ECE 100 - ITP

A Hands-On Introduction to Electrical and Computer Engineering

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ECE ITP Course Administration

- One lecture per week (1 hour and 15 minutes)
  - 118 Siegel Hall (66 students)
  - Prof. Flueck (224 SH), flueck@iit.edu
  - Office Hours: M 3-4 PM, W 2-3 PM
- One laboratory per week (2 hours and 40 minutes) in **SH 326**
  - Groups of 18 will have access to the lab (SH 326) in teams of 3
  - TA Resources: One ECE junior/senior per lab
    - Khoi Nguyen (T 1:50-4:30) knguye10@hawk.iit.edu
    - Mingyang Yu (W 1:50-4:30) myu5@hawk.iit.edu
    - Bir Kafle (R 1:50-4:30) bkafle@hawk.iit.edu
    - Luis Larco (F 1:50-4:30) llarco@hawk.iit.edu
- Course grade = 40% Pre-Lab/Post-Lab Reports, 15% Oral Presentations, 20% Teamwork, 20% Final Portfolio, 5% Lecture Attendance, plus extra credit for technical performance

Teaching Materials

- Self-contained textbook "Robotic Explorations" by Fred G. Martin
  - Easy to read; great reference/learning aid from Prentice Hall
  - $138.20 new, $103.65 used from IIT bookstore, 20 left ($99 new Amazon, 4 left)
- Robot kit ($500)
  - $300: assembled HandyBoard, charger, batteries (Gleason)
  - $35: Sensor/Motor Kit (Gleason Research)
  - $165: LEGOs
- ECE 100 web site
  - Lecture Notes, online guides to "Technical Report Writing", "Oral Presentations", "ECE Careers", IIT resources

Science and Engineering

Science

- Analysis: ask questions, look for patterns, develop knowledge
- Produce knowledge
- Characteristic activity: research (learn about nature)
- Study of what is
- tryscience.org

http://en.wikipedia.org/wiki/Science

Engineering

- Synthesis: integrate bits of knowledge to create something new
- Produce processes and things (part of technology)
- Characteristic activity: creative design
- Study of what never was
- discoverengineering.org

http://en.wikipedia.org/wiki/Engineering

Engineering Design Process

Scientific Method

- ❑ State your question
- ❑ Do background research
- ❑ Formulate hypothesis; identify variables
- ❑ Design experiment, establish procedure
- ❑ Test hypothesis via experiment
- ❑ Analyze results; draw conclusions
- ❑ Present results

Engineering Process

- ❑ Define a need
- ❑ Do background research
- ❑ Establish design criteria (size, weight, function, cost)
- ❑ Prepare several preliminary designs, evaluate tradeoffs
- ❑ Build and test a prototype (most promising design)
- ❑ Test and redesign as necessary
- ❑ Present results

http://sciencebuddies.org/mentoring/project_engineering.shtml

Engineering Traits

- ❑ Characteristics of a successful engineer
  - ➢ Thorough knowledge base of the subject
    - ❖ Strong math/science skills
    - ❖ Good intuition
  - ➢ High level of concentration and determination
    - ❖ Strong logical thinking skills
    - ❖ Organized
  - ➢ Unusually curious about how/why things work
    - ❖ Tinkering leads to discovery and innovation
  - ➢ Creative vision
    - ❖ Willing to take risks
    - ❖ Strong visual thinking skills
  - ➢ Succinct in both written & oral communications

Primary Ingredients of ECE ITP

- Fundamentals of engineering design and problem solving
  - ITP is accessible to first-year "eager to learn" students
  - Assumption: ECE freshmen have **not** had ECE signals & systems, electronics, circuits, nor structured programming, but they can master the basics as needed
- Challenging laboratory exercises
  - Design competitions are real
  - Significant laboratory experience (lab exercises are large in scope, extending over several weeks)
- Presentations from practicing engineers
  - Three lectures devoted to industry
- Your grade = communication skills + teamwork skills + bonus
- Autonomous robot competitions are exciting!

ECE ITP Technology Trio

- Students will practice engineering design and problem solving via
  - Hardware
    - Motorola 68HC11 8-bit microprocessor-based control board
  - Software
    - C-like interactive "programming" environment called Interactive C
  - Mechatronics
    - LEGO Technic system with motors, gears, axles, wheels and sensors
- By the fourth week of class, students will
  - Build a Lego-based robot
  - Configure touch sensors
  - Program a basic obstacle avoidance routine
  - Experiment with strategies for emergent behavior
  - Develop an autonomous robot for maze navigation

Course Timeline - Lectures and Laboratories

- Lectures are required
  - Sign-up sheet, 5% of your final grade
- Laboratories are required
  - Miss one laboratory, lose one letter grade
  - Show up on time, otherwise you are absent
- All Pre-Laboratory and Post-Laboratory reports are due in lab at the beginning of the lab session
- Use the Pre-Laboratory and Post-Laboratory report templates available on the ECE 100 web page
- Laboratory sessions begin next week Tuesday-Friday (SH 326)
- No laboratory during the week of Thanksgiving Break

Course Deliverables: Pre-lab, Post-lab, Design Portfolio

- Design Portfolio (written report: pre-lab assignments, lab notes; final design portfolio due Monday, December 3, 1:30 pm)
  - Problem Statement (explain to someone else; enumerate constraints and assumptions; develop "goodness" criteria)
  - Investigation/Research (collect facts; develop theory; explore positive/ negative aspects of problem, root cause)
  - Alternative Solutions (sketch processes [flowchart] and validate code)
  - Optimum Solution (choose best solution; make a detailed plan)
  - Construction/Implementation (document detailed process, including modifications; "as-built" documentation)
  - Analysis & Testing (monitor, quantify, adjust if necessary)
  - Final Evaluation (standardize the solution, present major advantages and disadvantages, propose future work)
  - Dissemination (publicize the gains)
    - "Not Enough Time Is Time Enough", Andrew Morcos, 1994
    - "Intro to Engineering Design & Problem Solving", M. David Burghardt, 1999

Course Deliverables: Team Presentations

- Three Oral Team Presentations (given in the laboratory section)
  - Each team will provide a 10 minute PowerPoint presentation
    - Use the design portfolio framework presented on the previous slide
    - Hard (paper) copy of slides must be submitted to TA
  - Teams will deliver a status update on their project
    - What are your goals?
    - What have you accomplished?
    - How did your robot perform?
    - How will you improve your design?
  - Each team member will deliver some portion of the presentation
    - Delivery must be shared evenly among teammates
  - Presentations will be peer-reviewed
    - Students will review each other via team scores and individual scores
  - Presentation scores will be submitted via the ECE 100 web page
    - Average presentation scores for individuals will be incorporated in final grades

Course Deliverables: Teamwork Contribution

- Following each of the three team presentations, you will submit a score for each of your teammates' contributions to the success of the team.
- Scores must be non-negative and no larger than 5.
- The TAs will provide teamwork contribution scores as well.
- This practice is widely used in the consulting industry where team members evaluate each other at the end of a major project. The evaluations provide useful feedback to the employees and to management. Typically, the scores also affect performance bonuses.
- For the winning team in each section, I will add a small bonus to each member's final grade (might push your grade up one letter grade if you were just below the cutoff)
  - Bonus = student's teamwork score x 0.1 points

Interactive C code examples

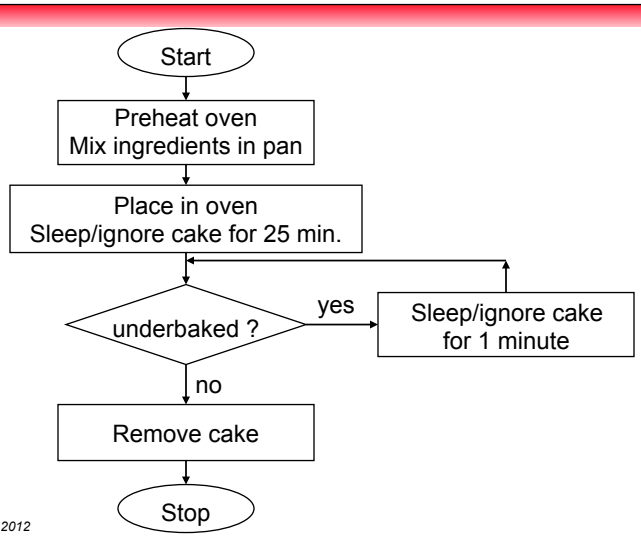
- Example IC code from the textbook (p. 25)
- "test.ic"

```
void test() {
        fd(0);
        sleep(1.0);
        bk(0);
        sleep(1.0);
        off(0);
        beep();
}
```

- Example IC code from the textbook (p. 27)
- "robot.ic"

```
/* sample robot program */
void main() {
        while (1) {
            printf("Going forward…\n");
              fd(0);
              if (digital(15)) {
                  printf("Backing up!\n");
                  bk(0);
                  beep();
                  sleep(2.0);
              }
        }
}
```


Flowchart example: Bake a cake (baking time = 30 minutes)



Zeroth Pre-Laboratory Assignment

- Due 11:59 PM, Sunday, August 26 - Send email to your TA
  - Subject: Section #, FirstName LastName
  - Body: "I have read and will comply with the ECE 100 course policies."
  - Also, include a listing of the timeslots in which you plan to study and do homework. "I plan to study during the following timeslots:"
    - Suggested study time outside of class (in hours) is twice the number of credits you are taking.
    - For example, most first-year students take 16 credits in the fall semester.
    - Therefore, you need to set aside 32 hours each week for study time outside of class. In most weeks, you will not need all 32 hours to review your lecture notes, read your textbooks and other materials, do your problem sets, write and debug your programs, write your papers, ask questions during office hours, study for exams, etc.
    - However, you need to plan for success. It doesn't just happen.
- Due 11:59 PM, Sunday, August 26 - Subscribe to "ece100-12f" list
  - Instructions and email list link can be found on ECE 100 web page

First Pre-Laboratory Assignment

- Due in your laboratory section (SH 326) the week of August 27
  - Read Chapter 2 "A First Robot" (intro), p. 20
  - Read Chapter 2 (section 2.1), pp. 20-28
  - Create flowcharts for "test.ic", "robot.ic" and "avoid_simple.ic" (pp. 72-73)
    - You can use PowerPoint, or any other software, to create your flowcharts
    - Your flowcharts should use simple English, not IC syntax
    - For IC library functions (e.g., "sleep"), put them in a rectangular box, instead of a detailed loop with a time variable
  - Skim Appendix E.1 "Interactive C Reference" (except E.3.10 & E.3.12), pp. 403-429
  - Read Chapter 2 (HandyBug, second version), pp. 50-71
  - Read Section 2.3 "First Program" pp. 71-75.
    - Type the sample program in section 2.3.2 ("avoid_simple.ic"). Use Notepad not Word. To save the file, enter the name with the quotes. Bring hardcopies (and electronic copies; USB memory stick) of your "test.ic", "robot.ic" and "avoid_simple.ic" programs
- Pre-Lab report (see Pre-Lab_Template.doc online) due at the beginning of lab: header, problem statement, research & investigation, alternative solutions (flowcharts), optimum solution, sources, code attachments.

First Post-Laboratory Assignment

- Due in your laboratory section the week of September 3
  - Header
    - See Post-Lab_Template.doc online
  - Follow the "Design Portfolio" format described on earlier slide
    - Explain "Construction/Implementation"
      - Document the key construction steps. Were there any modifications as you built your robot? Any critical part substitutions?
    - Explain "Analysis & Testing" from lab
      - For example, how did you extend the "avoid_simple.ic" code so that your robot would turn away from obstacles on the left and the right?
    - Dissemination is the act of writing up your results and submitting a report.
  - Put the following questions and answers in "Analysis & Testing". Write each question in a bold font so it's easy to find in your report. After each answer, leave a blank line.
    - Questions 1-2 in section 2.3.3.
  - Staple your final IC code and laboratory notes to your post-lab report as an appendix

Pre-Laboratory 2 Assignment (due week of Sep 3)

- Review Section 2.3 "First Program" pp. 71-75.
  - Type the sample code "turtle.ic" on p. 75. Use Notepad not Word. To save the file without the default .txt extension, enter the name with the quotes.
  - Rewrite the extended "avoid_simple.ic" from Lab 1 using the movement abstractions in "turtle.ic" (call the new program "avoid_abstract.ic").
  - Create a flowchart of the "avoid_abstract.ic" main routine. Use simple English statements in your flowchart.
- Read Sections 2.6 and 2.7, pp. 87-94.
  - Type the sample codes "metasens.ic", "timer.ic", "avoid.ic". Ignore the repeated statements following the final "}" at the end of "timer.ic" & "avoid.ic". They're typos.
  - Create a flowchart of the "metasens.ic" main routine. As a guide, refer to Figure 2.26, but be sure to use simple English statements in your flowchart. Also, be sure to include both the left touch and right touch cases.
- Pre-lab 2 report follows the Design Portfolio structure (described on earlier slide) up to and including Optimum Solution (Plan)
  - Include avoid_abstract.ic and metasens.ic flowcharts in Alternative Solutions.
- Deliverables due at the beginning of lab: Pre-lab 2 report including hard copies of your codes as attachments and electronic copies for download.

Advice

- Study hard (the more you put in, the more you get out) !!!
- Get to know your peers (study groups, startups, study breaks).
- Get to know the faculty & staff (scholarships, job opportunities).
- Get some research or industry experience.
- Get organized!!!
- Watch Randy Pausch's lectures: http://cmu.edu/randyslecture
- Join the IEEE (professional activities, networking, education).
- Join a student organization or two (but **not** all of them).
- Volunteer to help.
- Exercise your mind and body.
- Call home!!!