Teaching Electronics in Undergraduate EE Students
Prof. Yannis Papananos

Annotation: The article is the printed version of the original Power Paint presentation

• Problem: Enrollment in electronics major drops during the past few years
• Cause: New ‘computer generation’ students are departed from hardware-oriented design activities

(1)

Problem:
• Since students are used to immediate gratification, teaching circuit analysis theory well in advance before presenting practical applications, will make them loose interest and motivation.

(3)

Solution:
• Introduce theory and practice in the same course.
• Move this course in earlier semesters.
• Make the course essentially a lab course while maintaining consistency with basic theoretical concepts.

(4)

Yet another problem:
• Today’s EE curricula are overcrowded (NTUA for example has more than 60 courses in a 5-year Dipl. Eng. study)
• The introduction of another course, especially in the early semesters, will exaggerate the problem.

(5)

Solution:
• Remove a later course from the curriculum. However this must be carefully done in order to ensure a smooth transition.
• Leave all courses coexist at the beginning and follow a gradual transition to new curriculum.

(6)

• Today’s students are familiar with computers and their usage: they are software agile and more or less take software for granted: Somebody somewhere else designs the hardware.
• Today’s students do not have:
  - Hands-on experience (e.g. radio amateurs)
  - Patience
• They need to re-establish contact with the hidden hardware!
Such courses have already been successfully introduced in many schools:
- Columbia University
- UC Berkeley
- MIT
- Univ. of Illinois

NTUA plans to introduce a series of general lab. courses starting from first semester. Curriculum is under restructuring.

Hints for the first lab. course:
- Allow students to experiment with real hardware! Do not introduce computer simulation at this stage. Reality before virtual reality.
- Provide the bare-minimum background theoretical knowledge before executing the experiments but let the experiments motivate further study.
- Provide fool-proof constructed boards to the students to guarantee immediate successful operation of the devices.
- Focus in time-domain measurements and analyses as time-domain analysis is directly associated to the real world.
- Avoid systematic analysis and concentrate on simple principles like Kirchhoff’s laws.
- Do not teach digital before analog! We live in an analog world.

Experiments included in the first lab. course as suggested by Prof. Y. Tsividis in his book “A First Lab in Circuits and Electronics”
- Introduction: Good lab. practices and other useful hints (ground connections, dc V and measurements etc.)
- Simple DC circuits
- Introduction to time-varying signals: introduction to oscilloscope operation and use
- Basic characteristics of opamps
- Amplifier design using opamps; the audio amplifier paradigm

Experiments - cont’d
- RC circuit transients - more on measurement techniques
- Filters and frequency response
- LC circuits & resonance
- Diodes and their applications
- Modulation and radio reception
- MOSFET characteristics and applications
- Principles of amplification
- Bipolar transistors and amplifiers
- Digital logic circuits: gates and latches
- Flip-flops and registers
- Counters

Lab. equipment
- For the introductory laboratory course, only the simplest type of equipment is needed. The students must not resort to complex instruction manuals in order to be able to operate the equipment!
- Simple boards with basic components and leads attached to them must be prepared in advance by the Department’s electronics shop.
- Robust constructions must be provided to sustain abuse of hundreds of students that will be practicing during the semester.

Feedback
- The introduction of such a course in the previously mentioned universities, gave excellent results already: The students loved the course and the purpose of motivating them was met since the enrolment in electronics major increased during the following years.
- The lab. course should be carefully monitored by the Department and students’ feedback should be always considered and carefully taken into account.
Electronics lab. courses: a step forward

- Having established a good background knowledge and practical lab. experience, computer simulation techniques and procedures can be safely introduced in later courses.
- Extensive use of state-of-the-art EDA tools for microelectronic circuit design can run in parallel with more advanced theoretical electronic design courses.
- Access to EDA tools is now available through Europractice thanks to the ongoing TEMPUS Project.
- Theoretical design courses can be combined with more advanced laboratory courses employing the equipment purchased through the TEMPUS Project.

References

- Most of the presented material was based on the paper: “Teaching Circuits and Electronics to First-Year Students” as presented by Y. Tsividis at the 1998 IEEE ISCAS Conference.
- Other relevant material: