Design for environment
  – Manufacturing impacts
  – Life Cycle Analysis tools

• Ethics in engineering
  – General principles for ethical behaviour
  – ASME ethics code

• Check yourself:
  – How could ethanol use cause toxic waste?
  – Can you currently consult on biomedical projects?
What you have learned

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• Photos of project 2 testing: we had a lot of fun learning it :D

What you have learned

• Technical basis
  – Analytical and numerical analyses
  – Basic optimization techniques
• Practical knowledge
  – Useful parts, materials, sources, and tools
  – Design processes and techniques (iteration)
• Intuition for machine and robot design
  – Hands-on experience
  – Useful creativity
What you have learned

What you will learn next: EDII

• Product design research
  – Market research
  – Evaluating customer needs
• Design theories and principles
  – Design process
  – Project planning
  – Concept generation
  – Design optimization
• Open-ended problem solving
• Communication of product design
What I have learned

• My first undergraduate course
  – Many unexpected things...
  – Hands-on, exercise, apply, repeat
  – Goodness, teaching is hard!
• You have helped make this course stronger
• I’m impressed with your designs, and progress
• I’m proud of you
• Thank you