ECE3031 Electrical and Computer Engineering Design

Dr. Liuchen Chang & Dr. Riming Shao
Tel: (506) 447-3145, (506) 447-3470
E-mail: LChang@unb.ca, Rshao@unb.ca
Office: GD111, H1
Dept. Elec. & Comp. Eng.
University of New Brunswick

ECE3031 ECE Design (4ch)

- 3C-MWF 8:30-9:20am, 1T-Th 8:30-9:20am
- Application of design methodologies to design problems in electrical and computer engineering
- Prerequisites: ECE 2722 or EE 2722, ECE 2213 or CMPE 2213 or ECE2214 and ECE2215, ECE 2412 or CMPE 2412, ENGG 1001, ENGG 1003, ENGG 1015.
- Co-requisite: ECE 3111 or EE 3111.
- Deferred Exams: All deferred exams in courses offered by the Dept. of Elec. & Comp. Eng. are scheduled to be written on the 4th/5th day of classes in the following term. There are no exceptions.
- Check Your E-mails: notices are sent via e-mails

ECE3031 Contents

- Design specifications and requirements
- Conceptual design
- Detailed design
- Design verification
- Implementation and testing
- Environmental considerations
- Project team and management
- Basic economic evaluation techniques
- Introduction to standards

Labs, Projects, Assignments and Reports/Presentations

- Design projects are carried out in groups (normally 4 students per group)
- Projects are conducted in stages as laboratories
- Laboratories and projects are mandatory (attendance will be recorded)
- Design projects (design a functional prototype product)
  - An isolated dc power supply
  - A PV based battery charger
- Assignments
- Presentations
- Final reports

A Project of ECE3031 (Option-1): Design of an Isolated Power Supply

- Rather vague design requirements:
  - 120V/60Hz ac input, 15V dc output, 30W, regulated power supply
  - Electrically isolated between input and output (transformer)
  - Safe to use
  - Efficient
  - Reliable
  - Economical........
- You figure out the detailed specifications
- You design the actual “product”
- You implement and test the “prototype product” in labs
- It must work!!!

A Project of ECE3031 (Option-2): Design of a Battery Charger

- Rather vague design requirements:
  - Charger input from a dc source (e.g., a solar panel…)
  - Charger output to a lead-acid battery
  - Safe to use
  - Efficient
  - Reliable
  - Economical........
- You figure out the detailed specifications
- You design the actual “product”
- You implement and test the “prototype product” in labs
- It must work!!!

Assignments, Labs and Projects - Integrated Learning

Design is the central process in ECE3031

- Assignments: preparation for a design task (a lab)
  - Ex: how to determine the specifications of a product?
- Labs: active conduction of a design task and report of the activities, using your solutions of assignments as an initial guide (*Processes are important: what you have done?*)
  - Ex: to determine the specifications of your product
- Projects: extensive, detailed and refined conduction and reports of a design mission using the methods and processes learnt in ECE3031 (*Results are important: what are your design process and end product in meeting specifications*)
  - Ex: your design of a working power supply or a battery charger - must be working

Project as a Central Theme

Start: vague requirements

Design Step 1:
Lectures
Assignment#1
Lab#1

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- Lectures: provide knowledge
- Assignments: prepare design
- Labs: conduct design steps
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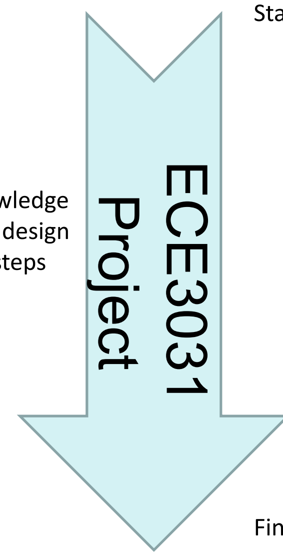
Design Step 5:
Lectures
Assignment#5
Lab#5

Presentation and Report



Finish: Working prototype

Labs and Projects are Mandatory

- Attendance of laboratories and projects are mandatory
- Missing one lab session will lose 3% of the total grade (missing 2 lab sessions will result in “F” grade)
- Each group should write one Group Lab Report (80% weighting) and each group member should write an Individual Lab Report (20% weighting)
- Group Lab Reports should contain two parts: (1) detailed report on the lab process; and (2) detailed report on the lab outcomes
- Individual Lab Reports should outline the contributions you have made to your group, roles you have played in the group during the execution of the lab, and comments and suggestions.

Course Evaluation

Assignments	8%
Labs (Group and Individual Reports)	15%
Projects (Project Reports)	20%
Presentation	7%
Final Exam (no min. marks to pass)	50%
TOTAL	100%

- Note: No make-up labs (group projects)
  Labs and projects - team work

References

- No textbooks
- **Peter H. Gregson, ECED-2900 Design Methods I (Dalhousie University Faculty of Engineering, Electrical and Computer Engineering).**
  http://idlab.dal.ca/ECED-2900/2900.pdf
- The URL for the ECE3031 is: http://www.ece.unb.ca/Courses/ECE3031/LC
- Lecture notes will be posted online

What is Engineering?

- Engineering (to change the world): professional activity of creating artifacts and systems (or solving a problem) to meet human needs (physical or intellectual), with design as the central process, scientific knowledge and economic considerations as its essential inputs, and public safety and environment as its overriding concerns.
- Science (to understand the world): involves 3 sequential and interrelated activities - research using a method; process for accepting (or not) research results as facts; predictions based on facts.

What is Engineering Design?

The Canadian Engineering Accreditation Board:

Engineering design integrates mathematics, basic sciences, engineering sciences and complementary studies in developing elements, systems and processes to meet specific needs. *It is a creative, iterative and often open-ended process subject to constraints* that may be governed by standards or legislation to varying degrees depending on the discipline. These degrees may relate to economic, health, safety, environmental, social or other pertinent factors.

Engineering Design is Important!!

- **Design is the essence of engineering and engineering education**
- **Design is the central process of engineering (making things happen)**
- **Design and innovation are closely linked, and thus is important to our economy**

Design Problems

- Design problems are usually vaguely defined at the beginning (such as with our ECE3031 projects)
- The solution to a design problem is open-ended
- Solving a design problem is an interactive process
- Solving a design problem requires to follow a methodology or process
- Solving a design problem usually requires a team effort (maybe multi-disciplinary).

One of the two Projects of ECE3031: Design of an Isolated Power Supply

- Rather vague design requirements: for example:
  - 120V/60Hz ac input, 15V dc output, 30W, regulated power supply
  - Electrically isolated between input and output (transformer)
  - Safe to use
  - Efficient
  - Reliable
  - Economical........
- You figure out the detailed specifications
- You design this electrical “product”
- You implement and test the “prototype product” in labs
- It must work!!!

What Knowledge Do You Need to Be an Engineering Graduate

Group Categories	Minimum Requirements	Curriculum Categories	Minimum Requirements
Mathematics and Natural Sciences	420 AU	Mathematics	195 AU
		Natural Sciences	195 AU
Engineering Sciences and Engineering Design	900 AU	Engineering Sciences	225 AU
		Engineering Design	225 AU
Complementary Studies			225 AU
Entire Engineering Program			**1950 AU**

But that is not enough to be a design engineer, let alone a competent design engineer.

Attributes of a Competent Design Engineer

Knowledge + Skills

A competent design engineer should possess sufficient knowledge, understand how to generate design requirements and how to proceed from design requirements to a final artifact by establishing objectives and criteria, generating alternatives, synthesizing, analyzing, constructing, testing, evaluating and improving.

------------------------more specifically==>

Attributes of a Competent Design Engineer

1 Technical knowledge (taught and self- studied)
2 Information gathering skills
3 Problem definition skills
4 Idea generation skills
5 Design and development skills
6 Evaluation and decision making
7 Business skills (such as economics, management etc.)
8 Communication skills
9 Teamwork skills

1. Technical Knowledge

Knowledge can be taught or self-studied

Skills can be gained through practice: labs & projects

- Mathematics: linear algebra, calculus, differential equations, statistics etc.
- Natural Sciences: chemistry, physics, biology etc.
- Engineering Sciences: mechanics, heat transfer, circuits, systems, electronics etc.
- Complementary studies: (broad spectrum)
- Engineering Design: ENGG1003, ENGG1015, ECE3031, ECE4040....

2. Information Gathering Skills

Literature search, patents, products, industry, survey techniques, people/stakeholders, standards/codes

(Serves as a foundation)

3. Problem Definition Skills

Understand open-ended nature of design problems, goal statements, constraints, problem definitions

(Product/Project: requirements)

4. Idea Generation Skills

Team -brainstorm, individuals -ideas, design concepts, synthesis,

(Product/Project: preliminary design)

5. Design and Development Skills

Detailed solutions to open-ended design problems within constraints and meeting goal statements - trial design of a LED-resistor-battery

- direct applications of technical knowledge
- an interactive process

(Product/Project: detailed designs)

6. Evaluation and Decision Making Skills

Iterative approach to evaluate the designed products against goals and criteria, to modify the design, and finalize the design

(Product/Project: evaluation and modifications

7. Business Skills

Project management, time management, business finance and economic principles, risk analysis and budgeting, appreciation for intellectual properties etc.

(Product/Project: management)

8. Communication Skills

Use/make engineering drawings, write effective reports, express verbally, listen effectively, be able to “sell” concepts, products and themselves

(Product/Project: drawings, presentations, reports, documentation)

9. Teamwork Skills

Be able to form teams, and work with a multi-cultural workforce in an interdisciplinary environment

(Product/Project: design team)

Design Process

5 Major Design Stages

- Idea Generation
- Conceptual Design
- Detailed Design (Design Embodiment)
- Prototype/Verifications
- Refinement/Final Design/Documentation which leads to production and marketing

1. Idea Generation -Problem Definition and Information Gathering

- What are the needs?
  - Often vague statements
  - Market survey, clients' request, focus group, interviews, business opportunities
- What are the constraints?
  - Regulatory, standards, codes, ethics, environmental
  - Cost, materials, manufacturing process
- What are the attributes (i.e. features)?
  - Features of the new products in clear statements
- What are the engineering (tech.) requirements?
  - Technical objectives of the new products

    Brainstorming, information gathering

2. Conceptual Design -several options without details

- What are the functions?
  - Breaking the product into some basic modules
- What are the solution alternatives?
- Can the solutions meet the technical and economic criteria?
  - Screening options (the discard the ones which do not meet the design criteria)
- What are the better rough designs (selection through a evaluation process)?
  - For more detailed design in the next phase

3. Detailed Design -Design Embodiment

- Technical intensive solutions:
  - Calculations, simulations, solutions
- Details of the products
  - Materials, components, dimensions, values
- Detailed drawings and specifications
  - Drawings/diagrams, specifications of materials and components, manuals, production procedures/plans etc.
- Costs and environmental impact
  - Component costs, production costs, marketing/distribution costs
  - Life cycle assessment, effects to environment and sustainability

4. Design Verification

- Design optimization (also occurred in the previous design stages)
- Testing
- Prototype development/manufacturing
- Simulations
- Initial marketing

Design is an interactive process, not an isolated process

5. Final Design for Production

The product design has accomplished its goal

- Refinements
  - Changes/refinements for production
- Productions/quality assurance
  - Manufacturing process for mass production
- Documentation
  - Detailed drawings, components, manuals