

## LESSONS LEARNED FROM MANAGING A LARGE CLASS OF BASIC ELECTRICAL ENGINEERING

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**Abstract** *¾ The paper describes a management practice to handle a large class of basic electrical engineering course offered to undergraduate non-EE students. It also includes design of examination questions and investigation into problems arisen from course management. The author has developed three effective teaching strategies namely (1) using problems aiming at practical knowledge, (2) delivering suitably organized contents, and (3) providing real-world problem discussions. Mixed modes of examination questions have been used to assess students' analytical and design capability. The examination paper contains multiple-choice type of questions of 40% and problem-solving type of 60%. In addition to describing the administration of the multiple-choice type of questions, data for three analyses is presented. (i) the difficult effectiveness of the designed examination questions. (ii) the effectiveness of discrimination ability level of the students, and (iii) mean reliability index of such items. These approaches have been used with 400 students and resulted in greatly improved students' performance and learning capability.*

**Index Terms** *¾ electrical engineering course, non-electrical engineering, large class.*

### INTRODUCTION AND OVERVIEW

Suranaree University of Technology (SUT) was established in 1990 as a public autonomous university under supervision of the Royal Thai Government. SUT runs a 12-week trimester system. The undergraduate engineering curricula of SUT require all engineering students from 10 schools except Electrical, Telecommunication, and Computer Engineering Schools to undertake a course basic electrical engineering. The main goal of this course is to prepare our students the fundamental knowledge of electrical engineering to cope with electrical technologies in life. During their second year of study, these non-EE students enroll the course "403296 Electrical engineering I" (EE.I-403296). Previously, this course is compulsory course for the Broad of Engineering Professional of Thailand (BEPT) for Mechanical and Industrial Engineering which is mainly focused on analytical and design level. The BEPT is required to be at least C grade. Currently, the engineering council of Thailand (ECT) assumes the BEPT's responsibility. There is the only industrial engineering, which is required to undertake this

course by the ECT. On the other hand the enrollees from other schools need not follow this requirement of the ECT. This unmandated requirement can be interpreted as that the students from these schools need to know very basic materials on electrical engineering. This course is also considered a large size class in which the enrollees have different objectives of literacy. Consequently, the author has developed more effective teaching strategies and well designed problem would decrease a gap of these distinct objectives of learners.

### 403296 Electrical Engineering I Course

The course offers 12-week-term for 4 credits and requires 4 hours of lecture and 8 hours of self-study. The outline course is followed to the requirement of the ECT, that is shown as follows:

- The EE.I-403296 syllabus : Prerequisite : Physics II
- Elementary DC and AC circuits
- Magnetic circuits
- Transformers
- Electrical machine such as dc motors and generators
- Electronic devices such as diode and BJT for amplification and switch
- Basic concepts of control

### FORMER PRACTICE ON COURSE ORGANIZATION

The EE.I-403296 was first offered in the trimester 3/1995. Due to the shortage of academic staff, 485 students were accommodated in a lecture hall at the same time. In 1998, it was possible to offer this course twice. However, class sizes were large, 850 and 160 students, respectively. The smaller class of 160 was offered to some students who had obtained grades below C from their previous enrollments. At this early stage of the course delivery, learning objectives were set as follows.

*Learning Objectives: Students should be able to*

- Understand the principles of electric, electronics circuit and control system.
- Understand the principles of electromechanical energy conversion

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- Analyze magnetic circuits, to determine electrical and mechanical performance and energy requirements.
- Understand the basic operation of electric machines.
- Understand and prescribe specifications of electric machines given application.
- Analyze and design simple diode circuits for rectifier and regulation.
- Analyze and design simple BJT circuits for amplification and switching electronics.

From the trimesters 3/1995 to 1/1998, examinations were based on multiple choice type of question (40 questions approximately) [1] owing to limited time used to complete the grading of examination papers. Each examination problems were fairly difficult and rather time consuming. The results of the analysis indicated that most students guessed the solutions. The class GPAs (maximum of 4.00) in the first 3 trimesters in Table I decreased subsequently. However students' mindfulness, lecturers' and students' performance, and properness of questions and large class size have contributed to the class GPA and learning capabilities.

Later, course management practice had been adjusted. It was expected that students' performance be improved. From the trimester 3/1998 up to 1/2000, examination questions of problem-solving type were brought into action. The evaluation of students consisted of assignments 10%, midterm examination 40%, and final examination 50%. Students were grouped into several classes of 60-80. With this arrangement, lecturers could better look after the students both in the classes and during the office hours. Unfortunately, the lecturers could not receive good responses from most students, As being noticed from table I, the class GPAs of these trimesters increase very little. What our lecturers learned from the classes (through class assessments) were that

- Course materials were too much and very difficult.
- Students were overloaded with assignments.
- Examination questions were too difficult.

### Inherent problems

These attitudes and opinions indicated that most students were stressed and bored. This led to an introspection of teaching strategies. It was judged that only homework might be not enough or necessary for entire problem solvings. From large classes, it was easy to obtain a copy of homework solutions. Hence, we believed that the splitting students into small classes were not the best practice.

During the year 1997 to 2000, there were several problems that the author dealt with in teaching EE.I 403296. These problems can be categorized into two parts:

- Teaching a large class
- Different mindfulness and learning role of students.

From the author's observation, a large number of students did not consider that this course was relevant to

their majors. This would lead to little mindfulness, in term reflecting voluntary state of mind [2], and connecting among motivation, cognition, learning role and eventually a very low class GPA.

## CURRENT PRACTICE ON COURSE ORGANIZATION

These problems together with others that arise due to the large class size [3],[4] should be resolved by accommodating practice of teaching strategy. In the last trimester EE.I-403296 was offered in its four groups. The course was organized completely different as three parts.

- **Appropriate content and its organization:**

Consequently, the different mindfulness and role of learning of the enrollees, the original learning objectives were changed to suite the enrollees that were essentially and not essentially approach to design and analyze skill. Hence, the organization of the book has been followed in this course which presents the principles of electrical, electronic, and electromechanical engineering in non-electrical engineering majors and also the essential material in an easy-to-understand fashion, focusing on practical knowledge and wide range of basic applications. The organization of the book has been referred to in [5],[6] as the textbook for the course.

- **Using of problems aiming on practical knowledge:**

In the evaluation part of the course, homeworks were completely dropped from the grading scheme and were replaced by 8 quizzes (10% by total weight). The quizzes are of problem-solving type focusing on practical issues.

- **Discussion of electrical problems in real-world industry in Thailand:**

There is a discussion at the end of the class that is relevant to the real-world problems such as Kirchhoff's current law applied to an automotive electrical harness[5], and electrical safety and the utilization of solar energy into agriculture in country were the project to honor HM the King Bhumibol Adulyadej [7], etc. Although, it would be difficult to conduct such discussion with a large class size but it can be effectively if the students are led properly as the lecturers properly encourage students to get involved and ask the enthusiastic questions to keep the discussion focused. Obviously, the discussions can provide many great advantages.

## EVALUATION SCHEME

The evaluation part of the course composes of 10% quizzes, and 40% midterm examination and 50% final examination (maximum of 100%). The design of midterm and final examination questions can be divided into two parts. First part, multiple choice type problems have 20 questions with 5

TABLE I  
TRIMESTER OFFERED FOR ELECTRICAL ENGINEERING I  
COURSE AND EVALUATION RESULTS

Trimester/Year	Class GPA	Total of students	Type of problems
3/1995	1.57	485	MCT
3/1996	1.52	637	MCT
3/1997	1.02	841	MCT
1/1998	1.00	250	PST
3/1998	1.07	602	PST
2/1999	1.15	169	PST
3/1999	1.25	705	PST
1/2000	1.34	246	PST
3/2000	1.60	426	HPT

Multiple choice type: MCT  
Problem-solving type: PST  
Hybrid problem type: HPT

multiple-choice answers (40% by the exams weight) that have been emphasized on basic materials. Second part, the problem-solving type composes of 10 question and answers (50% by the exams weight) that have been focused on applied and analytical materials. Both types of examination questions or hybrid problem type have the appropriate design of exams as the usage of multiple choice type of question is well-designed such that it can be supportive for the rest of the problem-solving type of questions. These well-designed examinations questions are not time consuming and ease evaluation process.

### DISCUSSIONS

In the trimester 3/2000, 426 students completed the hybrid problem test. The total of examination scores and the evaluation of item analysis of multiple choice type of problem were used as the evaluation of our course management approach. Statistical methods including correlation are employed for all analysis. Three analyses are discusses in this section.

Firstly, difficulty indices mean difficult level of choice in each of items for total examinees. This level ranges between 0 to 1. Figure 1 shows the difficulty of the items each of the 25 questions on multiple choice type questions in final examination. Observations indicate that the difficult level of the items range between rather easy to very easy level were 48%, moderate was 16%, while rather difficult to very difficult 36%. These results show the mean of difficulty indices of 0.519, its score indicated the middle of difficulty-easy level of such items. The author believes that difficult-easy examination questions were composed, it can evaluated the students' performance with different learning role.

Secondly, discrimination index means an effectiveness of examination question shows distinguish ability level of students. This result was calculated by value of subtraction of upper and lower difficulty indices value. The discrimination index ranges between -1 to +1.

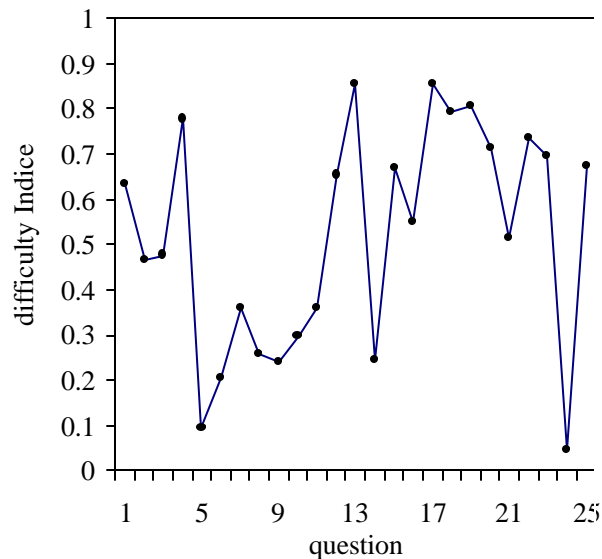


FIGURE 1  
GRAPH SHOWING THE DIFFICULTY OF THE ITEMS EACH OF THE 25 QUESTIONS ON MULTIPLE CHOICE TYPE QUESTIONS IN FINAL EXAMINATION

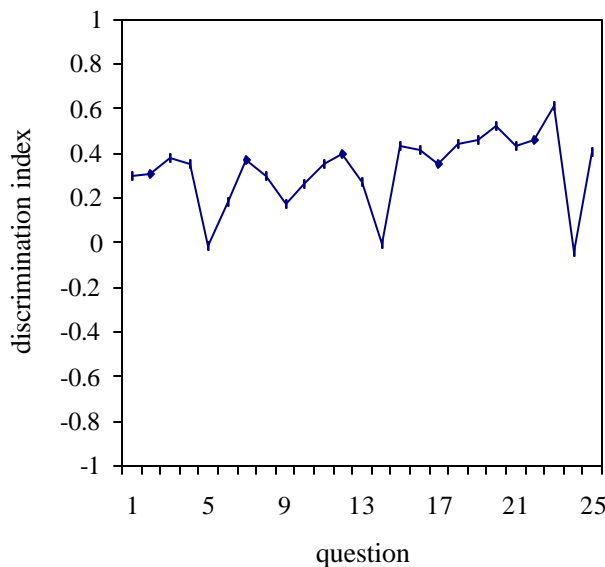


FIGURE 2  
GRAPH SHOWING THE DISCRIMINATION OF THE ITEMS EACH OF THE 25 QUESTIONS ON MULTIPLE CHOICE TYPE QUESTIONS IN FINAL EXAMINATION.

Figure 2 shows the discrimination of the items each of the 25 questions on multiple choice type questions in the final examination for 426 students. The results show the mean of discrimination index of 0.325, its score indicated that most items have fairly distinguishable ability level of the students.

Finally, reliability index means the consistent measurable results of the items. This value ranges between 0 to 1. The results show the mean of reliability of items of 0.595, its score indicated that the reliable student's marks have moderate level. The total of final examination scores of 25 items, the mean score of 12.98 and the standard deviation of 3.33.

There are several different indicators that the changes have made the class more enjoyable for the students. At Suranaree University of technology, students fill out an evaluation form to evaluate their lecturers, usually during the last week of the trimester. The average grade for the author received ranges between 2.82 to 3.05. Referring to Table I, the class GPA in the last course offered in trimester 3/2000 is 1.60 (maximum of 4.0 scale) or went up by 9%, that has compared with the average of class GPA in the previous term. Note that class GPA 1.60 in the last course compare with the class GPA 1.57 in first term that are almost the same score. But the nature of multiple choice type questions cannot evaluate the student's performance. The results of practice in course management were not reliable since most students guessed the solutions. So that the author is not take be significant However, more important thing than the rise of class GPA is that the students received the effective materials in discussions that are relevant to the real-world problem and the gained better attitude of the students with less stress. It was observed that some students were not nervous to speak up and express their views and this tended to sustain the discussions. Moreover, this depends on the lecturer's ability encouraged the students to interact in the class.

## SUMMARY

This paper has described a practice in course management to handle a large class of basic electrical engineering course for non-EE students. The strategy greatly helps to increase learning mindfulness of the students. The practice to handle of the course emphasizes the learning from drill and real-world problems. In addition, discussions by the end of each lecture are very important to improve the students' understanding of the course contents. The examination questions can be divided into two parts. First part, multiple choice type problems are able to assess the student's fundamental capability. Second part, problem-solving type questions are able to assess the students' analytical and design capability. The analysis of multiple choice type questions shows that the discriminating effectiveness of the examination questions is fair. It was found to be 0.325 of the range -1 to +1. The results mean fair distinguishable students' effectiveness. The average of difficulty indices of the items was found to be 0.519. This indicate that can be evaluated the effective of different learning role of students.

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