Major in Embedded Information Systems Engineering at the Budapest University of Technology and Economics: Experiences, short- and long-term considerations

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I. Experiences ...

This major is offered **since February 2000**, for **electrical engineering** students of BUTE,

its **core part** (88 ECTS credits out of 300) includes

- 10 mandatory courses: lectures & labs,
- a two-semester project laboratory course,
- and the Diploma thesis.

6th semester:

(1) **Embedded Systems:** deals with sensors, signal conditioning, basic signal processing and networking, (5 ECTS credits)

(2) **Logic Design:** covers design processes, CAD systems, system design with FPGAs, system integration, design reuse, IPs, (5 credits)

(3) **Analysis of Embedded Systems Laboratory:** introduces measurement tools and methods,..., vibration analysis, biomedical signal processing, (3 credits)

7th semester:

(4) **Software Technology**: includes real-time problems, declarative methods, object-oriented programming, introduction to Java and UML,

(5 credits)

(5) **Digital Signal Processing:** covers Fourier analysis, digital filtering, adaptive signal processing and estimation theory, (5 credits)

(6) **Logic Design Laboratory:** the students work on design project using FPGAs, (3 credits)

8th semester:

(7) **Analysis of Computer systems:** deals with performance analysis, modeling of distributed systems, dependability and information security issues, (5 credits)

(8) **Microprocessor-Based Systems Laboratory:** the students practice the design, implementation and testing of microcontroller-based systems, (3 credits)

9th semester:

(9) **Design of Embedded Systems:** modeling of real systems (ET, TT), time representation, embedded software architectures, real-time operating systems, functional design of interfaces, hardware-software co-design, (5 credits)

(10) **Information Systems Laboratory:** sensor integration and interfacing, application of DSP processors, evaluation of network-enabled embedded devices, and reliability analysis using Petri nets, (3 credits)

8th & 9th semester:

The **Project Laboratory** (16 credits)
covers complete individual development projects
from specification to implementation,
documentation and testing.

10th semester:

Diploma thesis (30 credits)

II. Some short- and long-term considerations:

1. How to stabilize the core part of such a major/master to meet short- and long-term industrial requirements?

Embedded systems education **should be robust enough** to produce young engineers who can efficiently utilize information technology in solving complex problems coming from **rather different domains**, and having **rather various requirements**.

2. What should be the foundation of a Graduate Curriculum on Embedded Software and Systems?

Undergratuate curricula offering **good knowledge in system's engineering** seem to be good candidates, if longer-term productivity is more emphasized. In our experience, in this respect electrical engineering students outperform those having strong background only in informatics.

II. Some short- and long-term considerations:

3. How to balance theory and practice within the courses, how to provide the necessary design and development skills?

To teach such vastly different topics such as control theory and informatics in sufficient depth and limited time might be impossible **unless the practical applicability** of the underlying theory **is evident early enough** for the students.

A **new generation of teaching staff** is also needed having contemporary skills and practice in the field.

III. Some propositions ...

1. **Identification of „best practices”** in the core fields (e.g., real-time programming ,etc.) might be important and these practices could be followed, „disseminated”, etc.,
2. **Training of the teaching staff:** there is a shortage of people who are able to transfer this wide area of engineering knowledge,
3. **To create a repository** of didactical student-projects, which can serve as exercises, home-work examples for the core courses, etc.,
4. **„Virtual laboratory”:** international student projects, where the students of different sites work together, **...**