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Electric Power Engineering Education in Korea: Status Report

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Abstract: This report is the result of the survey conducted in 1996 to see the status of electric power engineering in Korea. This report is limited to 37 responded electrical and related engineering departments of four-year colleges and universities in Korea. This report contains electric power engineering faculty, graduate students, graduate and undergraduate courses, and average course enrollments. Also, included are the comparison of the graduate students and the faculty of power engineering in Korea and the US & Canada.

Keywords: electric power engineering, power engineering education, survey, Korea, status report

I. INTRODUCTION

The year of 1997 is the 50th anniversary of the foundation of the Korean Institute of Electrical Engineers (KIEE), the oldest an biggest body of electrical and electronic engineers in Korea. Among the fields of the electrical engineering, electric power engineering has the longest history in teaching and research in Korea. Actually, the electric power engineering is the only major field of study for the first decades since the foundation of the Republic of Korea in 1945 after the World War II, liberated from the Japanese colonization. During the economic development period of 1960s, which includes the massive construction of power plants to meet the growing demand and the electrification of the whole nation, the electric power engineering played an essential part by supplying engineers and providing the continuing education for the field engineers.

However, currently, the demand of electric power engineers is seen to be diminished partly as the power system is quite well established and reliable and does not need big engineering forces and partly as new technology field such as information and communication including Internet and computer is relatively more attractive and hiring more graduating students.

In this background, a KIEE committee which is preparing the commemoration of the 50th year of the foundation of the institute asked the author to conduct a survey on electric power engineering education. This report is the result of the survey responded by 37 four-year universities and colleges which maintain electrical engineering and/or related field.

This report includes data on curricula, faculty, course enrollments of electric power engineering supplied by the universities and colleges, plus derived statistic such as totals, averages, and comparisons. Also, we listed some suggestions made by faculty members of electric power engineering to invigorate the field and to attract more quality graduate students. This report does not attempt to rank or categorize electric power engineering programs or departments or universities in terms of quality and/or quantity, so the names of the universities are disguised with numbers.

II. A BRIEF HISTORY OF ELECTRICAL ENGINEERING IN KOREA

Before we report the status of electric power engineering, it may be a great help with the understanding of the uniqueness of the term "electrical engineering" in Korea to briefly review the history of electrical engineering. And the history of the electrical engineering in Korea cannot be described without mentioning the foundation and the development of the Seoul National University, because the university, from its foundation, has become the model to be followed in administration and education by all other later-founded universities. The Seoul National University was founded by the Korean government in 1946, one year after the liberation from Japan, and the Department of Electrical Engineering was one of the first departments founded in the college of engineering.

A. Split and Merger of Electrical Engineering

However, since its foundation, the electrical engineering experienced the separation and split, and this trend has continued until early 1990s. First, in 1947 just after a year, Electric and Communication Engineering Department was formed, separated from Electrical Engineering and later, it became the Electronic Engineering Department. In 1978, with the advent of the era of electronics and computers, a new department, which eventually became the Control and Instrumentation Department, was formed separated from the Electrical Engineering.

These splits were partly prompted by the government's drive for "self-technology" which provided financial support and gave bigger student enrollment quota to newly formed and strategic fields of science and engineering[1].

Since 1978, the split from electrical engineering to form new department started through all the universities and colleges in Korea with an explosive speed. Since then the filed of studies in electrical engineering is called the electrical and electronic engineering. In the Classification of Field of Majors prepared by the Korea Science and Engineering Foundation (KOSEF) [2], electrical and electronic

engineering are classified as separated ones and the specific fields of electrical and electronic engineering are separated as indicated in Table I. In electrical engineering, almost all fields are electric power engineering or related fields, or at least they are close to power engineering. In electronic engineering, even power electronics is included.

TABLE I. CLASSIFICATION OF FIELD OF MAJOR

07 Electrical Engineering	08 Electronic Engineering
01Power Generation	01 Communication
02 Power Transmission and Distribution	02 Electronic Signal Exchange
03 Electric Power Machinery	03 Instrumentation and Control
	04 Power Electronics
04 High Voltage Technology	05 Computer Science (Engineering)
05 Power Engineering Application	06 Circuit Theory
06 Electric Materials	07 Bio-Medical Engineering
07 Control	08 Microwave and Wave Propagation
99 Others	09 Electronic Materials and Elements
	99 Others

And department names in electrical and electronic engineering are numerous and sometimes confusing and obscure. Some of the department names are listed below:

Department of
electrical engineering
electrical and electronic engineering
electrical and electronic and control engineering
electrical and electronic and communication and information and microwave engineering
electrical and control engineering
electronic engineering
electronic and computer engineering
electronic and computer and communication engineering
electronic and electrical engineering
electronic and control engineering
control and instrumentation engineering
electronic and electrical and control engineering
electronic and communication engineering
control engineering

However, in 1992, the 3 separated departments in the Seoul National University decided to merge and form the School of Electrical Engineering and this triggered a reverse movement in the electrical and electronic engineering. From 1995, the merger of similar departments became a policy of the Korea Ministry of Education, which advocated the advantage of the merger by arguing that resources can be more efficiently allocated and quality education can be provided by reduced teaching loads of the faculty. Then, most universities followed the suit and when this study is done, many universities either had done, or are planning, or considering merger.

B. Electric Power Engineering

During the turbulent period of the split and merger, the field of electric power engineering has not been changed: the only difference is that during the split, electric power engineering was regarded as the electrical engineering, and in the merger, it is considered as a field of electrical engineering. During the early days before the merger or even before the split, power engineering field was the most important field in electrical engineering and the number of faculties in electric power engineering could reach more than 40% of the faculty in electrical engineering [3].

However, when the split started in 1970s and 1980s, the electrical engineering and thus the electric power engineering suffered from lack of quality students admitted. And this suffering is more severe when the merger occurred and universities and colleges are hiring professors more in the computer and electronics fields and less or none in electric power engineering. Also the number of students who want to take electric power engineering courses and the number of graduate students in electric power is less in numbers and low in quality.

III. SURVEY RESULTS: STATUS OF THE ELECTRIC POWER ENGINEERING EUDCTAION IN KOREA

A. Survey Questionnaire and Analysis

The survey study was conducted by sending the survey questionnaires to 47 four-year colleges and universities, selected by the help of the KOSEF data [2] and [3], where there is at least one electric power engineering professor or there offers at least one electric power engineering course. The report is limited to the above universities and colleges that replied to the questionnaire on a voluntary basis. The questionnaire was designed to find the following things:

- Electric power engineering courses taught in undergraduate and graduate level, their status of being required or elective, and the course enrollments.
- The effect to the electric power engineering curricula after the merger of electrical and related engineering departments.
- Number of faculty members in electric power engineering.
- Power engineering faculty's suggestions to invigorate the electric power engineering in the era of computer and communication.

Survey Form

To effectively convey the above purpose, we design the survey form to include the following ten items:

1. Name and position of the respondent [Optional]:
2. University Name:
3. Department Name:
4. Total number of faculty members in the department:
5. Number of electric power faculty members:
6. Undergraduate electric power engineering courses (required or elective) and average course enrollments:
7. Graduate electric power engineering courses and average enrollments and number of students in master's and Ph.D's level:
8. Did (Does) the university merge the departments in

electrical and related engineering?:

9. Did (Does) above incident affect the electric power engineering curricula?
10. Suggestions to vitalize electric power engineering education in the computer and Internet age.

Survey Analysis

Out of 47 survey forms mailed, 37 responded and Table II shows the result of the survey in the number of faculty and the number of graduate students. It also indicates if the merger of departments was occurred (or is occurring) and, if it was (or is), its influence on the electric power engineering curricula. In the table, the names of the universities are indicated with numbers, because this report does not attempt to rank or categorize electric power engineering programs or departments or universities in terms of quality and/or quantity. Also, currently in Korea, the school assessment committee of the Ministry of Education is conducting a thorough evaluation of universities and colleges, so the author determined the school names be unidentified.

From the analysis of the responses, we have the following findings:

- Total faculty members in the responded department is 10 in average.
- There are 11 electric power engineering faculty members in every 5 responded universities.
- Electric power graduate students in Master Level and Ph.D. level are 242 and 177, respectively, in the 37 universities.
- There are 13 Master and 9 Ph.D. electric power graduate students in every 2 universities or colleges.
- 68% of the universities and colleges, which are 24, merged electrical and related engineering departments. And there are 12 universities and colleges which experienced some changes in electric power engineering curricula.
- There are 9 universities in which department name was changed in the previous year.

TABLE II. THE SURVEY RESULT

U.	Name of Department	A	B	C	D	E	F
1	Electrical Eng	2	8	2	2	N	N
2	Electrical and Electronic and Microwave Eng	3	11	10	4	Y	N
3	Electrical Eng	3	10	7	3	Y	N
4	Electronic and Electrical Eng	1	7	6	1	Y	Y
5	Electrical Eng	1	8	2	0	N	N
6	Electrical Eng	1	6	3	3	N	N
7	Electrical Eng	1	5	0	0	Y	Y
8	Electrical Eng	1	8	2	5	Y	Y
9	Electrical Eng	3	6	4	0	Y	Y
10	Electrical Eng	4	7	10	3	Y	Y
11	Electrical Eng	1	6			N	N
12	Electrical Eng	1	6			N	N
13	Electrical Eng	1	9	1	0	N	N
14	Electrical Eng	4	11	14	7	Y	N
15	Electronic and Electrical Eng	1	10	6	4	Y	Y
16	Electrical Eng	1	6	2		Y	Y
17	Electronic and Electrical Eng	8	24	20	12	Y	N
18	Electrical Eng	3	9	7	5	Y	Y
19	Electrical Eng	1	6	3	1	Y	Y
20	Electrical Eng	1	7	2	0	Y	N
21	Electrical Eng	2	10		2	N	N
22	Electrical Eng	1	13	7	8	Y	Y
23	Electrical Eng	1	9	7	7	N	N
24	Electrical Eng	4	6	6		N	N
25	Electrical Eng	2	6			Y	N
26	Electrical Eng	1	6	8		N	N
27	Electrical Eng	1	7	10		N	N
28	Electrical Eng	2	8	5	2	Y	Y
29	Electrical Eng	3	9	14	12	Y	N
30	Electronic and Electrical Eng	2	12	3	2	Y	N
31	Electrical Eng	1	8	3	5	N	N
32	Electrical Eng	7	48	45	48	Y	N
33	Electrical Eng	1	8	3		Y	N
34	Electrical Eng	1	4			N	N
35	Electronic and Electrical and Telecommunication Eng	1	12			N	N
36	Electrical Eng	6	10	25	12	Y	Y
37	Electrical Eng	3	15	5		Y	N

*A: Number of all the faculty members in the department
*B: Number of electric power engineering faculty members
*C: Number of graduate students (Master's level)
*D: Number of graduate students (Ph.D. level)
*E: Departments merged (Y/N)?
*F: Electric power curricula affected by the event E (Y/N)?

B. Electric Power Engineering Faculty

There are total 81 full-time permanent electric power faculty members in the responded 37 universities while total electrical engineering faculty members of the universities are 361. There are about 2 electric power engineering faculty members, occupying about 22 % of the total faculty members, in the electrical engineering department in a university. The majority of the universities have only one electric power engineering faculty as indicated in Figure 1.

If we compare this number with the US & Canada survey data based on [4], we can see that the number of electric power faculty members in a university or college in US is one more than in Korea. US & Canada universities have more than 3 power engineering faculty members in a university or college. The comparison is tabulated in Table III.

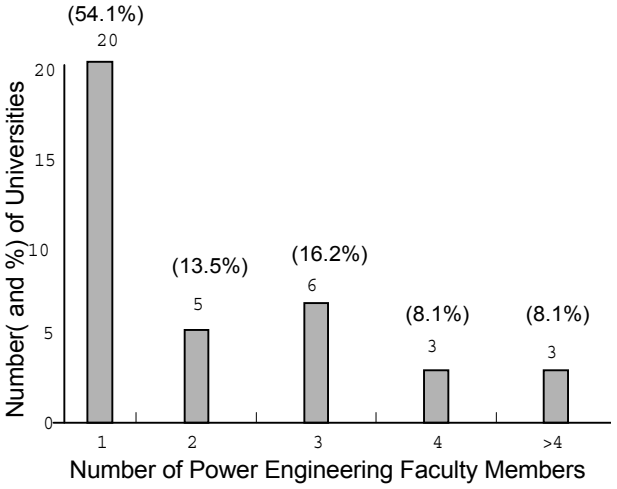

Figure 1. Number (and percentage) of Universities having one or more

Electric
Power Engineering Faculty Members

TABLE III. COMPARISON OF POWER ENGINEEING FACULTY MEMBERS BETWEEN KOREA AND THE US & CANADA.

Country	Korea	US & Canada
Year the survey was done	1996	93-94
Number of schools responded	37	91
Number of Electric Power faculty	81	329
Number of Electric Power faculty members per university	2.19	3.67

C. Undergraduate Electric Power Engineering Courses

For the electric power engineering curricula, title of the courses, enrollments, and a classification (i.e., required or elective) of the courses are analyzed. Almost 30 different courses of electric power engineering are being offered and taught as tabulated in Table IV. Most of them are traditional and conventional courses, and some of the course names are very similar and, in the author's view, the content of the courses may be almost the same. Also, some new courses were added and developed. A few of them are: Energy & Environment and Computer Applied Electric Power.

From Table IV we can see that the most widely taught electric power courses are: Electric Power System Engineering (in 32 universities), Power Generation (in 11), Energy Conversion (in 5), and High Voltage Engineering (in 5 universities). However, the two courses that are required in most universities are: Electric Power System Engineering and Power Transmission Engineering.

TABLE IV. UNDERGRADUATE COURSES

Electric Power Engineering Course	A*	B*	C*	D*
High Voltage Engineering	5	39	1	4
Electric Power Generation	11	114	2	9
Power Distribution Engineering	2	100	0	2
Power Transmission & Distribution	3	83	3	0
Power Transmission Engineering	19	191	12	7
Electric Power System Engineering	43	157	12	31
Introduction to Energy Systems	1	50	0	1
Energy Systems & Environment	1	40	0	1
Energy Conversion	5	58	0	5
Electric Machinery	5	128	2	3
Electrical Equipment	2	40	1	1
Energy Systems Engineering	2	35	1	1
Electric Energy Systems Control	2	27	0	2
Applied Electrical Systems	1	40	0	1
Rotating Machine Driving	1	20	0	1
Applied Electric Power Systems	1	30	0	1
Electric Power System Analysis	1	100	0	1
Electric Power System Control	1	16	0	1
Electronics in Electric Power Systems	1	100	0	1
Illumination &Environment	1	50	0	1
Superconductivity Engineering	1	40	0	1
Computer Applied Power Systems	1	50	0	1
Application of Electromotive Force	1	80	0	1

*A: Number of schools offering the course
*B: Average Enrollments
*C: Number of schools set as required course
*D: Number of schools set as elective course

D. Graduate Electric Power Engineering Courses

Power engineering curricula in the graduate level is characterized with variety and specialty. There are nearly 30 different courses taught in 47 universities and colleges as shown in Table V. The most widely offered courses are: Advanced Power System Engineering (in 15 schools), Power System Analysis (in 12), Power System Operation and Control (in 12), and Power System Planning (in 10).

E. Graduate Students in Electric Power Engineering

In the Annual National Education Statistics [5], the total number of graduate students in "Electrical & Electronic" Engineering in 1995 is 4832, in which 3594 were Master's Level students and 1238 were Ph.D students. When this report is being written, the statistic for the year of 1996 has not yet been printed. Therefore, we projected the number with the annual increase rate of 25% for the graduate students in "Electrical & Electronic Engineering" in 1996. Then the projected number of the Master and the Ph.D. Level students in 1996 are 4493 and 1548, respectively.

In the survey, the graduate students in power engineering are 242 for Master's Level and 148 for Ph.D. Therefore the ratio of the electric power engineering students to the overall graduate students is 6.4 %. And the ratio for Master' level is 5.4% and the rate for Ph.D. level is 9.5%.

TABLE V. GRADUATE COURSES

Electric Power Engineering Course	A*	B*
Special Topic on EMTP	1	6
Protective Relaying	1	6
Protection System Simulation	1	6
Reliability Engineering	2	13
Power Generation	1	5
Power System Planning	11	9
Advanced Power System Engineering	15	20
Power System Status Estimation	2	8
Power System Simulation	3	11
Stability Theory	1	5
Power System Stability Analysis	3	6
Power system Stability	2	8
Power System Operation and Control	12	7
Special Topic on Power System Operation	5	9
Power System Transient Analysis	1	8
AI Application in Power Systems	4	11
Expert Systems Application in Power Systems	1	6
Power System Control	8	17
Power System Analysis	12	6
Power System Economics	1	7
Power System Analysis Theory	4	8
Insulation Breakdown Theory	2	5
Special Topic on Illuminating Engineering	1	5
Extra-High Voltage System Theory	1	4
Extra-High Voltage Transmission	1	6
Computer-Aided Protection Coordination	1	6
Special Machinery	2	7

Energy Conversion	2	7
Power System Protection and Insulation Coordination	2	9
Distribution Automation	1	8
Computer Application in Power Systems	1	8

*A: Number of schools offering the course
*B: Average course enrollment

These numbers, as indicated in Table VI, have very significant meaning: the higher ratio in the Ph.D. level than the Master's Level tells us that the electric power engineering now is less attractive than years ago among students, because in Korea almost all graduate students continue their study without discontinuity from Master's level to Ph.D. level.

TABLE VI. ELECTRICAL ENGINEERING GRADUATE STUDENTS

	Master's Level	Ph.D. Level
Electric Power Graduate Students (A)	242[a]	148[a]
Total Graduate Students in Electrical & Electronics(B)	4492[b]	1548[b]
Ratio in percentage (A/B)	5.4%	9.5%

a: by the 1996 survey of 37 four-year universities and colleges
b: projected numbers of 1996 by the Annual National Education Statistics, Ministry of Education, Korea.

The total number of graduate students in electric power engineering is compared with that of the US & Canada. The US & Canada data was also from [4]. In table VII, the comparison is tabulated and it can be seen that each university in the US & Canada has more Mater's and Ph.D. students in electric power engineering.

TABLE VII. COMPARISON OF THE NUMBER OF GRAUATE STUDENTS BETWEEN KOREAN AND US$CANADA.

		Korea	US$Can.
Year the survey was conducted		1996	1993-1994
Number of schools responded		37	90
Number of Electric Power Engineering Graduate Students	Master Level	242	957
	Ph.D. Level	148	409
Number of Electric Power Engineering Graduate Students per School	Master Level	6.5	10.6
	Ph.D. Level	4.0	4.5

F. Influence on the Power Engineering Curricula after Departmental Mergers

There are 7 schools which responded that the electric power engineering curricula were changed because of departmental mergers. Another five responded that changes are expected to come soon. The changes in the 7 universities are summarized below:

- Some electric power engineering courses, typically Power Generation, were dropped to provide more room for students to choose other courses.
- Some electric courses such as Power System Analysis were closed or canceled because of the lack of enrollments.
- Some electric power engineering courses which was required before became elective now.
- There are new courses which attempt to combine electric power engineering and computer (or communication) technology.

G. Suggestions by Electric Power Engineering Faculty

The faculty members responded the survey considered the current trend in electrical engineering and the merger of the electrical engineering department as an awakening moment for finding and developing better teaching methods for electric power engineering. Also, they voiced on the lack of good text books on electric power systems. It's apparent that there is no significant difference between the text book they used while studying a long time ago and the one they are teaching now. Of course the contents may not necessarily be different and new technologies may not have to be added, but the method of the knowledge delivery may ought be changed or amalgamated with the current trend in computer and information age.

Also, to secure a balanced development in the academic discipline, some incentives and scholarship for graduate students majoring in electric power engineering must be provided. Also, they stressed that the only electric power company, the Korea Electric Power Company (KEPCO) should provide more research money to academia and employment opportunities for power engineering degree holders. And, last but not the least, they in unison stressed the development of new courses to attract more students and equip them better and competitive. They felt that some efforts are being made but a significant development is yet to be seen.

IV. CONCLUSIONS

This report, based on the survey conducted in 1996, shows the status of electric power engineering education in Korea. We reported the electric power engineering faculty, graduates students, graduate and undergraduate courses, course enrollments, and comparisons with US & Canada survey result. This report, in commemoration of the foundation of the KIEE, presents a short history the electrical engineering in Korea and the current status of electric power engineering. The oldest and the biggest field in electrical engineering in Korea for the last 50 years, now faces challenges in its existence and evolution in the changing era of computer and communication.

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VI. BIOGRAPHIES

C. J. Kim (M '90) received his BS and MS degrees in electrical engineering at Seoul National University in Korea, in 1980 and 1982, respectively. He received a Ph.D. degree in electrical engineering from Texas A&M University in1989. From 1990 to 1991 he worked as a post-doctoral research associate for the Power System Automation Laboratory (PSAL) at Texas A&M University. From 1992 to 1994, he worked as a research faculty member for the Department of Electrical Engineering at Texas A&M University. From 1994 to 1998, he was with Department of Electrical Engineering at the University of Suwon where he holds an assistant professor position. Currently, he's with the Department of Electrical Engineer at Howard University. Dr. Kim's research interests include information technology and intelligent systems application to power system control, monitoring, protection, and distribution incipient failure detection.