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

Faculty of Engineering and Industrial Technology

Title of program	Doctor of Philosophy Program in Polymer Science and Engineering (International Program)
Title of degree	Doctor of Philosophy (Polymer Science and Engineering) Ph.D. (Polymer Science and Engineering)
Place of instruction	Faculty of Engineering and Industrial Technology, Silpakorn University, Sanamchandra Palace Campus, Nakhon Pathom

Objectives

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.
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.

Admission requirements

1. Type 1 (Thesis)
   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.
   1.2 Type 1.2 Thesis equivalent to 72 credits
   The applicants must possess a Bachelor of Engineering degree with honors in Petrochemicals and Polymeric Materials or equivalent degree with permission from the Department of Materials Science and Engineering, Silpakorn University.
2. Type 2 (Thesis and additional courses)
   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 Type 2.2 Thesis equivalent to 48 credits and 27 additional course credits
   The applicants must possess a Bachelor of Engineering degree with honors in Petrochemicals and Polymeric Materials or equivalent degree with permission from the Department of Materials Science and Engineering, Silpakorn University.
3. Applicants for program plans described in 1 and 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 and in accordance with the announcement of the Ministry of Education on graduate program accreditation criteria, B.E. 2548

4. Applicants for program plans described in 1 and 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.

5. Applicants for program plans described in 1 and 2 must have other qualifications as required by the Department of Materials Science and Engineering.

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

1. Type 1 (Thesis)

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

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

2. Type 2 (Thesis and additional courses)

2.1 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

2.2 Type 2.2 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.

Courses	Credits			
	Type 1.1	**Type 1.2**	**Type 2.1**	**Type 2.2**
Dissertation	48	72	36	48
Research methodology (non-credit)	-	2	-	2
Seminar (non-credit)	1	2	1	2
Compulsory courses	-	-	6	21
Elective courses	-	-	6	6
Total credits	**48**	**72**	**48**	**75**

Curriculum

Type 1.1

Seminar (non-credit)

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

Dissertation 48 credits

622 792 Dissertation equivalent to 48 credits

Type 1.2

Research methodology (non-credit)

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

Seminar (non-credit)

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

Dissertation 72 credits

622 793 Dissertation equivalent to 72 credits

Type 2.1

Seminar (non-credit)

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)

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

Research methodology (non-credit)

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

Seminar (non-credit)

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)

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

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)

Condition: 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)

Condition: 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.

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)

Condition: 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.

Note:

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.