Department/Academic Unit: Chemical Engineering Degree Program: PhD

Degree Level Expectations, Learning Outcomes, Indicators of Achievement and the Program Requirements that Support the Learning Outcomes

Expectations	Learning Outcomes	Indicators of Achievement	Relevant Courses and academic requirements
Depth and breadth of knowledge	A thorough understanding at the forefront of the student's specific sub-discipline in chemical engineering, the broader field of chemical engineering, and related areas, including: a. A systematic understanding of one of the following: - Biomaterials - Bioremediation - Green Chemistry - Electrochemical Power Sources - Macromolecular Science & Technology - Microfluidics, Colloids, Biosensors - Process Analytics, Optimization & Control - Transport Phenomena b. A critical awareness of problems and/or new insights in the immediate area of research and cognate areas, which is at the forefront of the discipline. c. Development of specialized knowledge, intellectual autonomy, critical thinking and analytical skills beyond the M.Sc. degree. d. Development of scientific communication skills.	Performance in courses, satisfactory performance at supervisory committee meetings, satisfactory presentation of thesis work for two research seminars, composition and defense of a thesis based on the student's research. Satisfactory performance as a teaching assistant in an undergraduate course at least once per year.	a. Four (4) term-length lecture courses beyond the Master's level or modular equivalents selected by the student and supervisor. For promoted students a total of four (4) term-length lecture courses or modular equivalents at the graduate level. b. CHEM 801 – Laboratory Safety. c. Regular participation in CHEE 897 – Seminar Course. Students in the Collaborative Biomedical Engineering specialization must take the CBME 802 - Seminar course. d. Composition and defense of a thesis based on the student's research. e. For those in the Collaborative Biomedical Engineering specialization, CBME801 – Special Topics in Biomedical Engineering must make up one of the total 4 term-length courses required for the degree.

Research and scholarship	Development of a conceptual understanding and methodological competence in the student's area of chemical research that enables: a. The formulation and completion of original research projects at the forefront of the field. b. The ability to produce original research of a quality to satisfy peer review and to merit publication. c. A working comprehension of how established techniques of inquiry and investigation are used to create and interpret information and knowledge. d. The review, analysis and critical evaluation of research carried out in the laboratory or with computer simulation. e. The ability to critically process information from primary and secondary literature sources and to distinguish opinions from facts.	Completion of a thesis project consisting of original research and composition of a thesis, which demonstrates: a. Competency and judgment in research. b. An understanding of the theoretical basis for the research and associated methodology. c. Appreciation of the scope of the research field. d. Completion of original research resulting in peer reviewed publications, communications, presentations and/or conference proceedings.	All students complete a PhD research project, and write and defend a thesis based on that research.
Application of Knowledge	Competence in the research process needed to: a. Undertake pure and/or applied research at an advanced level. b. Review, interpret, and present quantitative and qualitative information. c. Make sound judgments in accordance with the major theories, concepts and methods of the subject.	Completion of a thesis project consisting of original research and composition of a thesis, which demonstrates: a. The ability to apply research techniques and knowledge to study new problems in chemical engineering. b. The integration of learning and application of ideas and theories to old and new questions in chemical engineering.	All students complete a PhD research project consisting of original research, and write and defend a thesis based on that research. Students also complete four (4) term-length lecture courses (or modular equivalents) to broaden their knowledge of the discipline. Performance in these courses requires the application of knowledge in the form of tests, presentations, and reports as the instructor sees fit.

	d. Evaluate the appropriateness of different approaches to solving problems in their area of study. e. Contribute to the development of academic or professional skills, techniques, tools, practices, ideas, theories, approaches, and/or materials.	c. The ability to perform research at an advanced level. d. Development of academic or professional skills, techniques, tools, practices, ideas, theories, approaches and/or materials.	
Professional capacity/autonomy	Students have the qualities and transferable skills needed to: a. Enter employment in areas requiring academic and intellectual autonomy, professional character and judgment in complex situations. b. Remain current and informed in their area of study. c. Exhibit academic integrity and social responsibility. d. Evaluate the broader implications of applying knowledge.	Critical thinking skills, independent inquiry, rational argumentation and ethical behaviour consistent with academic integrity and appropriate for the responsible conduct of research.	All students complete a PhD research project consisting of original research, which involves: a. The ability to work independently and exhibit professional judgment. b. Professional interactions with the research supervisor, supervisory committee, undergraduate students, lab-mates, and the scientific community.
Communication Skills	Students develop competency in oral and written scientific communication.	Scientific Communication is demonstrated by: a. Satisfactory performance of a teaching assistantship in the undergraduate program. b. Ability to write a research thesis and describe the work contained therein. c. Communication components to coursework. d. Publication of scientific articles and participation in research conferences.	All students are required to present two seminars based on their research thesis work. All students write and defend a scientific thesis. All students attend weekly department seminars as part of CHEE 897, CBME 801 or CMAS 801.

Awareness of limits of knowledge	Students gain an awareness of the limits of their knowledge with respect to their specific research area, the broader field of chemical engineering and related disciplines. Students also appreciate how the limits of their knowledge may influence their abilities to interpret and analyze experimental and theoretical data.	Exposure to various areas of chemical engineering provides an awareness of the complexity of knowledge and other interpretations, methods, and disciplines. Recognition of the limits of various experimental and theoretical methods. Awareness of the limitations of the student's work and how it contributes to the broader field.	Students are required to complete four (4) term-length lecture courses or modular equivalents, which can span several sub-disciplines of chemical engineering. For promoted students a total of four (4) term-length lecture courses or modular equivalents at the graduate level. PhD students are required to attend weekly seminars, which provide exposure to other interpretations and areas of research.