# PREDICTIVE SCIENCE AND ENGINEERING DESIGN CERTIFICATE

The following requirements are in addition to, or further elaborate upon, those requirements outlined in The Graduate School Policy Guide (https://catalogs.northwestern.edu/tgs/academic-policies-procedures/).

## Certificate

**Total Units Required**: 5

## Course Requirements:

To earn a graduate certificate in Predictive Science and Engineering Design, a student must enroll in at least 5 approved courses (three core courses plus two electives).

| Course | Title |
|---|---|
| **Core Area 1: PSED Seminar** | |
| This is a literature and project combined seminar course focusing on the common principles and techniques underlying Predictive Science and Engineering Design (PS&ED). In addition to learning the fundamental principles and techniques associated with PS&ED, students will work in teams on interdisciplinary projects related to the current design focus of PS&ED. | |
| PSED 510-1 | Predictive Science & Engineering Design Cluster Seminar |
| PSED 510-2 | Predictive Science & Engineering Design Cluster Seminar |
| **Core Area 2: Modeling, Simulation, and High Performance Computing** | |
| This topic introduces the next generation of advanced computational methods for predictive simulation of multiscale, multiphysics phenomena. Topics include molecular dynamics, lattice mechanics, methods of thermodyanmics, statistical mechanics, multiscale modeling, bridging scale methods, supercomputing, etc. Students will also become proficient in computing technology, including numerical computation and the practical use of advanced computer architectures. | |
| CHEM_ENG 451-0 | Applied Molecular Modeling |
| CIV_ENV 426-1 | Advanced Finite Element Methods 1 |
| or MECH_ENG 426-1 | Advanced Finite Element Methods I |
| CIV_ENV 426-2 | Advanced Finite Element Methods 2 |
| or MECH_ENG 426-2 | Advanced Finite Element Methods II |
| COMP_ENG 358-0 | Introduction to Parallel Computing |
| IEMS 435-0 | Stochastic Simulation |
| MAT_SCI 510-0 | Special Topics (Atomic-Scale Computational Materials Science) |
| MECH_ENG 417-0 | Multi-scale Modeling and Simulation in Solid Mechanics |
| or MECH_ENG 418-0 | Multi-Scale Modeling and Simulation in Fluid Mechanics |
| **Core Area 3: Computational Design Methods** | |
| This topic provides students across all disciplines a view of using computational techniques (including topics like modeling, simulation, optimization, uncertainty quantification, risk-based decision making) and the simulation-based design paradigm for designing complex "engineered" systems based on predictive models. | |
| IEMS 465-0 | Simulation Experiment Design & Analysis |
| MECH_ENG 341-0 | Computational Methods for Engineering Design |
| MECH_ENG 395-0 | Special Topics in Mechanical Engineering (Mechanistic Data Science for Engineering) |
| MECH_ENG 441-0 | Engineering Optimization for Product Design and Manufacturing |
| **Electives (2 required courses)** | |
| BMD_ENG 366-0 | Biomechanics of Movement |
| IEMS 401-0 | Applied Mathematical Statistics |
| MECH_ENG 359-0 | Reliability Engineering |
| MECH_ENG 382-0 | Experiments in Micro- and Nano Science and Engineering |
| MECH_ENG 432-0 | The Calculus of Variations and Its Applications (Optimization Methods in Science and Engineering) |
| MECH_ENG 442-0 | Metal Forming |
| MECH_ENG 446-0 | Advanced Tribology |
| MECH_ENG 451-0 | Micromachining |