Teaching Electronics in Undergraduate EE Students

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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)

- 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!

(2)

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 maintiningconsistency 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)

- 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.

(7)

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'slaws.
- Do *not* teach digital before analog! *We live in an analog world.*

(8),(9)

Experiments included in the first lab. course as suggested by Prof. Y. Tsividisin 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

(10)

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

(11),(12)

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.

(13)

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.

(14)

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 Europracticethanks to the on-going 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: “TeachingCircuits and Electronics to First-Year Students” as presented by Y. Tsividisat the 1998 IEEE ISCAS Conference.
- Other relevant material:
  - R.A. Rohrer, “Taking circuits seriously”, IEEE Circuits and Devices, vol. 6, ces, vol. 6, no. 4, pp. 27-31, July 1990
  - J.A.Orrand B.A. Eisenstein, “Summary of innovations in electrical engineering curricula”, IEEE Trans. Education, vol. 37, pp. 131-135, May 1994
  - S.W.Director, P.K.Khosla, R.A.Rhorerand R. Rutenbar, “Reengineering the curriculum”, Proc. IEEE, vol. 83, pp. 1246-1269, Sept. 1995