Self-Study Report for the

Department of Electrical Engineering

2005-2009

Tsinghua University

May, 2010

Table of Contents

Terminologies Used in the Report

China's Ministry of Education	It is the Government Ministry responsible for education in China.
China's Ministry of Science and Technology	It is the Government Ministry responsible for scientific research in China.
Discipline	China's Ministry of Education regulates 12 education Categories. Engineering is one of them. Below the level of Categories, there are Disciplines, such as Electrical Engineering, Electronic Science and Technology, Computer Science and Technology, etc.
Field	The education or research level below Discipline. There are five fields under the Discipline of Electrical Engineering, which are shown in Fig. 1.5.
Direction	The education or research level below Field. Faculties in the same Direction may form one research group.
National College Admission Test	Senior high students in China need to take part in this test before they are admitted into a university. Their score in the test will be the most important factor for their enrollment. Students can apply for multiple universities and disciplines on the application form. However only one university will recruit the student to one discipline according to their score in the Admission Test.
985 Project	It is the project of "Educational Promoting Action Plan Facing 21st Century" which started at 1998 and covers several top China' universities, called 985 universities.
211 Project	This is the project of "Developing 100 Advanced Universities in the 21st Century" which started in 1990 and covers dozens of China's universities, called the 211 universities.
Chinese Academy of Sciences (CAS)	This is the national academy for the natural sciences of China. Being an Academician of the CAS represents the highest level of national honor for Chinese scientists.
Chinese Academy of Engineering (CAE)	This is the national academy of China for engineering. Being an Academician of CAE is the highest academic title in engineering science and technology in China.
Cheung Kong Scholars Program	This is a higher education development program in China provided by China's Ministry of Education and the Li Ka Shing Foundation. Started in 1998, It provides scholarship funding for famous professors from China and other countries to work in China.
National Thousand Talents Program	This was announced in 2009 with the intention to tempt 2000 academics back to China during the next five to ten years.
National Science Fund for Distinguished Young Scholars (DYS)	This was launched by the National Natural Science Foundation of China (NSFC) with the aim of increasing the growth of young scientific talents in China.
National Challenge Cup Extracurricular Scientific	This is organized by the China Association of Science and Technology and China's Ministry of Education and participated by

Contest	students. About 100 projects get the first prize each year.
Outstanding Doctoral Dissertation of the Nation	This is elected by China's Ministry of Education. About 100 dissertations get this honor in all disciplines each year.
National top-quality Course	This is elected by China's Ministry of Education. About 500 courses get this honor in all disciplines each year.
Renowned Teacher of the Nation	This is elected by China's Ministry of Education. About 100 teachers get this honor in all disciplines each year.
National Experiment Teaching Demonstration Center	This is elected by China's Ministry of Education. About 100 lab centers get this honor in all disciplines each year.
National Teaching Achievement Award	This is elected by China's Ministry of Education. About 600 achievements get this honor in all disciplines every four years.
Academic Program Review	China's Ministry of Education organizes the Academic Program Review for disciplines every five years. It is the official evaluation for all disciplines. There have been two reviews of the Discipline of Electrical Engineering.
Key Disciplines	China's Ministry of Education organized the election of Key Disciplines in 2007. There are five Key Disciplines in Electrical Engineering in China, i.e. Tsinghua University, Zhejiang University, Huazhong University of Science and Technology, Chongqing University, and Xian Jiaotong University.
973 Project	This is the project of "Key Basic Research Development Plan" which started in 1997 and is organized by China's Ministry of Science and Technology.
Major Program of Natural Science Foundation of China	This is the highest level fund supported by the NSFC. There has only been one Major Program granted in the Discipline of Electrical Engineering until now.
Key Program of National Natural Science Foundation of China	This is the second-highest level fund supported by NSFC. About 10 projects are granted each year.
863 Project	This is the project of "National High-tech Research Development Plan" which started in 1986 and is organized by China's Ministry of Science and Technology.
State Natural Science Award	These awards are granted by China's Ministry of Science and Technology every year to recognize achievements in natural science, innovation, and engineering.
State Technological Invention Award	
State Science and Technology Advance Award	
State Key Lab	China's Ministry of Science and Technology establishes State Key Labs as the important component of the National Innovation System. The goal of State Key labs is to organize advanced basic and applied research and cultivate scientists. There are currently about 210 State Key Labs and about 110 of them are built within universities. Tsinghua University has 15 State Key Labs.

Executive Summary

The Department of Electrical Engineering at Tsinghua University was founded in 1932. After nearly 80 years of development, it has established an excellent education and research reputation in China and around the world. More than 10,000 students have graduated. Thirty-six alumni, either previous/current faculties or graduated students, are elected as Academicians of the Chinese Academy of Science or the Chinese Academy of Engineering. Many graduates have became full-time professors in China and the other countries, chief engineers or general managers of China's power related industrial companies, and influential statesmen serving the country.

During the development of the Department of Electrical Engineering, many disciplines, i.e. electronics engineering, automation theory, computer science, and biomedical engineering, formed the new department. Currently the Department of Electrical Engineering is mainly engaged in the educational and scientific activities in the broad field related to the generation, transmission, and distribution of electrical power. Electrical power plays a pivotal role in the nation's development and China is undergoing a rapid development period for power engineering, including both power system and electrical equipments. The special characteristics of power systems, i.e. complexity, instant balance of power, extra-high voltage, and integration of power flow and information flow, reflect the specialty and the frontiers of power engineering research and development. These two aspects make the Department of Electrical Engineering at Tsinghua University an active and vigorous education and research institute.

By the end of 2009, the Department of Electrical Engineering has 90 faculties. 39 of them are professors and 36 are associate professors. More than 83% of the faculties hold Ph.D. degrees. Among them, there is one academician of the Chinese Academy of Science and the foreign academician of the Royal Swedish Academy of Engineering Sciences (Professor Qiang Lu), one academician of the Chinese Academy of Engineering (Professor Yingduo Han), one academician of the UK's Royal Academy of Engineering (Professor Yonghua Song), four IEEE Fellows (Professor Qiang Lu, Professor Jinliang He, Professor Yonghua Song, and Professor Boming Zhang), three IET Fellows (Professor Zhicheng Guan, Professor Xinzhou Dong, and Professor Yonghua Song). One faculty is supported by the National Thousand Talents Program (Professor Yonghua Song), three faculties are supported by Cheung Kong Scholars Program (Professor Yuanzhang Sun, Professor Shengwei Mei, and Professor Jinliang He), and four faculties have been awarded the National Science Fund for Distinguished Young Scholars (Professor Yuanzhang Sun, Professor Xidong Liang, Professor Jinliang He, and Professor Shengwei Mei). Professor Jinliang He has received the distinguished IEEE EMC Society Technical Achievement Award in 2010.

All undergraduate students admitted to Tsinghua University are ranked above the 99.9% score on the National College Admission Test and the enrolling score for the Discipline of Electrical Engineering ranks about sixth among more than thirty engineering and science disciplines at Tsinghua University. For Ph.D. enrollment,

40-50 students are recruited each year, more than 50% of whom are recommended students for direct admission (requiring only an interview). More than half of these come from the top 20% of undergraduate students in the Department of Electrical Engineering of Tsinghua University with the remainder come from the top 5% of other high-level universities, e.g. 985 universities or 211 universities, in China.

In this period of evaluation, 595 undergraduate students were enrolled and 583 undergraduate students were awarded their Bachelor Degrees. About two thirds of them continued their academic programs in various disciplines and universities. From 2005 to 2009, 376 Master candidates were enrolled and 415 students were awarded their Master degrees; 222 Ph.D. candidates were enrolled and 205 students were awarded their Ph.D. degrees. Recently about 60% of the graduates were employed by academic institutions or industrial companies related to power engineering.

From 2005 to 2009, one undergraduate group won the first prize of the National Challenge Cup Extracurricular Scientific Contest; two Ph.D. dissertations were elected as Outstanding Doctoral Dissertations of the Nation; four undergraduate level courses were elected as National Top-quality Courses; one faculty was awarded the title of Renowned Teachers of the Nation; all three lab centers were elected as either National or Beijing Experiment Teaching Demonstration Centers; and one project won the first prize of the National Teaching Achievement Award. In 2006, China's Ministry of Education organized the second Academic Program Review on Electrical Engineering. The Department of Electrical Engineering at Tsinghua University was again ranked as the top Department with a perfect score of 100 [1]. In 2007, the Department of Electrical Engineering was elected as one of the Key Disciplines in Electrical Engineering in China by China's Ministry of Education.

The annual scientific funding per faculty increased from 630k RMB in 2005 to 1,370k RMB in 2009 [2]. In this evaluation period, 1480 journal papers and 783 conference papers were published with the affiliation of the Department of Electrical Engineering at Tsinghua University, and 149 invention patents were licensed by China's State Intellectual Property Office. The Department of Electrical Engineering at Tsinghua University undertook several key projects from the nation and industry, i.e. the first and the second 973 Projects started from 2000 and 2004 respectively, the only NSFC Major Project started in 2005, ultra-high voltage and smart grid engineering projects from the State Grid Corporation of China and China Southern Power Grid started each year. Several achievements played a key role in leading the development of China's electrical engineering discipline and power engineering technology. In the evaluation period, one second prize of the State Natural Science Award and three second prizes of the State Technological Invention Award were obtained by faculties of the Department of Electrical Engineering at Tsinghua University. The State Key Laboratory of Control and Simulation of Power System and Generation Equipments was again accredited as "Excellent" by China's Ministry of Science and Technology

[1] In the first evaluation organized in 2003, the Department of Electrical Engineering at Tsinghua University was ranked first in all four aspects, i.e. faculty, research, education, and reputation. China's Ministry of Education did not release individual aspect rank details in the second evaluation.

[2] Roughly equal to 90kUSD and 200kUSD respectively.

in 2008 [3].

The strategy plan for the next period of evaluation focuses on continuously cultivating potential leaders and playing a leading role in the broad aspects of the electrical engineering discipline and power engineering technology in China and across the world. The specific considerations include systematically carrying out innovative education project for undergraduate students, increasing flexibility and project-based courses in the undergraduate curriculum, augmenting the international academic exchange for both faculties and students, exploring new possible interdisciplinary research directions, and inspiring original research achievements, etc.

[3] In 2003, 5 out of 52 State Key Labs were "Excellent". In 2008, 5 out of 54 State Key Labs were accredited as "Excellent". The State Key Laboratory of Control and Simulation of Power System and Generation Equipments is one of the three State Key Labs which were twice accredited as "Excellent".

Part 1 The Department of Electrical Engineering

1-1 Motto, Vision, and Mission

In 1914, the third year after the establishment of Tsinghua School, the predecessor of Tsinghua University, teacher Qichao Liang quoted two sentences from China's ancient philosophy book, The Book of Changes, to encourage students to study diligently and behave kindly. Later, Tsinghua University summarized the motto accordingly as "Self-discipline and Social Commitment" ("自强不息厚德载物"in Chinese). Tsinghua University also holds the academic spirit of "Rigor, Diligence, Veracity, and Creativity", the spirit of "Patriotism, Devotion and Pursuing Excellence", and the tradition of "Actions Speak Louder than Words."

Years after the start of Department of Electrical Engineering, Professor Mingtao Zhang, the then Head of the Department of Electrical Engineering, spoke to students in one meeting as follows: "You are here at the Department of Electrical Engineering of Tsinghua University both for scholarliness and integrity, while the later one is more crucial for young peoples." In 1992, the then China's Premier Rongji Zhu, who graduated from the Department of Electrical Engineering in 1951, again mentioned these words at the 60th anniversary of the foundation of the Department of Electrical Engineering and elaborated it as "Conscientious academics and honest behavior" ("为学在严为人要正"in Chinese), which commendably echoed the motto of Tsinghua University. Then it was regarded as the motto of the Department of Electrical Engineering.

Tsinghua University does not maintain a formal vision and mission statement. The Department of Electrical Engineering at Tsinghua University is dedicated to pursuing the following visions:

- to maintain highly qualified faculties and staffs, each of them being able to develop in a harmonious and active atmosphere;
- to educate students who are capable of taking a leadership affecting the broad aspects of the electrical engineering discipline, power engineering industry, and society; and
- to generate knowledge and serve society through scientific research, thereby leading the development of the electrical engineering discipline and power engineering technology of China and the world.

The mission of the Department of Electrical Engineering at Tsinghua University is to discover, disseminate, and apply knowledge related to the broad aspect of electrical engineering through various activities including education, scientific research, and social service so as to impact the direction of the electrical engineering discipline and the power engineering technology, and thus contribute to the progress of civilizing China and the world.

1-2 Introduction

1-2-1 Tsinghua University

Founded in 1911, Tsinghua University – one of China's most famous universities – is situated in a

former Qing Dynasty imperial garden surrounded by many historical sites in northwest Beijing. It was originally under the name of "Tsinghua Xuetang" for those students who were sent by the government to study in the United States. The school was renamed "Tsinghua School" in 1912. The university section was founded in 1925. The name "National Tsinghua University" was adopted in 1928.

In nearly 100 years, Tsinghua University has witnessed and shared the hardships and glories of the nation. At present, the university has 15 schools and 55 departments with more than 7,000 faculties in science, engineering, humanities, law, medicine, history, philosophy, economics, management, education and art. As one of China's most renowned universities, Tsinghua has become an important institution for fostering talent and scientific research. Now over 36,300 students, including 14,600 undergraduates and 21,700 graduate students (7,300 Ph.D. students) are studying in the university.

Taking talent cultivation as its basic task, Tsinghua University has an accomplished faculty, a comprehensive program of interdisciplinary studies, a conducive environment for teaching and research, and a broad range of cultural activities. All of these advantages provide its students with a pleasant environment for their all-round development. Aiming at nurturing talented students with an innovative spirit, Tsinghua has developed a complete system for undergraduate and graduate education and provides many off-campus high level training programs.

The educational philosophy of Tsinghua is to "train students with integrity." With this philosophy, Tsinghua University is dedicated to the well-being of Chinese society and to world development. Among students who have graduated from Tsinghua, since its foundation, are many outstanding scholars, eminent entrepreneurs and great statesmen remembered and respected by their fellow Chinese citizens.

In the new century, Tsinghua University will draw on its heritage of excellence and make full use of the comprehensive advantages to mold itself into a world-leading university and contribute further to China's modernization and prosperity.

1-2-2 The Department of Electrical Engineering

Electrical engineering was established as a separate discipline from the branch of physics more than a century ago. The Department of Electrical Engineering at Tsinghua University was founded in 1932 as one of the first five engineering departments.

In the beginning, there were two groups in the department, the power group and the communication group. Then in 1952, China underwent a national scale recombination of universities and departments according to the Soviet Union's higher education structure. Influenced by this trend, the Department of Electronic Engineering, based on the communication group, was created. Later the Department of Computer Science and Technology and the Department of Automation were established with the same reasons in 1958 and 1970 respectively. The latest separation took place in 2001, when the Department of Biomedical Engineering was founded, based on the applied electronics group in Department of Electrical Engineering, to be the first department in the School of Medicine. The new departments evolving from the Department of Electrical Engineering are illustrated in Fig. 1.1.

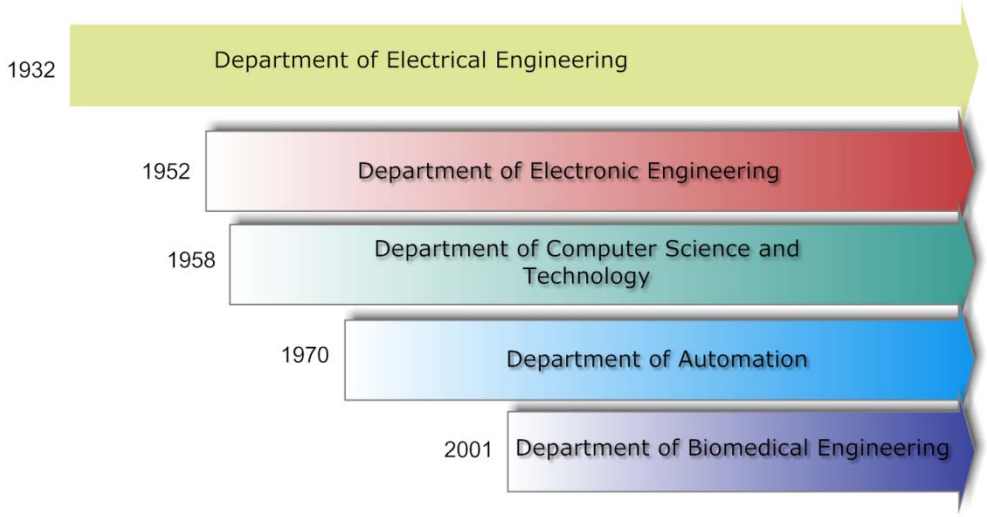

Fig. 1.1 Departments evolving from the Department of Electrical Engineering

Although many research disciplines were separated in the development of the Department of Electrical Engineering, its basic ideas have never been changed, these can be summarized as scientific research and talents cultivation to both meet the strategic demands of the nation and keep up with the cutting edge of world scientific development.

The Department of Electrical Engineering currently has five research fields. They are power system and its automation, high voltage and insulation technology, electrical machinery and electric equipment, electrical theory and new technology, power electronics and power drives respectively. These fields cover the major themes of power engineering and have strong ties with electronics, computer science and other disciplines.

1-2-3 Power Engineering in China

China's electrical power industry has changed dramatically since the early 1990s to become the world's second-largest electricity consumer, after the United States.

The installed capacity in China continuously maintains a high growth rate. Figure 1.2 shows the increasing curve of the installed generating capacity in China from 1980 to 2009 and Fig. 1.3 illustrates the annual electricity production of the major countries around the world in 2008. These figures clearly demonstrate that power engineering in China is becoming the most energetic and active in the world.

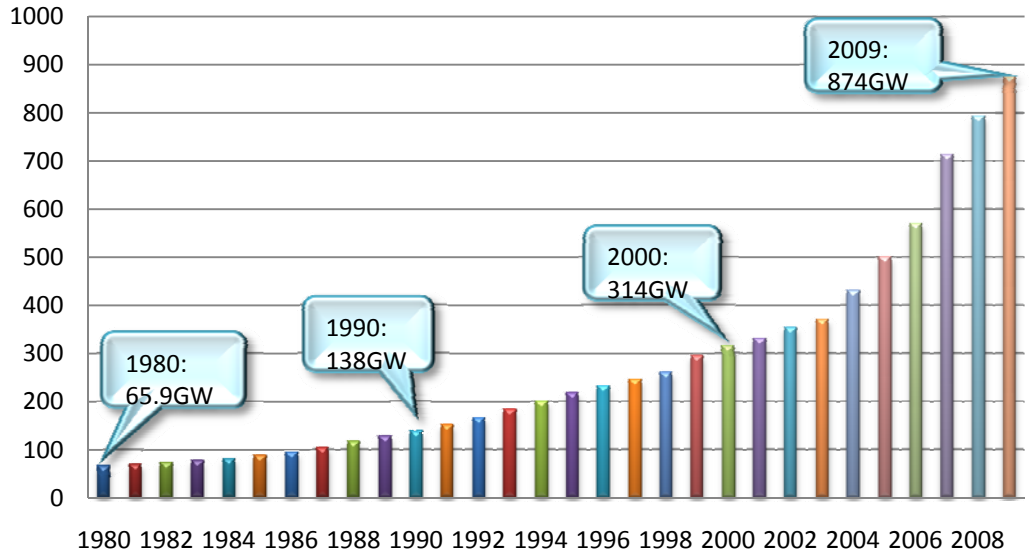

Fig. 1.2 The installed generating capacity in China

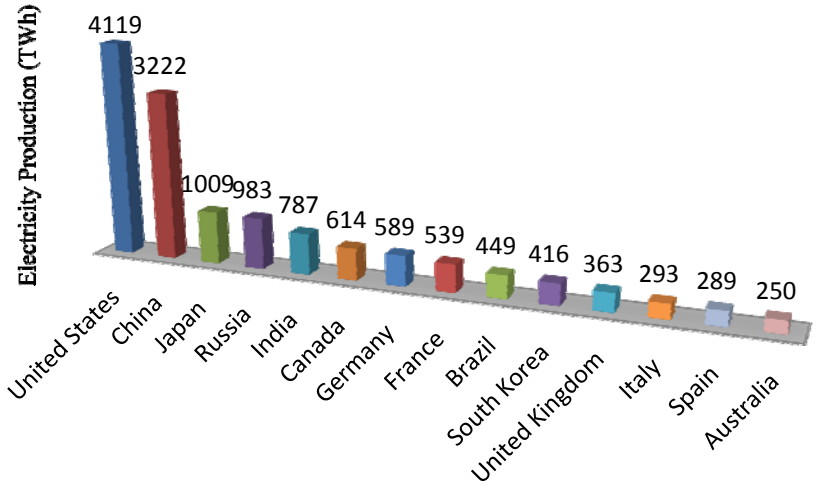

Fig. 1.3 Annual electricity production of the world's major countries in 2008

With the rapid development of China's power engineering, China's power industry is getting stronger. Table 1.1 illustrates the rank of three of China's power grid and power generation companies in the "Fortune" Top 500, which demonstrates the vitality of China's power engineering.

Table 1.1 The rank of China's power engineering companies in the "Fortune" top 500

Company	2005	2006	2007	2008	2009
State Grid Corporation of China (SGCC)	40	32	29	24	15
China Southern Power Grid	316	266	237	226	185
China Huaneng Group	N/A	N/A	N/A	N/A	425

Over the past one hundred years, the development of electrical power always focused on the theme of improving transfer capability and reducing transmission cost. Among the possible

solutions, raising the transmission voltage level is the most efficient method. It is flexible for transmission, interchange and distribution of power on the "strong" power grids. The State Grid Corporation of China and China Southern Power Grid, the two largest electrical power providers in China, are concentrating on developing a 1000kV AC network supported by a series of ±800kV DC projects to deliver large quantities of electrical power over long distances with lower power losses than traditional transmission lines. Figure 1.4 illustrates the current core infrastructure of China's power grid, where it is easy to see the complexity and challenges of distributing the electrical power.

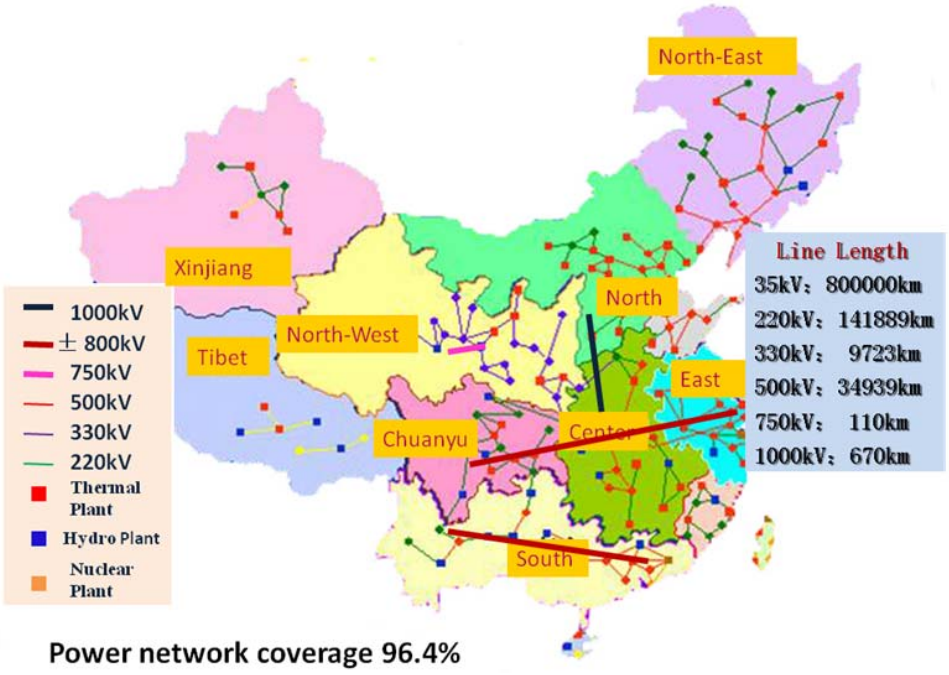

Fig. 1.4 The core infrastructure of China's power grid

The proposed "Smart Grid" is described as the next-generation electrical power system which is characterized by the increased use of communications and information technology in the generation, transmission, delivery, and consumption of electrical energy. It delivers electricity from suppliers to consumers aided by bi-directional communication technology to control appliances at consumers' homes to save energy, reduce costs and increase reliability and transparency. These modern electricity networks are being promoted by many governments, e.g. Australia, Canada, European Union, Korea, Japan, United States, etc., as a way of addressing energy independence, global warming and emergency resilience issues. To relieve the shortage of energy supplies that limits China's economic growth, China is developing new energy generation resources, such as wind, solar, geothermal, and tidal power. As China's new energy industry expands, a "Smart Grid" that ensures integration with renewable power sources and long distance transmission is what the market cries out for. In the middle of 2009, China announced an aggressive framework for Smart Grid deployment. The decade-long "Strong Smart Grid" project is expected to improve transmission efficiency, secure power supplies, reduce carbon emissions, and allow for intermittent power sources like wind generation. The National New Energy Development Plan promulgated in late 2009 confirms the smart grid development as part of the national energy strategy.

The rapid development of China's power engineering, in recent years, provides tremendous

employment positions; the complicated infrastructure of China's power grid suggests challenging research topics; and the widespread focus on smart grids around the world provides exciting opportunities. These research and development challenges contribute to the energetic and active status of the Department of Electrical Engineering at Tsinghua University. Based on this consideration, effective methods for teaching and research will be introduced in Part 2 and Part 3 respectively.

1-3 Organization

Tsinghua University has 15 schools, e.g. the School of Civil Engineering, the School of Economics and Management, the School of Information Science and Technology, etc., and 55 departments, most of which belong to one school. The Department of Electrical Engineering is one of the five departments which do not belong to any school. The administrative and academic infrastructure of the Department of Electrical Engineering is illustrated by Fig. 1.5.

Two committees, indicated by the yellow boxes in Fig. 1.5, direct the administration. The Academic Committee is responsible for establishing the strategic plan on faculty, education, and research of the department. The members of the Academic Committee are listed as follows:

- Chairman: Professor Wei Zhao
- Vice-chairman: Professor Xidong Liang
- Other members: Professor Qiang Lu, Professor Yingduo Han, Professor Yong Min, Professor Zhengming Zhao, Professor Zanji Wang, Professor Zhicheng Guan, Professor Rong Zeng, Professor Qing Xia, Professor Jiansheng Yuan, Professor Boming Zhang, Professor Jinliang He, Professor Shengwei Mei, Professor Xiaohua Jiang

The Degree Committee is responsible for maintaining and developing the graduate programs and offering Master degrees and Ph.D. degrees. The members of the Degree Committee are listed as follows:

- Chairman: Professor Yong Min
- Vice-chairman: Professor Zhengming Zhao
- Secretary: Professor Chongqing Kang
- Other members: Professor Jiansheng Yuan, Professor Boming Zhang, Professor Qing Xia, Professor Qirong Jiang, Professor Xinxin Wang, Professor Guozheng Xu, Professor Wenlong Qu, Professor Wei Zhao, Professor Rong Zeng, Professor Liming Wang, Professor Jianyun Chai

The executive directors of the Department of Electrical Engineering are as follows:

- Head (General Management): Professor Yong Min
- Deputy Head (Human Resource): Professor Zhengming Zhao
- Deputy Head (Scientific Research): Professor Rong Zeng
- Deputy Head (Education): Professor Chongqing Kang

There are also two Assistant Heads in the Department of Electrical Engineering, Dr. Yingyan Liu and Dr. Xinjie Yu, on general administration and discipline development respectively. Several administrative offices contribute to the regular management of the department, which is shown by the green boxes in Fig. 1.5.

Five administration institutes, shown by the purple boxes and connected with solid lines in Fig. 1.5, are set up under the administrative infrastructure. Institutes are entities under the

department. Most administrative orders are executed by institutes as units. The main research fields of these institutes will be introduced in Subsection 3-1.

Under the academic infrastructure, according to the regulations issued by China's Ministry of Education, the education and research activities of the Department of Electrical Engineering belong to the Discipline of Electrical Engineering, which has five fields below the level of discipline, as illustrated by the blue boxes in Fig. 1.5. Their relationship to the administrative entities in the Department of Electrical Engineering is illustrated in Fig. 1.5 by the doted lines.

The State Key Lab for Control and Simulation of Power System and Generation Equipments, the khaki color box in Fig. 1.5, was established, with nine sub-labs and three experimental centers, mainly in the Department of Electrical Engineering since 1989 [4]. Currently, the Director is Professor Xidong Liang. A detailed introduction to the State Key Lab is presented in Subsection 3-1of this report.

1-4 Faculty

There are 90 faculties, 25 laboratory staffs, and 12 administration staffs in the Department of Electrical Engineering at the end of 2009. The number of faculty member during the evaluation period is illustrated by Fig. 1.6, which means that the faculty number is relatively steady at about 90. Fig. 1.7 and Fig. 1.8 show the age distribution among these 90 faculties and the professional title distribution respectively.

Equivalent to the professional title Assistant Professor, Associate Professor, and Professor in US, Tsinghua University has the corresponding titles of Lecturer, Associate Professor, and Professor respectively. There is also another system of professional title, i.e. Assistant Researcher, Associate Researcher, and Researcher at Tsinghua University. The original intention of these two parallel systems was to separate research and teaching faculties. With the process of developing the research university, there are only a few professors who do not research and most researchers are willing to teach. Currently the difference between these two categories of professional title is often ignored and they are collectively called Lecturers, Associate Professors, and Professors, respectively, in the rest of this report. There is another professional title in China, i.e. Advisor for Ph.D. Candidates. Only those who hold Ph.D. degrees can apply for the title of Advisor for Ph.D. after they are promoted to Professor [5].

The professional title system at Tsinghua University is illustrated by Fig. 1.9. Each year, the Department of Electrical Engineering at Tsinghua University will advertise their vacancies worldwide. Qualified candidates are required to report their research and teaching abilities and other achievements to all professors in the department. Based on the vote results of the professors, the materials of several candidates are evaluated anonymously by experts in China. The vote results and the evaluation results will both affect the recruitment results. For Lectures with Ph.D. degrees, three years of faculty experience is the minimum period for promotion. The minimum period from Associate Professor to Professor is five years. One year is required for the promotion to Advisor for Ph.D. Candidates.

[4] Seven sub-labs are in the Department of Electrical Engineering. The other two sub-labs belong to Department of Thermal Engineering.

[5] Recently, a few Associate Professors with Ph.D. degrees have been awarded the status as Advisor for Ph.D. Candidates.

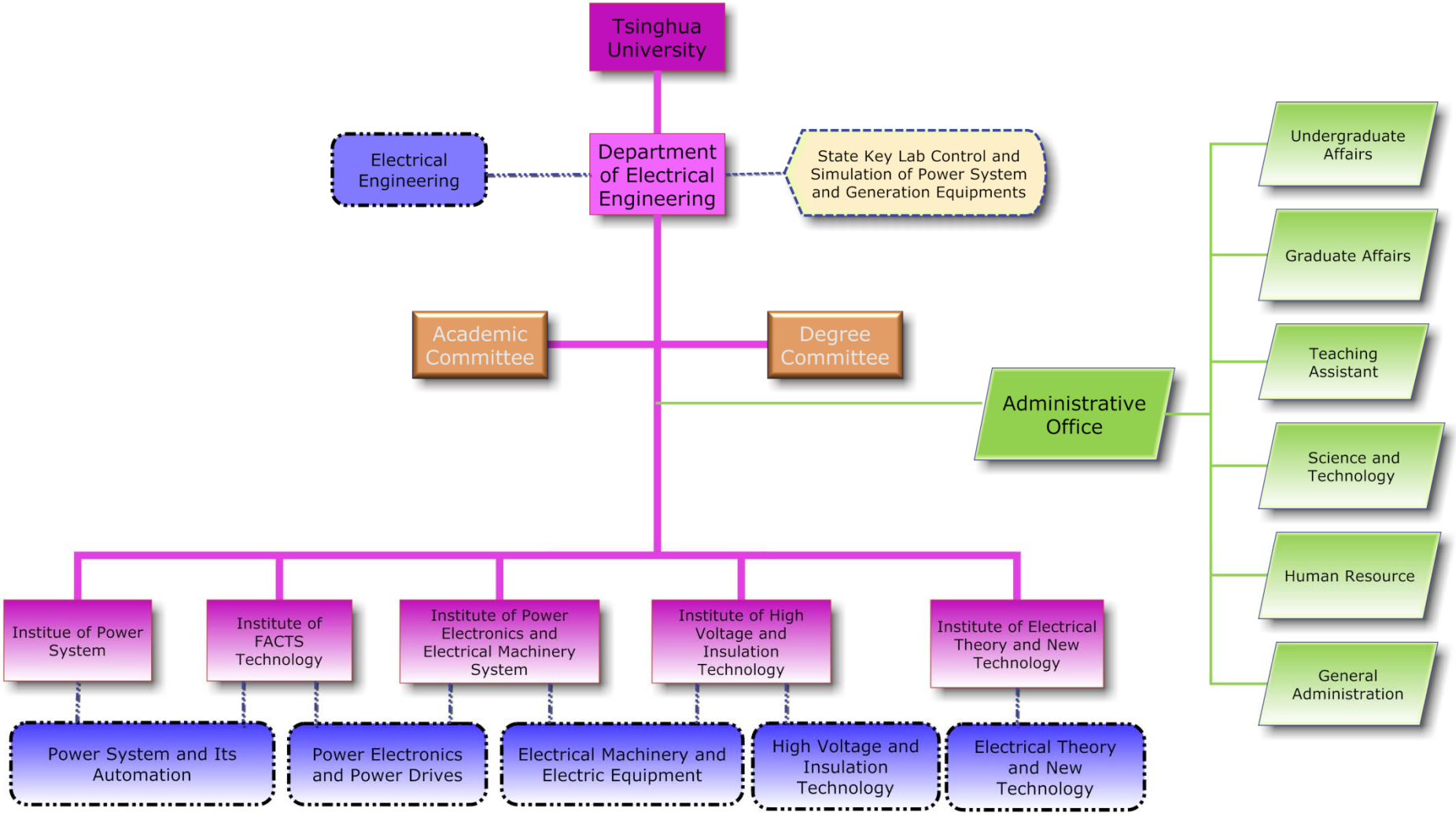

Fig. 1.5 Administrative and academic infrastructure of Department of Electrical Engineering

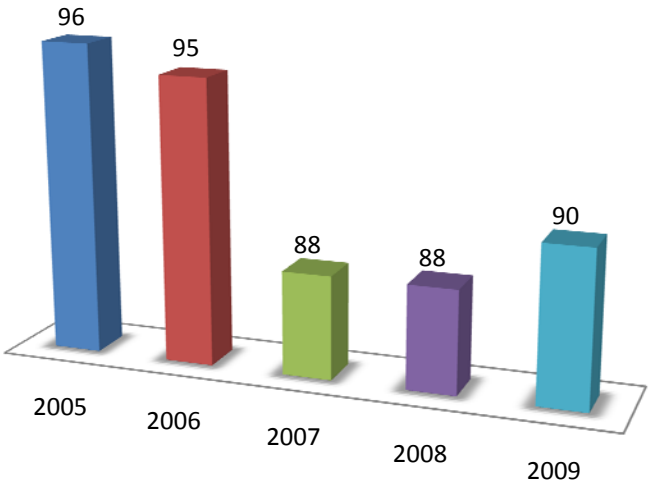

Fig. 1.6 The number of faculties at the Department of Electrical Engineering during the evaluation period

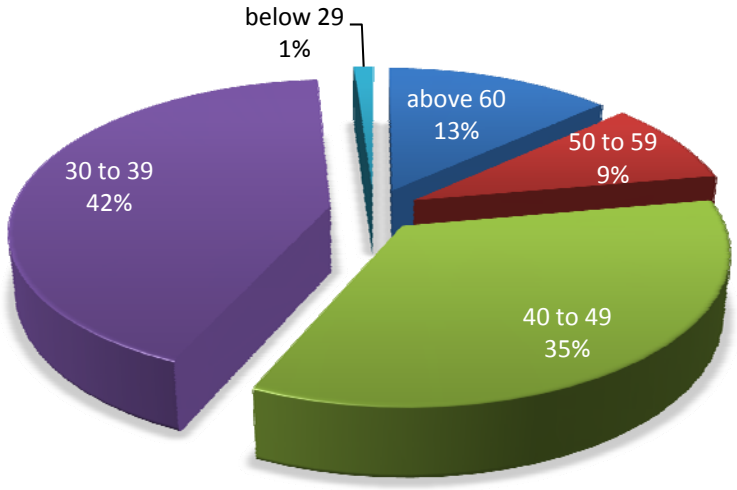

Fig. 1.7 The age distribution of faculties at the Department of Electrical Engineering in 2009

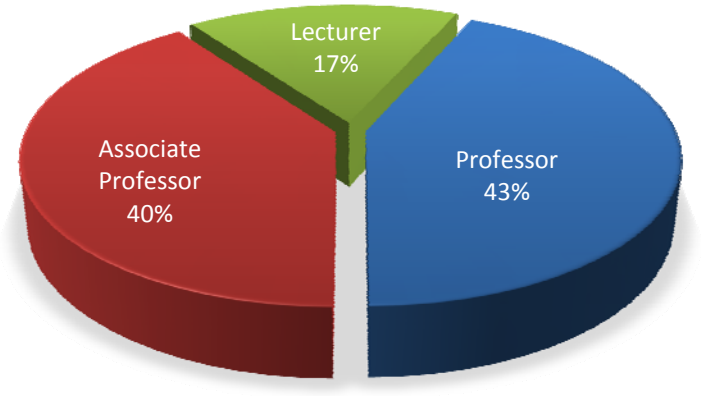

Fig. 1.8 The professional title distribution of faculties at the Department of Electrical Engineering in 2009

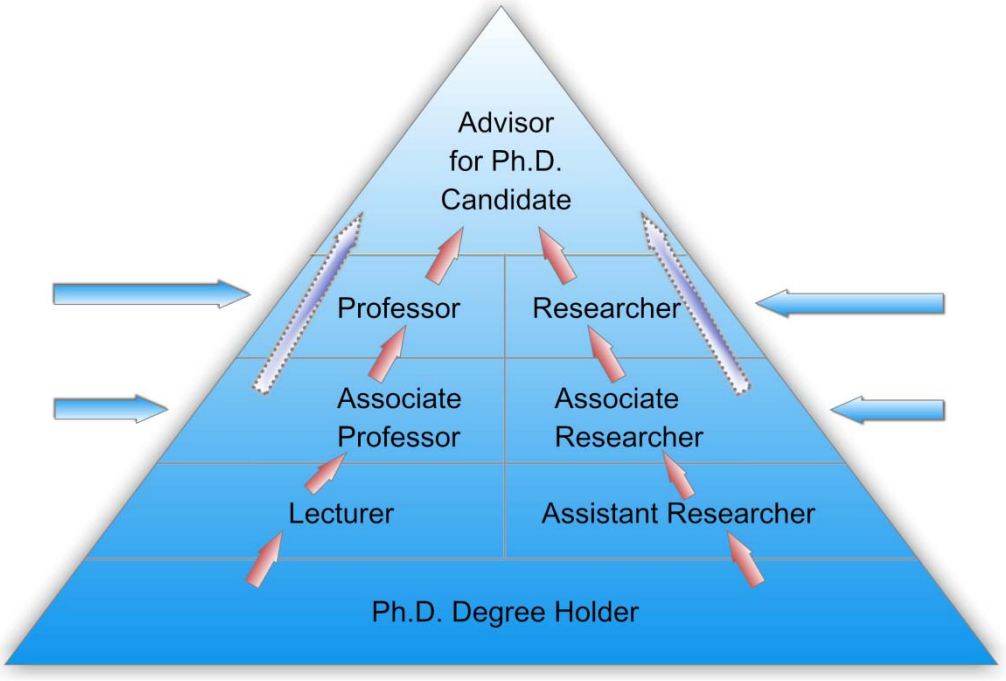

Fig. 1.9 The professional title system in China

It is necessary to point out that the promotion to higher professional title is not a qualification process but a competitive process. The necessary academic conditions can be relatively easily satisfied but applicants also need to compete on research achievements, teaching qualities, academic reputations, etc., which is a highly competitive task especially for Professors.

Fig. 1.10 illustrates the distribution of professional titles in the specific institutes.

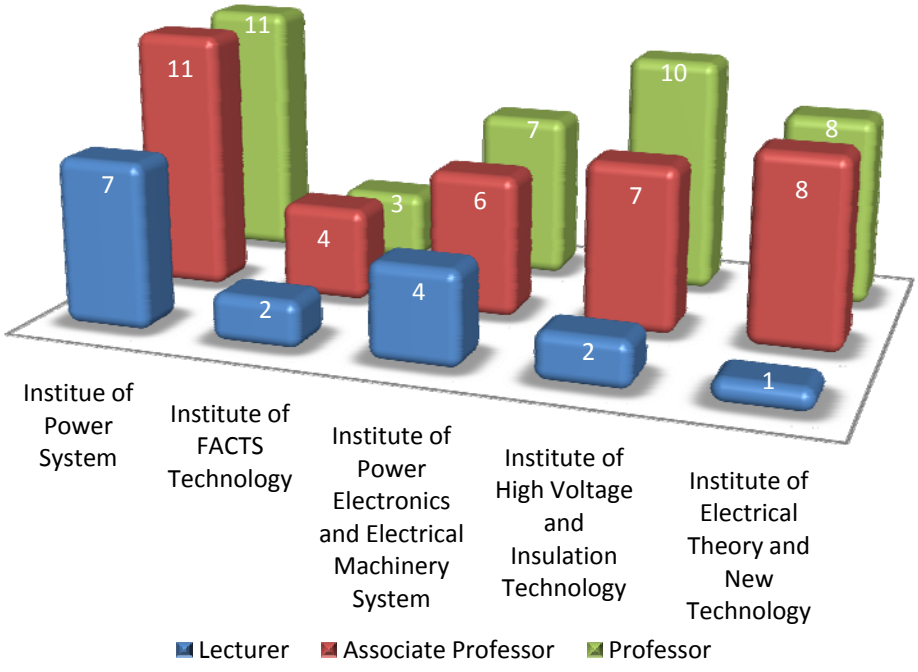

Fig. 1.10 The distribution of professional titles in the institutes

The distinguished faculties include one academician of CAS, one academician of CAE, one academician of RAE, four IEEE Fellows, and three IET Fellows. In the period of evaluation, one faculty is supported by National Thousand Talents Program, three faculties are supported by Cheung Kong Scholars Program, four faculties won the National Science Fund for Distinguished Young Scholars, and one faculty received the IEEE EMC Society Technical Achievement Award.

The curriculum vitae of faculties are presented in the Supplementary Material.

The Department of Electrical Engineering at Tsinghua University is paying greater attention to international academic exchanges. The faculties' long-term (more than six months) and short-term international academic exchanges number and foreign exchanges, including Hong Kong, Macau, and Taiwan, during the evaluation period are illustrated by Fig. 1.11. According to this data, one faculty on average goes abroad every three years and 13 foreign scholars visit the department every year. The Department thinks that these numbers need increasing to build a truly world world-leading power engineering department.

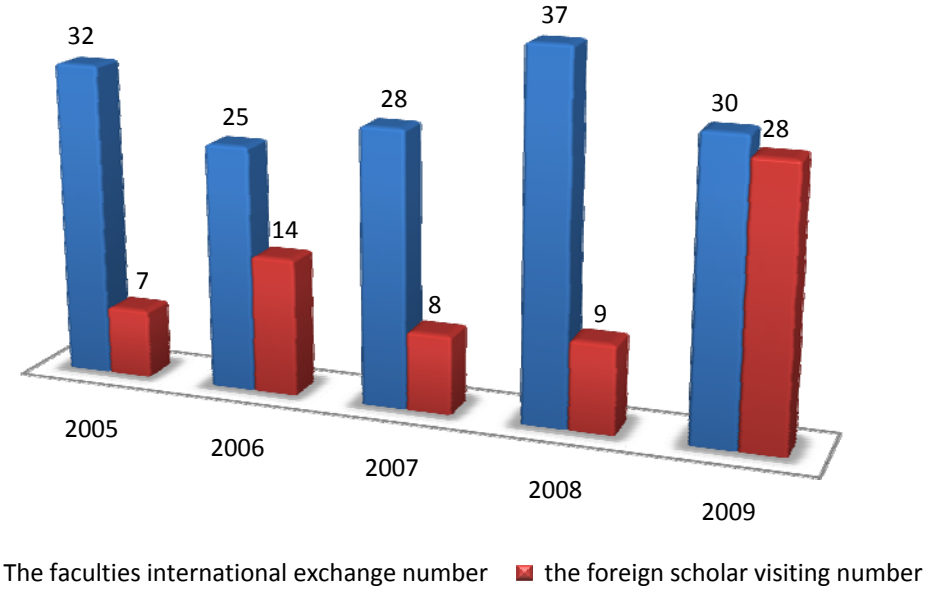

Fig. 1.11 The faculties international exchanges and the foreign scholar visiting the Department

The Department of Electrical Engineering also appointed 2 Guest Professors and 25 Adjunct Professors from foreign and domestic academic institutes to strengthen the education and research cooperation between the department and other institutions.

1-5 Facilities

1-5-1 Area

The total area of the Department of Electrical Engineering is 8800m^2. The distribution of the area is as follows:

- Area for education: 1500m^2, including the areas for classroom, educational experiments and computers.

- Area for research: 6750m^2, 1850 m^2 of which is for large instruments and the remainder is used by research groups in various institutes.
- Areas for administration: 550m^2.

1-5-2 Laboratories

There are two kinds of laboratories in the Department of Electrical Engineering, i.e. teaching related labs and research related labs, which is illustrated by Fig. 1.12. A detailed introduction to teaching related labs could be found in Subsection 2-5-4. The research related labs belong to the State Key Lab of Control and Simulation of Power System and Generation Equipments, whose introduction is presented in Subsection 3-1.

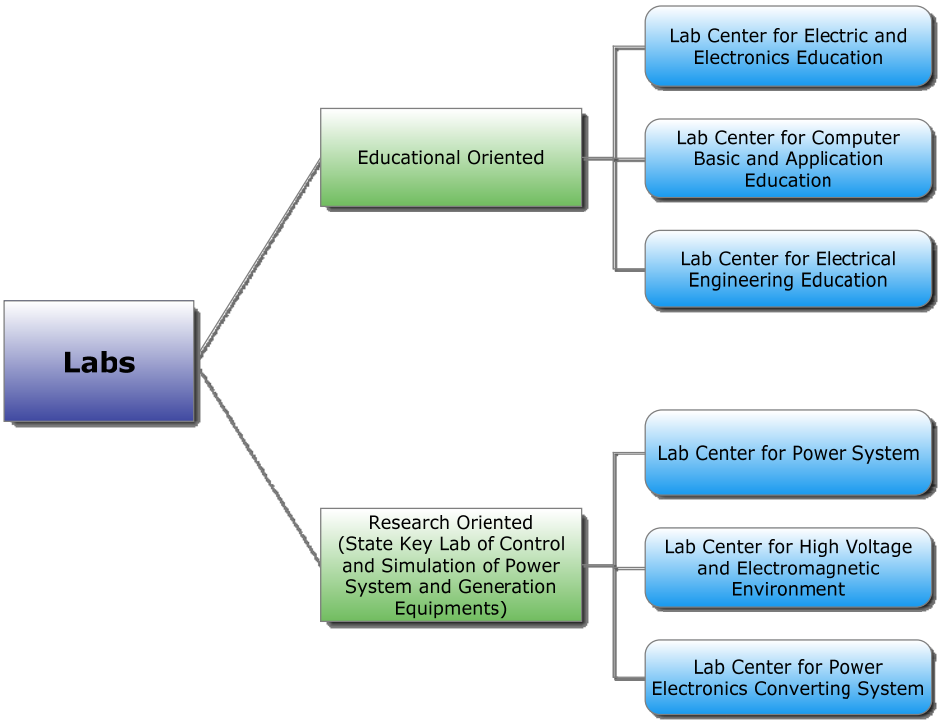

Fig. 1.12 Labs in the Department of Electrical Engineering

1-5-3 Computing and Information Resources

Students at the Department of Electrical Engineering have various ways to access computing resources.

- The Computer and Information Management Center of Tsinghua University is located in the main building. It contains an open lab which is an important part of computer experimental teaching center of Tsinghua University. The area of the lab is about 1,000m^2. With 470 high performance PCs, excellent software and learning materials, the center provides a modern learning environment for all enrolled students, especially for freshman.
- The Lab Center for Computer Basic and Application Education belongs to the Department of Electrical Engineering and is located in the west of the main building. The area of the lab is about 320m^2. It contains 128 high performance PCs, with circuit simulation and

programming development software. It provides an excellent computing resource for undergraduate students in the Department of Electrical Engineering.

- The research groups in the Department of Electrical Engineering own 1,017 PCs, laptops, workstations, and servers, with special purpose software, to satisfy various academic requirements. Senior or graduate students in Department of Electrical Engineering can use these resources with the agreement of the group leader.

Tsinghua University Library was established in 1912. In the new century, it is striving to be a modern, digitized, open, and research university library to keep pace with the university's progress to become towards a world-leading university. The total physical collections were over 3.76 million item/volumes by the end of 2009.

Now faculties and students of Tsinghua University are able to access the library's e-resources round the clock from any university PC via the gigabit Ethernet. The electronic collections include 392 databases, 2,470,000 e-books, 44,000 e-journals, and 810,000 e-dissertations. The following important full-text databases related to the discipline of Electrical Engineering are all available on campus: IEEE/IET(IEL), Cambridge Journals, Elsevier, Kluwer, Oxford Journals, SIAM, SpringerLink, Wiley InterScience.

The library also subscribes to the dissertation and thesis database--ProQuest (ABI、ARL、PSJ、PQDT) and the abstract databases of EV2 (EI、INSPEC、NTIS) and ISI Web of Knowledge (SCI/SSCI/AHCI、ISTP/ISSHP、DII、JCR、BP、CCC、CCR/IC、ESI、INSPEC).

Part 2 Education

2-1 Educational Objectives

The graduates of the Department of Electrical Engineering at Tsinghua University should maintain well-balanced qualities in “conscientious academics and honest behavior” and should be capable of taking leadership affecting broad aspects of the electrical engineering discipline, power engineering industry and society. Specifically, the following qualities should be held by our graduates:

a) mastering the underlying principles and the practical abilities of mathematics, science, and engineering for the broad discipline of electrical engineering, i.e. the knowledge objective;
b) preserving a desire for new knowledge, understanding interdiscipline aspects, interested in knowledge discovery, and hence having the potential for solving complicated real world problems throughout the graduates’ whole life, i.e. the lifelong learning and initiative objective;
c) having the moral integrity of both respecting others and self-criticism, as a result, having upright academic ethics, communication skills, and team spirit, i.e. the integrity objective; and
d) being aware of the various challenges faced by China and the world and willing to commit themselves to the corresponding social responsibility, i.e. the informed and responsible objective.

2-2 Introduction

2-2-1 The Education Infrastructure in the Department of Electrical Engineering

The education infrastructure in the Department of Electrical Engineering is illustrated by the Fig. 2.1.

The Academic Committee considers the strategy plan for the undergraduate programs, verifies the curriculum, and determines new courses and qualifications of a new teaching faculty.

The Deputy Head for Teaching is authorized by the Academic Committee, with the help of the Teaching Administration Office, to deal with specific teaching affairs.

The Teaching Supervision Group members are experienced faculties, who are responsible for the approving new courses, examining the qualifications of a new teaching faculty, and inspecting the quality of the courses by auditing the lectures.

The Vice-Directors of Institutes are required to operate in coordination with the Deputy Head for Teaching.

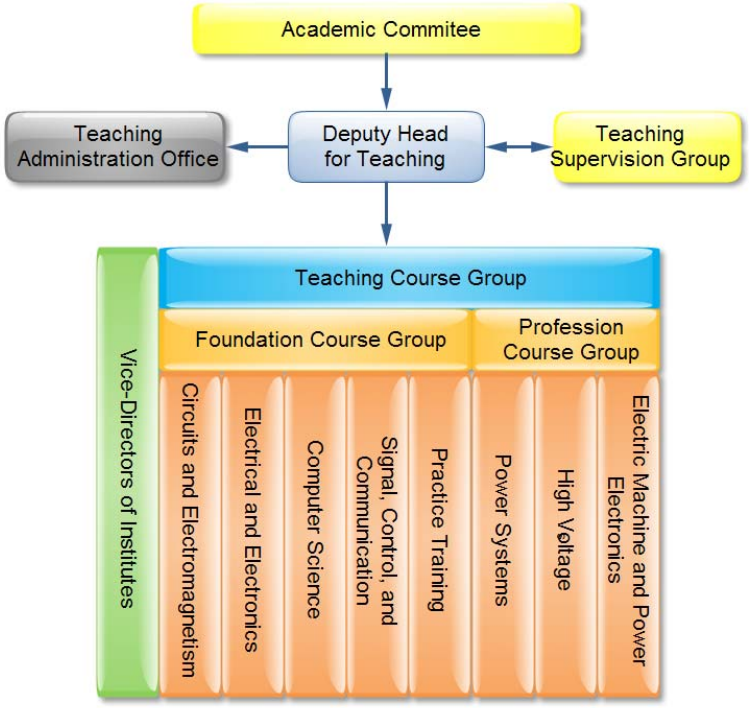

Fig. 2.1 The education infrastructure for the Electrical Engineering curriculum

Below the Department level teaching administration, all the courses are divided into two high-level groups, i.e. the foundation course group and the profession course group. They are then further divided into eight course groups.

- The Circuit and Electromagnetism group is responsible for teaching, reforming, and starting undergraduate and graduate level courses in electric circuits and electromagnetism.
- The Electrical and Electronics group is responsible for teaching, reforming, and starting electrical and electronics courses for the non-electric major undergraduate students at Tsinghua University.
- The Computer Science group is responsible for teaching, reforming, and starting undergraduate level courses related to computer science, both software and hardware, for non-computer-science major students at Tsinghua University.
- The Signal, Control, and Communication group is responsible for teaching, reforming, and starting undergraduate and graduate level courses related to signal processing, automatic control, and communication.
- The Practice Training group is responsible for implementing the undergraduate students' experiment courses and practical activities.
- The Power Systems group is responsible for teaching, reforming, and starting undergraduate and graduate level courses related to the field of power systems.
- The High Voltage group is responsible for teaching, reforming, and starting undergraduate and graduate level courses related to the field of high voltage.
- The Electric Machine and Power Electronics group is responsible for teaching, reforming, and starting undergraduate and graduate level courses related to the field of electric machine and the field power electronics.

2-2-2 The Education Budget of the Department of Electrical Engineering

The average annual educational income of the Department of Electrical Engineering at Tsinghua University is 24.9M RMB, which mainly includes salaries for faculties, administrative allocation, discipline development funding from the "985 Project" and the "211 Project" for laboratory development and facility recruitment, subsidies, scholarships, and financial aids for students. The average annual expenditure on students of the Department of Electrical Engineering at Tsinghua University is 8.3M RMB, which mainly includes subsidies for TAs, RAs, and financial supports. A pie chart of the education budget of the Department of Electrical Engineering is illustrated in Fig. 2.2.

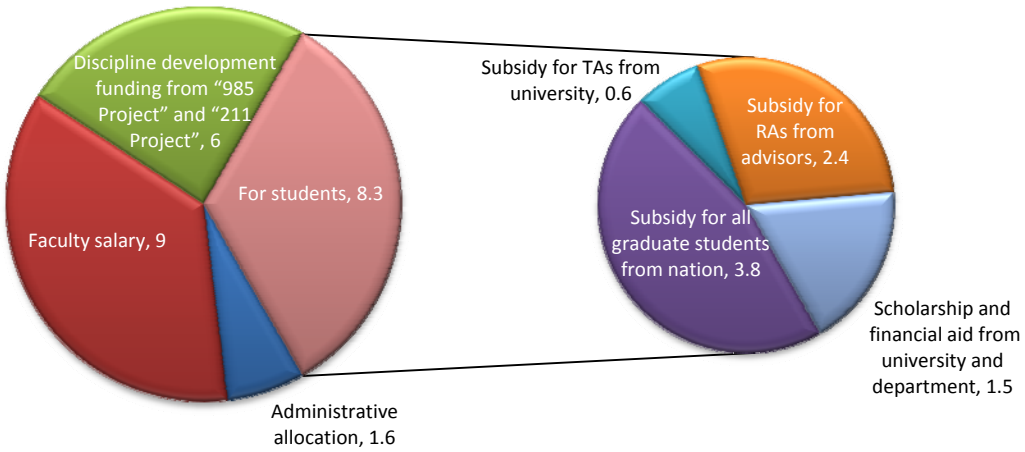

Fig. 2.2 The education budget of the Department of Electrical Engineering (numbers in the chart are M RMB)

2-3 Admissions and Graduation

2-3-1 Recruitment Policy and Status of Undergraduate Students

In China, high school students take the National College Admission Test (NCAT), and then choose the university and the major according to their scores. In recent years there have been over 10,000,000 students annually taking the NCAT. About 6,500,000 students will be enrolled by universities. Tsinghua University recruits 3,300 students each year. The minimum enrolling NCAT score for Tsinghua University is the highest score in most Provinces. All undergraduate students admitted to Tsinghua University are roughly top 0.1% of the NCAT. In recent years, more than 70 percent of the top-ten students for engineering and science disciplines from all of China's provinces, excluding Taiwan, Hong Kong, and Macau, have been enrolled at Tsinghua University. The very small admission ratio and the very high enrolling score assure the entry quality of the

undergraduates.

The undergraduate enrolling score of the Department of Electrical Engineering always ranks in the top ten, and has ranked sixth in recent years, among the 34 engineering and science disciplines at Tsinghua University, and the ratio of first choice of major [6] is 70%-80%, as shown in Table 2.1.

Table 2.1 Enrollment status of undergraduate

Year	The rank of enrolling score (34 disciplines in total)	Score (Full score is 750)	The ratio of first choice of major
2005	10	666	66.30%
2006	10	676	67.20%
2007	6	678	70.50%
2008	9	659	81.20%
2009	6	651	77.57%

2-3-2 Recruitment Policy and Status of Postgraduate Students

The postgraduate students are recruited by three routes: direct-recommendation from the department, direct-recommendation from other universities, and the National College Admission Test.

For direct-recommendation from the department, students should choose the major field and the supervisor first, and then the department will recruit the students according to their grade point average. In the last five years, the number of direct-recommended master students is between 41 and 46. With the rapid development of the power industry in China, the number of students who choose the direct-recommended Ph.D. is increasing and the average GPA order (lower GPA order means higher GPA score) of the students is declining, this is shown in Table 2.2. This means that more and more top undergraduate students choose to pursue Ph.D. degrees.

Table 2.2 Status of direct-recommended PhD from the Department

Year	Number	Average Order
2005	11	33
2006	9	35
2007	10	24
2008	14	19
2009	18	13

For direct-recommendation from other universities, the students usually come from the universities which have the key disciplines of Electrical Engineering, such as Huazhong University of Science and Technology, Xian Jiaotong University, etc. and the GPA rank is the top 1% in general. The status of direct-recommendation from other universities is shown in Table 2.3.

[6] When the students choose the major, they can have several choices. The ratio of first choice of major is the number of students who choose the Department of Electrical Engineering as their first choice divided by the enrollment number of the Department of Electrical Engineering.

Table 2.3 The status of direct-recommendation from other universities

Year	The number of direct-recommendation Ph.D.	The number of direct-recommendation Master
2005	9	5
2006	11	5
2007	16	4
2008	11	5
2009	10	5

2-3-3 Status of International Exchange of Students

- Undergraduate students

In the last five years, the Department of Electrical Engineering annually selected several undergraduate students to participant in international exchanges. Generally, the exchange lasts for one term and the cooperation universities are Purdue University, Georgia Institute of Technology, etc.

- Graduate students

In the last five years, there were 214 students who participated in the international exchange activities, which is illustrated by Figure 2.3.

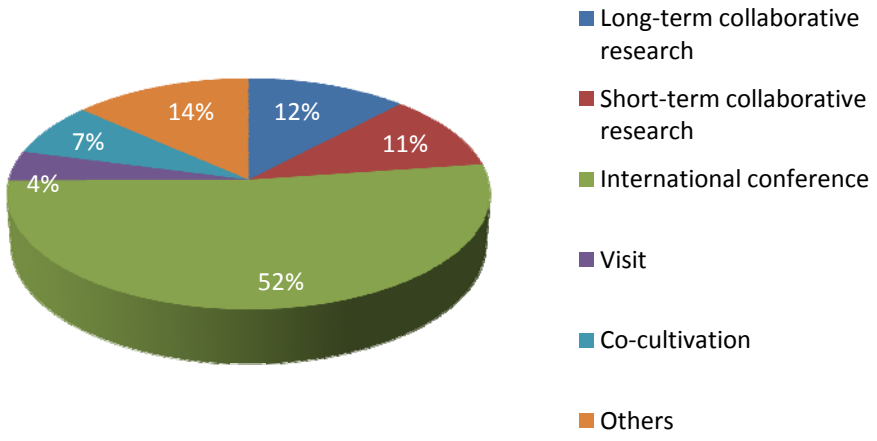

Figure 2.3 Status of international exchanges of graduate students (2005-2009)

2-3-4 Students Graduation and Student/Teacher Ratio

The Department of Electrical Engineering has a low Student/Teacher ratio, which allows staff to undertake world class research and provide effective teaching. The ratios are shown in Tables 2.4-2.6.

Table 2.4 Undergraduate student enrollment and graduation statistics

Year	2005	2006	2007	2008	2009
Number of enrollment	115	121	119	122	118
Number of graduation	115	127	108	119	114
Total student number	480	472	478	490	498
Total teacher number[7]	96	95	88	88	90
Student/teacher ratio	5.0	5.0	5.4	5.6	5.5

Table 2.5 Master student enrollment and graduation statistics

Year	2005	2006	2007	2008	2009
Number of enrollment	71	83	77	76	69
Number of graduation	78	118	82	69	68
Total student number	248	205	186	185	179
Total teacher number[8]	69	68	67	71	75
Student/teacher ratio	3.6	3.0	2.8	2.6	2.4

Table 2.6 Ph.D. student enrollment and graduation statistics

Year	2005	2006	2007	2008	2009
Number of enrollment	43	44	41	46	48
Number of graduation	24	51	41	53	36
Total student number	222	214	215	206	219
Total teacher number[9]	35	34	33	36	39
Student/teacher ratio	6.3	6.3	6.5	5.7	5.6

2-4 Curriculum

There are two teaching semesters and one practice term in the academic year at Tsinghua University. The autumn semester starts in September, lasts 18 weeks, and ends in January; the spring semester starts in March, lasts 18 weeks, and ends in July; the summer practice term starts in July or August and lasts 5 weeks. The winter and the summer vacation last about 5 weeks each respectively.

2-4-1 Undergraduate Program

The Department of Electrical Engineering grants Bachelor Degree for Electrical Engineering and Its Automation for the four-year undergraduate program. 175 credits are required to complete the program [10]. The distribution of credits is illustrated by Fig. 2.4, where practice training courses are implemented in the summer term and others are in the ordinary semesters. The average credit per semester is about 20, i.e. students take four hours of lectures per workday.

[7] Total teacher number means the number of faculties in the year.
[8] Total teacher number means the number of Associate Professors and Professors in the year.
[9] Total teacher number means the number of Advisors for Ph.D. Candidate in the year.
[10] One credit means one 45 minutes in-class lecture per week.

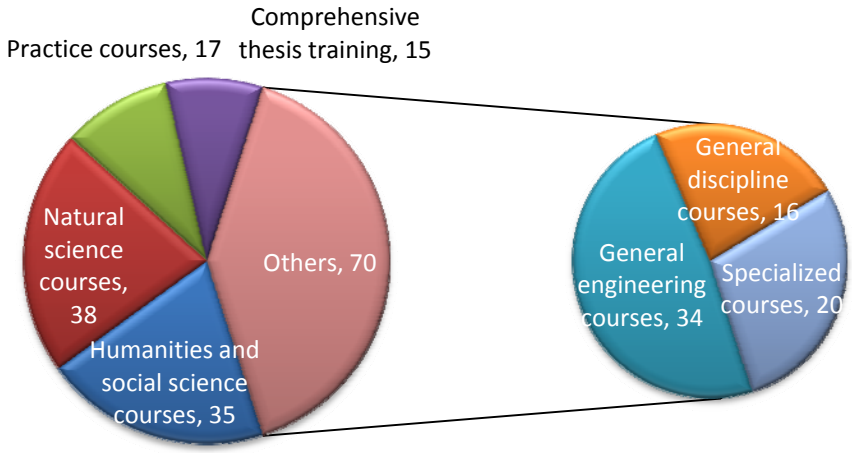

Fig. 2.4 Credits in the undergraduate curriculum of the Department of Electrical Engineering

Fig. 2.5 presents the roadmap of the required courses in the undergraduate program [11]. Five different colors are used to differentiate math courses, physics courses, general engineering courses, general discipline courses, and practice courses. General engineering courses are defined as the courses suitable for most engineering disciplines, especially electrical-related disciplines. General discipline courses are set up based on the fields under the Electrical Engineering Discipline.

Humanities and social science courses includes 27 credits in history, culture, philosophy, and arts courses, 4 credits in physical education courses, and 4 credits in foreign language courses.

Natural science courses includes math, physics, chemistry, and biology (the latter two courses are alternatives). There are 8 required math courses, illustrated by the red boxes in Fig. 2.5, covering calculus, geometry, algebra, numerical analysis, optimization, complex analysis, probability, and statistics. The total credits for math courses are 25. The 11 credits physics courses, illustrated by the pink boxes in Fig. 2.5, include mechanics, electromagnetics, thermodynamics, optics, and their related experimental courses.

The 34 credits of general engineering courses, illustrated by the green boxes in Fig. 2.5, provide the foundation for further study in the broad aspects of electrical engineering. The core courses are electric circuits, (analog and digital) electronics, signals and systems, automation, electromagnetic fields, programming, and computer architecture.

The main natural science and general engineering courses are given in the first two year of the program, which provides sufficient time for general discipline courses and specialized courses.

The Department hopes that undergraduate students could understand the most important topics for each field, master the techniques and ideas for solving problems in each field, and grasp the experiment skills for each field through the corresponding general discipline course. Four general discipline courses, i.e. Electric Machinery Fundamentals, Fundamentals of Power Electronics, Power System Analysis, and High Voltage Engineering, form the core of the undergraduate program[12].

[11] Some required courses have corresponding experiment courses. For the reason of simplicity, these courses are omitted from Fig. 2.5.

[12] The core course of the field of Electrical Theory and New Technology is Principles of Electric Circuits, which is

All the specialized courses are elective. Students can develop their academic career according to their interests and suggestions given by advisors by selecting a total of 20 credits.

The specialized courses related to power system, high voltage, electrical machinery, and power electronics are given by corresponding course groups, as illustrated by Fig.2.6, Fig. 2.7, and Fig. 2.8.

The general purpose and computer elective courses are illustrated by Fig. 2.9. "Selected Topics on the Development of Electrical Engineering" are of great importance in this part. Fifteen Associate Professors of the Department give lectures on their research interests and topics, which is very helpful for students' field selection and graduate period study.

The 17 credits practice courses can be divided into three parts: (1) general engineering practice, (2) on-campus practice on electrical engineering, and (3) off-campus practice on power engineering.

In metalworking practice and electronic process practice, students are required to learn and practice techniques on both mechanical machining and designing, implementing, fabricating, testing, and debugging practical electronic circuits.

In the summer term, students take one week of recognition practice. They visit power plants, transformer substations, and the power dispatching center in Beijing and gain practical knowledge on power engineering.

The three on-campus practice courses on electrical engineering are specifically designed to train students from three progressive levels.

- Programming Projects, based on Foundations of Computer Programming, are carried in the first year summer term. Their objective is to make undergraduates gain sufficient programming abilities by implementing relatively large software projects through team-work.
- Then in the second summer term, Electronics Course Projects, based on the Fundamentals of Analog Electronics and Fundamentals of Digital Electronics, are designed to train the students' design and implementation abilities for advanced electronic systems through the use of VHDL designs for FPGAs.
- After three years of study, the required fundamental knowledge for electrical engineering is understood by most undergraduates. Specialized Projects provides design projects on various problems related to electrical engineering. Students can use tools, experiences, and knowledge learned in previous practice courses and theory courses to fulfill a near engineering design problem in team.

The Comprehensive Thesis Training starts at the 11th week of the fall semester in the fourth year and lasts to the end of the spring semester. It could be thought of as smaller and simpler master thesis training. Faculties release topics according to their real scientific research requirements and interests and every student is required to pick one. Then the advisor is required to provide the necessary research platform to accomplish the project. Students will discuss their project fully with advisors and are required to submit a project selection report, mid-term inspection, and final thesis with an oral defense to achieve the credits. This is very helpful for their research ability training.

The syllabuses of the undergraduate courses are presented in the Supplementary Material.

a general discipline course.

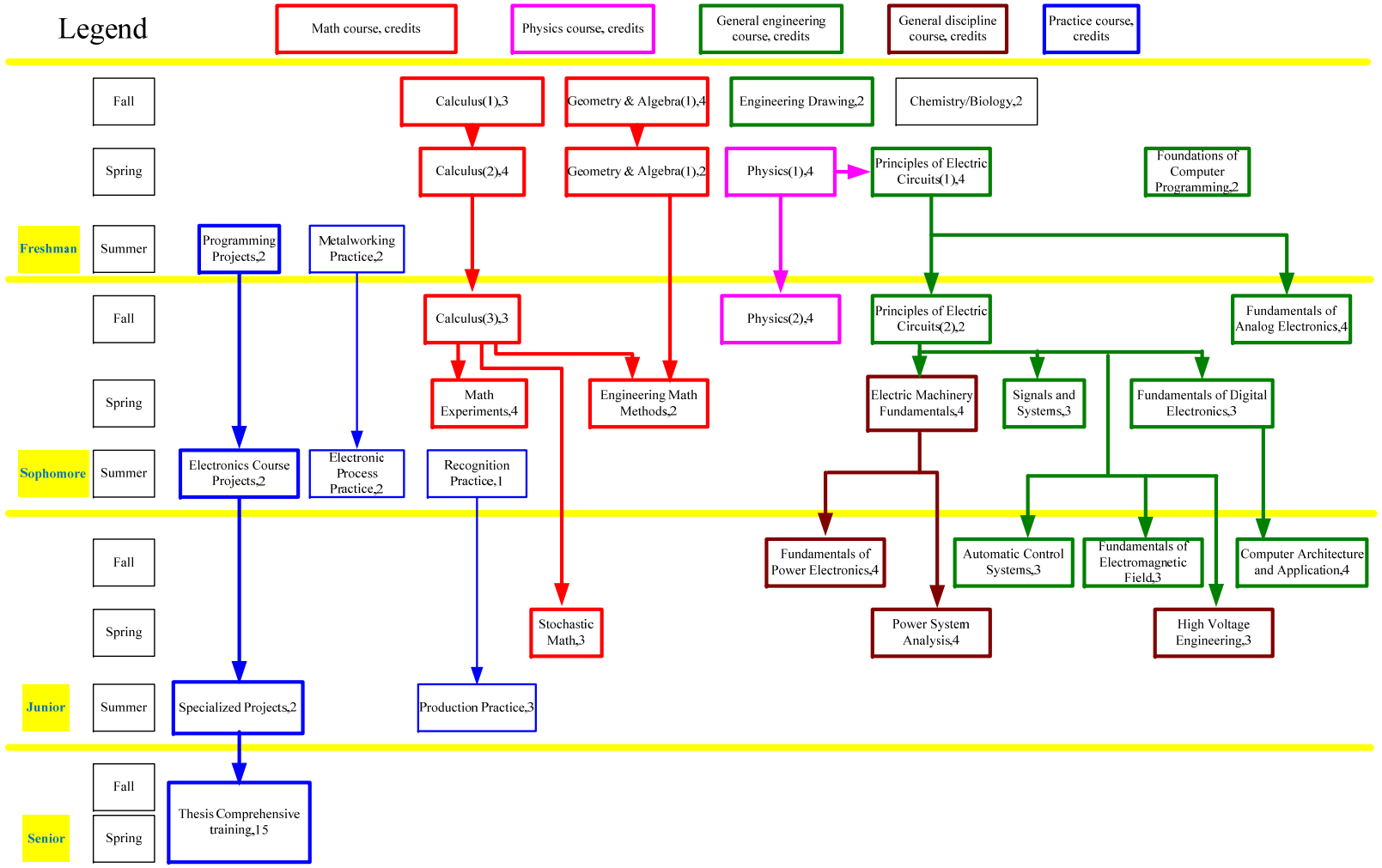

Fig. 2.5 Roadmap of the required courses in the undergraduate curriculum of the Department of Electrical Engineering

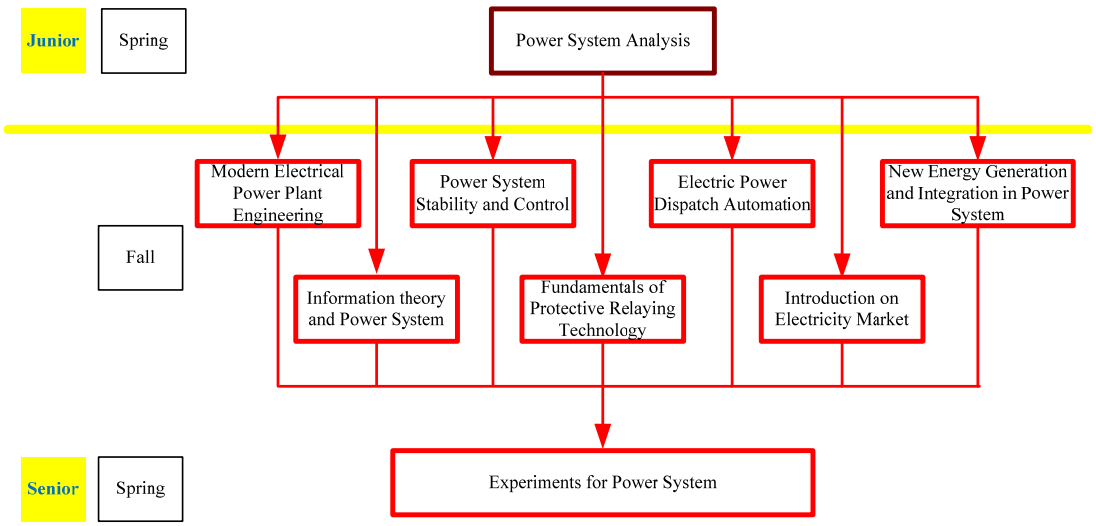

Fig. 2.6 Roadmap of the power systems elective specialized courses in the undergraduate curriculum of the Department of Electrical Engineering

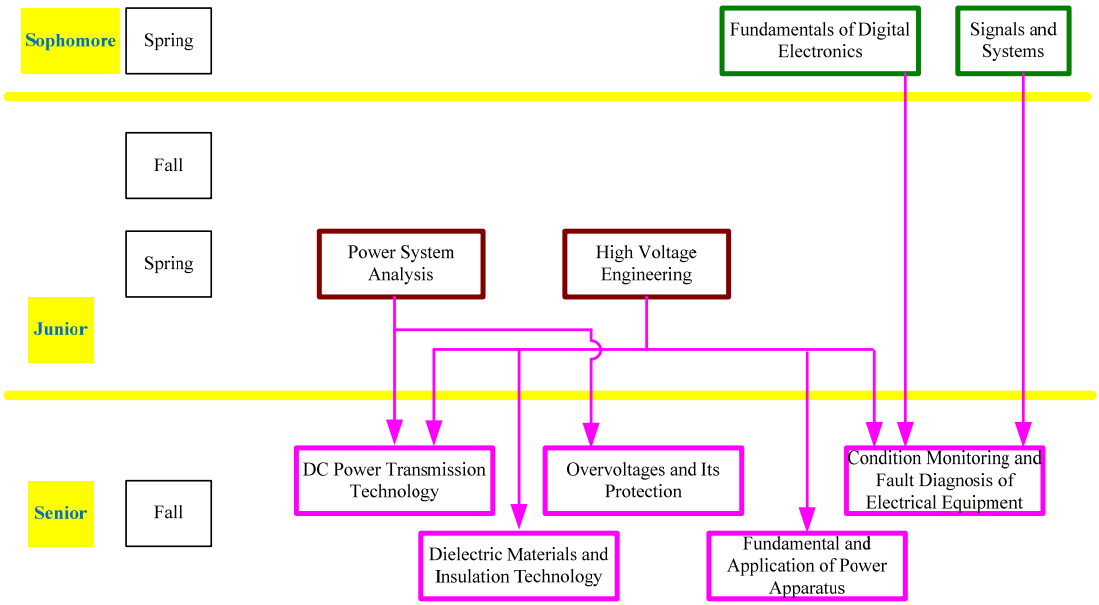

Fig. 2.7 Roadmap of the high voltage elective specialized courses in the undergraduate curriculum of the Department of Electrical Engineering

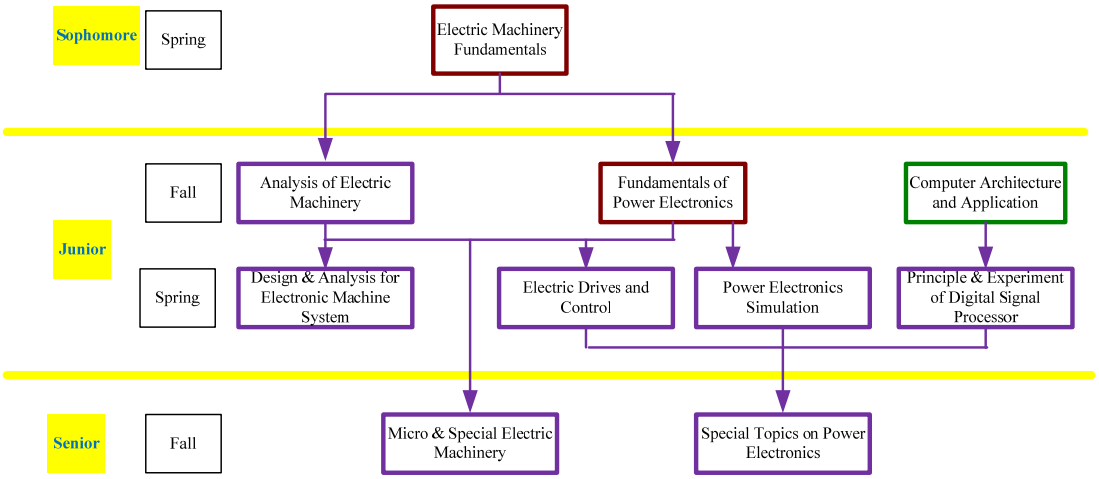

Fig. 2.8 Roadmap of the electric machinery and power electronics elective specialized courses in the undergraduate curriculum of the Department of Electrical Engineering

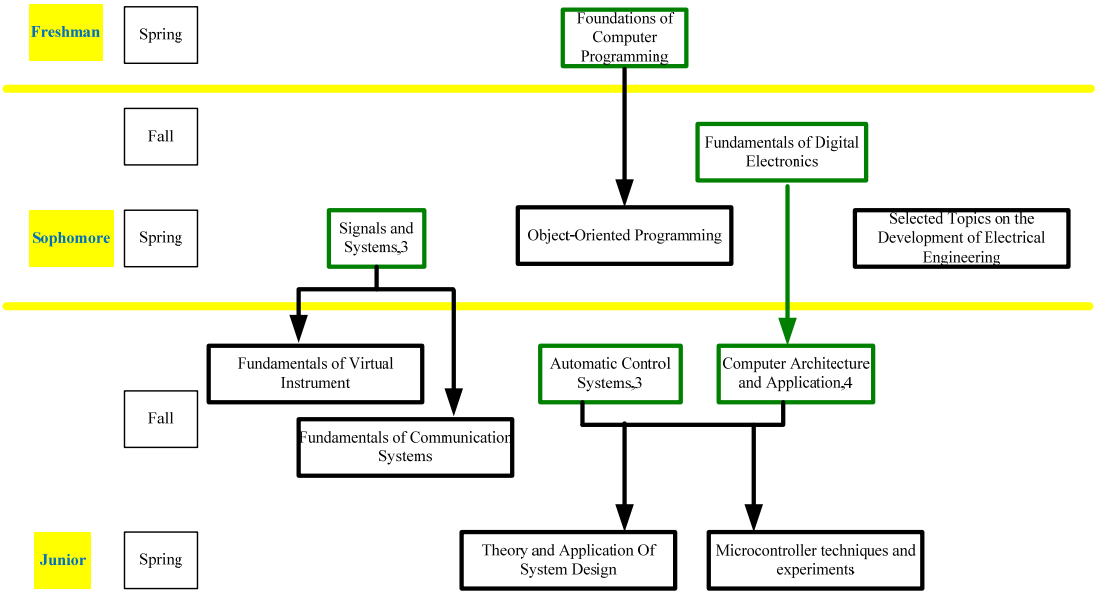

Fig. 2.9 Roadmap of the computer and other general elective specialized courses in the undergraduate curriculum of the Department of Electrical Engineering

2-4-2 Master Program

The Department awards two kinds of Masters Degree for Electrical Engineering, i.e. research-oriented and professional-oriented.

Research-oriented Masters Program

The goal of the research-oriented masters program is to make students gain the abilities necessary

for scientific research. These are useful for pursuing a Ph.D. degree or engaging in research work in research institutes.

The key steps for a research-oriented masters program at the Department of Electrical Engineering are illustrated in Fig. 2.10. It will take two to three years to accomplish all the steps. Among them, the topic selection report and the defense are of great importance. The advisor of the student takes fully responsible for course selection and other thesis related activities.

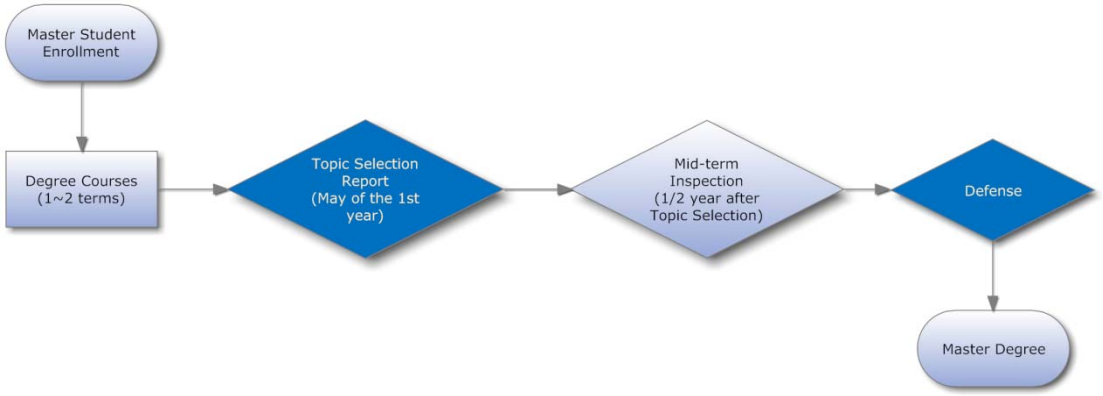

Fig. 2.10 Key steps for research-orientated masters program of the Department of Electrical Engineering

24 credits are required for the degree courses of research-oriented master students. The distribution of the credits is illustrated in Fig. 2.11. The electrical engineering specialized courses offered by the Department are displayed by Fig. 2.12, where courses are divided into four groups, i.e. general purpose, power systems, high voltage, and electric machinery and power electronics, so that advisors and students could make choices according to the research topics [13].

The syllabuses of the graduate courses are presented in the Supplementary Material.

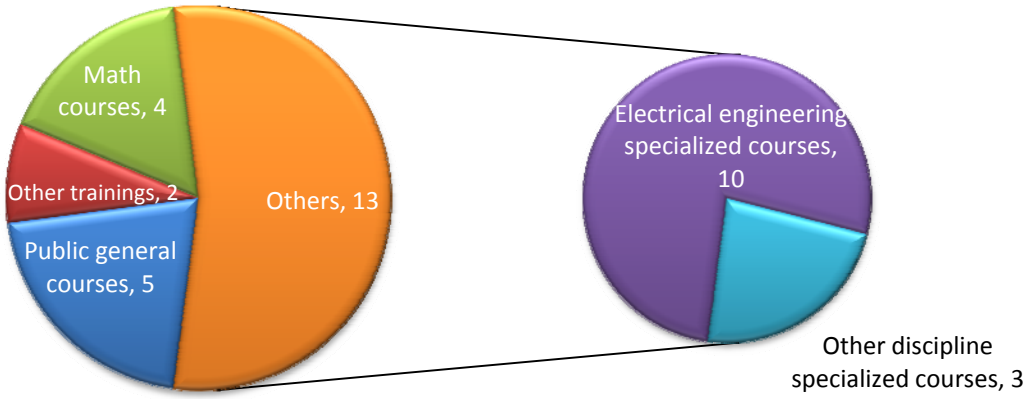

Fig. 2.11 Constitution and credits of the research-oriented master curriculum of the Department of Electrical Engineering

Before May of the 1st academic year, students should complete and present a topic selection

[13] The courses within Electrical Theory and New Technology are grouped into general purpose and the courses within Electrical Machinery and Electrical Equipment, Power Electronics and Power Drives are combined.

report to the committee composed by faculties in the related research fields. The committee will then determine whether the students have sufficient knowledge, skills, and ability to undertake the topics. Students have another opportunity in six months if they fail.

Six month later, the same committee will inspect the progress of the scheduled research plan and give appropriate comments and suggestions. Students who fail in the mid-term inspection need to retake it three months later.

Before the final defense, research-oriented master candidates should publish at least one paper related to his/her research topic in journals or at important conferences. The Committee of the Final Defense should include at least one degree member of Degree Committee. Students who failed in the mid-term inspection need to take it in six months.

In addition to the above requirements, master students should publically report, at least twice, their research progresses in related fields and attend at least 10 academic lectures.

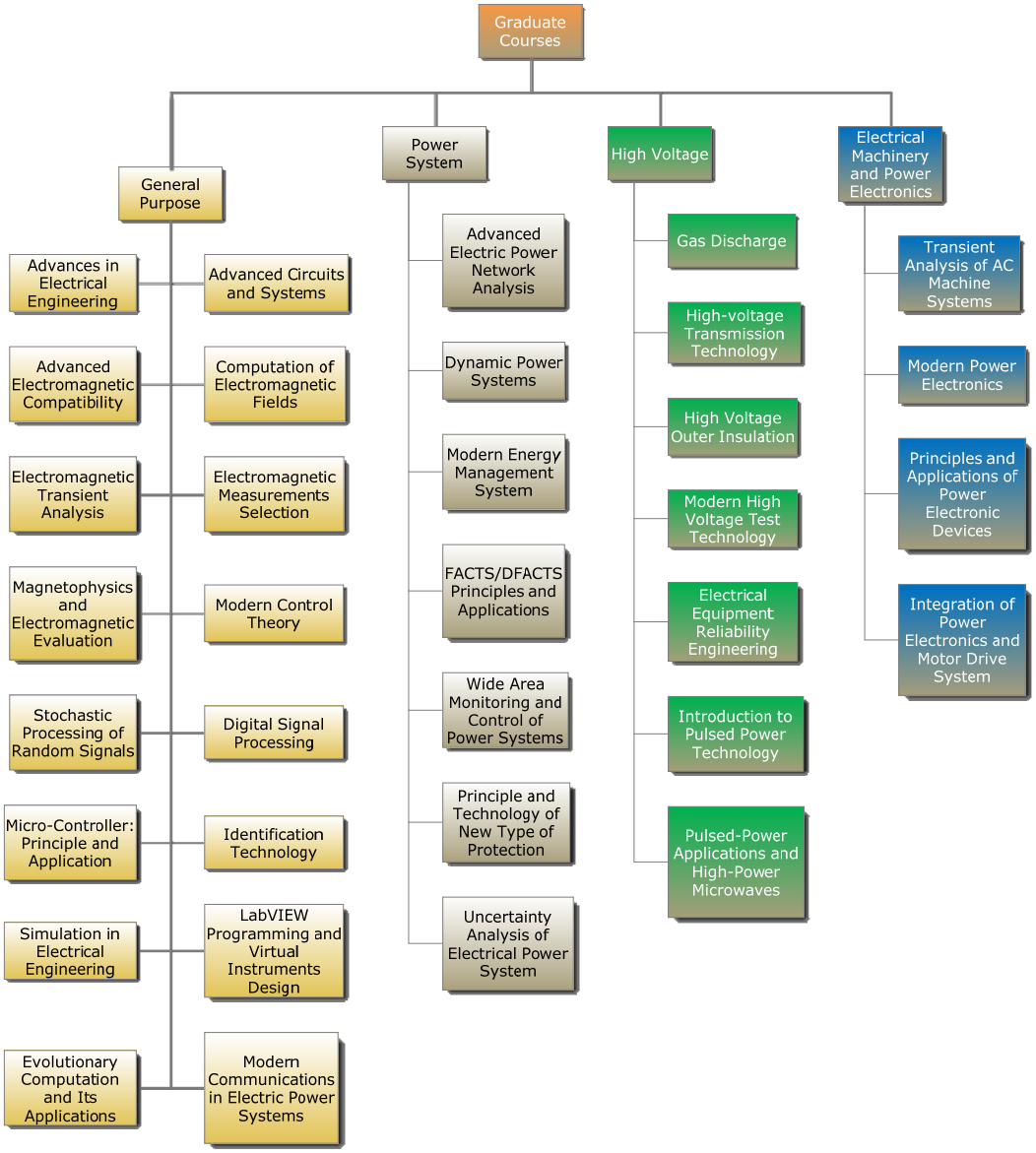

Fig. 2.12 Graduate level courses for the Masters program and the Ph.D. program

Professional-oriented Masters Program

The goal of the professional-oriented masters program is to make students gain the abilities necessary for understanding various technology or management tasks, which might be the advanced requirements in large power engineering companies or research institutes.

The key steps and the credits requirements for the professional-oriented masters program at the Department of Electrical Engineering are similar to that of the research-oriented master program. Five years is the longest allowed period for this program.

The main difference between these two programs lies in the advisory type and topic selection.

Two advisors are required for professional-oriented master students, i.e. one from the Department of Electrical Engineering and the other from high level technology or management staff of the power engineering industry. The industrial advisor pays attention to the engineering practicality of the topic whilst the departmental advisors take responsible for the academics content. Both advisors are required to participate in the topic selection report, mid-term inspection, and final defenses.

The topics for professional-oriented master degree could be selected from engineering design, development of new products, technology improvements, studying the imported advanced technology from abroad, etc.

The titles of Master dissertations during the evaluation period are presented in the Supplementary Material.

2-4-3 Ph.D. Program

The Department of Electrical Engineering has a Ph.D. program to grant Ph.D. Degree in Electrical Engineering. The typical duration is 3~5 years. Most of the Ph.D. students in the Department are enrolled from graduates with a Bachelors Degree, who are recommended students for direct admission (requiring only a satisfactory interview). Some research-oriented master students can join the Ph.D. program according to their scores in the entrance tests.

The goal of the Ph.D. program is to make students gain the necessary abilities for independent scientific research, which will be useful for undertaking research in universities and research institutes.

The key steps for the Ph.D. program at the Department of Electrical Engineering are illustrated in Fig. 2.13. Among them, the topic selection report, the final academic report, and the defense are of great importance. The advisor of the student takes fully responsible for course selection and other thesis related activities [14].

[14] An advisory group or one advisor plus one vice-advisor are other options for advising Ph.D. students, especially for multidisciplinary topics.

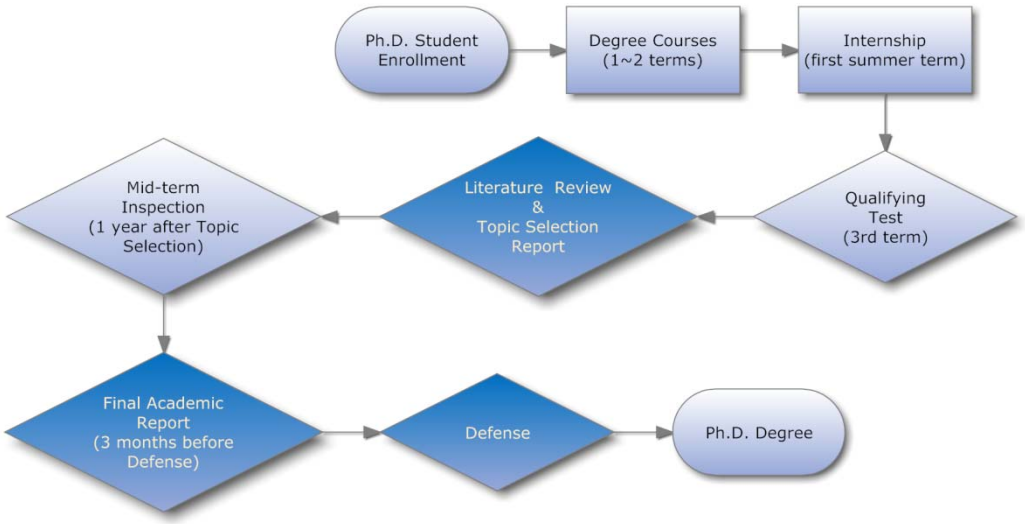

Fig. 2.13 Key steps for Ph.D. program of the Department of Electrical Engineering

28 credits are required for the degree courses of Ph.D. students with only Bachelors Degree and 13 credits for those with Masters Degrees. The distribution of the credits for a student entering with a Bachelors Degree is illustrated in Fig. 2.14 [15].

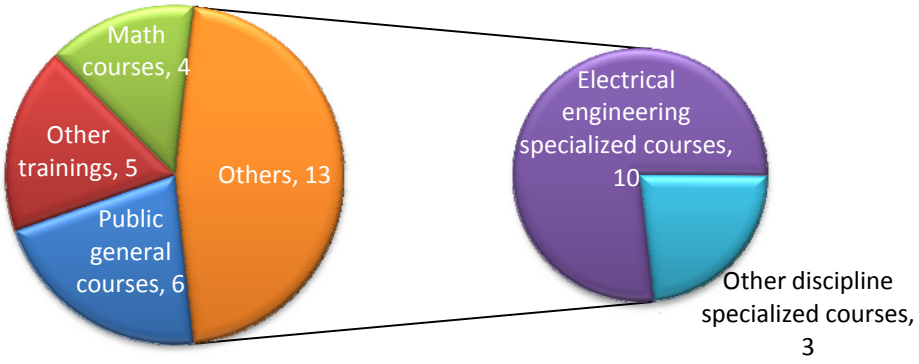

Fig. 2.14 Constitution and credits of the Ph.D. curriculum of the Department of Electrical Engineering

The qualifying test is carried out in the second academic year. The knowledge on three to four core undergraduate or graduate level courses related to the students' research topics will be examined. The test includes 2 hours of written examination and a 20 minutes oral viva. Students can repeat the test during the second year if they fail at the first attempt.

The literature review and topic selection report is one of the key steps for the Ph.D. program. Students should read and review at least twenty papers suggested by their advisor, and then present a topic selection report to the committee composed of the Ph.D. advisors in the related

[15] The courses are the same as master programs.

research fields. The committee will then determine whether the students have the ability, knowledge and understanding for the topic and whether the topic contains sufficient academic problems to fulfill the requirements of a Ph.D. Degree. If students fail the evaluation they are re-assessed six months later.

One year later, the same committee will inspect the progress of the scheduled research plan and give appropriate comments and suggestions. Students who failed in the mid-term inspection need to retake it three months later.

The final academic report is given three months before the final defense. Students need to summarize and report the innovations of his/her research work. The same committee will determine whether these innovations are sufficient for applying for a final defense and give comments for drawing conclusions and possible further research in the following months. Students who fail in the final academic report need to retake it six months later.

Before the final defense, Ph.D. candidates have to publish at least three papers related to his/her research topic in journals or at important conferences or publish at least one high quality paper in selected journals such as IEEE Transactions. The committee of the final defense should include at least one member of the Degree Committee. Students who failed in the final defense need to retake it six months later.

In addition to the above requirements, Ph.D. students should report their research progresses publically in related fields every semester and attend at least 30 academic lectures.

The titles and abstracts of the Ph.D. dissertations in the evaluation period are listed in the Supplementary Material.

2-5 Quality Assurance

The quality assurance mechanisms for education at the Department of Electrical Engineering are illustrated by Fig. 2.13 and are presented in detail in the following sub-sections.

Fig. 2.15 The quality assurance mechanisms for education in the Department of Electrical Engineering

2-5-1 Students Motivation

(1) High-Quality Ph.D. Development through Integration of Education and Scientific Research

The Department of Electrical Engineering carried through its idea of cultivating high-quality Ph.D. students by integrating education and scientific research during its long period of development. In one respect, Ph.D. students should do research which fits in with the cutting edge of world scientific development. On the other hand, their scientific research should meet the strategic demands of the nation, which is the first social responsibility of the university. Therefore the Department should integrate the Ph.D. student cultivation with the national economy development trends.

In the above mentioned objectives, the first one is about undertaking world-class scientific research, named as "*holding up the heavens*". The second one is about solving the complicated and challenging engineering problems though close contact with engineering practice, named as "*standing on the earth*". The integration of "holding up the heavens" and "standing on the earth" is the requirement of both China's fast development of power engineering and developing a world-class power engineering discipline in the Department. The effective high-quality Ph.D. development experiences generated by the Department Electrical Engineering are listed as follows.

- The research topic selection of Ph.D. students should be associated with key research topics in the development of the power engineering industry. This requirement is difficult for both advisors and students. Advisors should be in close contact with the practical engineering projects in China's power engineering industry and be able to summarize the challenging academic problems accordingly. Students should satisfy both the academic requirements and the engineering requirements.
- By integrating the Ph.D. student development with the national economy development main trends, quite a few high-quality Ph.D. graduates, who have the overall potential of solving both academic and practical problems, were produced. Generally speaking, the power system companies and the electrical equipment companies have high quality outputs but have less scientific research capability in China. So Ph.D. graduates with these capabilities are warmly welcomed by the power engineering industry.
- Solving practical engineering problems and providing high-quality Ph.D. graduates for the power engineering industry has built up long-term and close relationships between the Department of Electrical Engineering and the leading companies in China's power engineering industry, which in turn guarantees the cutting edge of the scientific research, sufficient research funding, and employment of Ph.D. graduates from the Department of Electrical Engineering.

Here we use four winners of Outstanding Doctoral Dissertations of the Nation from the Department of Electrical Engineering as examples to illustrate the "holding up the heavens" and "standing on the earth" objectives of the Ph.D. student development scheme.

Dr. Zhiguang Cheng's research topic focused on three dimensional eddy current analysis in large power transformers, which is of major importance when designing new types of transformer and reducing the working loss. Due to the nonlinear characteristics of the core material in power transformers, the eddy current analysis needs to consider complicated electromagnetic phenomena, e.g. nonlinear, anisotropic, and hysteresis. New models and new numerical methods for analysis have been studied in depth by Dr. Cheng. The model became the 21st benchmark problem of International Compumag Society (http://www.compumag.org/jsite/features.html). His dissertation, "Electromagnetic field analysis and validation in power transformers", won the first Outstanding Doctoral Dissertations of the Nation in 1999. Dr. Cheng joined Baoding Transformer Plant, one of the largest transformer producers in China, and progressed to become the vice-chief-engineer.

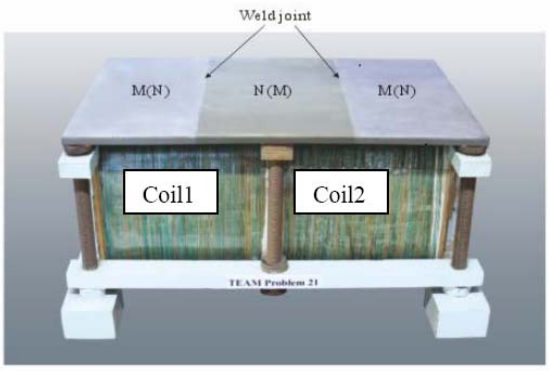

Fig. 2.16 The 21st benchmark suggested by Dr. Cheng

Dr. Yuming Tu's research topic focused on the static electrification phenomena owing to oil flow in extra-high voltage power transformers, which is considered the main reason for some explosions in China in the 1990s. The research on the static electrification phenomena considered the effects of oil velocity, oil flow state, oil temperature, AC field distribution, oil path arrangement and the electrical leakage characteristics of the composite oil/paper dielectric etc., which makes the topic rather complex. Dr Tu took the combination effects of flow-induced charging and AC energization-induced charging mechanisms into consideration for the first time. The experimental results and mathematical model obtained are of great significance for designing the insulation structure and oil path system as well as for the safe operation of the forced oil cooled EHV transformers. His dissertation, "Study on the mathematical model and the experiment for static electrification owing to oil flow in EHV power transformers", won the second Outstanding Doctoral Dissertations of the Nation in 2000. Dr. Tu is currently working as a senior R&D engineer with a power protection relay manufacturing company, PBSI, in UK.

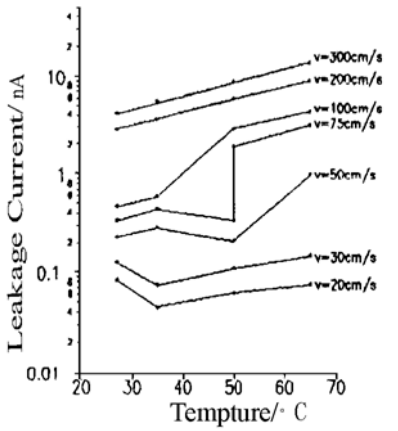

Fig. 2.17 Typical achievement by Dr. Tu

Dr. Xiaobing Zou's research topic focused on Z-pinch plasma implosion, which is considered one of the possible methods for realizing controlled thermonuclear fusion and pulsed intense soft x-ray source or neutron source. Considerable academic and application activities have been carried out in this field. Dr. Zou developed a three-frame Mach–Zehnder interferometer (TFMZI)

for taking three images (5 ns exposure and 13 ns interpicture delay) of Z-pinch plasma implosion within one shot. In addition to visualizing the evolution of the imploding plasma shell, key plasma parameters, such as the electron density $n_e(r,z,t)$ and the velocities of the plasma implosion were obtained. The plasma instabilities appearing as bubbles or fringe shearing were clearly observed, which is critical to understand the implosion dynamics and stagnation physics of z-pinch plasma. His dissertation, "Experimental studies on gas-puff Z-pinch plasma", won the Outstanding Doctoral Dissertations of the Nation in 2006. Dr. Zou is currently Associate Professor at the Department of Electrical Engineering at Tsinghua University.

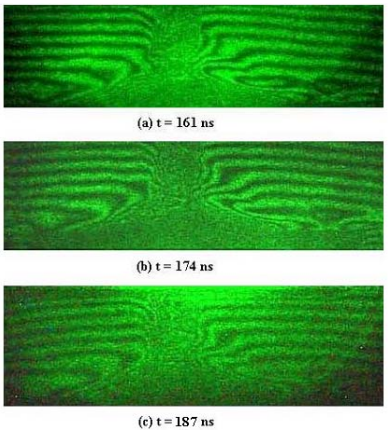

Fig. 2.18 Typical interferograms taken by Dr. Zou's interferometer

Dr. Feng Liu's research topic focused on real control system design in power systems, e.g. hydro-turbine governors and superconductive magnetic storage systems. The characteristics of power systems, i.e. high-dimensional, nonlinear and large-scale systems with strongly coupled dynamic and static behaviors, could be described by a group of differential algebraic equations (DAE). Because there is a lack of mathematical tools to directly handle the control problems of DAE, it is difficult to process the controller designs of power systems on the basis of DAE models. Dr Liu developed a new theory to establish certain equivalence between the ordinary differential equation (ODE) systems and the DAE control systems through state-space realization. Under this framework, several conventional control theories originating from ODEs can be generalized to DAEs, and several new systematic practical control approaches, including the State-Dynamic-Measurement (SDM) feedback approach, were developed on the basis of power systems modeled by DAE. His dissertation, "Nonlinear control of power systems on the basis of differential-algebraic-equation models", won the Outstanding Doctoral Dissertations of the Nation in 2007. Dr. Liu is currently a post-doc at the Department of Electrical Engineering of Tsinghua University.

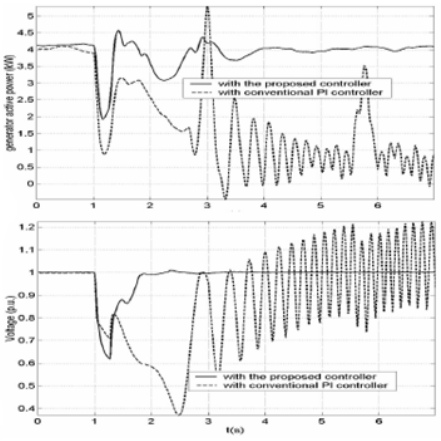

Fig. 2.19 Experiment results of Dr. Liu's control method

(2) Outstanding Innovative Talents Cultivating Plan for Undergraduate Students

To further promote the development of innovative ideas in curricular leaning and extracurricular activities, the Department has implemented the "Outstanding Innovative Talents Cultivating Plan for Undergraduate Students" since 2008. This plan relies on the integration of learning and research and is implemented in the form of scientific projects, using the platforms of various labs in the department,.

Every year, ten undergraduate students are selected according to their academic achievement, project plans, and performances in the on-site defense. The corresponding advisors are invited, by

the department, to supervise these students to implement the project. Some selected project titles are listed as follows:

- ✧ Performance Evaluation and Management System for Thermal power plant
- ✧ Power Management Systems for Energy Saving
- ✧ Hazard Prevention and Response for Ice-and-snow Disaster in South China
- ✧ New Invisible Locker
- ✧ Robots for Power Line Patrolling

The Department also promotes the "Outstanding Innovative Talents Cultivating Plan for Undergraduate Students". Winners of the extracurricular activities contests might be rewarded by adding scores to their GPAs or be recommended for direct admission of the graduate program according to their achievements.

With the help of these mechanisms and the diligence of the students, **one project won the first level prize for National "Challenge Cup"** and one project won the first level prize for the Schneider National Energy-Saving Contests in 2009. Thus 15 students were rewarded with various scores in GPAs and **two of them were enrolled directly into the graduate program**, which further stimulated the devotion of students on curricular leaning and extracurricular scientific activities.

Fig. 2.20 Students participating in the Outstanding Innovative Talents Cultivating Plan and their advisors

(3) Collecting Feedbacks from Students

Every spring/fall semester, students at Tsinghua University are asked to evaluate the courses they take before the final exam. The evaluation is on both the devotion and pedagogical technique of the instructors and the organization of the course. The data from the feedback informs instructors on how they can improve their course for the next session [16]. The university and the department give prizes to the outstanding instructors based on the student feedback.

Additionally, the Department of Electrical Engineering frequently compiles feedback from enrolled students and graduated students. The latest investigation was undertaken in 2005. More than 400 undergraduate students on campus filled in the questionnaire and about 70 graduated student sent feedback via email. Many suggestions were summarized and used as the basis for educational reform. Some of the interesting statistics are illustrated in the following graphs.

Fig. 2.21 shows the results of the "Ideal Goal of Life" for undergraduate students. The results are distributed among three categories, scientists, engineers or entrepreneurs. The majority

[16] The questionnaires of the feedback from students are listed in Appendix A.

indicated they wished to become Engineers or, Entrepreneurs, which coincides with the engineering background of the Department and its educational objectives.

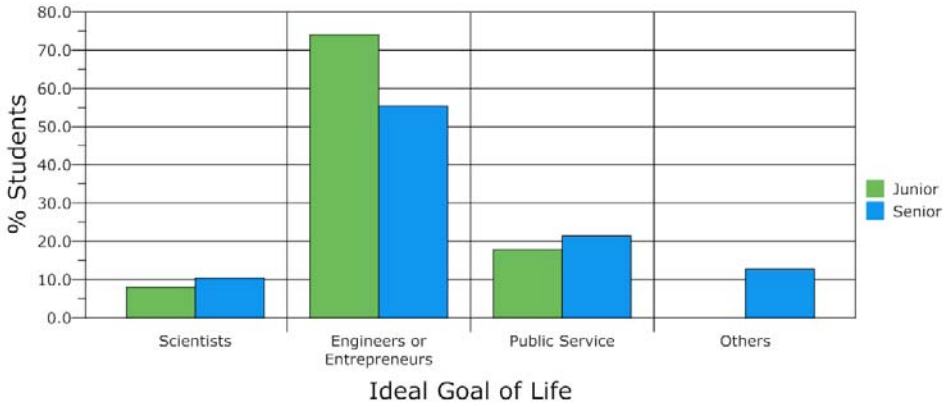

Fig. 2.21 The "Ideal Goal of Life" of undergraduate students at the Department of Electrical Engineering

Fig. 2.22 illustrates the feedback given by graduated students on the courses offered by the undergraduate curriculum. The red bars are the relative importance of the five categories of courses given by the respondents according to their further study and work experience. Electrical engineering courses, computer science courses, and economics and management courses are of great importance. The green bars are the relative advantages of the course offered by our curriculum. Most of the graduated students highly appreciated the electrical engineering courses and computer science courses. The blue bars are the relative shortcomings of the courses offered by the curriculum, i.e. humanities and social science courses and economics and management courses need to be reinforced.

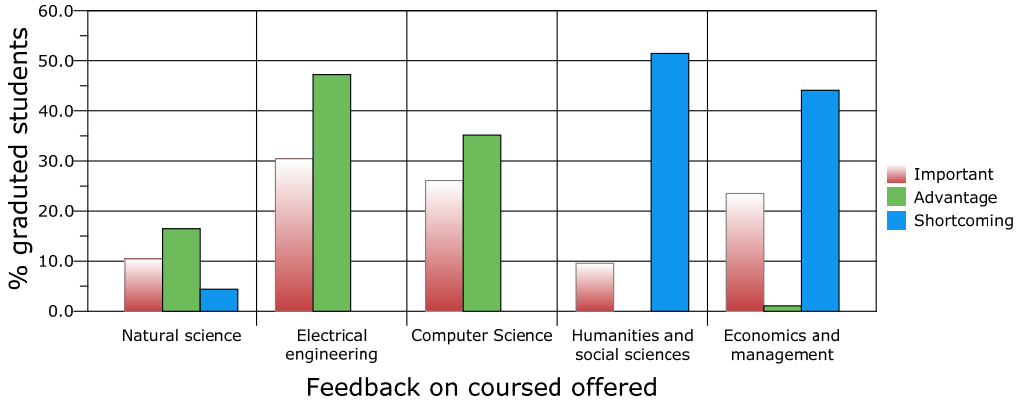

Fig. 2.22 Feedback on courses offered by graduated students at the Department of Electrical Engineering

(4) Other Methods for Student Stimulation

- Student Research Training (SRT). SRT is a scientific training program for promoting the academic quality of undergraduate students by engaging in research activities on projects given by faculties or students themselves. Dozens of students of the Department of Electrical Engineering take part in various kinds of SRT projects each year. Nearly every student accomplished at least one SRT project before graduation. Nearly 50 students in the Department of Electrical Engineering participate in SRT projects every academic year.

- Freshman Seminars. Freshman seminars are discussion-based courses given by celebrated professors to freshmen. Professors design research-oriented topics and students need to read papers, discuss, complete experiments on these topics in groups guided by professors. Two seminars, i.e. “High Voltages around Us” and “Understanding Stability”, are given by Professor Xidong Liang and Professor Yong Min respectively.
- Experiment Probing Project. This project is organized by the university. Dozens of educational and research labs are presented to junior undergraduate students by on-site demonstration, popular explanation, and related academic lectures in order to promote the students’ understandings for scientific process and share the experiences of faculties. Three labs of the Department of Electrical Engineering take part in this project.
- Students Associations and Quality Outreach Program. Tsinghua University has about 100 students association on physical training, humanities and social sciences, art, science and technology, and public welfare etc. Students find new interests and develop team-work spirit through the extracurricular activities. The Quality Outreach Program promotes the quality of the associations by setting up various projects.
- Science and Technology Innovative Fund for Ph.D. Students. This fund is to encourage Ph.D. students to create original, innovative research ideas, which should be clearly different from the research projects of their advisors.
- International Conference Attending Fund for Ph.D. The graduate school will cover travel expenses and partial registration fees for oral presentation by Ph.D. students as the first author in important international conferences. In the evaluation period, 55 Ph.D. students of the Department of Electrical Engineering were supported by this fund. Based on this, the State Key Laboratory of Control and Simulation of Power System and Generation Equipments established in 2009 a special fund for Ph.D. students to attend international conference. 17 Ph.D. students have benefited from this special fund.

2-5-2 Pedagogy Training

Instructors are the executors of the specific educational activities. Their quality, inspiration, and dedication to teaching will directly affect the quality of the course and influence the quality of the graduates. So the Department of Electrical Engineering constantly pays close attention to instructor development. The following mechanisms have been established in the department to promote excellence.

(1) Courses Offered by Senior Faculties

Throughout the history of the Department of Electrical Engineering, there has always been an active teaching tradition of offering high quality courses. Faculties respect their right and responsibility to teach and senior faculties give good examples.

- **90 faculties offer 157 courses, averaging 1.7 course per faculty.**
- **39 professors offer 72 courses, averaging 1.8 course per professor.**
- **8 winners of New Century Outstanding Scholars Fund Award offer 22 courses, averaging 2.7 courses per person.**
- **4 winners of National Natural Science Funds for Distinguished Young Scholar offer 10 courses, averaging 2.5 courses per person.**

In the Department of Electrical Engineering, there is an environment that high quality teaching is the first academic responsibility for faculties, which is the key cornerstone of developing and educating high quality graduates.

(2) Promoting High Quality Teaching

High quality teaching is one of the requirements for high quality education. The Department of Electrical Engineering promulgates several effective rules to enhance teaching quality. Some of them are listed as follows:

- Mutually auditing the class. Every faculty is asked by the department to audit at least two lectures each semester and give timely feedback to the corresponding instructor. Younger instructors benefit from both auditing other experienced instructors' classes and being well-prepared for every lecture as the auditing will happen without advanced warning.
- Effective rewarding methods. Basic Teaching Skill Contest, Award for Teaching Excellence, and Awards for Teaching Achievement are main reward mechanisms organized by department, university, Beijing Commission of Education, and China's Ministry of Education.
- Opportunities for national and international teaching exchange. Every year, teachers from other universities are invited to attend the classroom, give feedback, and vice versa. It encourages instructors of the same course, from different universities, to exchange their feelings and pedagogical techniques. The department also frequently sends young teachers abroad for teaching exchanges. Universities include MIT, University of Manchester, University of California at San Diego, etc.

2-5-3 Management Mechanism

As shown in Fig. 2.1, the significant characteristic of the teaching infrastructure at the Department of Electrical Engineering is **the course groups assisted by the teaching supervision group**, which forms the main management mechanism for all courses.

The leaders of the course groups are experienced teachers, who are listed in Table 2.7. Some of them are in charge of the National Top-quality Courses and some are Renowned Teachers of the Nation. They are responsible for the reform of the courses in the corresponding group, including gathering information from lectures, arranging seminars, and auditing the class, etc.

Table 2.7 The leaders of the course group in the Department of Electrical Engineering

Teaching Group	Leader
Circuit and electromagnetism	Professor Wenjuan Lu (In charge of the National Top-quality Course "Principles of Electric Circuits")
Electrical and electronics	Professor Qingyu Tang (In charge of the National Top-quality Course "Principles of Electrical Engineering")
Computer science	Ms. Xiaomei Zhu (Winner of the Award for Teaching Excellence by Young Teachers offered by Tsinghua University)

Signal, control, and communication	Professor Weidong Liu
Practice training	Mr. Yulong Huang
Power System	Professor Hongbin Sun (In charge of the National Top-quality Courses "Analysis of Power System", Winner of the Renowned Teachers of the Nation)
High Voltage	Professor Yuanxiang Zhou (Winner of the New Century Outstanding Scholars Fund Award offered by China's Ministry of Education)
Electric machine and power electronics	Dr. Xudong Sun (Winner of the Award for Teaching Excellence by Young Teachers offered by Tsinghua University)

The teaching supervision group is constituted of professors from various fields, i.e. Professor Shuangxi Zhou (emeritus) and Professor Qirong Jiang from Power Systems, Professor Guozheng Xu from High Voltage, Professor Lipei Huang from Power Electronics and Electric Machine, and Professor Wenjuan Lu and Professor Qingyu Tang from Advanced Electrotechnology for the period from 2009 to 2012, so that they can give advice on new courses and new instructors applications.

With the help of the teaching supervision group and course group, the Department of Electrical Engineering maintains an interactive and active improves process for courses, which contributes to the high quality teaching. This is illustrated by Fig. 2.23.

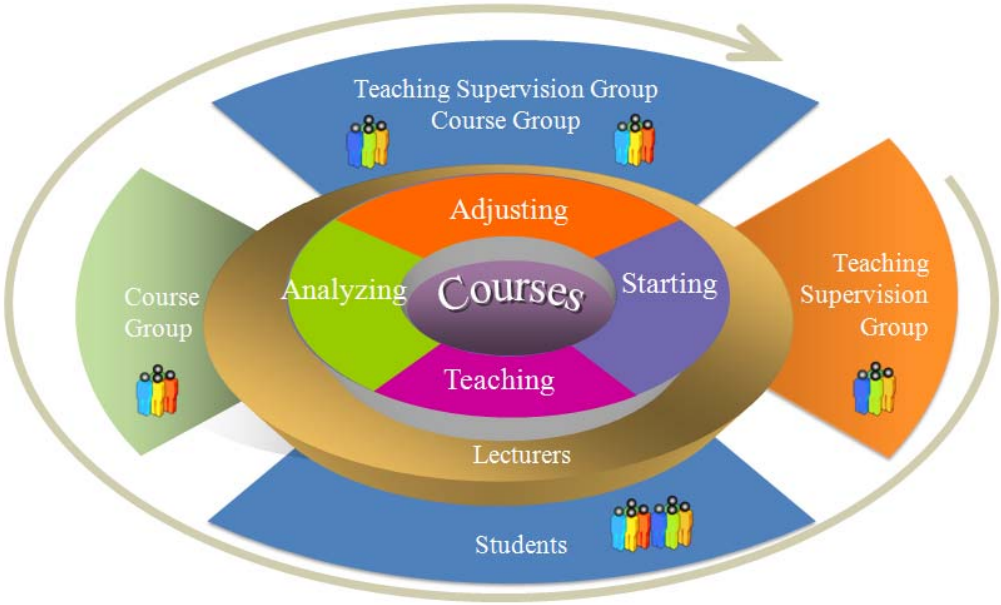

Fig. 2.23 The course improvement process at the Department of Electrical Engineering

2-5-4 Platforms

(1) Classroom Facility

Tsinghua University offers excellent classroom facilities for its students. Overhead projectors and blackboards are the standard configuration for nearly all classrooms, whose size varies from 30 seats to 500 seats. The six teaching buildings on campus are close to each other and open from 6:00 am to 10:00 pm.

(2) Internet Educational Resources

The well-established Campus Internet-based Online Classroom provides an out-of-class study environment for all students. The following screenshot is from the website of the course "Principles of Electric Circuits". Students can download handouts, supplementary materials, submit homework, discuss topics related to the course using this well-established platform. According to the sample survey, every student, on average, visits twice a week for each course.

Fig. 2.24 The campus internet-based online classroom at Tsinghua University

(3) Experiment Facilities

Besides the classroom and internet teaching platforms, the Department of Electrical Engineering offers a great practical environment for students to undertake experiments in the course and implement their innovative ideas for extracurricular activities.

There are three educational Lab Centers for students at the Department of Electrical Engineering. The Lab Center for Electric and Electronics Education covers all electric and electronic circuit experiments, the Lab Center for Computer Basic and Application Education covers all computer science experiments, and the Lab Center for Electrical Engineering Education covers all the experiments for general discipline courses and specialized courses.

Table 2.8 The three educational purpose lab centers for students at the Department of Electrical Engineering

Name	Area (m^2)	Equipment Number	Equipment Value (MRMB)	Experiment Courses Offered	Experiments Offered
Lab Center for Electric and Electronics Education (1)	2600	2700	17	17	210

Lab Center for Computer Basic and Application Education (2)	320	824	3.8	12	113
Lab Center for Electrical Engineering Education (3)	2500	1382	29	24	147

(1) This lab is the Beijing Experiment Teaching Demonstration Center[17]. It provides experiments for all Tsinghua students.

(2) This lab is part of the Tsinghua Computer Center, which is a National Experiment Teaching Demonstration Center. The Lab for Computer Basic and Application Education provides experiments for non-computer-science major students at Tsinghua University.

(3) This lab is a National Experiment Teaching Demonstration Center[18]. It provides experiments for students of the Department of Electrical Engineering.

As illustrated in the table, **all the teaching experiments are undertaken in high standard lab centers, whether the National Experiment Teaching Demonstration Center or the Beijing Experiment Teaching Demonstration Center. This guarantees the quality of these experiments.**

Senior undergraduate students will participate in the scientific research through SRT or other programs, which are introduced in the following subsections. Senior undergraduates can use the facilities of the State Key Laboratory of Control and Simulation of Power System and Generation Equipments, including the Center for Power System Dynamic Simulation, the Center for High Voltage and EM Environment, the Center for Power Electronics, with the help of their advisors.

(4) Internship Bases

The Department of Electrical Engineering gives high priority to internships for gaining understanding and developing an appreciation of the discipline of Electrical Engineering. Every undergraduate student is required to take part in a short-term (3 weeks) internship in their third academic year's summer term. Five internship bases including both power generation and electric equipment plants have been set up, their location and major are illustrated in Fig. 2.25.

[17] Up to now, there are 11 Beijing Experiment Teaching Demonstration Centers at Tsinghua University.
[18] Up to now, there are 8 National Experiment Teaching Demonstration Centers at Tsinghua University.

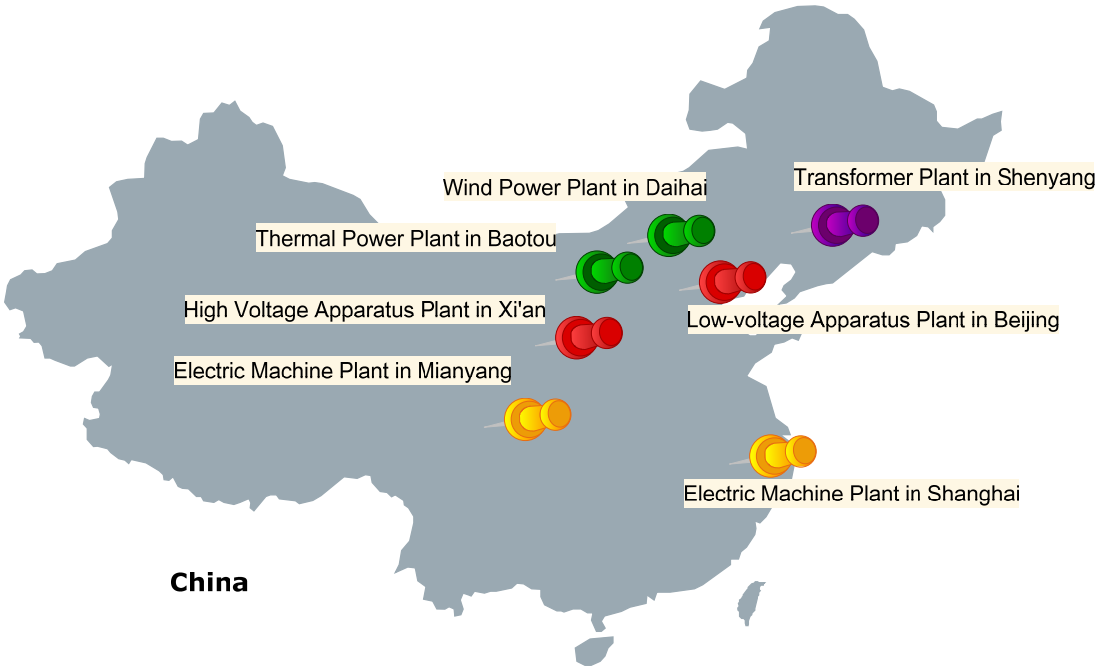

Fig. 2.25 The location and major of the internship bases for the Department of Electrical Engineering

Students may take part in the centralized internship in these five bases or select their own power engineering plants or companies based on their interests. For the latter case, at least three students form a group. The schedule of the internship is required from the target plant or company and checked by the Deputy Head of the department. Owing to the well-established intern schedule, most students select the centralized internship, as illustrated by Fig. 2.26 [19].

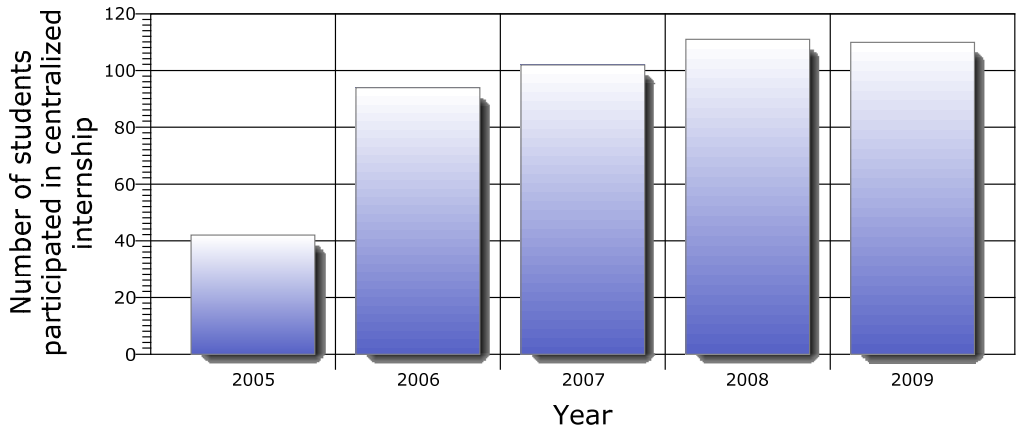

Fig. 2.26 The student number participated in the centralized internship at the Department of Electrical Engineering

Ph.D. students are required to undertake a 30 day internship during their first year summer term. Students select from various options provided by the partner companies. These requirements are gathered and distributed by the university. Table 2.9 illustrates the statistics of internship related to power engineering for Ph.D. students.

[19] There are about 120 undergraduate student enrolled into Department of Electrical Engineering each year.

Table 2.9 The number and distribution of Ph.D. students' internships

Year	Ph.D. students participated in the internship	Ph.D. students selected power engineering companies	Percentage of Ph.D. students selecting power engineering companies
2005	N/A	N/A	N/A
2006	N/A	N/A	N/A
2007	33	20	61%
2008	52	43	83%
2009	30	40	75%

These four aspects, i.e. classrooms, internet resources, experiment centers, and practice bases, form the perfect educational and development platform for students in the Department of Electrical Engineering.

(5) Textbooks

Faculties in the Department of Electrical Engineering at Tsinghua University pay special attention to summarize their teaching experiences and, accordingly, write textbooks for courses. Selected eighteen textbooks published during the evaluation period are listed in Table 2.10.

Table 2.10 Textbooks published by faculties of the Department during the evaluation period

Author	Title	Publisher	Year
Sun, Xudong, Wang, Shanming	Electric Machinery	Tsinghua University Press	2006
Wu, Wenchuan, Zhang, Boming	Power System Dispatch Automation	Tsinghua University Press	2006
Xie, Xiaorong, Jiang, Qirong	Flexible AC Transmission Systems: Principles and Applications	Tsinghua University Press	2006
Liang, Xidong, Chen, Changyu, Zhou, Yuanxiang	High Voltage Engineering	Tsinghua University Press	2006
He, Jinliang, Zeng, Rong	Power System Grounding technology	Science Press of China	2007
Jiang, Jiguang, Liu, XiuCheng	Principles of Electric Circuits 2nd	Tsinghua University Press	2007
Lu, Zongxiang	Reliability Prediction and Prevention of Failures in Electrical Power Plants	China Electric Power Press	2007
Yu, Xinjie , Zhu, Guiping, Lu, Wenjuan	Principles of Electric Circuits	Tsinghua University Press	2007
Sun, Xudong, Wang, Shanming	A Study Guide to Electric Machinery	Tsinghua University Press	2007
Sun, Xudong, Feng ,Dajun	Solutions to Electric Machinery Problems (second edition)	Science Press of China	2007
Tang, Qingyu	Electrical and Electronic Engineering	Tsinghua University Press	2007

Zhu, Guiping, Chen, Jianye	The Application of Computer Simulation in Power Electronics	Tsinghua University Press	2008
Huang, Songling, Wu, Jing	Fundamentals of Virtual Instruments Design	Tsinghua University Press	2008
Liu, Weidong	Foundation of Signal and System Analysis	Tsinghua University Press	2008
Wang, Shumin, Liu, XiuCheng, Lu, Wenjuan, Xu, Fuyuan	Selected test questions of Electric Circuits	Tsinghua University Press	2008
Zhao, Zhengming, Yuan, Liqiang	"Integration of Power Electronics and Motor Control", Tutorial Book	Tsinghua University Press	2008
Wang, Hongming, Duan Yusheng, Wang Yandan	Electrical engineering and Electronic	High Educational Press	2009
Zhu, Guiping, Yu, Xinjie, Lu, Wenjuan, Liu, Xiuchen	Guidance of Principles of Electric Circuits for Instructors and Students	Tsinghua University Press	2009

2-5-5 Teaching Assistance

The teaching assistance aspect of the Department of Electrical Engineering can be represented by the following two parts.

(1) Adequate Teaching Assistance Staff

The Department of Electrical Engineering has four teaching assistance staffs as follows:

- ✧ Mrs. Jinsong Sun is responsible for graduate students' cultivation.
- ✧ Mrs. Hong Dong is responsible for undergraduate students' administration.
- ✧ Miss Jiajia Dong is responsible for enrolling new students for both undergraduate and graduate students and internship.
- ✧ Mrs. Ruixiang Geng is responsible for the employment service.

(2) Excellent Class Advisor and Teaching Assistant System

The class advisors are faculty member who give advice to undergraduate students on optional course selection and personal career development. They are also responsible for encourage students to study hard and undertake extracurricular activities. There are four classes for each undergraduate grade. Each of them contains about 30 students. The Department designates one advisor for each class in their first two years and only one advisor for each grade in the subsequent two years.

The student adviser is a graduate student whose responsibility is to promote students' psychological health, quality outreach, physical exercises, and academic interests. There are 10 student advisers for undergraduate students and 10 student advisers for graduate students.

The teaching assistant (TA) is also a graduate student. The role of TA is to assist the instructor by managing the homework, assisting with exam preparation and grading, consulting with students during office hours, etc. the Department of Electrical Engineering strives to be generous with course teaching assistant support, particularly with core undergraduate classes. There are about 50 TAs for each semester.

2-5-6 Financial Support

Tsinghua University and the Department of Electrical Engineering give student financial support a high priority. We claim that "Never let a diligent and talented student drop out of Tsinghua University because of family poverty". There are five kinds of financial supports on campus as follows.

- **Scholarship**, provided by the university and the department, is for rewarding outstanding students in study, research, and extracurricular scientific activities;
- **Financial aid**, provided by the university and the department, is for supporting students who might abandon their studies due to family poverty;
- **Work-study program**, mainly provided by the university, to provide opportunities for students to improve livelihood;
- **Loan**, provided by the nation, is for supporting students who might abandon their studies due to family poverty[20];
- **Special subsidy**, provided by the university and the department, is the financial support for emergent events.

The first two methods are the main source of financial support. The total value of scholarships and financial aid within the last few years is illustrated in Fig. 2.27 [21].

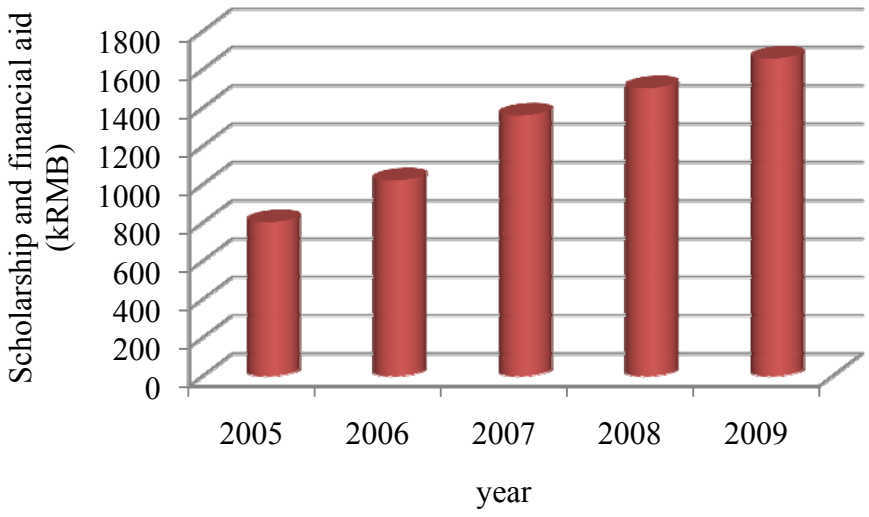

Fig. 2.27 The total value of scholarships and financial aid in the Department of Electrical Engineering

[20] Its purpose is similar to that of financial aid. But the load is given by banks and needs to be paid off after graduation.
[21] The exchange rate of RMB to USD is roughly 6.8:1.

The average value of scholarships and financial aid per student is illustrated in Fig. 2.28.

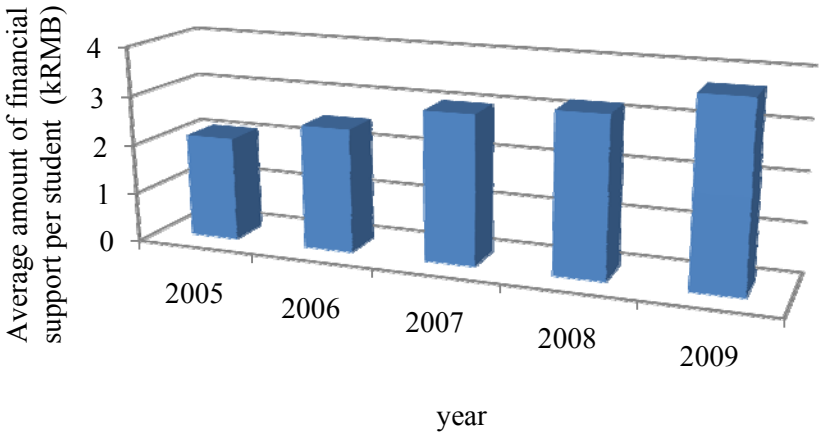

Fig. 2.28 Average value of financial support per student

The tuition fee for undergraduate students at Tsinghua University is 5k RMB per year and the accommodation fee is 1.5k RMB per year. The financial support rate increased from 39.8% to 54.1% during the evaluation period, i.e. **more than half of the students could improve their financial situation through scholarships and financial aid at the Department of Electrical Engineering of Tsinghua University.**

2-6 Educational Outcomes

The educational outcomes defined in this report are various abilities gained by students, awarded won by student, and employment of students through educational activities carried out by Department of Electrical Engineering at Tsinghua University.

As to the first outcome, i.e. abilities gained by students, the criteria defined by the Accreditation Board for Engineering and Technology (ABET) in United States is used. ABET is a peer review accreditation process that evaluates the quality of engineering programs. The ABET's educational outcomes include the following abilities, which are used to evaluate the outcomes of courses offered by the Department of Electrical Engineering at Tsinghua University:

1. An ability to apply knowledge of mathematics, science, and engineering.
2. An ability to design and conduct experiments, as well as to analyze and interpret data.
3. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. An ability to function on multi-disciplinary teams.
5. An ability to identify, formulate, and solve engineering problems.
6. An understanding of professional and ethical responsibility.
7. An ability to communicate effectively.
8. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
9. A recognition of the need for and an ability to engage in life-long learning.

10. Knowledge of contemporary issues.
11. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

2-6-1 Educational Outcomes of the Undergraduate Courses

The following tables shows the mapping of the courses to the 11 key abilities identified by ABET in the previous section for the undergraduate degrees offered by the Department.

Table 2.11 Educational outcomes of the undergraduate general engineering course

Course	1	2	3	4	5	6	7	8	9	10	11
Principles of Electric Circuits A(1)	√	√	√		√					√	√
Principles of Electric Circuits A(2)	√	√	√		√						√
Signals and system	√	√			√						√
Fundamentals of Digital Electronics	√		√	√							√
Automatic Control Systems	√	√	√		√						√
Fundamentals of Electromagnetic Field	√				√				√	√	√
Foundations of Computer Programming	√		√		√				√		√
Fundamentals of Analog Electronics	√	√							√		
Computer Architecture and Application	√		√								√

Table 2.12 Educational outcomes of the undergraduate general discipline course

Course	1	2	3	4	5	6	7	8	9	10	11
Electric Machinery Fundamentals	√	√	√		√					√	√
Fundamentals of Power Electronics	√	√	√		√					√	√
High Voltage Engineering	√	√							√	√	√
Power System Analysis	√	√			√			√	√	√	√

Table 2.13 Educational outcomes of the undergraduate practice course

Course	1	2	3	4	5	6	7	8	9	10	11
Electronics Course Projects			√	√		√	√	√	√		√
Recognition Practice				√	√	√	√	√			
Production Practice	√		√		√	√	√	√	√		√
Programming Projects	√	√									√
Specialized Projects		√	√	√	√		√	√		√	
Thesis Comprehensive Training	√	√	√		√	√		√			√

Table 2.14 Educational outcomes of the undergraduate power system elective specialized course

Course	1	2	3	4	5	6	7	8	9	10	11
Electric Power Dispatch Automation	√				√			√		√	√
Experiments for Power System		√					√				√
Fundamentals of Protective Relaying Technology			√		√					√	√
Information theory and Power System	√	√			√					√	√
Introduction on Electricity Market	√	√	√		√					√	√

Modern Electrical Power Plant Engineering	√		√		√						√
New Energy Generation and Integration in Power System	√		√		√					√	√
Power System Stability and Control	√				√				√	√	√

Table 2.15 Educational outcomes of the undergraduate high voltage elective specialized course

Course	1	2	3	4	5	6	7	8	9	10	11
DC Power Transmission Technology	√		√		√	√	√			√	√
Dielectric materials and insulation technology	√	√	√	√	√	√	√			√	
Condition Monitoring and Fault Diagnosis of Electrical Equipment	√				√						√
Overvoltages and Its Protection	√			√	√		√			√	√
Fundamental and Application of Power Apparatus	√		√		√	√					√

Table 2.16 Educational outcomes of the undergraduate electric machinery and power electronics elective specialized course

Course	1	2	3	4	5	6	7	8	9	10	11
Analysis of Electric Machinery	√		√		√	√	√			√	√
Design & Analysis for Electronic Machine System	√				√						√
Electric Drives and Control	√			√	√				√		√
Micro & Special Electric Machinery	√	√			√					√	
Power Electronics Simulation	√	√	√		√					√	√
Special Topics on Power Electronics	√	√	√		√					√	

Table 2.17 Educational outcomes of the undergraduate computer and other general elective specialized course

Course	1	2	3	4	5	6	7	8	9	10	11
Fundamentals of Virtual Instrument	√	√	√		√			√	√	√	√
Fundamentals of Communication Systems	√		√		√					√	√
Microcontroller techniques and experiments	√		√		√				√	√	√
Object-Oriented Programming	√		√	√	√		√			√	√
Theory and Application of System Design	√	√	√		√						

2-6-2 Educational Outcomes of the Graduate Courses

The following tables shows the mapping of the courses to the 11 key abilities identified by ABET in the previous section for the graduate degrees offered by the Department.

Table 2.18 Educational outcomes of the graduate general purpose course

Course	1	2	3	4	5	6	7	8	9	10	11
Advances in Electrical Engineering				√		√	√	√	√		√
Advanced Circuits and Systems	√	√	√	√	√	√	√		√	√	√
Advanced Electromagnetic Compatibility	√		√		√		√			√	√
Computation of Electromagnetic Fields	√				√			√	√	√	
Electromagnetic Transient Analysis	√		√		√	√	√			√	√
Electromagnetic Measurements Selection	√		√	√	√	√	√	√	√	√	√

Magnetophysics and Electromagnetic Evaluation	√	√	√		√			√	√	√	√
Modern Control Theory	√				√				√	√	
Stochastic Processing of Random Signals	√		√	√						√	
Digital Signal Processing	√	√	√	√	√		√	√		√	
Micro-Controller: Principle and Application	√	√	√				√				√
Identification Technology	√				√			√		√	√
Simulation in Electrical Engineering	√	√	√		√	√	√			√	√
LabVIEW Programming and Virtual Instruments Design	√	√	√		√			√	√	√	√
Evolutionary Computation and Its Applications	√		√		√	√	√			√	√
Modern Communications in Electric Power Systems	√		√		√					√	

Table 2.19 Educational outcomes of the graduate power system courses

Course	1	2	3	4	5	6	7	8	9	10	11
Advanced Electric Power Network Analysis	√		√		√				√	√	√
Dynamic Power Systems	√				√				√	√	
Modern Energy Management System	√				√		√			√	√
FACTS/DFACTS: Principles and Applications	√	√	√	√	√	√	√		√	√	√
Wide Area Monitoring and Control of Power Systems	√			√			√			√	
Principle and technology of new type of protection	√		√		√	√	√			√	√
Uncertainty Analysis of Electrical Power System	√	√	√		√	√				√	√

Table 2.20 Educational outcomes of the graduate high voltage courses

Course	1	2	3	4	5	6	7	8	9	10	11
Gas Discharge	√				√					√	
High-voltage Transmission Technology	√	√	√	√	√			√			
High voltage Outer Insulation	√				√			√		√	
Modern High Voltage Test Technology	√	√	√		√	√	√			√	√
Electrical Equipment Reliability Engineering	√			√	√						
Introduction to Pulsed Power technology	√							√		√	
Pulsed-Power Applications and High-Power Microwaves	√		√		√	√	√			√	√

Table 2.21 Educational outcomes of the graduate electrical machinery and power electronics courses

Course	1	2	3	4	5	6	7	8	9	10	11
Transient Analysis of AC Machine Systems	√	√			√				√		√
Modern Power Electronics	√	√	√		√	√	√	√		√	√
Principles and Applications of Power Electronic Devices	√	√	√	√	√	√	√			√	√
Integration of Power Electronics and Motor Drive System	√		√		√						√

As can be seen from the above Tables, the courses offered by the Department well covered the necessary abilities of ABET.

2-6-3 Awards Won by Students

Outstanding Doctoral Dissertations of the Nation

The selection of Outstanding Doctoral Dissertations of the Nation is organized by China's Ministry of Education and the Academic Degrees Committee of the State Council, which aims to establish an effective quality supervision and motivation system, to cultivate and stimulate the innovation spirit of PhD students.

The rating criteria are as follow:

1. The topic is based on the cutting edge, which has practical or theoretical significance;
2. There are innovations in theories or methods;
3. There are breakthrough results which reach advanced international standards, and have good social benefits or prospects;
4. The material is informational, and the reasoning is strict, and the expression is accurate.

The Outstanding Doctoral Dissertations of the Nation represents the highest level of doctoral dissertation in China because of the rigorous criteria. The total number is about 100 in all disciplines annually. Since 1999, there are 13 Outstanding Doctoral Dissertations of the Nation in the Electrical Engineering Discipline, four of which come from the Department of Electrical Engineering at Tsinghua University, which has been introduced in Subsection 2-5-1. The following table lists the distribution of the Outstanding Doctoral Dissertations of the Nation from 1999 to 2009.

Table 2.22 Distribution of the Outstanding Doctoral Dissertations of the Nation from 1999 to 2009 in Electrical Engineering

University	Number of Dissertations Awarded	Year
Tsinghua University	4	1999, 2000, 2006, 2007
Xian Jiaotong University	2	2003, 2005
Chongqing University	2	2006, 2008
Xian University of Technology	1	2001
Tianjin University	1	2004
Institute of Electrical Engineering of Chinese Academy of Sciences	1	2005
Huazhong University of Science and Technology	1	2009
Naval University of Engineering	1	2009

National Challenge Cup Extracurricular Scientific Contest

The National Challenge Cup Extracurricular Scientific Contest is organized by the China Association of Science and Technology and China's Ministry of Education. From the first competition in 1989, the “Challenge Cup” always adheres to the purpose that advocating science,

pursuing truth, studying hard, making innovations. It will promote the growth of young talents and push the nation's economic and social development.

Meanwhile, the Extracurricular Scientific exhibition of Tsinghua University is also called the "Challenge Cup", which is the oldest, largest Extracurricular Scientific competition with the highest level at Tsinghua University. According to statistics, there are more than 1,200 works and projects and more than 3,000 students involved in each "Challenge Cup".

The Department of Electrical Engineering adopted extracurricular activities many years ago and has come to the conclusion that: the training for an excellent program should not simply focus on the event itself, but must enhance mass participation so that more undergraduates can be involved in the programs. The Department of Electrical Engineering has a good performance in the Challenge Cup events every year, and won the first prize and the second prize in 2005 and 2009. The project "Micro-planar transformer" of Yinan Geng's team won the first prize of the school "Challenge Cup" and won the third prize of the National Challenge Cup in 2005; The project "The evaluation of energy efficiency and management optimization system in power plant" of Yuexi Yang's team won the first prize of the school "Challenge Cup" and won the first prize of the National Challenge Cup in 2009.

2-6-4 Statistics for Employment and Prominent Alumni

There are many elites of the nation among the students who have graduated from the Department of Electrical Engineering. For example, political leaders represented by the former Prime Minister Zhu, Rongji and academic masters represented by academician Jin, Yilian who have won the National Highest Prize for Science and Technology in 2002. Thirty six academicians of CAS or CAE have studied or worked in the Department of Electrical Engineering. A number of graduates became leading people in many important industries and businesses related to China's national economy such as the power sector, electro technology industries etc. Zhang, Fengxiang, former Vice Minister of the Chinese Electricity Department and Zhao, Xizheng, former General Manager of the State Grid are excellent representatives.

A pie chart of the current occupations of the students graduated in 1984, 1995 and 2008 are shown in Figs. 2.29- 2.31 respectively. It can be seen that there are a large proportion of the graduates have been employed in the enterprises related to the power industry and institutes related to scientific research. The proportion of graduates who study or work abroad increased from 1984 to 1995, and decreased in 2008.

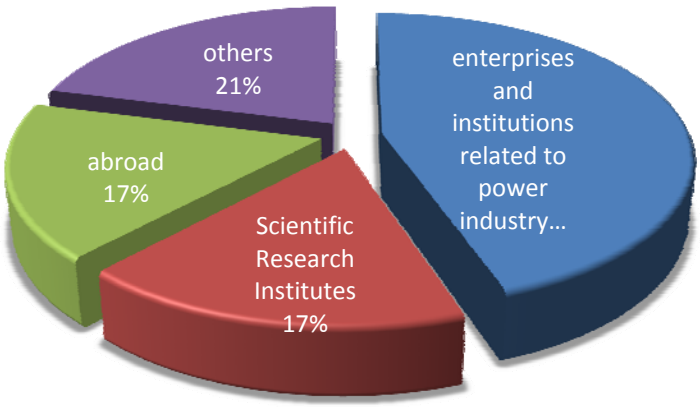

Fig. 2.29 Employment of students who graduated in 1984

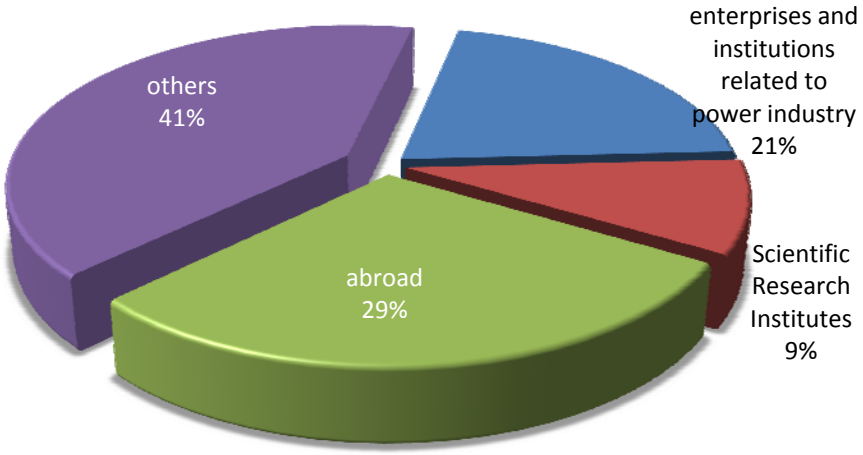

Fig. 2.30 Employment of students who graduated in 1995

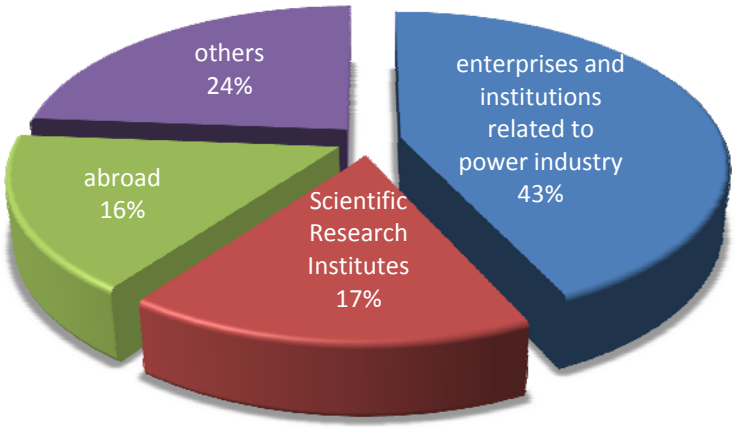

Fig. 2.31 Employment of students who graduated in 2008

The trends can be seen more clearly in Fig. 2.32 which shows the percentages of graduates in different occupations. The areas in blue, red, green and purple represent the enterprises and

institutions related to power industry, scientific research institutes, working or studying abroad, and others. It can be seen that the blue and red area decreases in the 1990s and increases from 1999, which means that more and more graduates are willing to participate in the power industry or electrical engineering discipline.

The increase in these two areas reflects the development of the power industry in China. The rapid growth of the Chinese national economy has brought a great opportunity for the development of the power industry and related businesses. Renewable Energy, Smart Grid, UHV Transmission, etc. have provided graduates a broad stage where they can demonstrate their excellence. The unprecedented opportunities in China's power industry attract most graduates to stay and devote their knowledge to help China become a leading country in modern power engineering.

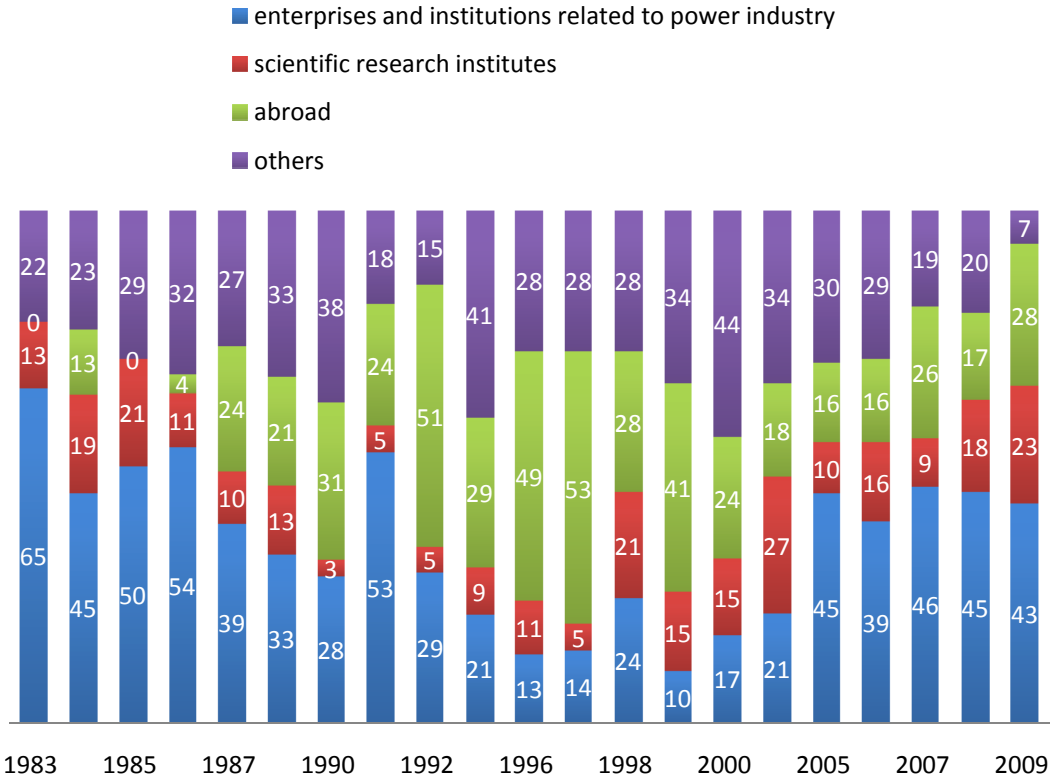

Fig 2.32 Occupation Trends from 1983 to 2009

For those who chose to study or work abroad, Table 2.23 illustrates the example of graduates in 2008. It can be seen that the universities are all world famous. Among these students, many of them will come back to China after they finished their work or research.

Table 2.23 overseas universities where students graduated in 2008 have gone for advanced study

Name	Degree	Nation	University
Jin, Xiangwen	Ph.D	US.	Carnegie-Mellon Univ.
Yang, Ying	Ph.D	US.	Massachusetts Institute of Technology
Ma, Feng	M.S	US.	Arizona State Univ.
Hu, Jiajun	M.S	US.	Columbia Univ.
Meng, Bowen	B.S	US.	Stanford Univ.

Xue, Jin	B.S	US.	Virginia Polytechnic Institute and State Univ.
Liu, Dazhao	B.S	US.	Missouri Univ. of Science and Technology
Lu, Yaodong	B.S	US.	North Carolina State Univ.
Zhao, Dongbo	B.S	US.	Texas A&M Univ.
Xu, Bo	B.S	US.	Cornell Univ.
Pan, Siming	B.S	US.	Univ. of Missouri
Li, An	B.S	US.	Boston Univ.
Tang, Wenyuan	B.S	US.	Southern California Univ.
Song, Shiyu	B.S	US.	Univ. of California, San Diego
Gao, Heng	B.S	US.	Univ. of Arizona
Wang, Wennan	B.S	Hong Kong	Hong Kong Univ.
Wang, Mingyang	B.S	US.	Univ. of Colorado-Boulder
Wu, Haoran	B.S	US.	Univ. of Virginia
Shen, Shen	B.S	US.	California Institute of Technology
Yu, Feng	B.S	US.	Virginia Polytechnic Institute and State Univ.
Gao, He	B.S	Hong Kong	Hong Kong Univ. of Science and Technology
Zhang, Hao	B.S	US.	Columbia Univ.
Zhang, Xueqiang	B.S	UK.	Cambridge Univ.
Chen, Yunzheng	B.S	German	Univ. of Aachen
Biao, Xiao	B.S	US.	Univ. of North Carolina
Jin, Shengzhu	B.S	Korea	Korea Univ.
Zhao, Tuo	B.S	US.	Univ. of Missouri Rolla
Meng, Ming	B.S	US.	Univ. of Washington

Tsinghua University is the leader of Chinese academic research. The Department of Electrical Engineering ranks No. 1 in the area of power engineering research. There are 36 academicians of CAS or CAE who have worked or studied in this department. They are excellent representatives of all the academic researchers who have devote their knowledge and career to Chinese power engineering research.

Table 2.24 Academicians of CAS or CAE who have worked or studied in the Department of Electrical Engineering of Tsinghua University

Zhu, Wuhua	**Zhang, Mingtao**	**Qian, Zhonghan**
Ma, Dayou	**Lü, Baowei**	**Chen, Liwei**
Cao, Jianyou	**Chang, Tong**	**Yang, Jiachi**
Lin, Weigan	**Hong, Chaosheng**	**Gao, Jingde**
Wu, Quande	**Xia, Peisu**	**Huang, Hongjia**
Wu, Youshou	**Wang, Shoujue**	**Zhang, Lüqian**
Wang, Zhongtuo	**Lu, Jianxun**	**Jin, Yilian**
Ma, Fubang	**Li, Sanli**	**Yan, Luguang**

Zhang, Bo	**Lu, Qiang**	**Gu, Guobiao**
Li, Yanda	**Chen, Qingquan**	**Han, Yingduo**
Zheng, Jianchao	**Zhou, Xiaoxin**	**Wu, Cheng**
Zhang, Zhonghua	**Li, Licheng**	**Ma, Weiming**

As a comprehensive university, Tsinghua does not expect all the graduates to become scientific researchers. Everyone has his own talent and the best way to develop is to choose an occupation which meets his interests. Not all the graduates from this department are engaged in the businesses related to power industry and scientific research. Some students have become political leaders. Zhu, Rongji, the former Prime Minister and Huang, Ju, the former Vice Prime Minister are their great representatives. Their leadership has greatly contributed to the development of the nation. Some information of the political leader graduated from this department are listed in the following table.

Table 2.25 Details of the outstanding alumni who worked in the governments

Name	Year of Graduation	Headship
Xiao, Yang	1951	Governor of Sichuan Province
Zhang, Fengxiang	1951	Vice Minister of Ministry of Water Resources and Electrical Power
Zhu, Rongji	1951	Member of the Political Bureau of the Central Committee of the Communist Party of China; Chinese Premier
Li, Meng	1960	Vice Governor of Sichuan Province; Vice Chairman of Chinese People's Political Consultative Conference
Yu, Jiahua	1962	Governor of Henan Province
Huang, Ju	1963	Standing Committee Member of Political Bureau, the CPC Central Committee; Chinese Vice Premier
Zhong, Yongsan	1964	Mayor of Hefei City
Hu, Shaoguang	1964	Deputy Mayor of Beijing
Zhang, Yixiang	1967	Vice Governor of Henan Province
Wang, Hanmin	1968	Vice Governor of Qinghai Province
Chen, Yichu	1968	Mayor of Zhengzhou City
Wu, Jianying	1989	Ministry of Human Resources and Social Security of the People's Republic of China

The largest proportion of the graduates is engaged in enterprises and businesses related to the Chinese power industry. They are the elites of the power industry. Zhao, Xizheng, former general manager of State Grid is an excellent example. Some information of the graduates in enterprises related to power industry is listed in the following table. They are the foundation and driving force for the Chinese power industry.

Table 2.26 Information on the outstanding alumni who work in enterprises related to the power industry

Name	Year of Graduation	Affiliation	Headship
Liang, Xinguo	1950	Institute of Automation, Chinese Academy of Sciences	Director
Bai, Qizhang	1951	Institute of Telecommunication, Ministry of Posts and Tele Communication	Chief Engineer
Yuan, Xiuxiu	1952	North China Power Design Institute	Chief Engineer
Liu, Jue	1953	Nanjing Automation Research Institute, SGCC	Chief Engineer
Xu, Mingqing	1955	Gezhouba Hydroelectric Board	Chief Engineer
Liu, Weilie	1955	North China Grid Company, Limited	Chief Engineer
Dong, Hongxun	1958	North China Radio Instrument Factory	Factory Manager
Tang, Bingwu	1958	China Development Bank	Chief Engineer
Zhao, Xiumin	1958	Shanxi Electromechanical Design Institute	Chief Engineer
Qian, Zhongwei	1961	North China Grid corporation Limited, SGCC	General Manager
He, Cheng	1962	Shanghai Electric Machine Factory	Manager
Wu, Zhong	1963	Xi'an XD Switchgear Electric Co., Ltd.	Factory Manager
Li, Shizhong	1963	SGCC	President
Wu, Jingxin	1964	North China Grid corporation Limited, SGCC	Chief Engineer
Zhao, Shuangju	1964	Beijing Electric Power Company, SGCC	Director of Bureau
Che, Nianjian	1965	Fushun Electric Porcelain and machinery Factory	Factory Manager
Zhu, Zhiqiang	1965	Yunnan Power Industry Board	Director of Bureau
Lin, Lixing	1965	Central China Grid Company Limited, SGCC	Director of Bureau
Wang, Renfu	1965	Xi'an High Voltage Apparatus Research Institute Co., Ltd	Chief Engineer
Li, Jubin	1966	Beijing Beizhong Steam Turbine Generator Co., Ltd.	Factory Manager
Wang, Wenxiang	1966	Harbin Electric Machinery Company Limited	Factory Manager
Zhang, Tingke	1983	China Huaneng Group	Vice President
Zhang, Qingmin	1983	China Development Bank, Guizhou Branch	President
Zhang, Shumin	1983	China Guodian Corporation, North West Branch	Chairman of the Board
Ren, Jiyun	1983	V-SUN Securities LTD.	Chairman of the Board
Qi, Dacai	1984	China Southern Power Grid CO., LTD	Vice President
Wang, Changbao	1984	Research Institute of Electrical Power	Dean of the power

		and Its Automation, SGCC	system department
Feng, Yuchang	1984	Northwest China Grid Company Limited, Operation and Technology Department	Director
Hu, Xiaofei	1984	Anhui Electric Power Company, Dispatching (transaction) Center	Director
Liu, Lei	1984	Jiangxi Electric Power Company, Dispatching (transaction) Center	Director
Lu, Gongchao	1984	Beijing Radio Administration Bureau	Director of Bureau
Li, Jinlong	1984	China Shougang Group, Electrical Machine Factory	Factory Manager
Yang, Baolin	1984	Xi'an Electric Corporation	Vice President
Jiang, Baogang	1984	Hydro Turbine Factory of Harbin Dynamical Power Equipment Corporation	Factory Manager
Wang, Liangyou	1985	China Southern Power grid CO., LTD	Vice president
Jiang, Yi	1985	Human Resource department, SGCC	Director
Ruan, Qiantu	1986	Investment Management Company of SGCC, Philippines Branch of SGCC	Vice President
Wu, Yun	1986	Investment Management Company of SGCC	Chief Inspector
Zhang, Zhigang	1987	Dispatching (transaction) Center, SGCC	Director
Ouyang, Changyu	1987	Energy Research Institute, SGCC	Party Secretary
Chen, Guoping	1987	International Corporation Department, SGCC	Vice Director
Cui, Jifeng	1988	Ningxia Electric Power Company, SGCC	President
Yao, Jianguo	1988	Department of Technology, Technology Section, SGCC	Deputy Director
Wang, Xiaoxi	1988	Operation Department, SGCC	Vice Director
Zhang, Jianjun	1988	Power Bureau of Gansu Province	Director of Scientific and Technological Commission
Zhang, Jiandang	1988	China Huaneng group	
Li, Dan	1989	North China Grid Company Limited, Operation and Technology Department	Director
Shi, Lianjun	1989	Marketing and Trading Center, SGCC	Vice Director
Luo, Qing	1989	Huaneng power international .inc	Manager
Hu, Jiawei	1989	Measurement and Control Company of Tsinghua Unis	Chairman of the Board Concurrently General Manager
Deng, Youman	1989	Intellectual Property Office of	Deputy

		Guangzhou Municipality	Commissioner
Ling, Junyin	1989	Beijing Sifang-leader Protection & Control co., ltd	President
Li, Mingjie	1990	Dispatching (transaction) Center, SGCC	Vice Director
Yu, Jun	1991	Dispatching (transaction) Center, SGCC	Vice Director
Wang, Haining	1991	China Electric Power Research Institute	Director
Wang, Guanghui	1991	Information & Telecommunication Co., Ltd, SGCC	Secretary
An, Jun	1991	Henan Electric Power Company, SGCC	Director
Zhang, Xiaomin	1991	Gansu Electrical Power Research Institute	Dean
Wang, Xiaohai	1991	Dispatching Station of Inner Mongolia Electrical Power Center	Dean
Chen, Tao	1991	State Electricity Regulatory Commission	Director of a Division
Zhou, Chengzhong	1991	Jingneng International	Director
Zhu, Jiong	1991	Zhejiang Electric Power Corporation, SGCC	Director
Li, Jingru	1992	State Power Economic Research Institute	Director of a Division
Diao, Qinhua	1992	Tsinghua Solar Systems Ltd.	Party Secretary
Wang, Hongzhi	1992	Tianjin Electric Power Company, SGCC	Vice President, Party Secretary
Zhu, Kaiguo	1992	Shenhua Guohua Power	Director
Wang, Yonggang	1992	XJ Group Corporation	Director
Hu, Jiangyi	1992	Department of Marketing, SGCC	Vice Director
Guo, Ricai	1992	Capital Construction Department, SGCC	Vice Director
Lv, Yunqiang	1993	International Operation Company, SGCC	Vice President
Peng, Shuangqun	1993	China Electricity Investment Co.	Director of a Division
Zhang, Jingsheng	1996	Power Bureau of Hohhot City	Director of Bureau
Ge, Jun	2001	Department of Technology, Technology Section, SGCC	director of a division
Sun, Zhengyun	2005	Heibei electric power company, SGCC	General Manager
Xin, Yaozhong	2006	State grid corporation of China dispatching (transaction) center	Vice Director
Liu, Yinshang	2006	Operation and Technology Department, SGCC	Vice Director
Wang, Jiye	2007	Information Center, SGCC	Vice Director

2-7 Educational Impacts

The educational impacts defined in this report are various governmental assessments, teachings awards, and honors for the Department of Electrical Engineering at Tsinghua University, i.e. the social recognition of the Department as an education institute.

2-7-1 National Assessment of Disciplines

China's Ministry of Education has evaluated the 81 Disciplines except military science in 2002-2004 and 2006-2008. The aim of the evaluation was:

- To identify the advantages and disadvantages of the various disciplines;
- To promote the academic development and improve the quality of graduate training, and enhance the international competitiveness of graduate education;
- To provide reliable information for the discipline chosen by the student;
- To provide data for the government educational department making decisions about university education.

The assessment criteria include objective indicators and subjective indicators. The objective indicators consist of faculty, research, and education, which reflect the overall strength of the discipline. The subjective indicator includes reputation, which reflects the academic contributions to the society.

In the first round assessment of Disciplines, which was during 2002 to 2004, the Electrical Engineering Discipline of Tsinghua University ranked first not only in the total points but also in the four individual criterions, as shown in Table 2.27. In the second round assessment of Disciplines, which was during 2006 to 2008, the Electrical Engineering Discipline of Tsinghua University maintained the first rank with full marks, as shown in Table 2.28.

Table 2.27 The Result of the first round assessment of the Electrical Engineering Discipline (2002 - 2004)

Name	Overall		Criterion							
			Faculty		Research		Education		Reputation	
	rank	score	rank	score	rank	score	rank	score	rank	score
Tsinghua University	1	88.59	1	93.47	1	81.89	1	85.94	1	100
Xi'an Jiaotong University	2	81.66	8	80.73	2	77.56	2	78.49	3	95.35
Huazhong University of Science and Technology	3	80.37	4	90.41	5	73.66	4	72.27	4	93.32
Zhejiang University	4	80.29	3	92.25	6	73.39	11	69.18	2	95.54
Shanghai Jiaotong	5	78.85	2	93.13	9	71.56	8	70.00	6	89.06

Name	Overall		Criterion							
			Faculty		Research		Education		Reputation	
	rank	score	rank	score	rank	score	rank	score	rank	score
University										
Harbin Institute of Technology	6	77.53	7	86.68	10	71.00	6	70.40	5	89.80
Tianjin University	7	76.94	6	87.43	11	70.29	10	69.35	7	88.56
Southeast University	8	76.42	5	90.30	12	69.52	9	69.53	8	83.61
Institute of Electrical Engineering, CAS	9	74.64	12	75.37	3	74.51	16	67.77	8	83.61
Chongqing University	10	72.95	10	77.65	15	67.38	5	70.57	11	81.93

Table 2.28 The Result of the second round assessment of the Electrical Engineering Discipline (2006- 2008)

Name	Overall	
	rank	score
Tsinghua University	1	100
Xi'an Jiaotong University	2	97
Huazhong University of Science and Technology	3	93
Zhejiang University	4	91
Chongqing University	5	87
Tianjin University	6	82
Harbin Institute of Technology	7	81
Shanghai Jiaotong University	8	80
North China Electric Power University	9	79
Southeast University	10	78

In addition to the Disciplines assessment, China's Ministry of Education also carried out assessment of key disciplines, which are planned for key construction. The Electrical Engineering Discipline of Tsinghua University has been voted as one of the five national-level key disciplines in 2007 [22].

[22] The other four universities are Zhejiang University, Huazhong University of Science and Technology, Chongqing University, and Xian Jiaotong University.

2-7-2 Teaching Awards

The teachers of the Department of Electrical Engineering pay great attention to their teaching work. They have profound knowledge and a responsible attitude, and have received many good results in the national, provincial and school teaching rating.

Table 2.29 National Teaching Achievement Award

Year	Project name	Representatives	Rating level
1997	Facing the main battlefields of economic construction and training high-level talents in the electrical engineering discipline	Jingde Gao, Yingduo Han, Qiang Lu, Renyu Zhang, Dachuan Xiao	Grand Prize
2005	The reform of undergraduate courses of power system	Hongbin Sun, Qirong Jiang, Yongting Chen, Luyuan Tong, Wenjin Cui	First Prize
2005	Fundamental courses of computer and the construction of practice base	Yuzhuo Zhong, Xingyan Wang, Zhizhong Tang, Jupeng Zhang, Zengke Zhang	Second Prize

Table 2.30 Provincial Teaching Achievement Award (Beijing)

Year	Project name	Representatives	Rating level
2004	The reform of undergraduate courses of power system	Hongbin Sun, Yuanzhang Sun, Yongting Chen, Qirong Jiang, Luyuan Tong	First Prize
2004	The teaching reform method of "Electrical and Electronic Technology"	Qingyu Tang, Yusheng Duan,	Second Prize
2004	Teaching material ”Nonlinear Control Systems and Power System Dynamic”	Qiang Lu, Yuanzhang Sun, Shengwei Mei	Second Prize
2004	Outstanding teacher in Beijing	Wenjuan Lu	
2004	Outstanding teacher in Beijing	Zanji Wang	
2008	The challenge and breakthrough in technology basic course-- The teaching reform of “electric circuit”	Xinjie Yu, Guiping Zhu, Wenjuan Lu, Yun Xu, Xiucheng Liu	Second Prize
2008	The teaching reform of “High Voltage Engineering”	Xidong Liang, Yuanxiang Zhou, Rong Zeng, Yingyan Liu, Shengyou Gao	First Prize

For rewarding young teachers who have made outstanding achievements in teaching and education reform, Tsinghua University sets up the “Teaching Excellence Award for Young Teachers”. The prize is awarded annually, by vote, with 10 prizes awarded each year. As can be seen from Table 2.31, the faculty member of the Department of Electrical Engineering won the award nearly every year.

Table 2.31 Teaching Excellence Award for Young Teachers at Tsinghua University

Year	Curriculum Name	Winners
1997	Electric Machinery Fundamentals	Xudong Sun
2002	Computer network and Internet	Rong Zeng
2004	Power System Analysis	Hongbin Sun
2005	Electrical and Electronic Engineering	Yingyan Liu
2006	Principles of Electric Circuits	Xinjie Yu
2007	Principles of Electric Circuits	Guiping Zhu
2008	Automatic Control Systems	Chen Shen
2009	Modern Electrical Power Plant Engineering	Zongxiang Lu

2-7-3 Quality Project by China's Ministry of Education

To effectively focus on improving the quality of higher education, the Ministry of Education and Ministry of Finance decide to implement the "Teaching Quality and Reforms of Undergraduate Education Project." The goal is to improve the quality of higher education and basically form the strategy of sustainable development and coordination of scale, structure, quality, efficiency of higher education; to achieve a breakthrough on the reform of talent foster modes and enhance students' practical capability and innovative spirit; to make further improvement on teacher development, the coordination of scientific innovation and talent training; to strengthen administration within institutions of higher education; to maximize the benefits of higher education in the strategy of national reform through science and talent, building an innovative country, and constructing a socialistic harmonious society, to meet our nation's needs in the development of society and economics. The Department of Electrical Engineering at Tsinghua University has achieved the following accomplishments in the higher education Quality Project:

(1) National Experiment Teaching Demonstration Center

In 2008, the Electrical Engineering Experimental Teaching Center was rated as "National Experiment Teaching Demonstration Center" by China's Ministry of Education.

(2) National Top-quality Courses

The National Top-quality Course is distinctive and has first-class teaching. The construction of the National Top-quality Course is based on the training objectives, which reflect the modern educational thinking and meet the scientific, advanced, and the universal law of education and teaching with the role of demonstration and promotion. Since 2005, there are 4 courses of the department of Electrical Engineering receiving this award, as shown in Table 2.32.

Table 2.32 National Top-quality Courses of the Department of Electrical Engineering at Tsinghua University

Course Name	Person in Charge	Award Date
Power System Analysis	Hongbin Sun	2006
Principles of Electric Circuits	Wenjuan Lu	2007
High Voltage Engineering	Xidong Liang	2007
Electrical and Electronic Engineering	Qingyu Tang	2008

(3) Top-quality Teaching Group

Through establishing the team-work mechanism, reforming the teaching contents and methods, developing the teaching resource, promoting the exchange of teaching experiences, the teaching level is improved. Professor Hongbin Sun leads the teaching group of power system, which was granted as the Beijing Top-quality Teaching Group in 2008.

(4) National Innovative Experimental Zone for Talents Cultivation

This project aims to encourage and support the personnel training mode in colleges, to innovate in the teaching philosophy and management system, to meet the needs of the country for the versatile and practical talents. The project of "Cultivating international talents for electrical engineering through focusing on basics and practices" was approved in 2007.

(5) Renowned Teacher Award

Professor Hongbin Sun was granted the National Renowned Teacher Award in 2009. Professor Wenjuan Lu and Qingyu Tang were granted the Beijing Renowned Teacher Award in 2008 and 2009 respectively.

Part 3 Research

3-1 Introduction

As has been explained in Section 1-2-3, electrical power plays a pivotal role in the nation's development and China is undergoing a tremendous high speed development period for power engineering, including both power systems and electrical equipment. The special characteristics of power systems, i.e. considerable complexity, instant balance of power, extra-high voltage, integration of power flow and information flow, reflect the specialty and the frontier of power engineering. These two aspects make the Department of Electrical Engineering at Tsinghua University an active and vigorous education and research institute.

The Department of Electrical Engineering at Tsinghua carries through its research work with the idea of discovering valuable and challengeable scientific problems through key engineering projects affecting the development of China's power engineering industry and, by solving those problems, contributing knowledge and technologies to the electrical engineering discipline and the power engineering industry of China and the world.

The research field of the Department of Electrical Engineering is mainly focused on the subjects of electrical power. The research directions of different fields are introduced as follows:

- Power System and its Automation: Security, stability, control and marketization of power systems;
- High Voltage and Insulation Technique: High voltage insulation, over voltage and its protection, electromagnetic compatibility, equipment detection and high voltage measurement;
- Electric Machines and Electric Apparatus: Large-scale machines, special machines, motor systems in electrical vehicles, machine protection, high voltage switchgear;
- Power Electronics and Electrical Drive: Basic theory and topology research in power systems and industrial application, flexible AC transmission system, electrical machine drive and control, interface and application of renewable energy system, power quality;
- Theory and New Technology of Electrical Engineering: Basic theory of electromagnetic field and its numerical calculation, electromagnetic measurement, wireless transmission of power energy, fault diagnosis based on electromagnetic theory.

The research work in the Department of Electrical Engineering at Tsinghua University is strongly connected with the State Key Laboratory of Control and Simulation of Power System and Generation Equipments, which is affiliated under Tsinghua University, was approved by the State Planning Commission in 1989. Examined and accepted by the State, the Laboratory was put into formal operation on the 17th October, 1995. The research field of the laboratory is divided into nine directions and includes three experimental centers. The nine research area are respectively bulk power grid security and economic operation (power system analysis and control, energy management, electricity market); AC/DC transmission technology and the electromagnetic environment (ultra-high and extra-high voltage transmission, over-voltage protection, grounding, organic external insulation, electromagnetic environment);flexible transmission and distribution technology (FACTS, electricity quality); large electric machinery and intelligent equipment

(electrical equipment and its detection and diagnosis and intelligent); power electronics and energy conversion (large capacity power electronics, independent power systems); new energy power generation and distributed power systems (wind power and solar power generation, distributed system, micro-grid); electrical theory and new technology (superconductivity, pulse power, electrical communication, as well as national defense industry); thermodynamic system simulation and control; Chinese overall energy strategy soft sciences research. The three experimental centers are the lab center for power system, lab center for high voltage and electromagnetic environment, lab center for power electronics converting system. The structure of the state key lab is shown in Fig 3.1.

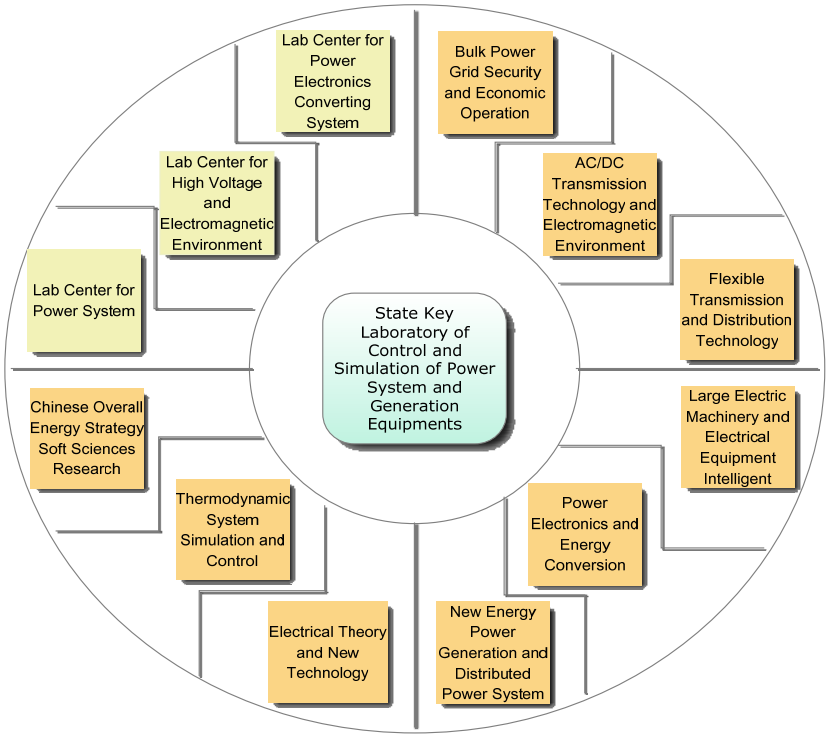

Fig 3.1 Structure of the state key lab

The Department has paid great attention to academic communication and collaboration domestically and internationally. Over forty faculties have international working experience, including four IEEE Fellows and three IET Fellows. Some of them are active in international academic groups, such as CIGRE, IEC and so forth. In recent years, the Department has successfully held several important international conferences, with over five hundred people attending each time. **The annual overseas research fund has recently reached over 8M RMB**.

Whilst cooperating with oversea institutes, the Department is also keeping close contact with domestic companies. The Power companies of State Grid and China Southern Power Grid are two key power operation companies in China. The Department of Electrical Engineering has built an excellent collaboration relationship with them. Several focused technology issues on the progress of power grid are being joint-studied. **In 2009, the research fund offered by State Grid and China Southern Power Grid totaled 40M RMB**.

At the same time, a number of joint-research institutes have been set up by the Department and well-known enterprises domestically and internationally. It shows a new mechanism to improve the innovation ability of power enterprises and meet the needs of state power development.

3-2 Funding

It is widely known, that the power industry plays an important role in the progress of the society. Faculties at the Department of Electrical Engineering of Tsinghua University have an unusually high involvement with the power industry, to meet its ever increasing demand. Centered around the subjects of 'Safe, Economical and Environmental Friendly', the Department has participated in numerous great national projects and also taken part in research work on the basic theory and key technology. With the achievements of the research, the Department has also undertaken the industrialization of the research results.

In the respect of the research funding, as an important group in China, the Department has been funded by many high-level projects each year. Several of them are promoted by the national government. It can be seen from this point that, firstly, faculties have the ability to take part in the key research work, and secondly, the state and main power companies have confidence in the research quality of the Department of Electrical Engineering at Tsinghua University.

With high-level research group, the Department of Electrical Engineering receives large amounts of research fund each year. Fig 3.2 shows the research fund per faculty in recent five years. Some of the main projects are listed in Table 3.1.

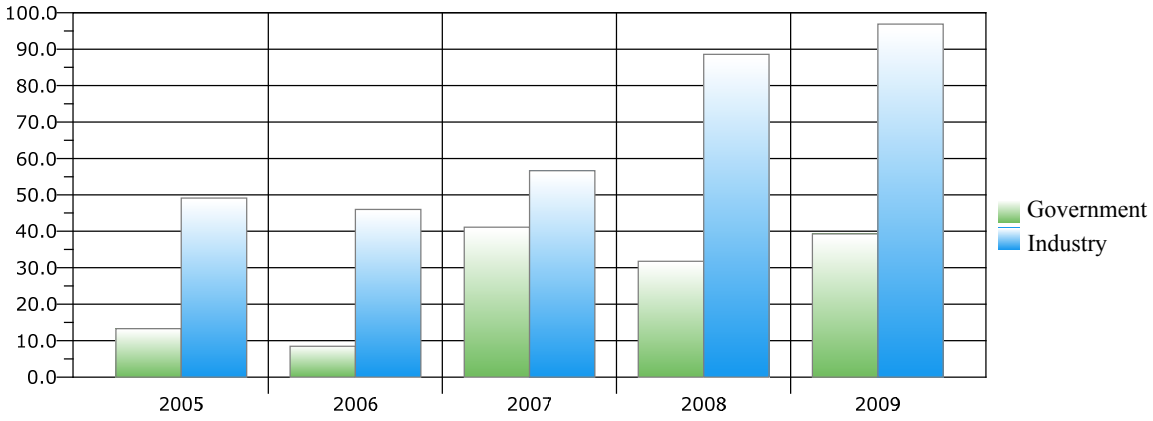

Fig 3.2 Research fund per faculty in recent five years (Units 10k RMB)

Table 3.1 Main research projects from government undertaken in recent years

Name	Source	Time Span	Principal Investigator
Digital Power System (G1998020301)	973	2000.9－2003.8	Lu, Qiang
Digital Power System --- Real-Time Digital Simulation System of Power Grid （G1998020302）	973	2000.9－2003.8	Zhang, Boming
Interaction between Physical Analogue and Realtime Digital Simulation of Power Systems （G1998020303）	973	2000.9－2003.8	Sun, Yuanzhang
Nonlinear Robust Control Theory of Power	973	2000.9－	Mei, Shengwei

Systems and Its Engineering Application（G1998020306）		2003.8	
Study on Dynamical Characteristics and Security Assessment of Power Receiver Systems（2004CB217901）	973	2004.9－2009.9	Sun, Yuanzhang
System complexity theory in safety assessment for large-scale power grid（2004CB217902）	973	2004.9－2009.9	Mei, Shengwei
Theories and Approaches about Distributed Processing for Large-Scale Interconnected Power System Calculation (2004CB217903)	973	2004.9－2009.9	Shen, Chen
Foundational Research on Reliability Enhancement to Large–Scale Interconnected Power Systems (2004CB217904)	973	2004.9－2009.9	Zhang, Boming
Study on Increasing the Transmission Capability of EHV AC lines（2004CB217906）	973	2004.9－2009.9	Liang, Xidong
High Power Electronics Technologies and Multi-feed HVDC for Increasing Power System Reliability（2004CB217907）	973	2004.9－2009.9	Liu, Wenhua
Development of Bio-Acoustic Frightening Product Against Agriculture Predators Based on Intelligent Wireless Sensor Networks and Research on Its Key Supporting Technologies	863		Zhao, Wei
Energy Conversion and Key Control Technologies for High Power Electrical Drive System with High Efficiency	863		Li, Yongdong
Research on Control Methods of Servo System at Very Low Speed	863		Xiao, Xi
Research of Oil & Gas Pipeline Crack Inspection based on EMAT guided wave	863		Huang, Songling
Coordinated system-wide voltage/Var optimal controller applied to hierarchical electrical power control centers	863		Sun, Hongbin
Key Biomedical Instruments	863		Jiang, Xiaohua
Electric machine and its control system for fuel cell city bus drive	863		Qu, Wenlong
Research on Electromagnetic Capability of the Electrical System in Fuel Cell City Bus	863		He, Jinliang
Fundamental Theories and Key Technologies for Security Defense in Power Systems based on WAMS（50595410）（Major Program）	NSFC Major	2005.4－2009.3	Sun, Yuanzhang
Abnormal dynamics and characteristics of extra large-scale power system（50595411）（Sub-Project of Major Program）	NSFC Sub-major	2005.3－2009.2	Mei, Shengwei
The Theory and Method on Wide Area Modeling	NSFC	2005.3－	Zhu, Shouzhen

and simulation for Power System Dynamic Security analysis（50595412）（Sub-Project of Major Program）	Sub-major	2009.2	
Wide-area Information based Power System Security Early Warning, Protection and Control Theory and Method（50595413）（Sub-Project of Major Program）	NSFC Sub-major	2005.3－2009.2	Han, Yingduo
Research on Foundational Theory and Key Technologies for Wide Area Security Defense of Power Systems（50595414）（Sub-Project of Major Program）	NSFC Sub-major	2005.3－2009.2	Zhang, Boming
Study of z-pinch physics driven by high-power pulse and correlative pulsed power technology（10035030）（Key Program）	NSFC Key	2001.1－2004.12	Han, Yu
Modeling and Simulations of Superconductive Electric Equipments（50137020）（Key Program）	NSFC Key	2002.1－2004.12	Wang, Zanji
Study on The Key Fundamental Problems of Novel Methods of Removing Chemical and Biological Pollutions Indoors（50436040）（Sub-Project of Key Program）	NSFC Key	2005.1－2007.12	Zhou, Yuanxiang
Mechanism of Breakdown and Performance Increasing of Dielectric under High Electro-magnetic Field Intensity（50437030）（Key Program）	NSFC Key	2005.1－2008.12	Liang, Xidong
Mechanism for Glow Discharge at Atmospheric Pressure（50537020）（Key Program）	NSFC Key	2006.1.－2009.12.	Wang, Xinxin
Study of Fast Z-pinch Physics（10635050）（Key Program）	NSFC Key	2007.1－2010.12	Zou, Xiaobing
Fundamental Study on Key Technologies for Deeply Suppressing Overvoltage of AC Ultra High Voltage Power System（50737001）（Key Program）	NSFC Key	2008.1－2011.12	He, Jinliang
The Theory and Cutting-technology for the High Power Electronics（50737002）（Key Program）	NSFC Key	2008.1－2011.12	Zhao, Zhengming
Study on The Key Techniques of High Power High Repetition Rate Switches（Key Program）	NSFC Key	2009.1－2012.12	Jiang, Weihua
Research on Several Basic Application Theories of Micro-Grid System（Key Program）	NSFC Key	2009.1－2012.12	Zeng, Rong
Research on Fault Travelling Waves Theory and Its Applications in Power System Fault Detection (50937003) （Key Program）	NSFC Key	2010.1.1－2013.12.31	Dong, Xinzhou
Research on Theory and Application of Safe and	NSFC	1999.1－	Sun, Yuanzhang

Economic Control for Power System(59825104)	DYS[23]	2001.12	
Fundamental Study on Multi-Stress Aging and Brittle Fracture of Composite（50025720）	NSFC DYS	2001.1－2004.12	Liang, Xidong
Research on ZnO Varistors with High Voltage Gradient（50425721）	NSFC DYS	2005.1－2008.12	He, Jinliang
Power System Transient Analysis（50525721）	NSFC DYS	2006.1－2009.12.	Mei, Shengwei

3-3 Research Status

The research status of the Department of Electrical Engineering at Tsinghua University includes scientific outcomes, e.g. published scientific books, peer reviewed papers, and authorized patents, and research directions.

3-3-1 Statistics of Scientific Achievements

With taking part in a number of great projects, the faculties in the Department of Electrical Engineering at Tsinghua University have produced numerous research outputs.

During the last five years, the faculties have authored dozens of academic books. The total words involved are approximately over 10 million. Detailed information of these books is presented in Table 3.2.

Table 3.2 Scientific books published by faculties of the Department in the evaluation period

Author	Title	Publisher	Year
He, Jinliang, Chen, Shuiming, et.al.	GB/T Terms for lighting protection of information system	Standard Press of China	2005
Zeng, Rong, He, Jinliang, Chen, Shuiming, et.al.	GB/T 19856.1-2005Lighting protection-Telecommunication lines Part 1: Optic fiber installation	Standard Press of China	2005
He, Jinliang, Chen, Shuiming, Zeng, Rong	GB/T 19856.2-2005Lightning protection—Telecommunication lines—Part 2: Lines using metallic conductors	Standard Press of China	2005
Li, Yongdong, Xiao, Xi, Gao, Yue	High Power Multi-level Convertors	Science Press of China	2005
Zhao, Zhengming, Liu, Jianzheng, Sun, Xiaoying, Yuan, Liqiang	Photovoltaic Generation Systems and Its Applications	Science Press of China	2005
Wang, Changchang, Li, Fuqi and Gao, Shengyou	On-line Monitoring and Diagnosis for Power Equipment	Tsinghua University Press	2006
Wu, Zhongzhi, Huang, Lipei, Wu	User’s Guide on Adjustable Speed Drive Inverters and Supporting	China Machine Press	2006

[23] National Natural Science Funds for Distinguished Young Scholar

Jialin	Devices (2nd Edition)		
Wang, Weijian, Wang, Xiangheng, Wang, Zanji	Internal Fault Analysis and Relay Protection for Large Power Generators and Transformers	China Electric Power Press	2006
Guan, ZhiCheng, Liu, Yingyan, Zhou, Yuanxiang, Jia, Zhidong, Wang, Liming, Shi, Weidong	Insulator and Outdoor Insulation of Power Equipment	Tsinghua University Press	2006
Qian, Jiali, Yuan, Dalu, Yang, Lihua, Zhang, Jierong , Guan, Yonggang	Modern High Voltage Switchgear	China Electric Power Press	2007
Jin, Lijun, Qian, Zheng, Guan, Yonggang	Modern Electrical Measurement Technology	Electronics Industry Press	2007
Sun, Kai, Zhou, Daning, Mei, Yang	Matrix Converter Technology and its Applications	China Machine Press	2007
Kang, Chongqing, Xia, Qing, Liu, Mei	Power System Load Forecasting	China Electric Power Press	2007
He, Jinliang, Zeng, Rong	Grounding in Power System	Science Press of China	2007
Zhao, Zhengming	“Energy Saving of Electric Motor System”, Chapter 2 “Adjustable Speed Drive System”, pp.39-87, Tutorial Book	International Copper Society	2007
Zhao, Zhengming	“Guidebook of Graduation Design for University Students”, Chapter 6 “Evaluation and Review Type for Thesis” , pp. 262-300	High Educational Press	2007
Chen, Jianye	Power Quality Control of Industry Enterprise	China Machine Press	2008
Jiang, Qirong, Zhao, Dongyuan, Chen, Jianye	Active Power Filter	Science Press of China	2008
He, Jinliang, Qiu, Chuanrui, Hu, Jun, Chen, Shuiming, etal	GB/T21714.4-2008 Protection against lightning - Part 4: Electrical and electronic systems within structures	Standard Press of China	2008
Chen, Shuiming, He, Jinliang	GB/Z 21713-2008Recommended practice on characteristic of surges in low-voltage (1000 V and Less) AC Power circuits	Standard Press of China	2008

Jiang, Weihua, Zhang, Chi	Chinese translation of "Pulsed Power Systems"	Tsinghua University Press	2008
Lu, Qiang, Mei, Shengwei, Sun, Yuanzhang	Nonlinear Control in Power Systems	Tsinghua University Press	2008
Mei, Shengwei, Xue ,AnCheng, Zhang, Xuemin	Power System Self-Organized Criticality and large scale power grid security	Tsinghua University Press	2008
Zhao, Zhengming , Yuan, Liqiang	Handbook of Power Electronics, Chapter 10 High Voltage and High Power Electronics	China Machine Press	2008
Zhao, Zhengming	"Handbook of Electrical Engineer", Volume 16, Chapter 3 "Solar Energy PV System"	China Power Press	2008
He, Guangyu, Sun Yingyun	Smart Grid Basis	China Electric Power Press	2009
Jiang, Weihua, Zhang, Chi	Chinese translation of "High Power Microwaves, 2nd Edition"	National Defense Industry Press	2009
Xing, Yan, Xiao, Xi, Wang, Lina	The Basis of Power Electronics Technology	China Machine Press	2009
Stefan Linder (Edited), Xiao, Xi, Li, Hong (Translated)	Power Semiconductors	China Machine Press	2009
Zhao, Zhengming, Yuan, Liqiang	Integrated Analysis of Power Electronics and Motor Drive System	China Machine Press	2009
Zhang, Boming	Electric Power Engineering- Power System Dispatch Automation	China Electric Power Press	2009
Jiang, Qirong, Zhang, Chunpeng, Li, Hong	Wind and Solar Power Systems: Design, Analysis and Operation	China Machine Press	2009
Mei, Shengwei, Xue, AnCheng, Zhang, Xuemin	Self-Organized Criticality Characteristic and Power System Security	Tsinghua University Press	2009
Zhao, Wei, Huang, Songling, et.al.	Basic Modern Electromagnetic Measuring Technology（Fourth Chapter of Foundation Volume of China Electrical Engineering Canon）	Chinese Electric Power Press	2009

In the respect of scientific papers output, hundreds of papers are published with the affiliation of the Department Electrical Engineering at Tsinghua University each year. In the recent five years, the number of peer reviewed papers published in journals and conferences is shown in Fig 3.3. Table 3.3 shows a detailed breakdown for 2009.

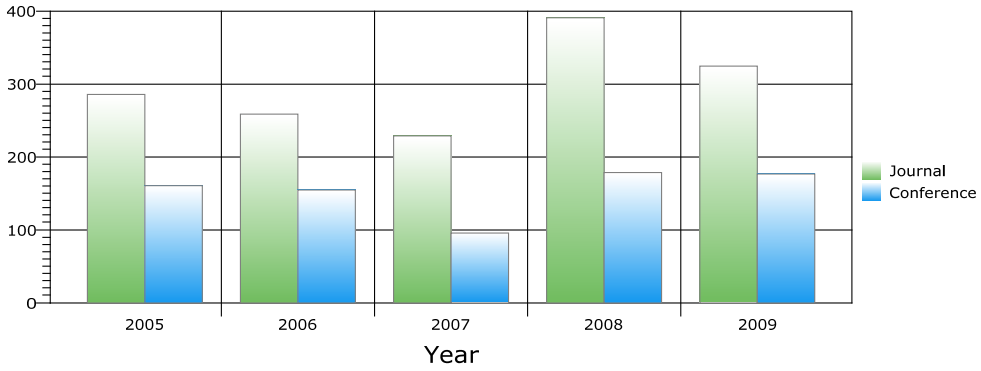

Fig 3.3 Peer review papers published in journals and conferences

Table 3.3 Several kinds of published papers in 2009

	Domestic Journal	International Journal	Domestic Conference	International Conference	Invited Report in International Conference
Number	242	38	31	112	12

Faculties in the Department think highly of publishing peer reviewed papers in high standard international journals, from which we select ten IEEE Transactions as examples including IEEE Transactions on power electronics, Applied Superconductivity, Electromagnetic Compatibility, Magnetics, Energy Conversion, Power Delivery, Power Systems, Industrial Electronics, Dielectrics and electrical insulation, Industry applications. IEEE/IET Electronic Library (IEEE Xplore) is used to do the search. Figure 3.4 presents the number of papers published with the affiliation of the Department Electrical Engineering at Tsinghua University from 1999 to 2009 and Fig. 3.5 compares the data of the Department with that of other universities. The details of these papers are presented in the Appendix.

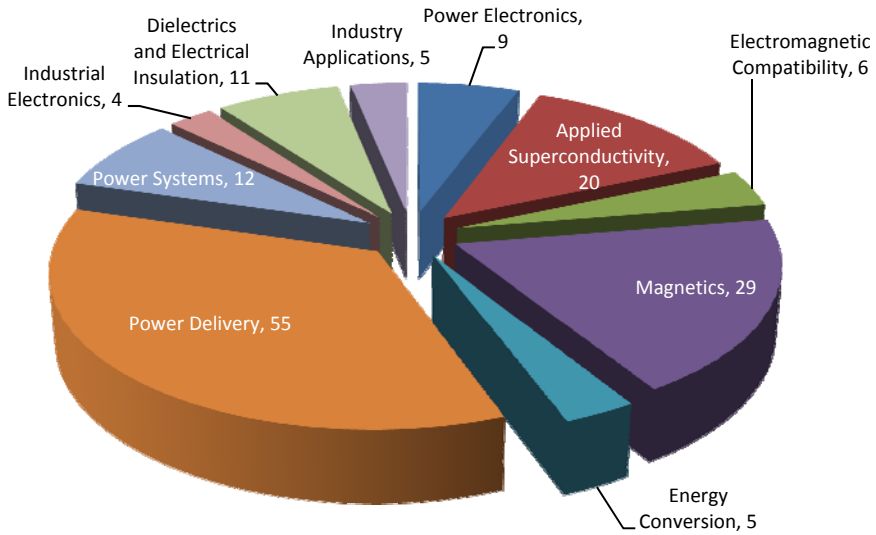

Fig 3.4 Number of papers published in ten IEEE Transactions with the affiliation of the Department Electrical Engineering at Tsinghua University from 1999 to 2009

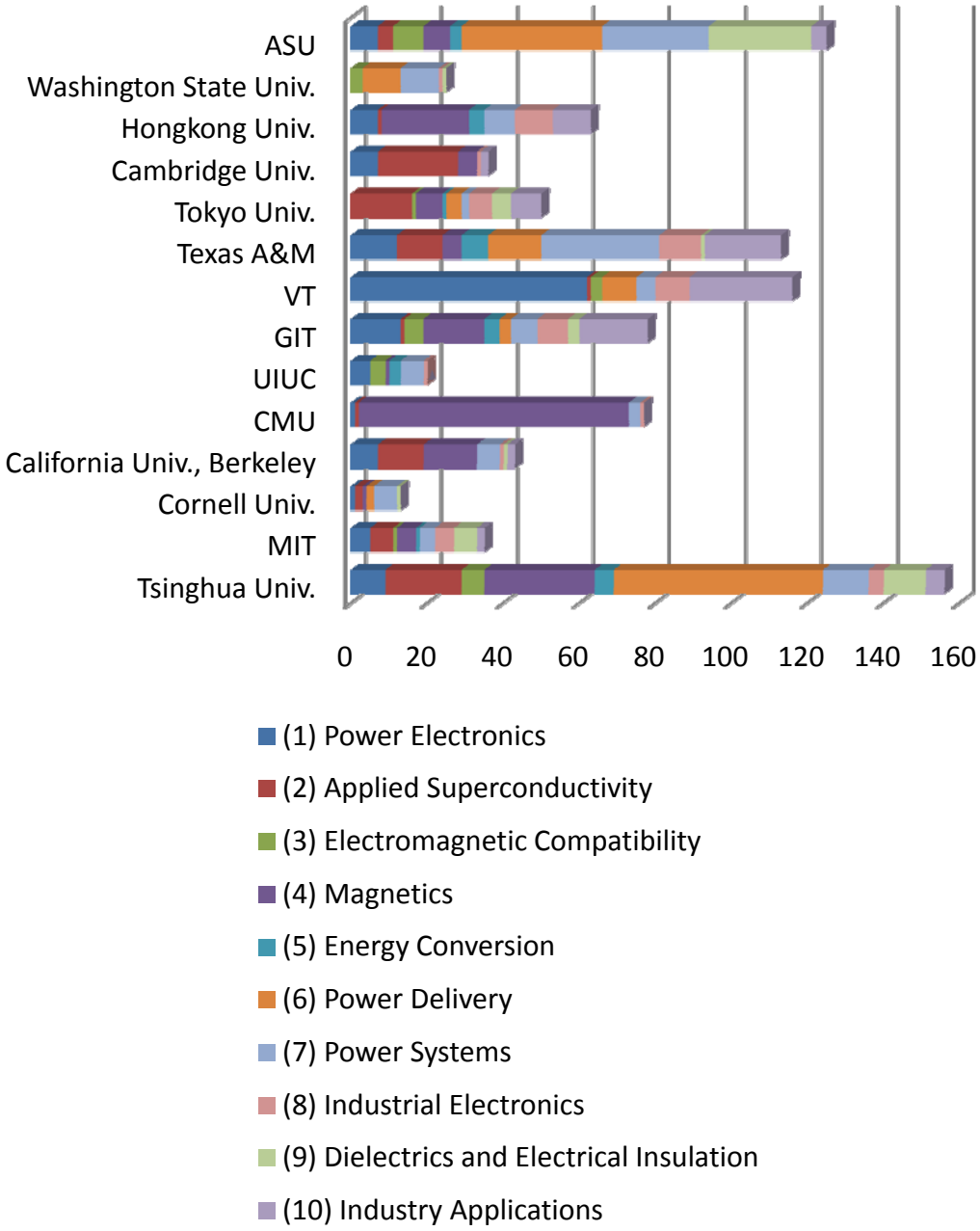

Fig 3.5 Number of papers published in ten IEEE Transactions with the affiliation of different universities from 1999 to 2009 [24]

[24] The data of Tsinghua University only contains papers with the affiliation of the Department of Electrical Engineering. For other universities, corresponding departments are used, i.e. Department of Electrical Engineering and Computer Science at Massachusetts Institute of Technology, School of Electrical and Computer Engineering at Cornell University, Department of Electrical Engineering & Computer Sciences at University of California, Berkeley, Department of Electrical and Computer Engineering at Carnegie Mellon University, Department of Electrical and Computer Engineering at University of Illinois at Urbana-Champaign, School of Electrical and Computer Engineering at Georgia Institute of Technology, Bradley Department of Electrical & Computer Engineering at Virginia Tech, Department of Electrical and Computer Engineering at Texas A&M University, Department of Electrical Engineering and Information Systems at The University of Tokyo, Department of Engineering at University of Cambridge, Department of Electrical and Electronic Engineering at University of Hong Kong, School of Electrical Engineering and Computer Science at Washington State University, School of Electrical, Computer and Energy Engineering at Arizona state University. If a paper is only with the affiliation of Tsinghua University, we only count in those whose authors are faculties of the Department of Electrical Engineering. If a paper is only with the affiliation of universities other than Tsinghua University, it is counted in.

Considering patents, in the recent five years, the Department has achieved tens of patent authorizations. The number of invention patents and utility model patents is shown in Fig 3.6.

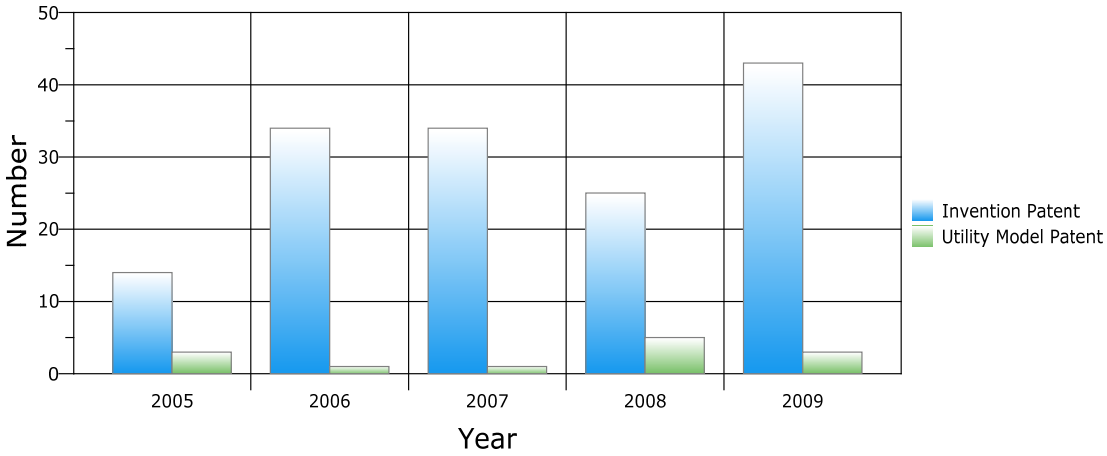

Fig 3.6 Invention and utility model patent in the recent five years

3-3-2 Research Directions

The research directions are listed in the following sections under four research fields (power electronics and electrical machinery are combined). More details are presented in the Supplementary Material.

3-3-2-1 Power System and Its Automation

Digital Power System

Qiang Lu, Shengwei Mei, Chen Shen, Guangyu He, Ying Chen, Xuemin Zhang

The Digital Power System group is led by Professor Qiang Lu who is an Academician of the Chinese Academy of Science and a foreign Academician of the Royal Swedish Academy of Engineering Sciences. The research interests of the group mainly focus on power system control for today's and future practice, including device level and system level control applications, power grid safety precaution and catastrophic failure prevention technologies, digital power system related technologies.

Flexible Transmission & Distribution Systems

Yingduo Han, Qirong Jiang, Wenhua Liu, Chao Lu, Qiang Song, Xiaorong Xie, Qingguang Yu, Zhichang Yuan, Chunpeng Zhang

The Flexible Transmission & Distribution Systems group is led by Professor Yingduo Han who is an Academician of the Chinese Academy of Engineering. The group continuously produces new solutions to practical engineering problems and the general research areas as follows: (1) Flexible AC Transmission System(FACTS); (2) Power Quality Analysis and Control; (3) Wide-area Measurement System(WAMS);(4) Evaluation and control of Subsynchronous Resonance and Oscillation; (5) Research on Power System Electromagnetic and Electromechanical Real-time Hybrid Simulation; (6) Photovoltaic Systems.

Smart Grid Technology

Yonghua Song

The Smart Grid Technology Laboratory is led by Professor Yonghua Song who is a fellow of the Royal Academy of Engineering (UK) and the IEEE (USA). He was a Professor and a Pro-Vice-Chancellor of Brunel University and the University of Liverpool. Currently there are 12 members in the laboratory: one associate professor, one postdoctoral fellow, seven Ph.D. candidates, and three master students. The Smart Grid Technology Laboratory currently focuses its research areas on Low-Carbon Electricity Policy and Technologies, Electric Vehicle (EV) Integration and Demand Response, and Smart Dispatch.

Electric Power Control Center

Boming Zhang, Hongbin Sun, Wenchuan Wu, Qinglai Guo

The Electric Power Control Center (EPCC) group is led by Professor Boming Zhang, who is a Follow of the IEEE. The group is devoted to develop theories and algorithms for computer applications in electric power control centers. This team is driving technology progress and extending application of Energy Management Systems (EMS) advanced application software in China. More than 10 pioneering innovative techniques have been proposed by this team and applied to real power system control centers. The EMS application software developed by this team has been extended to more than 60 power grids in China. The utility company PJM in USA cooperated with the EPCC team on automatic voltage control (AVC) study in 2008 and AVC implementation in the PJM control center in 2009.

Power System Stability and Control

Yong Min, Renjie Ding, Wei Hu, Zongxiang Lu, Fei Xu, Yiwei Zhang, Lei Chen, Ying Qiao

The Power System Stability and Control research group is led by Professor Yong Min, who is the Head of the Department of Electrical Engineering. The group is dedicated to improving power system security. The major research fields of the group are introduced as follows: Transient Stability Analysis and Control; Low Frequency Oscillation Analysis and Control; Hybrid Automatic Voltage Control; Reliability of Power Systems and Risk Based Condition Maintenance; Grid Integration Technology of New Energy Generation; Development Strategy and Key Technology on Vehicle-to-Grid; Distributed Generation and Microgrids.

Dynamic Power System

Yuanzhang Sun, Guojie Li, Jianzheng Liu, Lin Cheng, Xiong Li

The Dynamic Power System group is led by Professor Yuanzhang Sun, who is a Cheung Kong Scholar. The group studies the generation mechanism of ultra-low frequency oscillation and its control methods and proposes the integrated system of the wide area damping control theories. Moreover, the research group explores the statistic laws of power system catastrophes, analyzes the inherent causes and the formation mechanisms of the blackouts, and tries to find effective defense measures.

Power Economics and Information

Qing Xia, Chongqing Kang, Yu Shen

The Power Economics and Information group is led by Professor Qing Xia. The research interests of the group mainly focus on power economics and the electricity market, power system operation and dispatch technologies, power system planning technologies, load forecasting technologies, low-carbon power technologies, smart grid technologies and developing strategies, and the application of information technologies in power systems.

Power System Protection

Xinzhou Dong, Bin Wang, Shenxing Shi

The Power System Protection group is led by Professor Xinzhou Dong, who is an IET fellow. The group's research and achievements mainly focus on two aspects: proposing the fault detection theories and techniques based on the transient travelling wave analysis and the wavelet transform algorithm, and secondary disturbance information and its applications.

Power System Identification and Security Monitoring

Shouzhen Zhu, Jinghong Zheng, Xiaoyu Wang

Power System Identification and Security Monitoring is led by Professor Shouzhen Zhu. It mainly deals with modeling and identification of four major parameters in power system, i.e. power system load, excitation system, generator, priming mover and governing system Parameters; large generator units and brushless excitation security monitoring technology; distributed generation and its interconnection with power grids

3-3-2-2 High Voltage and Insulation Technology

Advanced Power Transmission Technology

Jinliang He, Rong Zeng, Shuiming Chen, Bo Zhang, Zhanqing Yu, Jun Hu

The Advanced Power Transmission Technology group is led by Professor Jinliang He who is an IEEE Fellow. Its research covers lightning physics and protection, grounding technology of AC and DC power system, electromagnetic environment and electromagnetic compatibility of AC and DC power system, advanced electromagnetic transient analysis, flashover characteristics of long air gaps in power system, and novel metal-oxide surge varistors for surge suppression.

High Voltage Insulation

Xidong Liang, Yuanxiang Zhou, Yingyan Liu, Ying Yang

The High Voltage Insulation Research group is led by Professor Xidong Liang who is the winner of the National Science Fund for Distinguished Young Scholars. It has a broad research vision on outdoor insulation, dielectric materials, and compact transmission technology. In each of these areas, both fundamental research and industrial applications are all emphasized.

Advanced Technology of Electrical Engineering & Energy

Zhicheng Guan, Liming Wang, Zhidong Jia, Ruobing Zhang

The Advanced Technology of Electrical Engineering & Energy group is led by Professor Zhicheng Guan, who is an IET fellow. The goups's major researches include outdoor insulation at high altitudes, corona cage, corona characteristics and electrical-magnetic environment of overhead transmission line, dynamics characteristics of the conductors and mechanical characteristics of composite insulators in overhead transmission line, discharge along contaminated surface and technique of room temperature vulcanized (RTV) silicone rubber, pulsed electric field (PEF) processing of liquid food, non-biodegradable waste water treatment by discharge plasma, electrospinning, preventive measures of ice shielding.

Gas Discharge and Plasma

XinXin Wang, Guixin Zhang, Xiaobing Zou, Weihua Jiang, Peng Wang

The Gas Discharge and Plasma group is led by Professor Xinxin Wang. The group has been engaged in gas discharge research and pulsed power technology for nearly 40 years. Recent research projects include atmospheric pressure glow discharge, x-ray backlighting of Z-pinch plasmas using an X-pinch as x-ray source, nanopowder production by electric explosion of wires, gaseous recovery in gas spark gap switches, repetitive pulsed power switches and their applications, sterilization of food using atmospheric microwave plasmas.

Intelligent Power Equipment

Guozheng Xu, Weidong Liu, Yulong Huang, Yonggang Guan, Wensheng Gao, Shengyou Gao

The Intelligent Power Equipment group is led by Professor Guozheng Xu. The main research activities in the group include: Phenomena and theory of heavy current interruption in circuit breakers, overvoltages and their suppression associated with the switching operation of circuit breakers, fault current limiting in power systems; measurement of high voltage, heavy current and fast transient, and on-site detection of the power equipment condition.

3-3-2-3 Power Electronics and Electrical Machinery System

Power Electronics and Motor Systems

Zhengming Zhao and Liqiang Yuan

The Power Electronics and Motor Systems group is led by Professor Zhengming Zhao. The group focuses on the following research topics: photovoltaic power systems, high-voltage high-power converters, and the integration of power electronics and motor system.

High Power and High Performance Control of AC Motors

Yongdong Li, Xinjian Jiang, Xi Xiao

The High Power and High Performance Control of AC Motors group is led by Professor Yongdong Li and is mainly concerned with control theories, real time implementation, sensor-less drives and applications of vector and direct torque control of AC motors; high-voltage, high-power converters for motor drives and active power filter application, etc.

All these areas are part of modern power electronics basically dealing with conversion, control and efficient utilization of electrical energy for variable applications where electrical motor control is particularly a fascinating and challenging topic.

Power Conversion & Industry Application

Lipei Huang and Kai Sun

The Power Conversion & Industry Application (PCIA) group is led by Professor Lipei Huang. It conducts research and development on the utilization of electrical energy with high efficiency and high performance. Main research topics of the PCIA group are advanced power electronics converters, high-performance AC adjustable speed drives, EMC & EMI of power converters and distributed generation systems.

Electric Vehicles and Drive

Wenlong Qu and Haifeng Lu

The Electric Vehicles and Drive group is led by Professor Wenlong Qu. For many years the group has been engaged in the teaching and scientific research of power electronics and motor control. The emphasis of the research is focused on motor drives in Electric Vehicles (EV). In the period of the Eighth to Eleventh Five-Year Plan of China, some key projects of EV were undertaken and completed. The main contribution is in the high performance control of induction motor vector control system.

Applied Superconductivity & Power Electronics

Xiaohua Jiang

The Applied Superconductivity & Power Electronics group is led by Professor Xiaohua Jiang. The group focuses on developing a 7T animal MRI system, being supported by the National High Tech. Research & Development Program 863 and collaborated by Hangzhou Biomedical Tech. Venture Park Co. Ltd. The most important sub-system, being developed, is a 7T NbTi magnet which is actively shielded and has an air bore of 21cm diameter and field homogeneity of 5ppm on a 10cm DSV.

Electrical Machine Analysis and Control

Shanming Wang, Yuguang Sun, Daqiang Bi, Lin Gui

The Electrical Machine Analysis and Control group is led by Associate Professor Shanming Wang. The group's research covers the following topics: multi loop analysis of AC machines, analysis and protection for internal faults of large AC generators, cycloconverter-fed synchronous motor drive system, synchronous generator system with inter-machine excitation, AC excited generator system with variable speed and constant frequency, AC/DC combined power supply system, and dual-stator winding multi-phase high-speed induction generator with rectifier load, etc.

3-3-2-4 Electrical Theory and New Technology

Circuits and Systems

Zanji Wang, Xinjie Yu, Fuping Wang, Hao Pang

The Circuits and Systems group is led by Professor Zanji Wang. The group focuses on the following research topics: modeling and simulations of fast transients and internal faults of large power transformers, superconductive electric equipments, electromagnetic pulse and system protection, and electromagnetic launch systems; digital signal processing and its application in power systems; identification and demodulation of communication signals; and chaotic signal processing and its application in communications.

Computation of Electromagnetic Fields and its Application

Jiansheng Yuan and Jun Zou

The Computation of Electromagnetic Fields and its Application group is led by Professor Jiansheng Yuan. The group focuses on the numerical calculation method research, software development and simulation of fields in devices. With in-house developed software and the multi-physics fields calculation software----ANSYS 11.0, the electromagnetic, mechanic, thermal and flow fields in different devices have been calculated, and optimization design suggestions have been provided, including power and locomotive transformers, current and potential transformers, permanent magnet motors, Tokamak, and electromagnetic logging.

Electromagnetic Measurement and Nondestructive Testing

Wei Zhao and Songling Huang

The Electromagnetic Measurement and Nondestructive Testing group is led by Professor Wei Zhao. The group is engaged in the studies of fundamental theories and applied techniques in the fields of electromagnetic measurement and nondestructive testing. The interested research topics include the inspection principles and methods of electromagnetism, radiography, ultrasonic, infrared, etc.

Power System Communications

Jingbo Guo

The Power System Communications group is led by Professor Jingbo Guo. The group primarily focuses on the following two directions: chaos theory and its application in electronic communication systems, which deals with chaotic signal detection and modulation & demodulation in chaotic communications, chaotic jamming in digital communications; power line communication and its application in electric power systems, which deals with dynamic resources management & optimization of the Power Line Communications (PLC), PLC Network communications and its application in remote metering.

Water Cooling System for Power Electronics

Jianye Chen and Guiping Zhu

The Water Cooling System for Power Electronics group is led by Professor Jianye Chen. It focuses on the design and implementation of water cooling system for power electronics equipment. The group maintains the patent “closed loop water cooling device”, which was approved in 2003 (ZL 02 2 42732.5). The technology was then used in China’s first 220kV 120MVA SVC power system, Shanghai 50MVA STATCOM, all the domestically made HVDC, TCSC, as well as high-power frequency conversion devices.

3-4 Research Impacts

The research impacts defined in this report are various governmental assessments, international conference hosting, faculties being the editorial board of journals, organizing committee of international conferences, and other academic positions, scientific awards, and the close relationship with power engineering industries of the Department of Electrical Engineering at Tsinghua University, i.e. the social recognition of the Department as a research institute.

The Department of Electrical Engineering at Tsinghua University has received high praise for the excellent research work. The State Key Laboratory of Control and Simulation of Power System and Generation Equipments, which covers the main specialties of the electrical engineering discipline, was accredited as "Excellent" (A) in the assessment held in 2003 by the Ministry of Science and Technology. In 2008, the Laboratory was again accredited as "Excellent" (A). In 2003, 5 out of 52 State Key Labs were "Excellent". In 2008, 5 out of 54 State Key Labs were accredited as "Excellent". State Key Laboratory of Control and Simulation of Power System and Generation Equipments is one of the three State Key Labs which were accredited as "Excellent" twice.

The following international conferences were hosted by the Department of Electrical Engineering at Tsinghua University.

- 2010 Asia-Pacific Symposium on Electromagnetic Compatibility & Technical Exhibition on EMC RF/Microwave Measurement & Instrumentation, Chairman Professor Jinliang He.
- 2005 14th International Symposium on High Voltage Engineering, Chairman Professor Zhicheng Guan.
- 2000 IEEE 6th International Power Electronic and Motion Control Conference.

Faculties in the Department of Electrical Engineering at Tsinghua University are active in the editorial board of many journals, organizing committee of international conferences, and present keynote speeches at international conferences. Selected data is presented in Table 3.4. The details of the professional affiliations and activities are introduced in the Supplementary Material.

There are one academician of CAS, one academician of CAE, one academician of RAE, four IEEE Fellows, and three IET Fellows in the Department. In the period of evaluation, one faculty is supported by National Thousand Talents Program, three faculties are supported by Cheung Kong Scholars Program, four faculties won the National Science Fund for Distinguished Young Scholars, and one faculty received the IEEE EMC Society Technical Achievement Award.

Table 3.4 Editorial board, organizing committee, and keynote speeches by faculties of Department of Electrical Engineering at Tsinghua University

Name	Editorial Board of Journals	Organizing Committee or Keynote Speech for International Conferences
Chen, Shuiming	➢ Lightning Protection and Standardization ➢ China Lightning Protection ➢ Lightning Protection World	
Dong, Xinzhou	➢ Power System Protection and Control ➢ Electric Automation Equipment ➢ Automation of Electric Power Systems Equipment	➢ 2004 and 2008 International Conference on DPSP ➢ 2004, 2007, and 2009 International Conference on APAP ➢ 2009 Asia and Pacific Transmission and Distribution Conference and Exhibition ➢ 2009 International Conference on Hydropower Technology& Equipment
Guo, Jingbo		➢ 2001 IEEE ISPLC
Han, Yingduo	➢ Proceeding of the CSEE ➢ Automation of Electric Power Systems ➢ Electric Power Automation Equipment	➢ 2009 International Electric Power Security Development and Emergency Management Forum ➢ 2005 International Conference on Power Transmission and Distribution Technology ➢ 2003 International Conference on Power Transmission & Distribution Technology ➢ 2002 International Power System Emerging Technology Seminar
He, Jinliang	➢ High Voltage Technology ➢ Journal of Lightning Research ➢ Journal of Lightning Protection and Standardization	➢ 2008, 2010, and 2011 Asia-Pacific Symposium on Electromagnetic Compatibility ➢ 2007 and 2009 Asian Lightning Protection Forum ➢ 2009 Int. Conference on Properties and Applications of Dielectric Materials ➢ 2008 Asian Lightning Protection Forum ➢ 2006 International Symposium on Electromagnetic Compatibility
Huang, Lipei	➢ Advanced Technology of Electrical Engineering and Energy ➢ World of Inverters ➢ Inverter Technologies and Applications	➢ 2008 and 2009 International Seminar on Power Electronics and Energy ➢ 2000 International Power Electronics and Motion Control Conference

Jiang, Weihua	➢ IEEE Transactions on Plasma Science Special Issue	➢ 2008 IEEE International Conference on Plasma Science ➢ 2010 IEEE Power Modulator and High Voltage Conference
Jiang, Qirong	➢ Proceeding of the CSEE ➢ Automation of Electric Power Systems	➢ 2008 Special Sessions of Power Quality of IEEE Asia Pacific Conference on Circuits and Systems
Kang, Chongqing	➢ International Journal on Power System Optimization ➢ Journal of Cambridge Studies ➢ Power System Protection and Control ➢ International Journal of Power and Energy Systems	➢ 2008 China/Japan Energy and Environment Symposium ➢ 2008 Sino-Dutch Energy for the Future Seminar ➢ 2009 Asian Conference on Power and Energy Systems ➢ 2010 International Conference on Probabilistic Methods Applied to Power Systems
Li, Yongdong	➢ European Journal of Electrical Engineering ➢ 'ELECTROMOTION' Quarterly ➢ Power Electronic Technology	➢ 1999 PEDS ➢ 2000 IPEMC ➢ 2005 IEEE IECON Annual Meeting ➢ 2010 IET Int. Conference on Power Electronics, Machines and Drives conference ➢ 2011 IPEMC
Liang, Xidong	➢ IEEE Transaction on Dielectrics and Electrical Insulation ➢ High Voltage Engineering ➢ Silicone Materials ➢ Non-ceramic Insulators and Arresters ➢ Electrical Technology	➢ 2001, 2003, 2005, 2007, and 2009 World Conference on Insulators ➢ 2005 International Symposium on High Voltage Engineering ➢ 2004 Asia Conference on Electrical Discharge
Liu Weidong	➢ High Voltage Apparatus	
Lu, Chao		➢ 2008 and 2010 IEEE Int. Conference on Networking, Sensing and Control ➢ 2008 IEEE International Conference on Information and Automation
Lu, Qiang	➢ Journal of Control Theory and Applications ➢ Journal of Modern Electric Power ➢ Automation of Electric Power Systems ➢ Electric Power Automation Equipment	

	➢ Proceedings of the Chinese Society of EE ➢ Advanced Technology of Electrical Engineering and Energy ➢ Journal of Science in China ➢ Journal of Power System Technology ➢ Journal of Tsinghua University ➢ Journal of Chongqing University ➢ Journal of High Voltage Engineering ➢ Journal of Electric Machines and Control ➢ Journal of Southern Power System Technology	
Mei, Shengwei	➢ Control Theory and Application ➢ Advanced Technology of Electrical Engineering and Energy	➢ 2007 Workshop On Sustainable Power Generation And Supply
Min, Yong	➢ Proceedings of the Chinese Society of Universities ➢ North China Electric Power ➢ Modern Electric Power	
Qu, Wenlong	➢ Electric Drive for Locomotives	
Song, Yonghua	➢ IEEE Transactions on Sustainable Energy ➢ Electricity ➢ Proceedings of CSEE ➢ Modern Electric Power ➢ Power System Technology ➢ China Electric Power	
Sun, Hongbin	➢ Journal of Electrical Power Science and Technology ➢ Electrical Power Automation Equipment Journal	➢ 2009 Asian Conference on Power and Energy Systems ➢ 2009 Asia-Pacific Power and Energy Engineering Conference
Wang, Zanji	➢ Advanced Technology of Electrical Engineering and	➢ 2001 International Conference on Power Transmission & Distribution Technology

	Energy ➢ Transformer	➢ 2000 International Conference on Power System Technology ➢ 2000 International Power Electronics and Motion Control Conference
Xia, Qing	➢ Electric Power Automation Equipment ➢ Modern Electric Power ➢ Electric Power System and Automation ➢ Southern Electric Power Technology	
Zhang, Boming	➢ Chinese Society of Electrical Engineering ➢ Power System Technology ➢ Automation of Electric Power System ➢ Electric Power Automation Equipment ➢ Power System Protection and Control ➢ Chinese Society of Universities	➢ 2005 International Workshop on Electric Power Control Centers
Zhao, Wei	➢ Journal of Astronautic Metrology and Measurement ➢ Journal of Electrical Measurement and Instrumentation ➢ Journal of Academic Degrees and Graduate Education	➢ 2007, 2008, and 2009 International Symposium and Exhibition on Electromagnetic Measurement Technology, Standardization and Products
Zhao, Zhengming	➢ Journal of Converter and Drive System ➢ Journal of Machine and Control Applications ➢ Transaction of China Electrotechnical Society ➢ Transaction on Electric machine and Control ➢ Journal of Electric Power Automation Equipment	➢ 1999 IEEE International Conference of Power Electronics and Drive System ➢ 2000 International Conference of Power Electronics and Motion Control
Zhou, Yuanxiang		➢ 2005 ISH ➢ 2004 ACED ➢ 2003 ICMEP ➢ 2003 ACEID

As well as taking part in numerous important projects, the Department of Electrical Engineering at Tsinghua University has received many scientific awards for its high-level scientific achievements. The awards in past five years are shown in Tables 3.5 and 3.6.

Table 3.5 National level awards received in the past five years

Year	Achievement	Person	Award
2007	Power Line online fault location technology based on travelling waves	Dong, Xinzhou	Second Prize of State Technological Invention Award
2008	Nonlinear Control Theory of Large Scale Power Systems	Lu, Qiang, Mei, Shengwei, Sun, Yuanzhang, Liu Feng	Second Prize of State Natural Science Award
2008	Key Technologies and Applications of New Generation Energy Management System for Power Grids with 3-Dimensional Coordination	Zhang, Boming, Sun, Hongbin, Wu, Wenchuan, Guo, Qinglai, Tang, Lei, Wang, Peng	Second Prize of State Technological Invention Award
2008	Arcing Protection Hardware with Stab, Clamping Insulator and Gap Arrester for Protection of Distribution Lines Against Lighting Breakage	He, Jinliang	Second Prize of State Technological Invention Award

Table 3.6 Provincial and Department level awards received in the past five years

Year	Achievement	Person	Award
2005	An Automatic External Network Equivalence System for Guangdong District Power Grids	Zhang, Boming, Zhang, Haitao	Third Prize of China Electric Power Technology
2005	Research on Technology Issues of Large Grid-Connected Wind Farm	Zhou, Shuangxi, Chen, Shouting	Third Prize of China Electric Power Technology
2005	Voltage Stability Analysis and Control for South China Electrical Power Grid	Sun, Yuanzhang, Cheng, Lin, Guan, Xiupeng, Zhang, Jianyun	Third Prize of Progress in Science and Technology (China Southern Power Grid)
2005	On-Line Detection, Location and Diagnosis of Partial Discharges in GIS Sensing in UHF Way from External GIS	Liu, Weidong	Second Prize of Progress in Science and Technology (Shanxi)
2005	Sequence Operation Theory and its Application in power systems	Kang, Chongqing, Xia, Qing, Xiang, Niande,	Second Prize of Science and

		Bai, Lichao, Zhou, Anshi, Liu, Mei, Zhao, Jing, Jiang, Jianjian	Technology (Beijing)
2006	Research on Mechanism Analyses and Preventive Measures of Influences of HVDC System Grounding Electrode Current on AC System	Zeng, Rong, He, Jinliang	Second Prize of Progress in Science and Technology (Education of Ministry)
2006	Reactive Power Optimization and Automatic Voltage Control System for Jiangsu Power Grid	Sun, Hongbin, Zhang, Boming	Second Prize of Progress in Science and Technology (State Grid)
2006	Research on Influences of HVDC System Return Current in Earth on AC System and Preventive Measures	Zeng, Rong, He, Jinliang,	Second Prize of Progress in Science and Technology (China Southern Power Grid)
2006	An Automatic External Network Equivalence System for Guangdong District Power Grids	Zhou, Shuangxi	Third Prize of Progress in Science and Technology (China Southern Power Grid)
2007	Key Technologies and Applications of New Generation Energy Management System for Power Grids with 3-Dimensional Coordination	Zhang, Boming	Second Prize of Progress in China High Education College
2007	IGCT-based High Voltage and High Power Three-level Adjustable Speed System	Zhao, Zhengming, Yuan, Liqiang, Zhang, Haitao	Second Prize of Progress in Power Science and Technology
2007	On-Line Security Stability Analysis and Early Warning System of Power Grids Based on EMS/DTS	Zhang, Boming, Wu, Wenchuan, Sun, Hongbin	Third Prize of Progress in Power Science and Technology
2007	The research of Collapse Prevention and Economical Operation model and realization of HAVC system in Shenzhen Grid	Hu, Wei	Third Prize of Progress in Power Science and Technology
2007	IGCT-based High Voltage and High Power Three-level Adjustable Speed System	Zhao, Zhengming, Yuan, Liqiang, Bai, Hua, Zhang, Haitao, Sun, Xiaoying	First Prize of China Electrotechnical Society

2007	Study on Evaluation Technology and Protection of Substation Electromagnetic Environment	He, Jinliang, Zhang, Bo, Chen, Shuiming, Zou, Jun, Zeng, Rong	Prize of Progress in Science and Technology (Beijing)
2007	Domestic high-capacity variable speed constant frequency doubly fed induction generator system for wind turbine	Jiang, Xinjian, Chai, Jianyun, Li, Yongdong	Prize of Progress in Science and Technology (Beijing)
2007	The Suggestion of Solar Energy Applications for 2008 Beijing Olympic Game	Zhao, Zhengming	Excellent Advice Prize (Beijing Technology Association)
2008	Researches and Implementations of Adaptive Coordinated Control for Multiple HVDC Links based on WAMS	Lu, Chao, Han, Yingduo	First Prize of China Electric Power Technology
2008	Study on Improving the Safety of Substation Grounding Systems	He, Jinliang, Zeng, Rong, Zhang, Bo, Zou, Jun, Cheng, Shuiming	Second Prize of China Electric Power Technology
2008	Study and Application of EMI on DC Protection Systems Caused by AC Switching Operations	Yu, Zhanqing, Zeng, Rong	Third Prize of China Electric Power Technology
2008	Distributed Dispatcher Training Simulator for Provincial and District Wide-Area interconnected Power Systems	Wu, Wenchuan, Zhang, Boming	Third Prize of China Electric Power Technology
2009	High-resolution visual inspection equipments of large tank floor defects	Huang, Songling	Second Prize of Progress in Science and Technology (Education of Ministry)
2009	Research and Application of Supplementary Excitation Control and Torsional Protection to Suppress Subsynchronous Resonance	Xie, Xiaorong	First Prize of China Electric Power Technology
2009	Management, Analysis and forecasting System for power sale market and its Applications	Kang, Chongqing	Third Prize of China Electric Power Technology
2009	Real-time Power Dispatch System Based on Coordination Among Security, Economy and Energy Saving	Xia, Qing	Third Prize of China Electric Power Technology
2009	Operation Supporting and Information Management System	Xia, Qing	Third Prize of China Electric Power

	for Energy-saving Based Power Dispatch in Guangdong Province		Technology
2009	The Development of Oil & Gas Pipeline Corrosion MFL(Magnetic Flux Leakage) Inspection Tools	Huang, Songling	First Prize of Automation in Fossil Oil and Chemistry Industry
2009	Four-Hierarchical Gradient Early Warning System for Security and Reliability Operation of Henan Power Grid	Zhang, Boming, Wu, Wenchuan	Second Prize of Progress in Science and Technology (State Grid)
2009	Energy Conservation based Generation Dispatching Technical Support and Information Management System in Guangdong Province	Kang, Chongqing	Second Prize of Progress in Science and Technology (China Southern Power Grid)
2009	Numerical Analysis of DC Current Distribution in AC Power System Near HVDC System	Zhang, Bo	First Prize of Youth Excellent paper (Beijing)
2009	Adaptive zone division based system-wide voltage control method for power grids	Sun, Hongbin, Wu, Wenchuan	Second Prize of Invention Patent (Beijing)
2009	Researches on Wide-area Control to Damp Inter-area Oscillations and Improve the Stability of Northeast China Power Grid	Lu, Chao	First Prize of Science and Technology (Northeast Grid)
2009	Security evaluation of Southern China power system in 2006	Lu, Zongxiang	Third Prize of Progress in Science and Technology (Guangxi)
2009	Research on an all digital power metering system under high voltage environment	Wang, Peng	Third Prize of Progress in Science and Technology (Qinghai)

In order to closely keep in touch with the industrial power industry, the Department of Electrical Engineering at Tsinghua University has built several joint research institutes with power enterprises. These institutes accelerate the cooperation between academic research and the real engineering requirements and thus significantly increase the impact of the Department of Electrical Engineering at Tsinghua University. The institutes set up in recent years are listed in Table 3.7.

Table 3.7 Joint research institutes operational in recent years

Founded Date	Cooperation Partner	Institute Name	Principal Investigator	Validity /Year	Funding / M RMB
2001.1	Baoding Tianwei Group Co., Ltd	Tsinghua-Baoding Electrical Technology Research Institute	Wang, Zanji	3	4
2001.11	Guodian Nanjing Automation Co., Ltd	Tsinghua-Nanzi Power Electronics Technology Research Institute	Zhao, Zhengming	5	20
2001.12	Beijing Sifang Co., Ltd	Tsinghua-Sifang Power System Stability Research Institute	Tong, Luyuan	3	5
2003.1	Henan XJ Group Co., Ltd	Tsinghua-XJ High Capacity Protection Research Institute	Wang, Xiangheng	3	1.5
2003.9	Beijing Ping Gao Electrical Group Co., Ltd	Tsinghua-Ping Gao Electrical Research Institute	Xu, Guozheng	3	4
2003.9	AREVA T&D Research Center	Tsinghua-AREVA T&D Research Institute	Dong, Xinzhou	8+5	0.8 M pounds
2004.3	Guodian Nanjing Automation Co., Ltd	Automation of Electric Network Management Research Institute	Zhang, Boming	3	10
2005.5	Beihai Yinhe H-tech Co., Ltd	Automation of Power System Research Institute	Lu, Qiang	3	5
2005.9	Liaoning Hi-Tech Energy Group	Micro-Grid Research Institute	Min, Yong	3	5
2007.5	Ping Gao Group Co., Ltd	Tsinghua-Ping Gao Electrical Research Institute	Liu, Weidong	3	9
2007.6	Changshu Switchgear Mfg. Co., Ltd	Tsinghua-Changshu Power Electronics Research Institute	Zhao, Zhengming	3	9
2009.12	China Petrochemical Corporation	Tsinghua-CPC Electrical Engineering Research Institute	Huang, Songling	3	9

Part 4 Strategic Plan

4-1 Challenges

With the rapid development of the power engineering industry in China and smart grid around the world, the research and education content in the Department of Electrical Engineering will expand far beyond its historical roots to encompass almost all areas of engineering activities i.e. communication, computer science, material science, etc. With this viewpoint, the Department of Electrical Engineering is facing the following challenges.

- The research and education directions are relatively narrow compared to the requirement of the future fusion of power and information technology. On the research aspect, though significant attention has been paid to the generation and transmission of electrical power, the aspects on the distribution of electrical power is far from sufficient, which might be the key part of the smart grid.
- The maturing of the power engineering technology means that it has transitioned from being technology driven to being application driven. This transition leads to the fact that even though there is currently a considerable research fund per faculty, the original research and leading achievements are not sufficient what is expected of a world class research department.
- Electrical power might become more important in the future energy structure of China. Unknown new challenges might emerge owing to the hyper-complexity of the energy system, which has not been currently considered by the Department.
- The current “institutes-based” research infrastructure provides a lack of flexibility for adapting to meet the previously mentioned challenges.
- Whilst it is relatively easy for the Department’s graduates to find jobs, which, in-turn, makes student recruitment healthy, and although this may continue for more than ten years in China, the Department of Electrical Engineering should be well prepared for the possible future changes and provide and maintain attractive curriculum.
- The international exchanges of both personnel and research are insufficient, which restricts the international influence of the department.

4-2 Education Plan

1. Taking proactive steps, e.g. form new undergraduate programs together with other departments, in recruiting talents into the Department of Electrical Engineering and Tsinghua University. Increase the attention paid by faculties to the admission process and the freshmen so that they are well informed of the competitive potential of power engineering in both employment and scientific research.
2. Enhancing the innovation education in the current curriculum to cultivate inquisitive students. While the undergraduate curriculum appears to be functioning well, the Department of Electrical Engineering must continue to work on the reform advocating innovative and interactive teaching.

3. Improving and perfecting the academic advisor system by inviting more experienced faculties as advisors.
4. Adding more project-based courses in the curriculum, especially in undergraduate program, to enhance the system analysis, design, and debugging skills and team-work spirit of the students.
5. Reducing the required credits appropriately in the undergraduate program. Students should be challenged to prepare for leadership roles in society. More opportunities, such as various associations, need to be available for students to enhance their abilities to become distinguished leaders through communication and collaboration.
6. Providing greater opportunities for students' exchange, including sending students to overseas institutions and attracting students from overseas institutions. To implement the latter task, a certain number of the courses should be delivered in English.
7. Increasing the internship opportunities by adding power system internship collaborators.

4-3 Research Plan

1. Constructing a more effective sustainable funding allocation mechanism to alleviate some faculties from repetitive application-oriented developments to allow them to focus on interesting topics related to the broad aspects of electrical engineering.
2. Exploring more effective scientific research infrastructure by trying various internal structures within the Department of Electrical Engineering or with other departments with the goal of promoting the collaboration and fusion of institutes. Encouraging faculties to engage with colleagues from different fields and research areas.
3. Providing more opportunities for faculties' exchange, including visits and intensive research cooperation.
4. Supplying generous startup packages for new faculties in order to provide them time and funding to establish a teaching and research program.
5. Hosting large international conferences and encouraging faculties into editorial boards of international journals and or organizing committee of international conferences to further strengthen the impact of Department of Electrical Engineering internationally.

4-4 Others

1. Hiring potential young Ph.D. graduates and aggressively recruiting successful scientists internationally based on the latest developments in various research fields.
2. Strengthening the connection with alumni by establishing an alumni database. Inviting alumni into department decision making.
3. Obtaining regular feedback from both enrolled students and graduates.
4. Increasing the number of faculties in the editorial board of the international journals and the organizing committee of the influential international conferences.
5. Establishing a regular external evaluation system for the Department and programs. The Department of Electrical Engineering will formulate the an Action Plan within the evaluation period (five to six years) according to the Strategic Plan presented in this

self-study report and the Evaluation Report produced by the external experts. The Action Plan will form the basis for the next international evaluation.

Appendixes A Forms for Educational Quality Assurance

A-1 Evaluation Form for Faculties' Trial Teaching

Name of the Instructor: _____ Name of the Course:_____
Time of the Trial Teaching: _____ Contents of the Trial Teaching_____

1. Evaluation Form

Item	Order	Detailed Item	Evaluation Rank			
			A Excellent	B Good	C Pass	D Fail
Contents	1	Topic Selection				
	2	Contents Organization				
	3	Basic Concepts				
Teaching Skills	4	Thought				
	5	Logic				
	6	Emphasis				
	7	Expression				
	8	Handwriting				
Teaching Methods	9	Heuristics				
	10	Utility of Teaching Tools				
Overall Performance						

2. Comments

3. Conclusion

Qualified	
Basically Qualified	
Not Qualified	

Experts:_____ Date: _____

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A-2 New Course Application Form

Course Title:

Note: Provide a tentative course title.

Program:

Note: Specify the program to whom the course offers.

Prerequisite(s):

Note: List all prerequisite course(s).

Credits:

Note: List the planned credits of the course.

Experiments(s):

Note: List the experiment(s) required by the course.

Project(s):

Note: List the project(s) required by the course.

Semester Offered:

Note: Specify the semester in which the course is planned to be offered.

Instructor(s):

Note: List the name(s) of all instructor(s).

Textbook(s):

Note: List all required and optional textbook(s).

Course Description:

Note: Provide a precise description of the course content.

Course Topics:

Note: List the major topics to be covered in the course.

Course Objectives:

Note: List the course objectives. The course objectives must match and be linked to Educational Objectives of Department of Electrical Engineering.

Course Outcomes:

Note: List the course outcomes based on ABET's 11 abilities. The outcome shall help to achieve the objectives

Course Assessment:

Note: Specify the components of the final score.

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A-3 Questionnaire on Instructors and Courses by Students

Name of the Course Name:_____ Name of the Instructor: _____

Note: Student's suggestion and feedback plays an important role in helping instructors to improve their course design and teaching quality. Please answer the questionnaire truthfully. Thank you for your cooperation.

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Please state the level of teaching quality (single choice):

For Evaluation: A-Excellent, B-Good, C-Adequate, D-Fair, E-Poor

For Statement: A-Strongly Agree, B-Agree, C-Undecided, E-Disagree, E-Strongly Disagree

Evaluation on the Instructor					
What is your overall rating of the instructor's teaching quality?	A	B	C	D	E
Statement on the Instructor and the Course					
1. The instructor is enthusiastic, devoted, and serious in teaching.	A	B	C	D	E
2. The instructor presents the topics clearly with emphases on core materials and difficult contents.	A	B	C	D	E
3. The instructor gives vivid and attractive lectures that stimulate students' inquiry of knowledge.	A	B	C	D	E
4. The instructor teaches with interactive approaches, encourages questions, and guides students to answers.	A	B	C	D	E
5. The course materials (textbook, reading, etc.) are useful.	A	B	C	D	E
6. Assignments (homework, projects, papers, etc.) help students to expand their knowledge in the field.	A	B	C	D	E
7. The course assessment criteria are designed to encourage students' initiatives to study and research	A	B	C	D	E
8. The instructor emphasizes on training students for innovation and research capability.	A	B	C	D	E
9. The instructor provides advices and suggestions for study and research outside the classroom.	A	B	C	D	E
10. You have learnt much in this course	A	B	C	D	E

Open Questions:

1. Features of the course of the instructor.

2. Hopes and suggestions.

A-4 Questionnaire on Instructors and Courses by Experts

Name of the Course_____ Name of the Instructor_____

Day_____ Time_____ Location_____

Aspects	Evaluation Item	Excellent	Good	Adequate	Fair	Poor
Instructor	Start and finish the lecture on time					
	Enthusiastic, devoted, and serious in teaching					
	Clear thought and right concept					
	Proficient in the content and well focused					
	Introduce real applications for theories					
	Stimulate students' inquiry of knowledge.					
	Active interactive atmosphere in the classroom					
	The contents reach the cutting edge of the corresponding fields					
	suitably utilize various teaching tools					
	Overall evaluation for the instructor					
Students	Obey the rules, no late-arrive or early-leave					
	Seriously study and actively thinking					
	Respect the instructor and well behavior					
	Overall evaluation for the students					

1. The overall evaluation for the instructor on the attitude to teaching, contents, methods, and characteristics.

2. The evaluation for the students attending the class (please also report the number of students who presented at the class, the number of student who were late for the class in less than five minutes, and the number of student who were late for the class in more than five minutes).

3. The feedbacks of students on the instructors.

4. Suggestions on improving this lecture.

Experts:_____ Affiliation_____ Date_____

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A-5 Questionnaire on Curriculum by Graduates

Note: As a graduating student, you have already been familiar with the university's education system. Your feedbacks are of great importance in inspiring the reformation and improvement of our curriculum system. Please answer the questionnaire seriously and truthfully. Thank you for your cooperation.

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Department:_____Class:_____ Date:_____

1. Please list the most beneficial courses (including lab and practice courses) or instructors, and put √ in the row(s) reflecting the feature(s).

Instructor	Course	Course contents reflecting the-state-of-the-art of the field	Characteristic teaching approaches (inspiring, exploring, etc.)	Solid foundation for further study and practice in the field

2. Please list the worst courses or instructors, and put √ in the row(s) reflecting the problem(s).

Instructor	Course	Out-of-date course content	Dull and less-stimulating lectures	Useless for further study and practice in the field

3. Please list the best textbooks, and put √ in the row(s) reflecting the feature(s).

Course	Textbook	Up-to-date contents	Logic and clear expression	Helpful for the study in this course

4. Please list the worst textbooks, and put √ in the row(s) reflecting the problem(s).

Course	Textbook	Old contents	Too many typos	Useless for the study in this course

5. Please put √ under the most impressive educational activities.

SRT	Competitions						Thesis Comprehensive Training	Others
	Structure Design	Mathematical Modeling	Agent	ACM	Electronic Design	Mechanical Design		

Appendixes B List of Papers Published in Ten IEEE Transactions with the Affiliation of the Department of Electrical Engineering at Tsinghua University from 1999 to 2009

B-1 Power Electronics

1. Zhuo Sun; Xinjian Jiang; Dongqi Zhu; Guixin Zhang; , "A novel active power quality compensator topology for electrified railway," Power Electronics, IEEE Transactions on , vol.19, no.4, pp. 1036- 1042, July 2004
2. Bai Hua; Zhao Zhengming; Yuan Liqiang; Li Bing; , "A High Voltage and High Power Adjustable Speed Drive System Using the Integrated LC and Step-Up Transforming Filter," Power Electronics, IEEE Transactions on , vol.21, no.5, pp.1336-1346, Sept. 2006
3. Bin He; Minggao Yang; , "Robust LPV control of diesel auxiliary power unit for series hybrid electric vehicles," Power Electronics, IEEE Transactions on , vol.21, no.3, pp.791-798, May 2006
4. Pengju Kong; Shuo Wang; Lee, F.C.; Chuanyun Wang; , "Common-Mode EMI Study and Reduction Technique for the Interleaved Multichannel PFC Converter," Power Electronics, IEEE Transactions on , vol.23, no.5, pp.2576-2584, Sept. 2008
5. Pengju Kong; Shuo Wang; Lee, F.C.; , "Common Mode EMI Noise Suppression for Bridgeless PFC Converters," Power Electronics, IEEE Transactions on , vol.23, no.1, pp.291-297, Jan. 2008
6. Qiang Song; Wenhua Liu; , "Control of a Cascade STATCOM With Star Configuration Under Unbalanced Conditions," Power Electronics, IEEE Transactions on , vol.24, no.1, pp.45-58, Jan. 2009
7. Haifeng Lu; Wenlong Qu; Xiaomeng Cheng; Yang Fan; Xing Zhang; , "A Novel PWM Technique With Two-Phase Modulation," Power Electronics, IEEE Transactions on , vol.22, no.6, pp.2403-2409, Nov. 2007
8. Haifeng Lu; Lei Zhang; Wenlong Qu; , "A New Torque Control Method for Torque Ripple Minimization of BLDC Motors With Un-Ideal Back EMF," Power Electronics, IEEE Transactions on , vol.23, no.2, pp.950-958, March 2008
9. Ge Baoming; Wang Xiangheng; Su Pengsheng; Jiang Jingping; , "Nonlinear internal-model control for switched reluctance drives," Power Electronics, IEEE Transactions on , vol.17, no.3, pp.379-388, May 2002

B-2 Applied Superconductivity

1. Jinfeng Tian; Xiaohua Jiang; , "2D visual design of permanent MRI magnets by a hybrid BEM-IEM computation," Applied Superconductivity, IEEE Transactions on , vol.10, no.1, pp.887-889, Mar 2000
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5. Xiaohua Jiang; Xiaoguang Zhu; Zhiguang Cheng; Xiaopeng Ren; Yeye He; , "A 150 kVA/0.3 MJ SMES voltage sag compensation system," Applied Superconductivity, IEEE Transactions on , vol.15, no.2, pp. 1903- 1906, June 2005
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B-3 Electromagnetic Compatibility

1. Zhan-Qing Yu; Jin-Liang He; Rong Zeng; Hong Rao; Xiao-Lin Li; Qi Wang; Bo Zhang; Shui-Ming Chen; , "Simulation Analysis on Conducted EMD Caused by Valves in \pm 800 kV UHVDC Converter Station," Electromagnetic Compatibility, IEEE Transactions on , vol.51, no.2, pp.236-244, May 2009
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B-4 Magnetics

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Transactions on , vol.37, no.1, pp.489-492, Jan 2001

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B-5 Energy Conversion

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B-6 Power Delivery

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