Program description (TQF 2)
Doctor of Philosophy Program
in Polymer Science and Engineering
(International Program/Revised Program 2013)

Institution Silpakorn University

Campus/Faculty/Department Sanamchandra Palace campus, Faculty of Engineering and Industrial Technology, Department of Materials Science and Engineering

Section 1 General Information

1. Title of program

Thai หลักสูตรปรัชญาดุษฎีบัณฑิต สาขาวิชาวิทยาการและวิศวกรรมพอลิเมอร์ (หลักสูตรนานาชาติ)

English Doctor of Philosophy Program in Polymer Science and Engineering (International Program)

2. Title of degree

Full title in Thai	ปรัชญาดุษฎีบัณฑิต (วิทยาการและวิศวกรรมพอลิเมอร์)
Abbreviated title in Thai	ปร.ด. (วิทยาการและวิศวกรรมพอลิเมอร์)
Full title in English	Doctor of Philosophy (Polymer Science and Engineering)
Abbreviated title in English	Ph.D. (Polymer Science and Engineering)

3. Major fields (If any) None

4. Program total credits

Type 1.1	48 credits
Type 1.2	72 credits
Type 2.1	at least 48 credits
Type 2.2	at least 75 credits

5. Type of program

5.1 Level Doctor's degree program; 3-year program for Type 1.1 and Type 2.1 and 5-year program for Type 1.2 and Type 2.2

5.2 Medium of Instruction English

5.3 Admission Thai and foreign students

5.4 Collaboration with other Institutions This program is administered solely by Silpakorn University

5.5 Type of Degree Conferred One degree (one major)

6. Program status and approval/endorsement

Revised program 2013 (Revision of Doctor of Philosophy Program in Polymer Science and Engineering 2007). Implementation in the first semester, academic year 2013.

This program was endorsed by the university academic committee in its meeting 18/2012 on 27 December 2012.

This program was endorsed by the university program revision committee in its meeting 6/2013 on 1 April 2013.

This program was approved by the university council in its meeting 5/2013 on 8 May 2013.

7. Expected year of promulgation of the qualified and accredited program

Academic year 2015

8. Professions/careers after graduation

(1) Instructors in public and private universities

(2) Researchers/academic staff in educational institutions or national research institutes

(3) Researchers/product developers in polymeric materials or advisors in the private sector

(4) Engineers in the private sector

(5) Business owners

9. Names, surnames, national ID numbers, positions and academic qualifications of instructors responsible for the program

(1) Miss Bussarin Ksapabutr

National ID number

Position: Assistant Professor

Qualifications: Ph.D. (Polymer Science), Petroleum and Petrochemicals College, Chulalongkorn University, Thailand (2003)

B.Sc. 2nd class honors (Materials Technology), Silpakorn University, Thailand (1996)

(2) Miss Pajaera Patanathabutr

National ID number

Position: Assistant Professor

Qualification: Ph.D. (Materials Science and Metallurgy), University of Cambridge, UK (1999)

B.Sc. 1st class honors (Materials Science), Chulalongkorn University, Thailand (1993)

(3) Mr. Nattawut Chaiyut
National ID number

Position: Lecturer
Qualifications: Ph.D. (Polymer Science and Technology) International Program, Mahidol University, Thailand (2005)
B.Sc. 2nd class honors (Materials Technology), Silpakorn University, Thailand (1998)

10. Place of instruction

Faculty of Engineering and Industrial Technology, Silpakorn University, Sanamchandra Palace Campus, NakornPathom

11. External context or developments affecting program planning

11.1. Economic context or developments

The Eleventh National Economic and Social Development Plan (B.E. 2555 – 2559) determined the national guidelines and strategies for building up Thailand's capacity for adapting to changes in many aspects in order to guard against risk factors which threaten Thai society, and for strengthening the national foundation in human and social development so as to develop a society made up of Thais of high quality; these changes will lead to the ability to adapt to changes, create opportunities to access natural resources and participate in economic, social and political developments efficiently and equally. Thai economic development will lead toward industries that are knowledge-based and environmentally sound; which are based on the application of knowledge, technology and innovation; which are creativity-based, productive and environmentally friendly in their consumption of natural resources, leading to sustainable development of the country.

The report of the National Economic and Social Development Board (NESDB) on the petrochemical and plastic industry in Thailand forecast that petrochemical production will increase rapidly. Increased production and a larger number of factories will create a need for more employment in this sector. Thailand will become the leading exporter of final petrochemical and plastic products and an importer of raw materials and intermediate products. The major emerging markets for Thai petrochemical products are East Asia, especially China, and Southeast Asia. Thailand is also the top producer of major petrochemicals as ethylene in Asia. However, petrochemical industries encounter problems in research as well as in product and technology development. Moreover, the capability of the industries to make use of technology imported from abroad is not sufficient. The public sector can increase competitiveness in research and development by promoting the creation of networks between academic institutions, research institutes and petrochemical and related industries in the field of knowledge management as well as enabling them to share data and experiences so as to develop new products in related industries. An NESDB concluded that the greatest current problem of the petrochemical industries in Thailand is the lack of ability to produce higher value-added products such as specialty products because of a lack of research and

development. Moreover, a study on related factors and the competitiveness of Thailand by major economic competitiveness agencies as well as International institute for Management Development (IMD) and reports from the World Economic Forum (WEF) agreed that Thailand still has weakness in Science and Technology as indicated by investment in research and development, investment in infrastructure for Science and Technology, the level of employment in research and development, the number of patents and the enforcement of intellectual property rights. These indicators show that there are limitations on the application of science and technology for improving the country's competitiveness. Moreover, many Thai institutes doing related research still do not co-operate and lack effective tools to integrate research from the public sector, the private sector and the community; risk management, and unclear profit-sharing agreements for the use of research outcomes on a commercial scale. All of the above are limitations to the application of academic research for commercial purposes.

11.2. Social and cultural context or developments

Globalization and the advances in logistics have resulted in and increase in travel for business and pleasure around the world. Most countries have realized the importance of developing the skills of their people in order to make their country competitive; they have also developed economic cooperation within their regions to simplify regulations related to investment and work permits of foreign labor. Globalization has been the cause of introducing foreign culture into Thailand. The lack of ability of Thais to select good elements of culture (and prevent bad elements) has cause a decrease in good norms and moral values among Thais and led to an increase in materialism and high consumption. Moreover, the increase in world population has causes an increase in world consumption of natural resource and both direct and indirect environmental pollution. The development of polymeric materials from renewable resources (instead of petroleum and gas) is now a current hot issue in modern society.

12. Impacts of Items 11.1 and 11.2 on program development and relation to the mission of the institute

12.1 Impacts on program development

The Doctor of Philosophy Program in Polymer Science and Engineering (International Program) aims to produce graduates with advanced knowledge in polymer science and engineering in order to develop a variety of new products for petrochemical and polymeric material industries and develop higher value added petrochemical products from raw materials within Thailand. The program focuses on encouraging students to conduct the research process independently and to practice research skills by writing a dissertation on a topic related to polymer science and engineering in order to be part of the industrial development of Thailand. The program also focuses on encouraging students to research and communicate in a foreign language and to have professional ethics and good norms for living in society in order to prepare them for globalization and cultural transfer. The program will focus on environmental conservation and new eco-friendly polymeric materials and processes that are based on scientific and technological knowledge and which will encourage green

industries on the path towards sustainable development and well-balanced society. Research and development on biogas and biomass includes gasohol, bio-diesel, energy from garbage and animal muck, energy from renewable sources, fossil-substituted energy such as wind energy, solar energy, hydro-energy, energy from recycled waste, as well as technological developments and innovations in petrochemicals and polymeric materials.

12.2 Relation to the mission of the institute

The aims of Doctor of Philosophy Program in Polymer Science and Engineering (International Program) are in accord with the vision of Silpakorn University ("Silpakorn the leading creativity university"); the focus is on human development in Science and Technology and producing quality researchers in a quantity sufficient to serve the needs of the public. The program focuses on the integration between acquiring knowledge and conducting research by producing doctoral graduates who are able to think creatively in order to produce new knowledge in polymeric material production for petrochemical industries in Thailand and to produce polymeric materials from renewable resources such as starch and natural rubbers as substitutes for synthetic materials without creating environmental problem. The research includes polymeric nano-materials for various applications such as medicine and energy, as well as research in local communities in Thailand on natural dyeing of silk and cotton fabrics, and natural fiber composites from local plants; this community-based research is a form of knowledge-based transfer from one locality to the international community in accord with Silpakorn's philosophy "Create Art, Science and Knowledge for the Public".

The Department of Materials Science and Engineering, Silpakorn University, was the first in Thailand to offer a Bachelor of Engineering program in Petrochemicals and Polymeric Materials in 1992. The graduates have gained a strong background in polymer research and education with fundamental knowledge in multidisciplinary fields in chemistry, physics, engineering, and industrial management. Since its creation, more than 550 students have graduated and have been offered positions in emerging careers in polymer science and process production, research and development and quality control in leading companies in Thailand as well as in government laboratories and academic institutions. In order to implement the government policy on human development by increasing the number of Ph.D. graduates educated in Thailand and the policy on knowledge development to substitute for imported technology through the production of local machinery and technology as well as to utilize local raw materials and to develop processes leading to higher efficiency, the Department of Materials Science and Engineering emphasizes involvement in academics and advanced research to develop versatile and well-educated Ph.D. graduates for the academic and industrial demands of Thailand. Faculty members in the department have cooperated on research with colleagues from other universities in Thailand such as Chulalongkorn University, Kasetsart University, and King Mongkut's Institute of Technology North Bangkok, and international universities in Singapore, Germany, and Italy.

13. Relationship (if any) with other programs offered by faculties/departments within the institute

None

Section 2 Program Specific Information

1. Philosophy, significance and objectives of the program

1.1 Philosophy

The Doctor of Philosophy Program in Polymer Science and Engineering (International Program) aims to develop academic staff and researchers with knowledge, ability and understanding at an advanced level in Polymer Science and Engineering.

1.2 Significance

The program focuses on producing Ph.D. graduates in Polymer Science and Engineering who have knowledge both in theory and practical skills as well being able to conduct research in Polymer Science and Engineering using a research methodology which encourages students to search for new knowledge independently and to practice laboratory skills by writing a research dissertation in Polymer Science and Engineering which aims to improve industrial development in Thailand. The program also focuses on producing Ph.D. graduates who are able to think creatively in order to create new knowledge for advance the field of study and integrate various subject fields. Moreover, the program focuses on producing Ph.D. graduates who have the knowledge and skill to conduct research in the academic and industrial sectors. The strength of the program is that the department has many qualified members of staff who have knowledge and a research background in broad areas such as nano-structured polymers and nano-composites, polymer processing (including micro- and nano-fabrication), polymer synthesis and characterization, natural polymers and rubber, biomedical applications of polymers, functional polymers and systems, modeling and simulation of polymer processes and technology, polymer recycling and sustainability, as well as polymers in energy, all of which are significant research areas for industrial development in petrochemical and polymer industries in order to enable Thailand to complete with other countries both in ASEAN and around the world. Ph.D. students have considerable flexibility in the selection of a research topic according to their interest and based on their academic background under the supervision of department staff members who have experience in supervising research; the students will also have the opportunity to expand their knowledge using a multidisciplinary approach in conducting co-operative research with industry to create new knowledge or solve problems in industrial production, as well as student exchange for research or training in universities or research institutes aboard.

1.3 Objectives

1.3.1 To produce Ph.D. graduates capable of defining and solving problems in Polymer Science and Engineering by producing high quality research contributing to basic knowledge or creating new knowledge in Polymer Science and Engineering to benefit the development of the county.

1.3.2 To create Ph.D. graduates with research skills, who are creative and capable of making decisions, and who have advanced research skills, management skills, and the characteristic of life-long leaning.

2. Program improvement and modification plan

The Doctor of Philosophy Program in Polymer Science and Engineering (International Program) has an improvement and modification plan, significant strategies for pursuing the achievement of this plan, and evidence/indicators:

Improvement/Modification Plan	Strategies	Evidence/Indicators
Plan to develop high-quality and accredited program according to national qualification framework for higher education in Thailand within 2 years	1. Implement a description of program course according to TQF 3. 2. Implement a report on course operation outcome according to TQF 5. 3. Implement a report on program operation according to TQF 7.	1. TQF 3 for all courses 2. TQF 5 for all courses 3. Annual TQF 7
Plan to revise the program to make it consistent with employment demands and country's need within 5 years	1. Implement program evaluation through a report on program operation, evaluation of satisfaction of employers of Ph.D. graduates, and report on Ph.D. graduate employment.	Program evaluation
Plan to disseminate research outcomes within 3 years	1. Published research outcomes and academic articles of department staff and Ph.D. students in the program	Published articles or proceedings at academic and research conferences

Section 3 Educational management system, implementation and curriculum structure

1. Educational management system

1.1 System

Bi-semester system, at least 15 weeks per semester with all regulations in accordance with Silpakorn University's regulations on graduate study, B.E. 2550 and/or any revisions thereto (as in Appendix A)

1.2 Summer session

A summer session of 8 weeks is offered with the approval of the graduate committee of the Faculty of Engineering and Industrial Technology.

1.3 Credit equivalent to bi-semester system

None

2. Program implementation

2.1 Study period

First Semester	June-September
Second Semester	November-February
Summer Session	March–May

2.2 Admission requirements

2.2.1 Type 1 (Thesis)

2.2.1.1 Type 1.1 Thesis equivalent to 48 credits

The applicants must possess a Master of Engineering degree in Polymer Science and Engineering or equivalent degree with permission from the Department of Materials Science and Engineering, Silpakorn University.

2.2.1.2 Type 1.2 Thesis equivalent to 72 credits

The applicants must possess a Bachelor of Engineering degree with excellent academic performance in Petrochemicals and Polymeric Materials or equivalent degree with permission from the Department of Materials Science and Engineering, Silpakorn University.

2.2.2 Type 2 (Thesis and additional courses)

2.2.2.1 Type 2.1 Thesis equivalent to 36 credits and 12 additional course credits

The applicants must possess a Master of Engineering degree in Polymer Science and Engineering or equivalent degree with permission from the Department of Materials Science and Engineering, Silpakorn University.

2.2.2.2 Type 2.2 Thesis equivalent to 48 credits and 27 additional course credits

The applicants must possess a Bachelor of Engineering degree with excellent academic performance in Petrochemicals and Polymeric Materials or

equivalent degree with permission from the Department of Materials Science and Engineering, Silpakorn University.

2.2.3 Applicants for program plans described in 2.2.1 and 2.2.2 must have other qualifications as required in accordance with Silpakorn University's regulations on graduate study, B.E. 2550, Title 7 and/or any revisions thereto (as in Appendix A) and in accordance with the announcement of the Ministry of Education on graduate program accreditation criteria, B.E. 2548 (as in Appendix B)

2.2.4 Applicants for program plans described in 2.2.1 and 2.2.2 must have good English reading, writing and speaking abilities as demonstrated by passing the required English examination, conducted by Silpakorn University as part of the admission test. The applicants can be exempted from the foreign language test by presenting evidence from other tests such as:

(1) TOEFL score of at least 500 (paper based) or at least 173 (computer based) or at least 61 (Internet based), or
(2) IELTS score of at least 5.5, or
(3) TOEIC score of at least 625, or
(4) CU-TEP score of at least 60, or
(5) TU-GET score of at least 45

The test scores must have been achieved within two years of the date of admission to the program. Exceptionally, applicants who cannot submit an English test score before the date of admission may be accepted for the Ph.D. program with the permission of the Department of Materials Science and Engineering under the condition of fulfilling the English requirement within the period of study according to the plan for each program.

2.2.5 Applicants for program plans described in 2.2.1 and 2.2.2 must have other qualifications as required by the Department of Materials Science and Engineering.

2.3 Problems of newly enrolled students

2.3.1 Students encountering English problems in writing dissertation proposals, progressive reports and dissertation in English.

2.3.2 The students having insufficient fundamental knowledge in Polymer Science and Engineering

2.4 Strategies for solving problems/ limitations of students specified in item 2.3

2.4.1 The Department provides native speakers of English to correct and proofread English.

2.4.2 The Department provides sufficient current textbooks in Polymer Science and Engineering and on topics related to student research topics.

2.5 Student enrollment plan and expected numbers of graduates in the next five years

Type 1.1 and Type 2.1

Year	Number of students in each academic year				
	2013	2014	2015	2016	2017
Year 1	4	4	4	6	6
Year 2	-	4	4	4	6
Year 3	-	-	4	4	4
Total	4	8	12	14	16
Number of expected graduates	-	-	4	4	4

Type 2.1 and Type 2.2

Year	Number of students in each academic year				
	2013	2014	2015	2016	2017
Year 1	1	1	1	1	1
Year 2	-	1	1	1	1
Year 3	-	-	1	1	1
Year 4	-	-	-	1	1
Year 5	-	-	-	-	1
Total	1	2	3	4	5
Number of expected graduates	-	-	-	-	1

2.6 Planned budget

2.6.1 Revenue budget (Unit: baht)

Revenue details	Fiscal year				
	2013	2014	2015	2016	2017
Academic fees	698,000	1,465,800	1,535,600	1,640,300	1,745,000
Registration fees	840,000	1,134,000	1,155,000	1,260,000	1,278,000
Government support	1,200,000	1,405,000	1,671,000	1,698,300	1,787,230
Total revenue	**2,738,000**	**4,004,800**	**4,361,600**	**4,598,600**	**4,810,230**

2.6.2 Expenditure budget (Unit: baht)

Five-year expenditure budget from Faculty of Engineering and Industrial Technology and Graduate School

Budget category	Fiscal year				
	2013	2014	2015	2016	2017
A. Operational costs					
Staffs expenses	750,000	825,000	900,000	975,000	1,050,000
Operational expenses	300,000	350,000	400,000	450,000	500,000
Scholarships	500,000	500,000	750,000	750,000	750,000
University expenses	-	-	-	-	-
Total (A)	**1,550,000**	**1,675,000**	**2,050,000**	**2,175,000**	**2,300,000**
B. Investment costs					
Equipment	100,000	100,000	100,000	100,000	100,000
Construction	-	**-**	**-**	**-**	**-**
Total (B)	-	-	-	-	-
Total (A)+(B)	**1,650,000**	**1,775,000**	**2,150,000**	**2,275,000**	**2,400,000**
Number of students	5	10	15	18	21
Expense per student	330,000	177,500	143,333	126,389	114,286

Approximate cost for producing a Ph.D. graduate is 178,302 baht per person per year

2.7 Teaching and learning modes

[/] Classroom
[ ] Distance learning through the primary source of printed media
[ ] Distance learning through the primary source of audio-visual media
[ ] Distance learning through the primary source of e-learning media
[ ] Distance learning through the primary source of Internet media
[ ] Other (please specify)

2.8 Course/credit transfer and inter-university course registration (if any)

Course/credit transfer and inter-university course registration are in accordance with Silpakorn University's regulations on graduate study, B.E. 2550, Title 7 and/or any revisions thereto (as in Appendix A).

3. Curriculum and faculty members

3.1 Curriculum

3.1.1 Number of credits

3.1.1.1 Type 1 (Thesis)

Type 1.1 Total credits for the program: at least 48 credits for applicants who have a master's degree

Type 1.2 Total credits for the program: at least 72 credits for applicants who have a bachelor's degree with honors

3.1.1.2 Type 2 (Thesis and additional courses)

Type 2.1 Total credits for the program: at least 48 credits for applicants who have a master's degree; thesis of at least 36 credits and coursework of at least 12 credits

Type 2.1 Total credits for the program: at least 75 credits for applicants who have a bachelor's degree with honors; thesis of at least 48 credits and coursework of at least 27 credits

Ph.D. students, who have a bachelor's degree in other related fields equivalent to the Petrochemical and Polymeric Materials program, or who have a master's degree in other related fields equivalent to the Materials Science and Engineering program must take fundamental courses in the bachelor's degree program in Petrochemicals and Polymeric Materials or master's degree program in Polymer Science and Engineering with the consent of the Department of Materials Science and Engineering as non-credits courses.

3.1.2 Program structure

Doctor of Philosophy Program in Polymer Science and Engineering offers four options for program structure: Type 1.1, Type 1.2, Type 2.1 and Type 2.2

3.1.2.1 Type 1 (Thesis)

Dissertation and non-credit courses or additional academic activities without credit

Courses	Credits	
	Type 1.1 applicants who have a master's degree	**Type 1.2 applicants who have a bachelor's degree with honors**
Dissertation	48	72
Research methodology (non-credit)	-	2*
Seminar (non-credit)	1*	2*
Total credits	**48**	**72**

* As non-credit subjects.

3.1.2.2 Type 2 (Thesis and additional courses)

Courses	Credits	
	Type 2.1 applicants who have a master's degree	**Type 2.2 applicants who have a bachelor's degree with honors**
Dissertation	36	48
Research methodology (non-credit)	-	2*
Seminar (non-credit)	1*	2*
Compulsory courses	6	21
Elective courses	6	6
Total credits	**48**	**75**

3.1.3 Courses

3.1.3.1 Explanation of course numbers

The course code is composed of two sets of numbers (xxx xxx); each set is composed of a three-digit number; the two sets are separated by a blank between the first set and the last set of numbers.

The first set is composed of three digits and describes the organization responsible for the course.

622 indicates the Polymer Science and Engineering, Department of Materials Science and Engineering, Faculty of Engineering and Industrial Technology, Silpakorn University

The second set is composed of three digits and describes the type of course:

The first digit indicates the degree level of the course:

5-7 Graduate degree program

The second the **digit** indicates group subject concentration

1 Polymer Science
2 Polymer Engineering
3 Polymer Properties
4 Polymeric Materials
8 Selected Topics in Polymer Science and Engineering
9 Research and Seminars, Dissertation

The third digit is the number of the specific course.

* As non-credit subjects.

3.1.3.2 Criterion for calculation of credits

Lecture courses: 1 credit is equivalent to one hour per week

Practical courses: 1 credit is equivalent to two or three hours per week

Dissertation: 1 credit is equivalent to three hours per week

The number of credits for each course is calculated by the total of work hours: lecture hours ($\boldsymbol{l}$) plus practical hours ($\boldsymbol{p}$) plus and self-study hours ($\boldsymbol{s}$) divided by three, according to the following formula

Number of credits = $\frac{\boldsymbol{l+p+s}}{\boldsymbol{3}}$

Credit shown for each course will be presented as a four-digit number **X($\boldsymbol{l}$-$\boldsymbol{p}$-$\boldsymbol{s}$)** where the first digit is outside the parentheses and the second, third and fourth digits are inside the parentheses, indicating lecture hours ($\boldsymbol{l}$), practical hours ($\boldsymbol{p}$), and self-study hours ($\boldsymbol{s}$), respectively. For example, in 2(2-0-4), the 2 outside the parentheses represents number of credits, the 2 inside the parentheses represents lecture hours per week, the 0 inside the parentheses represents practical hours per week and the 4 inside the parentheses represents self-study hours per week.

3.1.3.3 Curriculum

3.1.3.3.1 Type 1 (Thesis)

Type 1.1 Ph.D. students who have a master's degree

622 791	Seminar II	1*(0-2-1)
622 792	Dissertation	equivalent to 48 credits

Type 1.2 Ph.D. students who have a bachelor's degree with honors

622 591	Research Methodology	2*(2-0-4)
622 592	Seminar I	1*(0-2-1)
622 791	Seminar II	1*(0-2-1)
622 793	Dissertation	equivalent to 72 credits

3.1.3.3.2 Type 2 (Thesis and additional courses)

Type 2.1 Ph.D. students who have a master's degree

Seminar

622 791	Seminar II	1*(0-2-1)

Compulsory courses: 6 credits including the following courses

622 711	Special Topics in Polymer Science	3(3-0-6)
622 721	Special Topics in Polymer Engineering	3(3-0-6)

* As non-credit subjects.

Elective courses: at least 6 credits from the following courses

622 712	Biological Polymers	3(3-0-6)
622 713	Smart Polymers	3(3-0-6)
622 714	Polymeric Composites	3(3-0-6)
622 715	Polymeric Nanomaterials	3(3-0-6)
622 716	Elastomers and Thermoplastic Elastomers	3(3-0-6)
622 717	Polymeric Material Systems Selection	3(3-0-6)
622 718	Conductive Electroactive Polymers	3(3-0-6)
622 722	Polymer Process Machinery Technology	3(2-2-5)
622 723	Rapid Prototype	3(2-2-5)
622 724	Mold Design	3(2-2-5)
622 725	Plastic Production Design	3(2-2-5)
622 731	Special Topics in Polymer Properties	3(3-0-6)
622 781	Selected Topics in Advanced Polymer Science and Engineering I	3(3-0-6)
622 782	Selected Topics in Advanced Polymer Science and Engineering II	3(3-0-6)

Dissertation 36 credits

622 794	Dissertation	equivalent to 36 credits

Type 2.2 Ph.D. students who have a bachelor's degree with honors

Research methodology

622 591	Research Methodology	2*(2-0-4)

Seminar

622 592	Seminar I	1*(0-2-1)
622 791	Seminar II	1*(0-2-1)

Compulsory courses: 21 credits including the following courses

622 511	Advanced Polymer Synthesis	3(3-0-6)
622 512	Polymer Physics	3(3-0-6)
622 513	Advanced Polymer Characterization	3(3-0-6)
622 521	Applied Mathematical Methods for Polymer Engineering	3(3-0-6)
622 522	Advanced Rheology and Polymer Processing	3(3-0-6)
622 711	Special Topics in Polymer Science	3(3-0-6)
622 721	Special Topics in Polymer Engineering	3(3-0-6)

* As non-credit subjects.

Elective courses: at least 6 credits from the following courses

622 712	Biological Polymers	3(3-0-6)
622 713	Smart Polymers	3(3-0-6)
622 714	Polymeric Composites	3(3-0-6)
622 715	Polymeric Nanomaterials	3(3-0-6)
622 716	Elastomers and Thermoplastic Elastomers	3(3-0-6)
622 717	Polymeric Material Systems Selection	3(3-0-6)
622 718	Conductive Electroactive Polymers	3(3-0-6)
622 722	Polymer Process Machinery Technology	3(2-2-5)
622 723	Rapid Prototype	3(2-2-5)
622 724	Mold Design	3(2-2-5)
622 725	Plastic Production Design	3(2-2-5)
622 731	Special Topics in Polymer Properties	3(3-0-6)
622 781	Selected Topics in Advanced Polymer Science and Engineering I	3(3-0-6)
622 782	Selected Topics in Advanced Polymer Science and Engineering II	3(3-0-6)

Dissertation 48 credits

622 795	Dissertation	equivalent to 48 credits

3.1.4 Study Plan

3.1.4.1 Type 1.1 Thesis: Ph.D. students who have a master's degree

1st academic year, 1st semester

Course number	Course name	Number of credits (l-p-s)
622 791	Seminar II	1*(0-2-1)
	Total	-

1st academic year, 2nd semester

Course number	Course name	Number of credits (l-p-s)
622 792	Dissertation (equivalent to)	9
	Total	9

* As non-credit subjects.

2nd academic year, 1st semester

Course number	Course name	Number of credits (l-p-s)
622 792	Dissertation (equivalent to)	9
	Total	9

2nd academic year, 2nd semester

Course number	Course name	Number of credits (l-p-s)
622 792	Dissertation (equivalent to)	9
	Total	9

3rd academic year, 1st semester

Course number	Course name	Number of credits (l-p-s)
622 792	Dissertation (equivalent to)	9
	Total	9

3rd academic year, 2nd semester

Course number	Course name	Number of credits (l-p-s)
622 792	Dissertation (equivalent to)	12
	Total	12

3.1.4.2 Type 1.2 Thesis: Ph.D. students who have a bachelor's degree with honors

1st academic year, 1st semester

Course number	Course name	Number of credits (l-p-s)
622 591	Research Methodology	2*(2-0-4)
	Total	-

* As non-credit subjects.

1st academic year, 2nd semester

Course number	Course name	Number of credits (l-p-s)
622 592	Seminar I	1*(0-2-1)
622 793	Dissertation (equivalent to)	6
	Total	6

2nd academic year, 1st semester

Course number	Course name	Number of credits (l-p-s)
622 791	Seminar II	1*(0-2-1)
622 793	Dissertation (equivalent to)	6
	Total	6

2nd academic year, 2nd semester

Course number	Course name	Number of credits (l-p-s)
622 793	Dissertation (equivalent to)	6
	Total	6

3rd academic year, 1st semester

Course number	Course name	Number of credits (l-p-s)
622 793	Dissertation (equivalent to)	9
	Total	9

3rd academic year, 2nd semester

Course number	Course name	Number of credits (l-p-s)
622 793	Dissertation (equivalent to)	9
	Total	9

* As non-credit subjects.

4th academic year, 1st semester

Course number	Course name	Number of credits (l-p-s)
622 793	Dissertation (equivalent to)	9
	Total	9

4th academic year, 2nd semester

Course number	Course name	Number of credits (l-p-s)
622 793	Dissertation (equivalent to)	9
	Total	9

5th academic year, 1st semester

Course number	Course name	Number of credits (l-p-s)
622 793	Dissertation (equivalent to)	9
	Total	9

5th academic year, 2nd semester

Course number	Course name	Number of credits (l-p-s)
622 793	Dissertation (equivalent to)	9
	Total	9

3.1.4.3 Type 2.1 Thesis and Coursework: Ph.D. students who have a master's degree

1st academic year, 1st semester

Course number	Course name	Number of credits (l-p-s)
622 711	Special Topics in Polymer Science	3(3-0-6)
622 721	Special Topics in Polymer Engineering	3(3-0-6)
622 XXX	Elective courses	6
	Total	12

1st academic year, 2nd semester

Course number	Course name	Number of credits (l-p-s)
622 791	Seminar II	1*(0-2-1)
	Total	-

2nd academic year, 1st semester

Course number	Course name	Number of credits (l-p-s)
622 794	Dissertation (equivalent to)	9
	Total	9

2nd academic year, 2nd semester

Course number	Course name	Number of credits (l-p-s)
622 794	Dissertation (equivalent to)	9
	Total	9

3rd academic year, 1st semester

Course number	Course name	Number of credits (l-p-s)
622 794	Dissertation (equivalent to)	9
	Total	9

3rd academic year, 2nd semester

Course number	Course name	Number of credits (l-p-s)
622 794	Dissertation (equivalent to)	9
	Total	9

* As non-credit subjects.

3.1.4.4 Type 2.2 Thesis and Coursework: Ph.D. students who have a bachelor's degree with honors

1st academic year, 1st semester

Course number	Course name	Number of credits (l-p-s)
622 511	Advanced Polymer Synthesis	3(3-0-6)
622 512	Polymer Physics	3(3-0-6)
622 521	Applied Mathematical Methods for Polymer Engineering	3(3-0-6)
622 591	Research Methodology	2*(2-0-4)
	Total	9

1st academic year, 2nd semester

Course number	Course name	Number of credits (l-p-s)
622 513	Advanced Polymer Characterization	3(3-0-6)
622 522	Advanced Rheology and Polymer Processing	3(3-0-6)
622 592	Seminar I	1*(0-2-1)
622 XXX	Elective courses	3
	Total	9

2nd academic year, 1st semester

Course number	Course name	Number of credits (l-p-s)
622 711	Special Topics in Polymer Science	3(3-0-6)
622 721	Special Topics in Polymer Engineering	3(3-0-6)
622 XXX	Elective courses	3
	Total	9

* As non-credit subjects.

2nd academic year, 2nd semester

Course number	Course name	Number of credits (l-p-s)
622 791	Seminar II	1*(0-2-1)
	Total	-

3rd academic year, 1st semester

Course number	Course name	Number of credits (l-p-s)
622 795	Dissertation (equivalent to)	6
	Total	6

3rd academic year, 2nd semester

Course number	Course name	Number of credits (l-p-s)
622 795	Dissertation (equivalent to)	6
	Total	6

4th academic year, 1st semester

Course number	Course name	Number of credits (l-p-s)
622 795	Dissertation (equivalent to)	9
	Total	9

4th academic year, 2nd semester

Course number	Course name	Number of credits (l-p-s)
622 795	Dissertation (equivalent to)	9
	Total	9

* As non-credit subjects.

5th academic year, 1st semester

Course number	Course name	Number of credits (l-p-s)
622 795	Dissertation (equivalent to)	9
	Total	9

5th academic year, 2nd semester

Course number	Course name	Number of credits (l-p-s)
622 795	Dissertation (equivalent to)	9
	Total	9

3.1.5 Course Descriptions

622 511 Advanced Polymer Synthesis 3(3-0-6)

Rate expression and molecular weight control in step-growth and chain-addition polymerizations. Copolymerization reactions and control of their monomer sequence in copolymer chains. Polymerization reaction systems and systems used in industries. Emulsion polymerization systems, rate and molecular weight control, and their application for industry. Plasma polymerization. Sonochemical polymerization. Enzymatic polymerization. Electrochemical polymerization. Case studies of new polymer synthetic processes.

622 512 Polymer Physics 3(3-0-6)

Conformations of ideal and real polymer chains. Dynamics of polymer molecules. Linear viscoelasticity of polymers. Physics of amorphous and crystalline polymers. Transition temperature and free volume of polymers. Elastic properties of rubber materials. Mechanical behavior of polymers. Case studies of current research in polymer physics.

622 513 Advanced Polymer Characterization 3(3-0-6)

Relationship between polymers and the morphology-processing-property. Important techniques for polymer molar mass determination. Characterization of polymers using thermal analysis. Factors affecting those thermal properties. Morphological investigations using microscopy techniques. Application of techniques in spectroscopy and x-ray diffraction in polymer characterization. Case studies of current research in polymer structural analysis by polymer characterization.

622 521 Applied Mathematical Methods for Polymer Engineering 3(3-0-6)

Mathematical principles required to understand and solve engineering problems encountered in polymer studies. Analytical methods in polymer processing including stress-strain analysis in solids. Numerical methods in polymer processing. Case studies of fluid mechanics concerning rheology, mass and energy transport equations, viscoelastic properties related to polymer processing. Curve fitting and optimization techniques.

622 522 Advanced Rheology and Polymer Processing 3(3-0-6)

Relationships between stress and strain in tensor equations (3 dimensions) for elastic solids and Newtonian fluids. Linear and non-linear viscoelasticity of polymers. Rheological tests for polymers using various techniques. Use of rheology and continuum mechanics in extrusion, injection molding, blown film extrusion, and calendaring. Case studies of rheology use in polymer processing analysis for screw and die design.

622 591 Research Methodology 2*(2-0-4)

This course is evaluated as S/U

Research ethics. Creative thinking and problem-solving. Research concepts and examples of research. Systematic approaches to conducting research and the importance of each step towards the success of the research. Topic selection. Experimental design. Data collection. Analysis of data using quantitative and qualitative approaches. Research proposal preparation. Research report preparation. Presentation techniques. Analytical skills for defense. Publication of research. Abstract preparation.

622 592 Seminar I 1*(0-2-1)

This course is evaluated as S/U

Comprehensive reading and compilation of information from interesting and current topics in the field of Polymer Science and Engineering in order to give a presentation. Researcher's ethics and etiquette in references and the bibliography are emphasized. Compulsory seminar attendance and submission of a full report.

622 711 Special Topics in Polymer Science 3(3-0-6)

Critical examination of synthesis and characteristics of new polymers appearing in the research literature and being commercialized in the plastics industry. Liquid crystalline polymers. Functionalized polymer blends. Thermoplastic elastomers. Oligomerically-modified nanocomposites. Physical and thermal characterization of new polymers. Scattering physics of new polymers leading to a discussion of specific techniques.

* As non-credit subjects.

622 712 Biological Polymers 3(3-0-6)

Critical examination of biological polymers and their polymerization appearing in the current research literature. Biological degradation mechanisms. Selective membranes. Biological polymer applications in medical fields including body implants.

622 713 Smart Polymers 3(3-0-6)

Critical examination of polymers related that respond to excitation by changing their physical properties, appearing in the current research literature. Electro-rheological and magneto-rheological fluids. Smart gels. Positive thermal coefficient. Electrospun fibers. Shape memory polymer alloys. Piezoelectric polymers. Nonlinear optical polymers.

622 714 Polymeric Composites 3(3-0-6)

Critical examination of new polymeric composites appearing in the current research literature. Study of new polymeric composites in terms of their composition, morphology, properties, and applications. Innovations in the fabrication process for new polymeric composites.

622 715 Polymeric Nanomaterials 3(3-0-6)

Critical examination of polymeric nanomaterials appearing in the current research literature. Study of polymeric nanomaterials in terms of their preparation, structure, properties, and applications.

622 716 Elastomers and Thermoplastic Elastomers 3(3-0-6)

Critical examination of new elastomers and thermoplastic elastomers appearing in the current research literature. Studies of new elastomers and thermoplastic elastomers in terms of their composition, morphology, properties, and applications. Innovations in the fabrication process for new elastomers and thermoplastic elastomers.

622 717 Polymeric Material Systems Selection 3(3-0-6)

Critical examination of polymeric material system selection appearing in the current research literature. Screening of potential polymers. Recording of polymer performance. Selection of polymers based on priority performance requirements. Comparing and contrasting potential polymers. Evaluation of process demand and post-fabrication schemes.

622 718 Conductive Electroactive Polymers 3(3-0-6)

Critical examination of electrical properties of polymers appearing in the current research literature. Studies of functionally modified conductive electroactive polymers in terms of their synthesis, properties, and applications.

622 721 Special Topics in Polymer Engineering 3(3-0-6)

Critical examination of new plastic processing techniques appearing in the research literature which are currently being commercialized in the plastics industry. Multi-material injection molding technology. Multi-layer material technology. Advanced blow molding. Theory and design of polymer processing machinery. Hydraulic and electrical control circuits. Machine logic. Drives. Pumps and motors. Heating barrel and screw combinations.

622 722 Polymer Process Machinery Technology 3(2-2-5)

Discussion-oriented course focusing on the new polymer processing machinery presented at world-class exhibitions. Review of critical features of new polymer processing machinery launched by leading companies in the plastics industry in the last five years. Comparison of advantages, improvements, and limitations of new machinery.

622 723 Rapid Prototype 3(2-2-5)

Discussion-oriented course focusing on the rapidly expanding field of rapid prototyping. Stereolithography. Laminated object manufacture. Selective laser sintering. Fused deposition modeling. Solid ground curing. Case studies of rapid prototypes.

622 724 Mold Design 3(2-2-5)

Discussion-oriented course focusing on new materials for mold construction, machining operations, developments in rapid tooling, methods of mold repair, developments in hot runners, and special tooling. Use of computer-aided engineering and design (CAE and CAD) in mold design and construction. Case studies of mold design.

622 725 Plastic Production Design 3(2-2-5)

Discussion-oriented course focusing on the design of new polymer products made from polymers, applying the total systems approach to the balance between product design, choice of materials, and process technique. Use of computer-aided engineering and design (CAE and CAD) in product design and the analysis of product performance. Case studies of plastic production design.

622 731 Special Topics in Polymer Properties 3(3-0-6)

Critical examination of new techniques to evaluate polymer properties appearing in the research literature and being commercialized in the plastics industry. Dynamic Mechanical Analyzer (DMA). Moving Die Rheometer (MDR). Empirical, semi-empirical, and theoretical methods for determining polymer properties by refractive index, density, glass-transition temperature, modulus, and compatibility. Advanced techniques for predicting the engineering and physical properties of polymers from molecular structures.

622 781 Selected Topics in Advanced Polymer Science and Engineering I 3(3-0-6)

Current selected topics of interest in advanced Polymer Science and Engineering.

622 782 Selected Topics in Advanced Polymer Science and Engineering II 3(3-0-6)

Current selected topics of interest in advanced Polymer Science and Engineering. The content is not the same as that described in 622 781 Selected Topics in advanced Polymer Science and Engineering I.

622 791 Seminar II 1*(0-2-1)

This course is evaluated as S/U

Comprehensive reading and compilation of information on interesting and current topics in the field of Polymer Science and Engineering to give presentation. Compulsory seminar attendance and submission of a full report are course requirements.

622 792 Dissertation equivalent to 48 credits

Individual research dissertation under supervision in the field of Polymer Science and Engineering for type 1.1 students.

622 793 Dissertation equivalent to 72 credits

Individual research dissertation under supervision in the field of Polymer Science and Engineering for type 1.2 students.

622 794 Dissertation equivalent to 36 credits

Individual research dissertation under supervision in the field of Polymer Science and Engineering for type 2.1 students

622 795 Dissertation equivalent to 48 credits

Individual research dissertation under supervision in the field of Polymer Science and Engineering for type 2.2 students.

* As non-credit subjects.

3.2 Name, surname, national ID number, position and academic qualifications

3.2.1 Program committee

Position, Names-Surnames, national ID number	Academic qualifications, Major, Institution, Year of graduation	Average Teaching Load (hr/week/academic year)	
		Current	Revised
1. Assist. Prof. Dr.Nattakarn Hongsriphan	D.Eng. (Plastics Engineering), University of Massachusetts Lowell, USA (2003) B.Sc. (Chemistry), Chiang Mai University, Thailand (1994)	23	5
2. Assist. Prof. Dr.Bussarin Ksapabutr	Ph.D. (Polymer Science), Petroleum and Petrochemicals College, Chulalongkorn University, Thailand (2003) B.Sc. 2nd Class Honors (Materials Technology), Silpakorn University, Thailand (1996)	23	5
3. Assist. Prof. Dr.Pajaera Patanathabutr	Ph.D. (Materials Science and Metallurgy: Polymer Technology), University of Cambridge, UK (1999) B.Sc. 1st Class Honors (Materials Science), Chulalongkorn University, Thailand (1993)	23	5
4. Assist. Prof. Dr.Wanchai Lerdwijitjarud	Ph.D. (Polymer Science), Petroleum and Petrochemicals College, Chulalongkorn University, Thailand (2003) B.Sc. 1st Class Honors (Materials Technology), Silpakorn University, Thailand (1996)	23	5
5. Dr.Nattawut Chaiyut	Ph.D. (Polymer Science and Technology), International Program, Mahidol University (2005) B.Sc. 2nd Class Honors (Materials Technology), Silpakorn University, Thailand (1998)	23	5

3.2.2 Full-time faculty members

Position, Names-Surnames, national ID number	Academic qualifications, Major, Institution, Year of graduation	Average Teaching Load (hr/week/academic year)	
		Current	Revised
1. Assoc. Prof. Manop Panapoy	M.Eng. (Mechanical Engineering), King Mongkut's Institute of Technology Ladkrabang, Thailand (2003) M.Eng. (Materials Technology), King Mongkut's University of Technology Thonburi, Thailand (2000) B.Sc. (Materials Technology), Silpakorn University, Thailand (1996)	15	3
2. Assist. Prof. Dr.Chanchai Thongpin	Ph.D. (Polymer Science and Technology), UMIST, UK (1998) M.Sc. (Polymer Science and Technology), UMIST, UK (1993) B.Sc. Honors (Chemistry), Silpakorn University, Thailand (1983)	23	5
3. Assist. Prof. Dr.Nattakarn Hongsriphan	D.Eng. (Plastics Engineering), University of Massachusetts Lowell, USA (2003) B.Sc. (Chemistry), Chiang Mai University, Thailand (1994)	23	5
4. Assist. Prof. Niti Yongvanich	Ph.D. (Materials Science and Engineering : Solid State Chemistry of Inorganic Materials), University of Pennsylvania, USA (2007) M.S. (Materials Science and Engineering), University of Pennsylvania, USA (2003) B.S. (Materials Science and Engineering and Engineering and Public Policy), Carnegie Mellon University, USA (2001)	23	2

Position, Names-Surnames, national ID number	Academic qualifications, Major, Institution, Year of graduation	Average Teaching Load (hr/week/academic year)	
		Current	Revised
5. Assist. Prof. Dr.Bussarin Ksapabutr	Ph.D. (Polymer Science), Petroleum and Petrochemicals College, Chulalongkorn University, Thailand (2003) B.Sc. 2nd Class Honors (Materials Technology), Silpakorn University, Thailand (1996)	23	5
6. Assist. Prof. Dr.Pajaera Patanathabutr	Ph.D. (Materials Science and Metallurgy: Polymer Technology), University of Cambridge, UK (1999) B.Sc. 1st Class Honors (Materials Science), Chulalongkorn University, Thailand (1993)	23	5
7. Assist. Prof. Dr.Poonsub Threepopnatkul	D. Eng (Plastics Engineering), University of Massachussetts Lowell, U.S.A. (2006) M.Eng. (Chemical Engineering), Chulalongkorn University, Thailand (1998) B.Sc. (Chemical Engineering), Chulalongkorn University, Thailand (1996)	23	5
8. Assist. Prof. Dr.Pat Sooksean	Ph.D. (Engineering Materials : Glass-Ceramics and Electroceramics), The University of Sheffield, UK (2007) B.Sc. 1st Class Honors (Materials Science and Engineering), University of Manchester Institute of Science and Technology, UK (2002)	23	2

Position, Names-Surnames, national ID number	Academic qualifications, Major, Institution, Year of graduation	Average Teaching Load (hr/week/academic year)	
		Current	Revised
9. Assist. Prof. Dr.Vorrada Loryuenyong	Ph.D. (Materials Science and Engineering : Electronic Materials), University of Califonia-Berkeley, USA (2006) M.S. (Materials Science and Engineering : Electronic Materials), University of California-Berkeley, USA (2002) B.S. (Materials Science and Engineering : Ceramic Engineering), The Pennsylvania State University, USA (2000)	23	2
10. Assist. Prof. Dr.Wanchai Lerdwijitjarud	Ph.D. (Polymer Science), Petroleum and Petrochemicals College Chulalongkorn University, Thailand (2003) B.Sc. 1st Class Honors (Materials Technology), Silpakorn University, Thailand (1996)	23	5
11. Assist. Prof. Dr.Aran Wasantakorn	Ph.D. (Fuel Technology), The University of Sheffield, U.K. (2001) M.Eng. (Petrochemicals and Polymeric Materials), Chulalongkorn University, Thailand (1995) B.Eng. (Chemical Engineering), King Mongkut's Institute of Technology Thonburi, Thailand (1992)	15	3
12. Dr.Nattawut Chaiyut	Ph.D. (Polymer Science and Technology) , International Program, Mahidol University (2005) B.Sc. 2nd Class Honors (Materials Technology), Silpakorn University, Thailand (1998)	23	5

Position, Names-Surnames, national ID number	Academic qualifications, Major, Institution, Year of graduation	Average Teaching Load (hr/week/academic year)	
		Current	Revised
13. Dr.Sarawut Phupaichitkun	Dr.Agr.Sc. (Agriculture Science), Hohenheim University, Germany (2008) M.Eng. (Chemical Engineering), Chulalongkorn University, Thailand (1999) B.Sc. (Chemical Engineering), Chulalongkorn University, Thailand (1993)	23	3
14. Dr.Supakij Suttiruengwong	Dr.-Ing. (Chemical Engineering), Friedrich-Alexander, Universitaet-Erlangen-Nuernberg, Germany (2006) M.Sc. (Chemical Engineering), University of Wales, U.K. (1998) B.Sc. (Chemistry), Silpakorn University, Thailand (1995)	23	5
15. Dr.Sudsiri Hemsri	Ph.D. (Chemical Engineering), University of Connecticut, USA (2011) M.Eng. (Chemical Engineering), Chulalongkorn University, Thailand (2000) B.Sc. (Chemistry), Chulalongkorn University, Thailand (1996)	-	3

3.2.3 Expert instructors

Position, Name, Surname, National ID number	Academic qualifications, Major, Institution, Year of graduation
1. Dr.Amnard Sittattrakul	Ph.D. (Polymer Chemistry), Louisiana State University, USA (1985) M.S. (Organic Chemistry), University of Kansas (1974) B.Sc. (Chemistry), Chulalongkorn University, Thailand (1967)

4. Field experience components

None

5. Dissertation requirements (If any)

5.1 Brief Description of Task

The Doctor of Philosophy Program in Polymer Science and Engineering (International Program) aims to produce Ph.D. graduates who are capable of creating new knowledge or proceeding from fundamental knowledge by conducting research in depth in order to have a thorough understanding of a substantial body of advanced knowledge and research in the field of Polymer Science and Engineering. Ph.D. students must be capable of designing a research methodology to solve the emerging issues in polymeric materials and related technology which utilizes polymeric materials. They must also be capable of reviewing research reports, theses, dissertations and published articles as reference materials and able to obtain new knowledge from their own research. The program will encourage Ph.D. students to create new research and be able to make decisions on their own in their work. The Ph.D. students will be able to develop their own research methodology and will have the management skills needed to undertake life-long learning. The Ph.D. students will have social responsibility and professional ethics as well as realize the importance of national culture and art, and natural resources. They will develop leadership skills and good governance. Therefore, all Ph.D. students in every program plan will conduct research in Polymer Science and Engineering under the supervision of research advisers.

5.2 Standard learning outcomes

The Doctor of Philosophy Program in Polymer Science and Engineering (International Program) focuses on five standard program learning outcomes: Morals and Ethics, Knowledge, Cognitive Skills, Interpersonal Skills and Responsibilities, Numerical Analysis, Communication and Information Technology Skills.

5.3 Scheduling

Type 1.1 1st academic year, 2nd semester-3rd academic year, 2nd semester
Type 1.2 1st academic year, 2nd semester-5th academic year, 2nd semester
Type 2.1 2nd academic year, 1st semester-3rd academic year, 2nd semester
Type 2.2 3rd academic year, 1st semester-5th academic year, 2nd semester

5.4 Number of credits

Type 1.1	Thesis equivalent to	48 credits
Type 1.2	Thesis equivalent to	72 credits
Type 2.1	Thesis equivalent to	36 credits
Type 2.2	Thesis equivalent to	48 credits

5.5 Preparation

Ph.D. students in every program plan must take a seminar and those Ph.D. students who are applicants with a bachelor's degree with honors must take research methodology and other compulsory courses before receiving approval for the topic of their dissertation. The program will assign dissertation advisors who are qualified and have research experience in accordance with the announcement of the Ministry of Education on graduate program accreditation criteria, B.E. 2548 (as in Appendix B)

5.6 Evaluation process

The dissertation will be evaluated in accordance with Silpakorn University's regulations on graduate study, B.E. 2550 and/or any revisions thereto. Ph.D. students in a thesis program plan and those in a thesis with additional courses program plan who have passed all compulsory courses will take the qualifying examination, which is a written and oral examination covering all aspects in Polymer Science and Engineering. It will be in accordance with Silpakorn University's regulations on graduate study, B.E. 2550, title 33 and/or any revisions thereto (as in Appendix A). The qualifying examination will be administered twice each academic year as scheduled by the Graduate School. Once Ph.D. students have passed the qualifying examination, they can submit a research proposal to the committee for approval of the topic of research in Polymer Science and Engineering. Dissertation submission and approval will be in accordance with Silpakorn University's regulations on graduate study, B.E. 2550, title 35.3, and the evaluation of the completed dissertation will be in accordance with Silpakorn University's regulations on graduate study, B.E. 2550, title 26.4 and/or any revisions thereto (as in Appendix A).

Section 4 Learning outcomes, teaching and evaluation strategies

1. Development of students' special characteristics

Special Characteristics	Strategies or Student Activities
Ph.D. students who have a thorough understanding of a substantial body of advanced knowledge and research in Polymer Science and Engineering and are capable of creating new knowledge or proceeding from fundamental knowledge to contribute to research development in Polymer Science and Engineering in order to apply their advanced knowledge from courses in the program and write a dissertation to fulfill the needs of the country in Polymer Science and Engineering.	All Ph.D. students in the program must take research methodology, which will invite specialists or well-known professors/ researchers to inspire the students as well as invite full-time faculty members of the program to provide insights into their research interests to give students a variety of experiences. Moreover, the students will have the opportunity to visit research units of both public and private organizations to observe the professional career path.
	All Ph.D. students in the program must take a seminar in which students select topics suited to their interests and related to their research topics to review the literature in order to reinforce their ability to document research outcomes from thesis, dissertations, research project reports, and published articles in refereed academic or professional publications. The students will be well prepared for their research proposal and encouraged to think creatively for their research in Polymer Science and Engineering after completing all aspects of the literature review.
Ph.D. students are capable of applying their knowledge in Polymer Science and Engineering to create new research in polymeric materials technology. They can provide effective leadership in the field and can deal with complex emerging issues in the field by finding a suitable solution to the problems. They have social responsibility and professional ethics as well as realize the importance of national culture and art.	The department will allocate some part of the department's budget for a teaching assistance scholarship for Ph.D. students. They will be assigned to teach laboratory courses and characterization techniques to bachelor's degree students in order to gain insight and knowledge and practice communication skills. Therefore, they will gain self-confidence and experience in the field.
	The department will allocate some part of the department's budget for Ph.D. students. They will be assigned to teach bachelor's and master's degree students to use a variety of characterization techniques and processing machines under the supervision of faculty members. Therefore, they will gain in-depth experience in each characterization technique and processing machine. This will also encourage Ph.D. students to be more responsible in their assigned work and to acquire professional ethics by sharing the facilities of the department.

2. Development of learning outcomes in domains of learning

2.1 Morals and Ethics

2.1.1 Morals and Ethics to be developed

The student

(1) Exercises leadership in applying sound ethical and moral practices in the work environment and the wider community.

(2) Deals consistently and sensitively with complex ethical issues in academic and/or professional contexts and responds on the basis of sound principles and values.

(3) Takes initiative in raising deficiencies in existing codes of practice for possible review and amendment.

(4) Actively encourages others to apply sound ethical and moral judgments in dealing with issues and problems affecting themselves and others

(5) Is familiar with emerging issues at the forefront of the discipline and with the potential challenges of those issues for future change.

2.1.2 Teaching Strategies

The student

(1) Participates in group discussions on existing issues and potential issues in the future professional career path.

(2) Is instilled with a sense of morals and ethics among students and motivates them to apply these values in everyday life. For example, punctuality in class attendance and submission of assigned tasks, responsibility towards work and outcomes of the work, citation of references and acknowledgement of all support received.

(3) Is encouraged to apply sound ethical and moral judgment in dealing with issues and problems affecting themselves and others when conducting research during their study.

(4) Participates in group discussions on ethics of researchers.

2.1.3 Evaluation Strategies

The academic staff

(1) Evaluation from observation and records of student's behavior during group discussions.

(2) Evaluation from work behavior and performance by thesis advisors.

(3) Evaluation from student's behavior during preparation and presentations.

2.2 Knowledge

2.2.1 Knowledge to be acquired

The student

(1) Has a thorough understanding of a substantial body of knowledge in a discipline or professional field, including both specific information and underlying theories, principles and

concepts in order to apply this advanced knowledge to the further development of knowledge in their field.

(2) Has a thorough knowledge of developments in related fields that potentially impact on the area of inquiry.

(3) Knows about the latest developments in the field including emerging issues and research techniques and the potential challenges in developments of generally accepted conclusions.

(4) Has the ability to synthesize theory and research in Polymer Science and Engineering and other field to create innovative developments or interpret new knowledge.

2.2.2 Teaching Strategies

The academic staff

(1) Cites case studies related to course content and students' prior knowledge in the field of study in order to facilitate understanding and application.

(2) Organizes academic conferences by inviting experts and specialists in the field of study to discuss up-to-date issues and regulations and standardization related to the field of study.

(3) Assigns individual and group projects on issues related to the field of study.

2.2.3 Evaluation Strategies

The academic staff

(1) Evaluates examination results and compares individual academic performance with the group.

(2) Evaluates outcomes of academic conference.

(3) Evaluates student's performance on reports or presentations related on assigned tasks.

2.3 Cognitive Skills

2.3.1 Cognitive Skills to be developed

The student

(1) Is able to apply advanced theoretical insights and techniques of inquiry in the creative analysis of major issues and problems.

(2) Can develop new and creative insights or innovative solutions to respond to issues and problems

(3) Can synthesize research from related fields, published articles and create new knowledge, including the development of conclusions and suggestions, by interpretation or through original research or purposing of new knowledge.

(4) Can plan, design and carry out major research involving knowledge both theory and practice and research methodology to reach a conclusion which can contribute significantly to the field.

2.3.2 Teaching Strategies

The academic staff

(1) Arranges to have students conduct research in the format of a dissertation.

(2) Arranges to have students present the progress of their research.

(3) Arranges a workshop to encourage students to apply theoretical knowledge to practice, to make a situation analysis from research questions by emphasizing open-ended problem-solving by brainstorming and acceptance of different opinions.

2.3.3 Evaluation Strategies

The academic staff

(1) Evaluates research proposal.

(2) Evaluates research outcomes.

(3) Evaluates various research presentations.

(4) Evaluates outcomes of class activities.

(5) Evaluates seminar presentations by the students.

2.4 Interpersonal Skills and Responsibilities

2.4.1 Interpersonal Skills and Responsibilities to be developed

The student

(1) Deals consistently and sensitively with complex ethical issues in academic and professional contexts

(2) Acts consistently with a high level of autonomy and initiative in professional or scholarly activities.

(3) Takes full responsibility for own activities, and cooperates with others to deal with argument and problems.

(4) Exercises effective leadership appropriate to the occasion and environment in order to enhance teamwork.

2.4.2 Teaching Strategies

The academic staff

(1) Arranges to have students work team and group presentation with instructor's feedback to evaluate group behavior and performance through both self-evaluation and team evaluation.

(2) Arranges presentations on the progress of research with evaluation of students' work, according to the research plan and proposed work schedules for the following semester.

(3) Assigns tasks which continuously enhance student's capabilities and personal development. For example, interpreting current research articles in class, followed by assigning students to read textbooks or analyze problem prior to class.

(4) Organizes field trips.

2.4.3 Evaluation Strategies

The academic staff

(1) Evaluates research performance and presentations of research progress.

(2) Evaluates the presentation of assigned tasks.

(3) Evaluates group activities.

2.5 Numerical Analysis, Communication and Information Technology Skills

2.5.1 Numerical Analysis, Communication and Information Technology Skills to be developed

The student

(1) Routinely evaluates and makes effective use of mathematical and statistical data, and uses a wide range of appropriate information and communications technology in investigating issues and in communicating conclusions and recommendations.

(2) Communicates effectively and at appropriate levels with academic and professional audiences and the wider community through informal and formal reports and presentations and academic and professional publications, including a dissertation.

(3) Can use information technology to document, search, make conclusions, and suggest solutions for any problems.

2.5.2 Teaching Strategies

The academic staff

(1) Arranges to have students analyze data through numerical analysis, systematic thinking and reasoning.

(2) Organizes oral and poster research presentations or published articles.

(3) Assigns tasks using of various types of information technology such as e-learning, submission via e-mail, discussions via web or blogs.

2.5.3 Evaluation Strategies

The academic staff

(1) Evaluates research performance, dissertation, and research progress presentations in the form of reports or oral presentations.

(2) Evaluates presentation of assigned tasks.

(3) Evaluates outcomes of class activities.

(4) Evaluates seminar presentations

(5) Evaluates the numbers and quality of published research work.

3. Curriculum Mapping Illustrating the Distribution of Program Standard Learning Outcomes for each Course.

Meanings of learning outcomes in the curriculum map

Morals and Ethics

The student

(1) Exercises leadership in applying sound ethical and moral practices in the work environment and the wider community.

(2) Deals consistently and sensitively with complex ethical issues in academic and/or professional contexts and responds on the basis of sound principles and values.

(3) Takes initiative in raising deficiencies in existing codes of practice for possible review and amendment.

(4) Actively encourages others to apply sound ethical and moral judgments in dealing with issues and problems affecting themselves and others

(5) Is familiar with emerging issues at the forefront of the discipline and with the potential challenges of those issues for future change.

Knowledge

The student

(1) Has a thorough understanding of a substantial body of knowledge in a discipline or professional field, including both specific information and underlying theories, principles and concepts in order to apply this advanced knowledge to the further development of knowledge in their field.

(2) Has a thorough knowledge of developments in related fields that potentially impact on the area of inquiry.

(3) Knows about the latest developments in the field including emerging issues and research techniques and the potential challenges in developments of generally accepted conclusions.

(4) Has the ability to synthesize theory and research in Polymer Science and Engineering and other field to create innovative developments or interpret new knowledge.

Cognitive Skills

The student

(1) Is able to apply advanced theoretical insights and techniques of inquiry in the creative analysis of major issues and problems.

(2) Can develop new and creative insights or innovative solutions to respond to issues and problems

(3) Can synthesize research from related fields, published articles and create new knowledge, including the development of conclusions and suggestions, by interpretation or through original research or purposing of new knowledge.

(4) Can plan, design and carry out major research involving knowledge both theory and practice and research methodology to reach a conclusion which can contribute significantly to the field.

Interpersonal Skills and Responsibilities

The student

(1) Deals consistently and sensitively with complex ethical issues in academic and professional contexts

(2) Acts consistently with a high level of autonomy and initiative in professional or scholarly activities.

(3) Takes full responsibility for own activities, and cooperates with others to deal with argument and problems.

(4) Exercises effective leadership appropriate to the occasion and environment in order to enhance teamwork.

Numerical Analysis, Communication and Information Technology Skills

The student

(1) Routinely evaluates and makes effective use of mathematical and statistical data, and uses a wide range of appropriate information and communications technology in investigating issues and in communicating conclusions and recommendations.

(2) Communicates effectively and at appropriate levels with academic and professional audiences and the wider community through informal and formal reports and presentations and academic and professional publications, including a dissertation.

(3) Can use information technology to document, search, make conclusions, and suggest solutions for any problems.

Curriculum Mapping Illustrating the Distribution of Program Standard Learning Outcomes for each Course

Doctor of Philosophy Program in Polymer Science and Engineering

● Major responsibilities ○ Minor responsibilities

Course	Morals and Ethics					Knowledge				Cognitive Skills				Interpersonal Skills and Responsibilities				Numerical Analysis, Communication and Information Technology Skills		
	1	2	3	4	5	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
622 511 Advanced Polymer Synthesis	●	○	○	○	●	●	●	●	●	●	●	●	●	○	●	○	○	○	○	●
622 512 Polymer Physics	●				○	●	●	○		●	●	○		○	●				○	●
622 513 Advanced Polymer Characterization	●	○	○	○	○	●	●	●	●	●	●	●	●	○	●	○	○	○	○	●
622 521 Applied Mathematical Methods for Polymer Engineering	●				○	●	●	○		●	●	○		○				●	○	
622 522 Advanced Rheology and Polymer Processing	●				○	●	●	○		●	●	○		○	●			○	○	●
622 591 Research Methodology	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
622 592 Seminar I	●				○	●	●			○				●	●	●	●	●	●	●
622 711 Special Topics in Polymer Science	●				○	●	●	○		●	●			○	●				○	●
622 712 Biological Polymers	●				○	●	●	○		●	●			○	●				○	●
622 713 Smart Polymers	●				○	●	●	○		●	●			○	●				○	●
622 714 Polymeric Composites	●				○	●	●	○		●	●			○	●				○	●
622 715 Polymeric Nanomaterials	●				○	●	●	○		●	●			○	●				○	●
622 716 Elastomers and Thermoplastic Elastomers	●				○	●	●	○		●	●			○	●				○	●

Curriculum Mapping Illustrating the Distribution of Program Standard Learning Outcomes for each Course

Doctor of Philosophy Program in Polymer Science and Engineering

● Major responsibilities ○ Minor responsibilities

Course	Morals and Ethics					Knowledge				Cognitive Skills				Interpersonal Skills and Responsibilities				Numerical Analysis, Communication and Information Technology Skills		
	1	2	3	4	5	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
622 717 Polymeric Material Systems Selection	●				○	●	●	○		●	●			○	●				○	●
622 718 Conductive Electroactive Polymers	●				○	●	●	○		●	●			○	●				○	●
622 721 Special Topics in Polymer Engineering	●				○	●	●	○		●	●			○	●				○	●
622 722 Polymer Process Machinery Technology	●				○	●	●	○		●	●			○	●				○	●
622 723 Rapid Prototype	●				○	●	●	○		●	●			○	●				○	●
622 724 Mold Design	●				○	●	●	○		●	●			○	●				○	●
622 725 Plastic Production Design	●				○	●	●	○		●	●			○	●				○	●
622 731 Special Topics in Polymer Properties	●				○	●	●	○		●	●			○	●				○	●
622 781 Selected Topics in Advanced Polymer Science and Engineering I	●				○	●	●	○		●	●			○	●				○	●
622 782 Selected Topics in Advanced Polymer Science and Engineering II	●				○	●	●	○		●	●			○	●				○	●
622 791 Seminar II	●				○	●	●			○				●	●	●	●	●	●	●
622 792 Dissertation	●	●		●		●	●	●		●	●	●	●	●	●	●	●	●	●	●
622 793 Dissertation	●	●		●		●	●	●		●	●	●	●	●	●	●	●	●	●	●

Curriculum Mapping Illustrating the Distribution of Program Standard Learning Outcomes for each Course

Doctor of Philosophy Program in Polymer Science and Engineering

● Major responsibilities ○ Minor responsibilities

Course	Morals and Ethics					Knowledge				Cognitive Skills				Interpersonal Skills and Responsibilities				Numerical Analysis, Communication and Information Technology Skills		
	1	2	3	4	5	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
622 794 Dissertation	●	●		●		●	●	●		●	●	●	●	●	●	●	●	●	●	●
622 795 Dissertation	●	●		●		●	●	●		●	●	●	●	●	●	●	●	●	●	●

Section 5 Student evaluation criteria

1. Regulations and criteria for allocation and distribution of grades

Grading and evaluation will be in accordance with Silpakorn University's regulations on graduate study, B.E. 2550, category 4 and/or any revisions thereto (as in Appendix A).

2. Verification process for student achievement

2.1 Verification of student achievement in studying

The department will set up a verification process for students studying as a part of Education Assessment and Quality Assurance for Universities. The process of Verification of student achievements according to the program standard learning outcomes for each course will be conducted as follows:

(1) Students will evaluate teaching performance for each course.
(2) Examinations will be reviewed according to standard learning outcomes for each course as described in the course syllabus.
(3) Distribution of grades will be analyzed.
(4) Reports, assigned projects and other tasks will be compared with examination performance and students' grades.

2.2 Verification of student achievement after graduation

The department will set up a verification process for student achievements after graduation in order to improve the teaching process and overall administration of the program as follows:

(1) Survey of Ph.D. employment
(2) Survey of satisfaction of the employers with Ph.D. performance at different intervals of employment.
(3) Survey of opinions of the academic institution where the Ph.D. is working on his/her post-doctoral program to evaluate satisfaction with knowledge, capabilities and characteristics of Ph.D. graduates.
(4) Survey of satisfaction of the Ph.D. graduates who are employed in terms of capabilities and knowledge received from courses both in the field and related to the field; this will provide the program with information on the relevancy of these courses in the professions of Ph.D. graduates. The survey will also provide the opportunity to receive feedback to revise the program.
(5) Evaluation of satisfaction of Ph.D. graduates and their employers in order to revise the program in future.
(6) Experts will evaluate the verification process for student achievement in order to revise the program in future.

3. Graduation requirements

Graduation will be in accordance with Silpakorn University's regulations on graduate study, B.E. 2550, and/or any revisions thereto (as in Appendix A) with additional requirements of the Faculty of Engineering and Industrial Technology. The graduates of the Doctor of Philosophy in Polymer Science and Engineering (International Program) must satisfy the following criteria:

3.1 The period of study must not exceed the maximum duration for each program plan.

3.2 The graduates must complete all courses with the required cumulated credits according to each program plan.

3.3 Type 2.1 and 2.2 graduates must achieve an accumulated grade point average of at least 3.00 with at least B or S in all courses.

3.4 The graduates must pass the qualifying examination.

3.5 The graduates must successfully defend their own Ph.D. dissertation in front of an examination committee which consists of internal and external professional scholars. The examination committee is appointed by the Graduate School, Silpakorn University in accordance with Silpakorn University's regulations on graduate study, B.E. 2550, and/or any revisions thereto (as in Appendix A). The graduates must submit a dissertation in the format approved by the Graduate School, Silpakorn University.

3.6 At least one publication of the dissertation or a part of the dissertation of the Ph.D. students for type 1.1, 1.2, 2.1 and 2.2 must be published or at least be accepted for publication in a peer-reviewed international journal or international academic publication that is well-accepted in the field of Polymer Science and Engineering or related fields **and** at least one presentation at a conference with published proceedings.

3.7 The graduates must obtain S on the English examination conducted by Silpakorn University as part of the admission test or have an exemption on the foreign language test in accordance with Silpakorn University's regulations on graduate study, B.E. 2550, category 5, title 32.2 and/or any revisions thereto (as in Appendix A). They can have an exemption on the foreign language test by submitting evidence of results from another of the accepted language tests:

(1) TOEFL score of at least 500 (paper based) or of at least 173 (computer based) or of at least 61 (internet based), or

(2) IELTS score of at least 5.5, or

(3) TOEIC score of at least 625, or

(4) CU-TEP score of at least 60, or

(5) TU-GET score of at least 45

Tests scores must have been obtained within the previous two years.

3.8 The graduates must fulfill all requirements in accordance with Silpakorn University's regulations on graduate study, B.E. 2550, category 7 and/or any revisions thereto (as in Appendix A).

Section 6 Faculty development

1. Preparation of new faculty members

The Faculty will

(1) Organize an orientation to familiarize new faculty members with the University's policies, the Faculty and the assigned courses in the program.

(2) Allocate a seeding grant to new faculty members to encourage research and research development in their fields.

2. Knowledge and skills development for faculty members

2.1 Teaching, assessment and evaluation skills development

The Faculty

(1) Evaluates work performance of faculty members

(2) Develops teaching skills based on learner-centered concept and updated evaluation procedures.

(3) Supports faculty members in their acquisition of knowledge and consistently provides information or experience in teaching methods and research developments.

(4) Develops faculty members' practical skills in using technology and innovative education.

2.2 Academic and professional development

The Faculty

(1) Supports faculty members' involvement in community service activities in order to develop knowledge and morals.

(2) Supports faculty members acquisition of knowledge and consistently provides experience to improve their teaching and research in their field. Supports their continuing higher education, training, academic visits and membership in professional organizations, attendance at national and international conferences, and sabbatical leave.

(3) Encourages faculty members in their academic performance and supports them in achieving higher academic positions.

(4) Supports research which can provide new knowledge and develop teaching methods in order to enable faculty members to be experts in their field.

(5) Allocates money for research grants.

Section 7 Program quality assurance

1. Program management

A program committee is appointed by the Faculty to manage the program and the Faculty committee will monitor, advise and guide the program committee for five years.

Goals	Operations	Evaluation
1. A program committee which is responsible for the program is appointed.	Appoints the program committee	Evaluated by meeting memos of the program committee.
2. The program is qualified and fulfills at least the standard criteria specified by the Office of the Higher Education Commission.	1. Faculty members who teach in the program must have a Ph.D. or equivalent qualification or must be an associate professor or a specialist in the field. 2. The number of faculty members in the program must not be less than the standard criteria. 3. Faculty members will be supported in achieving higher academic positions and/or becoming specialists.	Numbers and list of faculty members, CVs of faculty members indicating their qualifications, experience and training.
3. The program is up-to-dated and in accordance with the country's employment needs.	1. Employer satisfaction survey on Ph.D. graduates will be at intervals of employment, such as 1^{st} or 5^{th} year. 2. Survey on satisfaction of the Ph.D. graduates who are employed in terms of capability and knowledge received from the courses both in the field and related to the field; on the relevancy of these courses in the professions of Ph.D. graduates. The survey will also provide the opportunity to receive feedback to revise the program. 3. Revision of the program.	1. Employer satisfaction report. 2. Report on satisfaction of the Ph.D. graduates who are employed.

Goals	Operations	Evaluation
4. Ph.D. students receive support in their study and research as well as improve their research presentation skills.	Faculty members who are experts in various fields of Polymer Science and Engineering advise on study and supervise research.	The dissertation or part of the dissertation of the Ph.D. students is published or at least is accepted for publication in a peer-reviewed international journal or an international academic publication that is well-accepted in the field of Polymer Science and Engineering or related fields and a presentation is given at a conference with published proceedings.
5. The Ph.D. dissertation evaluation process is standardized and is acceptable in the field of Polymer Science and Engineering.	The dissertation examination committee consists of an external professional scholar in order to qualify the student's research as acceptable to the public.	There is an external professional scholar on the dissertation examination committee.

2. Teaching and learning resources management

2.1 Budget management

The Faculty prepares an annual budget which includes funds received from the government and faculty revenue in order to allocate sufficient annual resources for teaching in accordance with international standards, to support classroom lectures and workshops as well as support self-learning environments for the students.

2.2 Existing teaching and learning resources

The Faculty has sufficient books, textbooks, journals and on-line databases in Science, Technology and Engineering through the University central library:

(1) The total number of books and textbooks is approximately 2,080

(2) The total number of Online Database is seven full text databases

The Department also has books, specialized textbooks and sufficient supporting teaching equipments as:

(1) The total number of books and textbooks is more than 300

(2) There are more than 400 types of scientific equipment.

2.3 Provision of additional teaching learning resources

(1) The Department has a teaching/learning resource procurement plan and follows up on the efficiency and effectiveness of teaching/learning resources.

(2) Faculty members and instructors for each course can suggest a list of books and textbooks in their field of interest to the department for consideration for purchase.

(3) The Faculty allocates funds to buy books, textbooks and databases.

(4) The Department co-operates with University central library to purchase books and textbooks related to the field.

(5) The program committee follows up on the needs and the efficiency and effectiveness of teaching/learning resources.

2.4 Assessment of sufficiency of teaching and learning resources

Goals	Operations	Evaluation
1. Classrooms and laboratories are sufficient for needs of faculty members and students.	Provides sufficient and effective classrooms and laboratories.	Report on satisfaction of faculty members and students on classrooms and laboratories.
2. Books, textbooks and journals are sufficient for needs of faculty members and students.	Allocates funds from government and faculty revenue as well as co-operates with University central library to provide additional books, textbooks and journals.	Report on satisfaction of faculty members and students on books, textbooks and journals.
3. Additional learning resources both in class and out-of-class for self-learning are sufficient and effective.	Creates networks and a self-learning center of sufficient quality and quantity so that students can study by themselves.	Report on satisfaction of students on use of self-learning resources.

3. Faculty management

3.1 Recruitment of new faculty members

(1) New faculty members must have qualifications endorsed by the Office of the Civil Service Commission (OCSC) and be able to cover aspects of all courses provided.

(2) Recruitment of new faculty members is in accordance with the regulations and criteria of Silpakorn University and the Office of the Higher Education Commission.

3.2 Faculty members' participation in program planning, monitoring and review

Program committee and faculty members who are responsible for each course in the program must have meetings on the following aspects:

(1) To plan teaching management, grading and evaluation processes before the beginning of each semester.

(2) To discuss course operations in order to achieve the goals of the program and produce graduates who have the characteristics of ideal graduates.

(3) To approve grades for all courses.

(4) To collect data on program operations in order to revise the program in the future.

3.3 Appointment of part-time faculty members

The Faculty's policy for recruiting part-time faculty members is as follows:

(1) Part-time faculty members must have in-depth experience in the field with special expertise or must have a Ph.D. or equivalent qualification or must be an associate professor or a specialist in the field.

(2) The total lecture hours for part-time faculty members must not exceed half of the total lecture hours for full-time faculty members.

(3) The evaluation of teaching performance of part-time faculty members will be conducted each semester/every teaching session.

4. Support staff management

4.1 Job description for specific characteristics of support staff

Qualifications for support staff who have a job description with specific characteristics must be endorsed by the Office of the Civil Service Commission (OCSC) and cover the aspects of the job which they are responsible for.

4.2 Enhancement of knowledge and skills

(1) The department teaching assistance in laboratories and professional training. For example, preparation of the laboratory for practical classes, technical training in operation of tools and maintenance.

(2) Research co-operation between support staff and faculty members will be supported.

(3) The department will support members of the support staff who continue to pursue higher education and payment will be given according to actual work performance and quantity.

(4) The department encourages and supports further education, training, academic conferences and field trips.

5. Student support and advising services

5.1 Academic advice and counseling

(1) The Faculty will appoint an academic advisor for each student and specify the role of the advisor.

(2) Every academic advisor must provide counseling hours and announce office hours in front of his/her office and on the Faculty webpage.

(3) Advisors for student projects will be assigned.

5.2 Student appeals

In case of doubt about a course grade, students can submit a request to see their own examination paper, answers for the examination, scores and grading criteria by instructors for each course to ensure fairness and transparency in grading.

6. Labor market needs, social needs and/or employer satisfaction

(1) A survey on employment needs in Polymer Science and Engineering will be conducted in order to plan for the expected number of the students in the program.

(2) A survey on the employment of the graduates in accordance with their field of study will be conducted within one year after graduation.

(3) A survey on the satisfaction of the employer with the overall quality of Ph.D. graduates will be conducted in order to revise the program.

7. Key performance indicators

Key performance indicators for the program

Types of indicators: Process

Standard criteria: Level

Type 1.1 and 2.1 Ph.D. students who have a master's degree

	Key Performance Indicators	2013	2014	2015	2016
(1)	At least 80% of full-time faculty members are involved in the planning, follow-up and review of program performance.	X	x	x	x
(2)	Course descriptions (TQF 2 Form) are provided according to the National Qualification Framework for higher education or professional standards (if any)	X	x	x	x
(3)	Course specifications (TQF 3 Form) for all courses are provided before the semester begins.	X	x	x	x
(4)	A course report (TQF 5 Form) for all courses is completed within 30 days after the semester ends.	X	x	x	x
(5)	A program report (TQF 7 Form) is completed within 60 days after the academic year ends.	X	x	x	x
(6)	The students' learning achievement according to the learning outcomes specified in the TQF 3 for at least 25% of the courses offered each academic year is verified.	X	x	x	x
(7)	The teaching and learning process, the teaching strategies or the evaluation strategies are developed/ improved according to the performance evaluation report on the TQF 7 of the previous year.		x	x	x
(8)	All new faculty members (if any) are given orientation or advice on teaching and learning.	X	x	x	x

Key Performance Indicators		2013	2014	2015	2016
(9)	All full-time faculty members participate in academic and/or professional development programs at least once a year.	X	x	X	x
(10)	At least 50% of support staff (if any) participate in academic and/or professional development programs each year.	X	x	X	x
(11)	The average level of satisfaction of final year students/new graduates with the quality of the program is at least 3.5 out of 5.0.			X	x
(12)	The average level of satisfaction of employers with new graduates is at least 3.5 out of 5.0.				x
	Total number of compulsory key performance indicators (No.1-5) for each year	5	5	5	5
	Total number of key performance indicators for each year	9	10	11	12

Evaluation criteria

The standardized program according to the National Qualification Framework for higher education must pass the following evaluation criteria:

All the objectives as per the compulsory key performance indicators (No.1-5) and at least 80% of all the objectives of the total number of key performance indicators (considering the number of compulsory and total key performance indicators designated for each year) must be achieved.

Academic year	Standardized program according to the National Qualification Framework for higher education
2013	Achieving the objectives of the compulsory key performance indicators 1, 2, 3, 4, 5 and the objectives of 9 key performance indictors in total.
2014	Achieving the objectives of the compulsory key performance indicators 1, 2, 3, 4, 5 and the objectives of 10 key performance indictors in total.
2015	Achieving the objectives of the compulsory key performance indicators 1, 2, 3, 4, 5 and the objectives of 11 key performance indictors in total.
2016	Achieving the objectives of the compulsory key performance indicators 1, 2, 3, 4, 5 and the objectives of 12 key performance indictors in total.

Type 1.2 and 2.2 for Ph.D. students who have a bachelor's degree with honors

Key Performance Indicators		2013	2014	2015	2016	2017	2018
(1)	At least 80% of full-time faculty members are involved in the planning, follow-up and review of program performance.	X	x	X	x	x	x
(2)	A course description (TQF 2 Form) is provided according to the National Qualification Framework for higher education or professional standards (if any)	X	x	X	x	x	x
(3)	A course specification (TQF 3 Form) for all courses is provided before the semester begins.	X	x	X	x	x	x
(4)	A course report (TQF 5 Form) for all courses is completed within 30 days after the semester ends.	X	x	X	x	x	x
(5)	A program report (TQF 7 Form) is completed within 60 days after the academic year ends.	X	x	X	x	x	x
(6)	The students' learning achievement according to the learning outcomes specified in the TQF 3 for at least 25% of the courses offered each academic year is verified.	X	x	X	x	x	x
(7)	The teaching and learning process, the teaching strategies or the evaluation strategies are developed/ improved according to the performance evaluation report on the TQF 7 of the previous year.		x	X	x	x	x
(8)	All new faculty members (if any) are given orientation or advice on teaching and learning.	X	x	X	x	x	x
(9)	All full-time faculty members participate in academic and/or professional development programs at least once a year.	X	x	x	x	x	x
(10)	At least 50% of support staff (if any) participate in academic and/or professional development programs each year.	X	x	x	x	x	x
(11)	The average level of satisfaction of final year students/new graduates with the quality of the program is at least 3.5 out of 5.0.					x	x
(12)	The average level of satisfaction of employers with new graduates is at least 3.5 out of 5.0.						x
	Total number of compulsory key performance indicators (No.1-5) in each year	5	5	5	5	5	5
	Total number of key performance indicators for each year	9	10	10	10	11	12

Evaluation criteria

The standardized program according to the National Qualification Framework for higher education must pass the following evaluation criteria:

All the objectives as per the compulsory key performance indicators (No.1-5) and at least 80% of all the objectives of the total number of key performance indicators (considering the number of compulsory and total key performance indicators designated for each year) must be achieved.

Academic year	**Standardized program according to the National Qualification Framework for higher education**
2013	Achieving the objectives of the compulsory key performance indicators1, 2, 3, 4, 5 and the objectives of 9 key performance indictors in total.
2014	Achieving the objectives of the compulsory key performance indicators 1, 2, 3, 4, 5 and the objectives of 10 key performance indictors in total.
2015	Achieving the objectives of the compulsory key performance indicators 1, 2, 3, 4, 5 and the objectives of 10 key performance indictors in total.
2016	Achieving the objectives of the compulsory key performance indicators 1, 2, 3, 4, 5 and the objectives of 10 key performance indictors in total.
2017	Achieving the objectives of the compulsory key performance indicators 1, 2, 3, 4, 5 and the objectives of 11 key performance indictors in total.
2018	Achieving the objectives of the compulsory key performance indicators 1, 2, 3, 4, 5 and the objectives of 12 key performance indictors in total.

Section 8 Program evaluation and improvement

1. Evaluation of Teaching Effectiveness

1.1 Evaluation of Teaching Strategies

(1) Assessment of quizzes, student behavior in class, debates and discussions between teachers and students, answers given by students to questions in class, midterm and final examinations.

(2) Teaching assessment for each course by students.

1.2 Evaluation of Faculty Members' Skills in Using Teaching Strategies

(1) Students assess teachers' performance in all courses after the semester end using the faculty assessment forms provided through the internet network.

(2) Assessment results are delivered to teachers and the curriculum head for further improvement.

(3) The faculty collects assessment results showing a need for teaching skill improvement and delivers these results to teachers and the curriculum committee who will make improvements in planning and/or teaching strategies that are suitable for the courses and the current situation.

2. Overall Program Evaluation

The faculty will organize curriculum assessment in order to improve the curriculum every five years. This will make the curriculum up-to-date and meet the minimum standards provided by the Office of the Higher Education Commission. The faculty has appointed the Curriculum Assessment Committee to pursue the following:

(1) Plan systematically for curriculum assessment.

(2) Survey information for use in curriculum assessment from current students at all levels of the curriculum, graduates of the curriculum, graduates' employers, and other related groups, such as academic institutions where graduates pursue higher education.

3. Evaluation of Program Performance

There is an annual academic assessment as indicated in the academic quality indicators in Section 7, No.7, by the Curriculum Assessment Committee, which consists of at least three persons, including an expert related to the curriculum, and is appointed by the university. The assessment criteria are set as follows:

The Assessment Criterion

1 Point	2 Points	3 Points
5 items in the Indicators No. 1 to 5 are achieved.	At least 80 % of the overall indicators designated for each academic year are achieved.	All indicators designated for each academic year are achieved.

It is noted that the university requires that every curriculum should be updated and show the improvement in standard indicators and academic quality at intervals of no more than three academic years, and that an assessment for continuous curriculum development should be conducted every five years.

4. Review of Program Evaluation and Improvement Plan

4.1 Course improvement

(1) Teachers evaluate assessment results from students after the course finishes and improve teaching strategies appropriately for the next semester/academic year.

(2) In case a problem is found in some courses, the course should be improved immediately if it is a question of just minor curriculum modifications not affecting the curriculum structure.

4.2 Curriculum improvement

Curriculum improvement in all courses is considered a major modification having an impact on the curriculum structure. It will be performed in every five academic years, which will result in up-to-date curriculum and conform to the needs of graduate employers. The steps are as follows:

(1) The faculty curriculum assessment committee will conduct an assessment and propose crucial ideas for curriculum improvement.

(2) The faculty will organize a seminar for curriculum improvement.

(3) The faculty will invite academic experts to evaluate the curriculum and give advice.

(4) The improved curriculum will be proposed for the university academic committee and the university program revision committee to evaluate before it is proposed to the university council for permission for use as a curriculum.