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Education of Power Electronics in Japan

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ABSTRACT

Power electronics is an interdisciplinary area that is interstitial to all of the major disciplines of electrical engineering including power, electronics and control Today, the covering field of power electronics has more widely spread out with the help of ever evolving microelectronics and computer science Whereas, in Japan the tendency is becoming remarkable nowadays that science, especially "mathematics" and "hardware work", are falling into disfavor with the young people For these reasons, it has become a very important problem to find out "what are the truest essentials of power electronics?" and "How to give students incentives to learn power electronics?" from an educational point of view in under-graduate and graduate courses in universities. On the other hand, the power electronics engineers in companies are always required to comply with the ever changing trend of global and open market. However, it takes long time to cultivate their skills Against the background, "The Cooperative Research Committee on Education of Power Electronics" was established in the IEEJ Industry Applications Society during 2000-2001 The present status of the power electronics education in Japan is surveyed in this paper, and some problems with remedy are pointed out based on the discussions performed in the committee.

Keywords: Power electronics education, PE education in undergraduate school, PE education in graduate school, PE education in company

1. Introduction

Recently, deterioration of the global environment and depletion of the future energy resources have become most important problems for the human beings For this reason, the importance of the energy related research field has been increasing Especially, the expectation to the power electronics has increased still more However, the power electronics is the comparatively new subject that was expansively independent from the electrical machinery in making to be school subject of undergraduate and graduate schools in universities Therefore, it is the situation that has not yet fixed on the optimum teaching method. Power electronics is also comparatively new technology field even in the industry The engineers who studied this in the university are not yet sufficient qualitatively and quantitatively In order to supplement the shortage of education in the university, the

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OTJ (on-the-job) training plays an important role in encouraging the potential talent However, the practical education with immediate usefulness has been expected strongly due to the sharpening of worldwide business development and competition in the industry The tendency has much more strengthened after the decay of the bubble economy. From the viewpoint of the teaching method that is connected with the business, it cannot be denied that U S A goes most. In the university in Japan, it tended to overemphasize the research in a past. Today, the necessity of emphasizing the education has been generally recognized However, the concrete countermeasure like U.S.A. has not yet been taken

Against the background above, "The Cooperative Research Committee on Education of Power Electronics (Chairperson Prof A Ueda)" was established under the Semiconductor Power Conversion technical committee in the IEEJ Industry Applications Society during April 2000 to March 2001. The main purposes of this committee were as follows:

(1) Survey on actual situation of the power electronics education, i e , how the education is carried out in universities and companies in domestic and overseas
(2) Extraction of the problems and proposal of the guidelines for improving the education techniques.

The authors who were the organizing members of this committee write this paper based on the survey result of the committee[1][2], which include the present state of the power electronics education in the universities and companies in Japan and problems with remedy.

2. Power Electronics Education in Undergraduate School

The origin of today's prosperity of the power electronics is traced back to the appearance of the thyristor in the commercial field in1957. As well known, power electronics is an interdisciplinary area that is interstitial to all of the major disciplines of electrical engineering including "power (static and rotating equipments)", "electronics (devices and circuits)" and "control (continuous and sampled-data)" as pointed out by Dr. W E Newell in 1973[3]. Today, the covering field of power electronics has more widely spread out with the help of ever evolving microelectronics and computer science[4] Whereas, in Japan the tendency is becoming remarkable nowadays that science, especially "mathematics" and "hardware work", are falling into disfavor with the young people For these reasons, it has become a very important problem to find out "what are the truest essentials of power electronics?" and "what is the effective way to give students incentives to learn power electronics?" from an educational point of view in under-graduate and graduate courses in universities. On the other hand, the power electronics engineers in companies are always required to comply with the ever changing trend of global and open market However, it takes long time to cultivate their skills

2.1 Typical related curriculum

On the curriculum, the power electronics has been developed following to the "electrical machinery". Therefore, it is general to place in order by this paralleling flow the lectures That is to say, "Electrical machinery I and II (transformers, induction machines, DC machines, synchronous machines, others)" as basic subjects on electrical machinery and apparatus, and "Power electronics (power devices, basic power conversion schemes, applications/ details refer to Table1)" as a basic subject on semiconductor power conversion techniques. It is general to place these 3 subjects in 2nd or 3rd grade. These 3 subjects are included in the curriculum of the most electrical engineering related schools with almost no exception One of the reasons is that the "Power electronics" is designated as the compulsory subject in the accreditation of the licensed electrical chief engineer. Generally, "Electric machine system control", "Energy systems", etc. are placed around the 1st semester of the 4th grade And, there are also some special cases that the power electronics systems are taught in the existing "Control theory" or "System engineering", etc due to the restriction of individual curriculum

Table 1 shows a typical example of syllabus of power electronics. The order of teaching items are following the description in the golden age of the thyristor based converters That is, the description at the order of "externally excited power converters (diode, thyristor rectifiers)", "self-excited power converters (chopper, inverter)" and "applications". And, much labor was being

Table 1 A Typical Syllabus of "Power Electronics" for Under Graduate Class in Japan (Aich Inst of Tech Dept of Electrical Eng / 3rd-grade Semester)

1 Outline of Power Electronics
2 Power Semiconductor Devices
3 Rectifiers
4 Controlled Rectifiers
5 External Commutation Inverters
6 Chopper Circuits
7 Basics of Inverter Circuits
8 Square Wave Inverters
9. PWM Inverters
10 Applications of Power Converters
11 Control of DC Motors
12 Control of AC Motors
13. Applications for Power, Transportation and Industrial Systems

spared for the description of constraint condition of natural commutation and commutation overlap phenomena, etc.. However, in these days, it is increasingly adopted the order with "self-excited converters" first, because of practical viewpoint and easiness of the understanding for the students.

It is not possible to remove the experiments from the curriculum, because it is essential for understanding the operation principles of electrical machinery and power electronics equipments Generally the experiments concerning the power electronics are carried out in the 1st and 2nd semesters of 3rd grade. In addition to the traditional subjects using transformers and rotating machineries, a power electronics system including rectifier and inverter, and programming exercise of a microprocessor which gives a control mean for a inverter are adopted The examples of adopting the latest themes of mechatronic systems such as robot arm and inverted pendulum using DSPs, etc. are also recently observed so that the students may have the interests and incentives.

2.2 Surrounding situations of power electronics education

As already mentioned, the amount of knowledge and skills that should be mastered during undergraduate course have increased with the development of science and technology And, due to the recent diversification of the learning ability of the students who entered the university, remedial education and basic subjects must have been intensified in many universities, which becomes the motive force to promote "slim" of the technical subject curriculum in undergraduate course education Originally, the power electronics is the interdisciplinary field which consists of regions such as electrical machinery, electric power engineering, control engineering, information theory which are formed on the basis of circuit theory and electromagnetics. Therefore, it is changeable with the object of integration and arrangement, and it tends to reduce the number of the lecture units. Actually, many of the application field subjects such like "Electric railways" and "Illumination engineering" have been faded away by subject slimming, and they tend to be covered with "Special lectures" by part-time lecturers dispatched from companies

Meanwhile, the recent tendency in which science, especially "mathematics" and "hardware work", are falling into disfavor with the young people is becoming remarkable. The number of students who like "making things" including handcrafts, industrial arts, circuit soldering, creating mechanism, etc is becoming fewer The students, who have rare motive to learn engineering and who cannot image their own future dream as the professional engineers in some special fields, are gradually but surely increasing nowadays Under such situation, the power electronics must be able to become the learning field that arouses the creativity of the students by conveying the interest of both making things and applying theory to practice Because, it is an application field that originally covers both of hardware and software Although the percentage of the students entering the graduate school is generally increasing recently (typically around 30-50%, in some cases 80% or more), number of students taking only undergraduate course is still large in most universities Though the theoretical education is important, experiment and practical training occupy especially important position in undergraduate school education, because it is a final stage of education In the senior high school education, the opportunity of experiment and practical exercise has been decreasing nowadays For this reason, such experience in the university would have the more important meaning. From this fact, the roll of the power electronics, which respects the practical application and verification of theory there, is becoming greater and greater in education of science and technology

2.3 Hints for attractive power electronics education

What kind of viewpoints will be necessary in order to make the power electronics education to be attractive thing? In the following, let's try to pick out some points from the discussions in the committee

(a) What should be tought: The power electronics is the field which handles the control in energy conversion In addition to the basis of electromagnetics/circuit theory and mathematical ground, the ability to catch the physical image and to observe phenomena from both microscopic and macroscopic view points should be cultivated In arranging the syllabus, the order and priority in teaching should be carefully considered, because the items to be studied have been increasing. However, the excessive rationalization is the taboo in the experiment. It is insufficient only to measure the characteristics of a completed equipment It is desirable for the students to wire and connect the circuit by themselves for measuring

(b) Ideas for making the lecture to be attractive: It is important how to reflect the tendency of the society for the lecture Though the lecture in university tends to be theoretical with principles, it is insufficient from the practical view point The students does not show the interest only in figure and theory It is important to increase the opportunity that the students can actually touch the reality by handing on real devices or seeing photographs by using OHP or another means of multi-media systems. However, it is not always easy to get the appropriate photographs, even though intending to introduce actual industrial products, etc.. Then, it is desirable if there may be a service system that collects and opens such materials for lectures in universities On this point, the authors have proposed an idea of a system for the collection, compilation and distribution of the power electronics educational use materials through web site[2]. And, we are hoping to realize the template in a working group in the successor committee which has started in October 2002 And, the lecture by the part-time lecturer from the company is effective in the meaning of informing the technology of forefront Though it tends to recently reduce the part-time units in universities due to the limitation of personnel costs, the utilization of volunteer is actively recommended

(c) The importance of a balance of software and hardware: In a development project in the companies, the engineer who can look over the whole of project is becoming fewer in these days. The engineer who plays active part in the development field recently is the one who is familiar with the hardware The one who is familiar with only the software tends to cling to the software For the students today, though they tends to dislike the hardware work, it should be taught that the balance of both is important.

(d) Effective use of simulation: Since the simulation study has become easy recently, it seems that the actual experiment using practical testing bench is often neglected. However, in the simulation, it is dangerous to take the whole results on trust, because the results comes out even if the physical phenomena is unproven For this reason, some professors put a ban "Don't use the simulation before you can image the waveforms! " for the student. However, considering the simulation as one of the means for analysis, it has many advantages such that the whole behavior of the complicated system can be easily known, even if it can not be followed only with the equations Therefore, it is important to let the students utilize these simulation tools, after understanding both of merit and demerit aspects, in a circulation manner with order of theory, simulation, experiment and then coming back to theory, and so forth.

(e) Points to be learned from European and American universities: In U S A , most university students cultivates their technical skills that are immediately useful in the company during their school life On the other hand, in case of Japan, the motivation of the students to learn in university is not always high, and the students who cannot find their way to go before their graduation is not a few in number. In learning, the basis becomes more important as the technology deepens Therefore, a radical exercise with repeated training like the U.S A style is necessary And, the many of university students in Europe consider relatively wade international area for finding their jobs The students of Japan should also brush up their international sense, so that they may be active in their future jobs in the international field

2.4 Power electronics education in the laboratory

In addition to the education through lectures and experiments described above, "Seminars" and "Graduation research (thesis)" in the 4th grade carried out in the individual laboratory will be the most important opportunity for the power electronics education. It is because the research activity itself, in which the students are involved with other laboratory staffs, is an important occasion for their education In this meaning, it is always asked to the professor who leads the students that how to keep the laboratory as a creative space for education and research In the case with a number of graduate students and research staffs are abounding in a laboratory, it is easy to make a hierarchical guidance system. However, when it is an environment with small number of graduate students and research staffs, such a guidance system is no longer easy to be made. In such a case, the transfer efficiency of the research contents (especially, circuits of the experimental equipments and know-how of the software) between academic years becomes worse Therefore, the daily contrivance for avoiding this "slowdown" is indispensable.

The daily management of the laboratory is carried out richly with individual characters of the laboratory Therefore the laboratory, where the student casually comes to belong, tends to become "all" of the living environment for the student It seems to be an undesirable condition such like "a frog in the well does not know the ocean". In order to prevent such condition, it is required to exchange with the outside environment by attending joint seminars with other laboratories, workshops and laboratory tours in other universities or companies In such occasion, the exchange with the same generation makes a good rival outside the laboratory, which surely becomes a positive incentive for improving the skills

Though it is not limited to the power electronics education, the job hunting activity tends to be started too early (typically in February, the end of 3rd grade) and prolonged (typically until July, the end of 1st semester of the 4th grade) in these days For this reason, it is very difficult to keep the atmosphere of the laboratory to devote into the research projects, and which is the recent commonly heard worry from many university professors in Japan In the 1st grade, it is common to provide some subjects for the remedial education to compensate for the lack of basic learning ability especially in mathematics and physics etc , which occupy some part of the regular curriculum for the 1st grade And, in the final grade, early started and prolonged job hunting activities make the curriculum deboning not a little also In such situation, it is not possible for the students to cultivate their capability From the viewpoint above, the authors propose to postpone the start of employment activity after the 2nd semester of 4th grade (typically in October) as it used to be 20-30 years ago It will fit the common advantage for the companies to get the higher quality students, and for the hole society to prevent loss of intelligence

And, the portable telephones have explosively spread in Japan recently It is said that this fact has greatly changed the life styles of the students. In the laboratory, it is remarkable that the human relationship between the students tends to become weakened, and the research hour spent in the laboratory tends to be decreased and cut into pieces due to the increasing part-time job hour In this situation, the traditional style in good old days of the power electronics, in which spending enough time for experiments and discussions with friends and staffs, sounds no longer attractive for the younger generation. It is not limited to the case of power electronics that the interest of students is facing to the software rather than the hardware, and that is the stream of the times today Therefore, it is necessary to keep it in mind, and always try to take new devices, new materials, new methodologies into the lectures so that the power electronics may appeal its ever advancing aspects in its technologies

Power electronics itself has become a commonly used technology, because more than 40 years has passed since the birth of thyristor. Advanced ICs, modularization and unitization techniques have been adopted in the main circuit and the control circuit also, where the tendency of the masking like a "black box" is remarkable for the whole On the other side, it tends to complicate the research object from individual element to the system Therefore, the burden of the student also increases As a result, it is considered to have given the ineffective sensation of "The whole image can not be easily grasped." to the students Also there is no choice, there needs a new efficient teaching way of the power electronics with a new viewpoint. In that meaning, it is possible that the simulation easily shows the whole of the system, and it can become effective measures when the function and the importance of each part are taught in the whole system. Recently, some workshops for exchanging views in university and industry on power electronics teaching method have been held synchronized to some international conferences, etc . Ideal way of the introductory education for the student without the base of power electronics originally, and efficient teaching method using simulations, etc are discussed there Further activation of such discussion is expected

3. Power Electronics Education in Graduate School

The wave of the popularization of university education is surging even in the graduate school recently In the faculty of engineering, there are some universities where more than 80% of undergraduate students enter the graduate school master course Although these examples are the exceptional cases, it seems to be achieving at about 30-50% nationwide. Here, present state and problems of power electronics education in the graduate school are introduced on the example of Tokyo Institute of Technology The completion requirement for the master's degree program by Ministry of Education and Science is to acquire over 30 credits, and it is necessary to acquire 22 credits (11 subjects) from the lectures It is required (necessary condition) that 4 credits should be acquired from another major or graduate school lectures of another graduate course Therefore, about 30 students attend the lecture on "Advanced lecture on power electronics" in the 1st semester, however, about 20% of them has taken neither "Power electronics" nor "Circuit theory" in undergraduate school The motive of attending a lecture from another major is "credit acquisition", and therefore, it must come to lecture on the power electronics general as well as the undergraduate school, as it is shown in Table 2. As a result, the gap of the consciousness between them and the students belonging to the power electronics laboratory who expects the more advanced lecture becomes large As seen in the example above, it is the problem how are the contents of the "Advanced lecture" should be which fit for graduate school level This problem is common in popularized graduate school having bipolarized groups of students One of the solutions will be linking the curriculums of undergraduate and graduate schools systematically On the contrary, the number of attendees to the lecture on "Power system and electromechanical system analysis" in the 2nd semester reduces by half to be 15 students. The contents of the lecture and its promotion method can be leveled-up as shown in Table 3, because the level of attendee is well selected.

So far the companies in Japan have not been asking, at the entrance examination, about what the student had studied in graduate school. However, now is the age of progress with globalization and quick change, and even the graduate school students are required to get immediate usefulness in their ability

Table 2 A Typical Syllabus of "Advanced lecture on Power Electronics" for Graduate School Class in Japan (Tokyo Inst of Tech Graduate School of Elect & Electronics Eng / Master Course 1st Semester)

1	Outline of Power Electronics
2	Power Devices and Their Characteristics
3	Rectifiers and Their Input/Output Characteristics
4.	Phase Controlled Rectifiers and Their Characteristic Improvement
5.	Cycloconverters
6.	AC Power Conditioning and Var Compensation
7	DC Choppers and Switching Power Supplies
8	Circuit Topologies of Typical Inverter Circuits and Their Operating Principles
9.	Typical PWM Control Strategies for Inverter Circuits
10	Applications of Inverter Circuits
11	Self-Commutated Rectifiers
12	Active Filters

Table 3 A Typical Syllabus of "Power System and Electromechanical System Analysis" for Graduate School Class in Japan (Tokyo Inst of Tech Graduate School of Elect & Electronics Eng / Master Course 2nd Semester)

1. Outline and Basic Laws of Analysis Method
2. Treatment of Single Phase AC System and Its Power
3. Active Power, Reactive Power and Distortion Power
4 pq Theory for Three-phase Circuits
5 Application of pq Theory
6 Absolute Transformation and Relative Transformation
7 dq Transformation
8. Gamma-DeltaTransformation
9 Voltage and Current Differential Equations of Rotating Machine
10 Instantaneous Torque of Rotating Machine
11 Vector Control of Induction Machine
12 Vector Control of Synchronous Machine

Therefore, it seems that the power electronics education in the graduate school should be more systematically carried out also.

4. Power Electronics Education in Company

There are two styles of education in companies, one is the training course carried out in a training center, etc , and the other is based on OJT (On the Job Training) Generally, both of them are used in combination. The level of the course in training center is divided into typically three steps, introductions, fundamentals and applications The "Introduction course" is for the beginners of the technology. The expected attendee of this course is not limited to engineering department but also the business department and the producing department to get knowledge of the products. This course is for the persons who want to be the specialist on the technology field For the person with the aim to be the specialist on the technology of the field, the "Fundamental course" is provided, where the mastery of the basic theory of the technology and knowledge is its purpose For the specialist on the technology, the "Application course" is provided, where the mastery of the theory for applying the technology to the business and mastery of the application of the newest technology are the purposes As a form of the execution, there are gathering courses, office courses, whole company seminars, intranet courses, etc The intranet course is the new trial which utilized IT (Information Technologies), and in U.S A., the e-Learning instructional system as WBT (Web Based Training) is rapidly spreading out since 3 years ago, and is gradually spreading in Japan also

The power electronics covering range is wide, and variety of technologies in different area must be acquired for the development of the application product.

Fig. 1 shows the field which must be covered by the power electronics technologies. In the electrical and electronic circuit field which is basic technology, the most important technologies to be acquired exist. That is to say, alternating current theory, rectification theory, inverter circuit technique, analytic technologies including Fourier and Laplace transformation techniques, control technologies such like PWM control and digital control techniques, communication technologies, etc

In the field of the power semiconductor technology, the switching power device application technology that includes power devise drivers, snubber circuits and protection circuits etc. is important. In addition, the cooling technique and structural technology such as noise reduction are also important which are necessary in constructing inverter stacks and rectifier stacks In the field of electric power and electrical machinery technology, technology to design transformer, rotating machine, magnetic component such as the reactor, capacitor, circuit breaker, etc is also important In the field of applications and practice, the equipment of

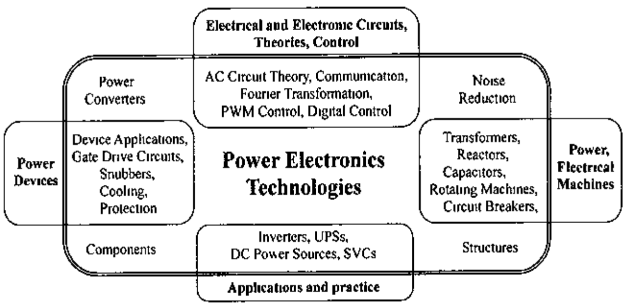

Fig 1 Related Technology Field of Power Electronics

inverters, UPS, DC power sources, SVCs, etc are realized by combining the system construction technology in addition to the above-mentioned basic technology

In each company, several kinds of courses are provided such as "Power electronics general technology", "Power device technology", "Inverter technology", "Motor control technology", "Power conversion technology", "Noise and products related technology", etc.. Table 4 shows an example schedule of 4-days course on "Power electronics general technology course" in a manufacturer It is a total technology course that covers typical subjects from the basis of the power electronics to the application It becomes the practical education course including "Group meeting", "Studies on subjects", "Exercise and review", "Factory tour" etc in addition to the classroom lectures

In the above, the situation of the power electronics education in companies has been described The application field is wide for the power electronics technology, and the engineering education with uniform manner is not always possible The education in the company is the mastery of basis and application examples to the last Therefore, the brush-up with the learned knowledge is indispensable, before they are applied to the charge product. It is an important problem that how to cultivate an capable engineer who can demonstrate the creativity in the engineering field.

5. Problem and Request from Company

The power electronics is a interdisciplinary field composed of variety of component technology including semiconductor, control and network theory, and so on. Recently, energy problems and environmental countermeasures at the global scale are discussed. The role increases more and more on the power electronics that converts and controls electric energy using the semiconductor as key technology that solves such problem In order to utilize the power electronics, each component technology must be widely mastered Therefore, the long term is needed for the rearing of the power electronics technology engineer

From the companies, as a standpoint of research and development of the power electronics related product, the following requirements are raised as expecting to the person who graduates from the university. (a) The systematic learning of basic subjects such as electromagnetics, circuit theory, electronic physics, electric machinery, etc. (b) The eye which observes thing and essence of the phenomenon. (c) The fresh sense to have interest on novel things and to learn from them (d) The management sense of the wide meaning to contributes to society and company through the technology. (e) The common sense as a cosmopolitan.

Table 4 Typical Example of 4-days Course on "General Technology of Power Electronics" Placed in a Manufacturer

Time Table	1st Day	2nd Day	3rd Day	4th Day
8 00	Opening and Orientation	Review of Power Converter Circuits	Review of Exercises	Transfer to Factory Site
9·20	Outline of PE	Fundamentals of Power Converter Circuits II	Basic Characteristics and Control of Motors	Practical Applications of PE
10 20	Principles and Usage of Power devices			
12 00	Lunch			
13 00	Principles and Usage of Power devices	Fundamentals of Inverter Circuit Design	Fundamentals of Motor Drive Systems	Factory Tour
14·30	Fundamentals of Power Converter Circuits I			16 30 General Discussions and Sociable
18·00	Supper			
19 00	Group Meeting and Studies on Subjects	Exercises on Power Converter Circuits	Exercises on Motor Drive Systems	19 00 Closing
21 30				

From the view point of technology education, it is a problem that recent young engineer tens to verify the performance of the equipment without experiment but with only the simulation, that is the recent tendency in society affected by respecting the information technology However, the ability of evaluating the result is insufficient. Therefore, it is expected to improve the education so that it may sufficiently grasps the physical concept by increasing opportunity for the experiment And, it is recommended that the special lecture is increased by calling the part-time lecturer from the company, for ultramodern system and technology on the product

In addition, there are many problems which need the systematic approach further than the individual equipment in recent power electronics business and power electronics product For this reason, the training of "system oriented thinking" is strongly desired

Today, globalization and opening of the market have been advancing in all fields In the graduate school in Japan, the typical style of education is rather shifted to OJT through the research theme The power electronics is total interdisciplinary field which integrated various technology as mentioned Therefore, for the person who have completed graduate course of this field, it is expected to have wide knowledge, idea with creative thinking, and the capable talent suited for the project leader And, for the university as a research institute, it is expected to challenge large scaled project with long term, which the company cannot work on

6. Conclusion

Based on the investigation in the committee, present status of the power electronics education and trend of the improvement have been described The power electronics is the technology field of which advance is very rapid The reform of the education must be attempted, while the advance of the related newest technology must be adopted also It is expected that the university and company share the common recognition on educating the younger generation by exchanging discussion for promoting the new methodology of power electronics education

The IEEJ Industry Applications Society has established the 2nd stage successor committee on power electronics education entitled, "The Cooperative Research Committee on Education of Power Electronics in Information Technology Age (Chairperson Prof K. Oguchi)" during October 2002 to September 2004.

In this committee, investigations on following items have been planed

(1) Minimum syllabus for Power electronics education (lecture and experiment) in undergraduate school and technical college
(2) Minimum syllabus for power electronics education in the graduate school.
(3) Requests from the industrial field on education in university
(4) University/industry cooperation in the power electronics education
(5) The utilization of Internet in the power electronics education
(6) The present status of power electionics education in foreign countries
(7) The international cooperation in the powei electronics education

"Education", that is to hand oui student a key to open his own knowledge. The goal of education is to knock the door in his mind Said certain famous educators The education to foster the youth in the next generation by giving them true incentive leading to human welfare is a universally important problem. And, it is a suitable subject for discussion beyond the individual situation. The authors hope that the international cooperation in power electronics education will be deepened through out this kind of valuable exchange.

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Mikihiko Matsui was born in Fukui, Japan, in 1957. He graduated from Nagoya Institute of Technology and received B.E. and M.E. degrees in electrical engineering in 1979 and 1981, respectively. From 1981 to 1992, he was with the Tokyo Institute of Technology as a Research Associate, and received Dr. Eng. degree on "Study of High-Frequency Base Power Conversion with Circulating Current" in 1991. In 1992, he moved to Tokyo Institute of Polytechnics as an Assistant Professor, and became an Associate Professor in 1993. In 2002, he has become a Professor there. He is a member of IEEE, IEEJ and so on. His research interests include power converter technologies for renewable energies including photovoltaic systems and wind turbine generation systems, and energy storage systems connected to the ac mains. Power Electronics education, and utilization of simulation and mechatronics for PE education are also his main interests. He received *IEEJ Paper Award* in 1987. He is Organizer of the Cooperative Research Committee on Education of Power Electronics, IEEJ, for 2000-2001.

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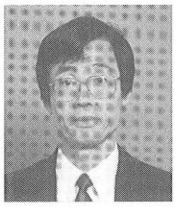

Kuniomi Oguchi was born in Fukuoka, Japan, in 1940. He graduated from Kyusyu University and received B.E. degree in electrical engineering in 1963. From 1963 to 1965, he was with Fuji Electric Manufacturing Co. From 1965 to 1976, he was with the Kyusyu University as a Research Associate, and received Dr. Eng. degree on "Study of AC Adjustable Speed Drives Using Thyristor Inverters" in 1977. In 1976, he moved to Ibaraki University as an Assistant Professor, and became an Associate Professor in 1979. In 1994, he has become a Professor there. He is a senior member of IEEE, and a member of IEEJ and so on. His research interests include high power converter topologies and control of adjustable-speed doubly-fed induction generator systems. Power Electronics education is also his main interest. He received *IEEE Industrial Power Converter Committee Paper Award* in 1983, 1993, 1997, and 1998.