# An Introduction to the Curriculum Schedule for Undergraduate Students at the Department of Electrical Engineering, National Taiwan University

**Liang-Gee Chen[1], Jenn-Gwo Hwu[2], Hao-Hsiung Lin[3], Way-Seen Wang[4], and Powen Hsu[5]**

*[1]R443, Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan, ROC, http://www.ee.ntu.edu.tw*
*Tel: +886-2-23635251 ext 443, Fax: +882-2-23671909, lgchen@cc.ee.ntu.edu.tw*
*[2]R446, Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan, ROC, http://www.ee.ntu.edu.tw*
*Tel: +886-2-23635251 ext 446, Fax: +882-2-23671909, hwu@cc.ee.ntu.edu.tw*
*[3]R419, Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan, ROC, http://www.ee.ntu.edu.tw*
*Tel: +886-2-23635251 ext 419, Fax: +882-2-23632442, hhlin@cc.ee.ntu.edu.tw*
*[4]R423, Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan, ROC, http://www.ee.ntu.edu.tw*
*Tel: +886-2-23635251 ext 423, Fax: +882-2-23671909, wswang@cc.ee.ntu.edu.tw*
*[5]R544, Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan, ROC, http://www.ee.ntu.edu.tw*
*Tel: +886-2-23635251 ext 544, Fax: +882-2-23671909, phsu@cc.ee.ntu.edu.tw*

**Abstract:** The field for electrical engineers is very broad and deep. The range covers from the basic materials to very complicated systems. Though different sub-fields have their own specialties, the emerging of micro-fabrication and integrated technologies makes them closely related to each other. In additions, the pace of the electronic technologies is very fast. Broad and solid academic training is very necessary for undergraduate students majored in electrical engineering to accommodate their futures. For this purpose, a curriculum schedule designed in the Department of Electrical Engineering, National Taiwan University is reported. In this schedule, five-category required courses and three-out-eight laboratory courses are specially designed to strengthen the background and broaden the view of undergraduate students.

**Keywords:** curriculum, electrical engineering, electronic industry.

## 1. Introduction

The field for electrical engineers is very broad and deep. Generally, it covers four different levels, namely materials, devices, circuits, and systems, from the basic root to the complicated applications. Each level has its own specialties. However, the emerging of micro-fabrication and integrated technologies makes these levels closely related to each other, and is generating lots of new technologies based on several different subjects simultaneously. Micro-motors, micro-filters fabricated by micro-machining technology are good examples. In additions, the pace of electronic technologies is very fast. According to the famous Moore's law [1], the device number in integrated circuits doubles per eighteen months. This quick pace makes the electronic industry very competitive. A design engineer should be familiar with both the required system specification and the available device and material technologies at the same time to survive from his competitors. On the other hand, material and processing engineers also have to have solid device and circuit knowledge otherwise they can not tune their structures to meet the urgent requests from their customers. In addition, the technologies they are using currently will become out of date in three years. How to design curriculum schedule for undergraduate students majored in electrical engineering (EE) to accommodate their futures is a very important issue. For this purpose, after a two-year discussion, a new curriculum schedule was designed in Department of Electrical Engineering, National Taiwan University (NTU), and has been actually used since 1997.

## 2. Curriculum Schedule Design

The detailed curriculum schedule is listed in Table I. The schedule requires 142 credits in total. It includes 30 credits for general education courses, 64 credits for basic and core EE courses, 27 credits for five-category required courses, 6 credits for three-out-eight laboratory courses, and 15 credits for elective courses.

General-education courses are issued and designed for all the undergraduates of National Taiwan University by the office of the dean of academic affair, National Taiwan University. The rest courses in the schedule were designed by the course committee of the Department of Electrical Engineering. This task was started in 1995. Survey and panel were used to collect the suggestions and comments from the faculties and students of the department. These suggestions and comments were then considered in the design meeting of the committee to correct the curriculum. The cycle was repeated three times, and the final curriculum was settled and approved in the department affair meeting in 1997.

Among the rest courses, basic and core EE courses were designed to strengthen the background of undergraduates majored in electrical engineering. These courses include very basic and general mathematics, physics and chemistry courses. In addition, traditional core courses of electrical engineering including computer programming, engineering mathematics, electronic circuits, electronics, and electromagnetics. As mentioned above, the technologies in electronic industry evolves very quickly. However, the evolutions still stand on the basic physics, chemistry and electronics principles, which are included in these core courses. This is also the reason why up to 64 credits is required for these courses. Undergraduate students used to take most of these courses during their first and second years.

Basically, the field of electrical engineering is very vast. At the Department of Electrical Engineering, National Taiwan University, there are ten different research groups to cover the whole research field of electrical Engineering. They are circuit, solid state, optoelectronics, electromagnetic wave, communication, electrical power, control, bio-medical engineering, computer-aided design, and computer. To accommodate the vast field, five-category required courses and three-out-eight laboratory courses were designed. These two are the features of this curriculum schedule. They are projected from the ten different research groups at the Department of Electrical Engineering, National Taiwan University, and are also considered as the introduction to the graduate courses. Undergraduates can select interested subjects from these courses as a start for their deeper graduate study in the future.

### 2.1 Five-category required courses

Basically, the idea of five-category required courses originated from the ten sub-fields structure at the Department of Electrical Engineering, National Taiwan University. However, directly mapping these ten sub-fields to undergraduate curriculum is not appropriate, because these sub-fields are too complicated for undergraduate students. What they need is introduction-type courses to lead them to the field they are interested.

After widely discussing at the department, the conclusion was reached in 1997 in which the ten categories were concentrated to five categories. They are electronics, electromagnetic wave and communication, control and electric power, computer, and the others. In each category, there are four to seven courses. The requirement for undergraduate students is to take 9 courses in total and at least 1 course from each group. The requirement of one course for each group is to ensure the breadth of the learners. And the rest 4 courses can be selected from the categories the students are interested. The learners can either spread them to different categories to further broaden their view or concentrate them into a special category to deepen their knowledge.

The former four categories were designed as specialty training of each related field. The courses for these four categories are listed in Table I. Basically, they provide introduction and knowledge background for their related sub-field. The last category, others, was designed for courses do not belong to the former four categories. For examples, fundamentals of electro-optics belongs to this category, because it is an introduction course for students interested in solid-state and/or optical communication. However, it is still not suitable to be placed in basic core course because it is not general enough. Another two courses, integrated circuit design and introduction to computer-aided design systems, were also designed to belong to this category but not electronics or computer. It is because that the customer designed integrated circuit has become more and more important, and integrated circuit design is now an important tool for engineers working on communication, power electronics, consumer electronics,

and even bio-medical engineering. The course, introduction to computer network is also based on the same consideration.

### 2. 2 Three-out-eight laboratories

Laboratory courses have no alternatives in engineers' training. In the basic and core EE-course of this curriculum, there are seven laboratory courses (7 credits in total). They are general physics laboratory 1 &2 (2 credits), general chemistry laboratory 1&2 (2 credits) and electrical engineering laboratories 1, 2 & 3 (3 credits). The three electrical engineering laboratories include one electric circuit laboratory (1 credit) and two electronics laboratories (2 credits). Basically, these laboratories and their related lecture courses are offered simultaneously. However, the pace of the same subject in the laboratory course is intentionally slower than that in the lecture course. The design let student learn the subject from lecture course first, then do the experiments.

Besides the laboratories of basic and core EE course, three-out-eight laboratories were designed to broaden student's knowledge. The eight laboratories are electric machinery, digital circuits, electromagnetic wave, semiconductor, communication, control, microprocessor, network and multimedia. These are 2-credit courses, and take 6 hours per week. Students should choose three laboratories that they are interested from these eight courses during their junior and senior years. Basically, these eight laboratories have their related lecture courses in five-category required courses. Students can take the related lecture courses before or at the same time. However, the available laboratory equipment limits the number of student in some laboratory courses. For example, only 25 students can take semiconductor laboratory in each semester. That means only 50 among 150 students have the opportunity to take this course in each grade. In 1999, some of these laboratory courses were offered in the summer vacation to partially solve this problem.

## 3. Summary

In summary, we report the curriculum schedule for undergraduate students of the Department of Electrical Engineering, National Taiwan University. The five-category required courses and three-out-eight laboratory courses in this curriculum are discussed. These two courses cover the vast field of electrical engineering, and are the features of this curriculum. They are designed to strengthen and broaden students' knowledge so as to accommodate the competitive, fast-evolving electronic industry.

## References:

[1] S. A. Campbell, "The science and engineering of microelectronic fabrication," Chap 1, Oxford University Press, 1996.

**Table I:** Curriculum schedule designed for undergraduate students of the Department of Electrical Engineering, National Taiwan University.

**Curriculum Schedule** (142 credits):

**General education courses** (30 credits):

Chinese 1&2 (6 credits), second foreign language 1&2 (6 credits), Chinese history field 1&2 (4 credits), constitution of R.O.C. and civil education (2 credits), other general education courses (12 credits).

**Basic and core EE courses** (64 credits):

calculus 1&2 (8 credits), general physics 1&2 (6 credits), general physics laboratory 1&2 (2 credits), general chemistry 1&2 (4 credits), general chemistry laboratory 1&2 (2 credits).

computer programming (3 credits), introduction to computing (3 credits), switching circuit and logic design (2 credits), probability (2 credits), differential equation (3 credits), linear algebra (3 credits), complex variables (2 credits), electric circuits 1&2 (6 credits), electronics 1, 2 & 3 (9 credits), electromagnetics (6 credits), electrical engineering laboratory 1, 2 & 3 (3 credits).

**Five-category required courses** (27 credits):

**Electronics**: semiconductor engineering (3 credits), solid state electronics (3 credits), electronic circuit design (3 credits), electronic instrumentation (3 credits).
**EM wave and communication**: principle of communications (3 credits), microwave engineering (3 credits), antennas and propagation (3 credits), introduction to digital signal processing (3 credits), digital communication systems (3 credits).
**Control and electric power**: introduction to power electronics (3 credits), electric machinery (3 credits), power system (3 credits), control systems (3 credits), linear system (3 credits).
**Computer:** data structure (3 credits), microprocessor and application (3 credits), computer architecture (3 credits), operating systems (3 credits).
**Others:** introduction to computer network (3 credits), signals and systems (3 credits), numerical method (3 credits), fundamentals of electro-optics (3 credits), modern physics (3 credits), integrated circuit design (3 credits), introduction to computer-aided design systems (3 credits).

**Three-out-eight laboratory courses** (6 credits):

electric machinery laboratory (2 credits), electromagnetic waves laboratory (2 credits), digital circuit laboratory (2 credits), semiconductor laboratory (2 credits), topics on communications laboratory (2 credits), microprocessor laboratory (2 credits), automatic control laboratory (2 credits), networking and multimedia laboratory (2 credits).

**Elective courses** (15 credits).