



**THE GEORGE  
WASHINGTON  
UNIVERSITY**  
WASHINGTON, DC

# DOCTOR OF PHILOSOPHY IN SYSTEMS ENGINEERING

ONLINE - DP5

## INTRODUCTION

Offered by the Department of Engineering Management and Systems Engineering Online Programs Office (EMSE-OP), this online weekend program leads to award of the Doctor of Philosophy degree in Systems Engineering. A group of students will begin study as **Ph.D. COHORT DP5** in August 2020, with a target graduation date of May 2023. Under the direction and supervision of Professor Shahram Sarkani, Ph.D., P.E., EMSE-OP Director, professionals who are employed full-time pursue study and research in an intense, focused environment alongside like-minded fellow students.

## CURRICULUM

The Ph.D. program consists of a minimum of 54 credit hours (ch) divided into a classroom experience of 8 graduate-level, 3-credit-hour courses culminating in the student's acceptance to an appropriate engineering professional society conference, and an independent research effort of at least 30 ch of dissertation research culminating in the dissertation defense. Results of the research must be accepted for publication. After completing the course work with a grade point average of 3.4 or better and no grade below B-, the student is admitted to candidacy for the degree and begins specialized study and research under the supervision of a designated member of the faculty.

## CLASSROOM PHASE (24 CREDIT HOURS)

### EIGHT PROPOSED CLASSROOM COURSES

- EMSE 6115 Uncertainty Analysis for Engineers
- EMSE 6807 Advanced Systems Engineering
- EMSE 6765 Data Analysis for Engineers and Scientists
- EMSE 6817 Model-Based Systems Engineering
- EMSE 6760 Discrete Systems Simulation
- EMSE 6710 Applied Optimization Modeling
- EMSE 6769 Machine Learning for Engineers
- EMSE 8000 Research Formulation in Engineering Management and Systems Engineering

### SCHEDULE

Course sessions last 10 weeks. Classes meet Saturday mornings from 9:00 am-12:00 pm and afternoons from 1:00-4:00 pm (all times Eastern). This program is taught in an accelerated, cohort format in which students take all courses in lock step. Classes cannot be taken out of sequence, attendance at all class meetings is expected, and students must remain continuously enrolled; i.e., leaves of absence are permitted only in medical or family emergency, or in case of deployment to active military duty.

SESSION	# CRSES	# CH	TENTATIVE DATES
Fall-1 2020	2	6	August 8, 2020 – October 10, 2020
Fall-2 2020	2	6	October 17, 2020 – January 9, 2021
Spring-1 2021	2	6	January 16, 2021 – March 20, 2021
Spring-2 2021	2	6	March 27, 2021 – May 29, 2021

\* NO CLASSES THE WEEK OF THANKSGIVING AND WINTER BREAK

## RESEARCH PHASE (30 CREDIT HOURS)

Upon successful completion of the classroom phase, students are admitted to candidacy for the Ph.D. and will be registered for a minimum total of 30 ch of **EMSE 8999 Dissertation Research**: 3 ch in Summer 2021, 6 ch Fall 2021, 6 ch Spring 2022, 3 ch Summer 2022, 6 ch Fall 2022, 6 ch Spring 2023. More than 30 ch of EMSE 8999 may be approved, depending on the candidate's progress; approved candidates will be registered for the standard number of ch per semester of extension (3 ch in Summer, 6 ch in Fall or Spring). Candidates who do not successfully complete the requirements will have their work transferred to a professional degree program. Candidates who make good progress may accelerate the rate of their research by registering for more than the standard ch per semester, and thus

may finish the program early. Throughout this phase, the candidate conducts research and writes the dissertation, and is expected to attend all regular meetings with the faculty research advisors. Work on the dissertation is normally completed in 2 years. **Candidates who do not successfully complete the requirements within five years (by August 2025) will have their work transferred to a professional degree program.**

#### 4 MILESTONES

To be admitted to candidacy for the Ph.D., the student must earn a GPA of at least 3.4 in the 8 classroom courses, with no grade below **B-** (Milestone 1).

By no later than the first semester of research, Summer 2021, the student must be accepted to present their proposed research at an appropriate engineering professional society conference (Milestone 2). This will serve as the qualifying exam. If a candidate is unsuccessful in being accepted to a conference, their studies will be terminated and their work will be transferred to a professional degree program.

Next, the candidate must submit an article based on the results of the dissertation research to an approved, referred scholarly journal. Credit must be given in the publication to the fact that the material is abstracted, summarized, or developed from a dissertation submitted to the George Washington University in partial fulfillment of the requirements for the Doctor of Philosophy degree. Before the candidate is permitted to defend the dissertation, this original article must be accepted for publication (Milestone 3).

The dissertation defense, or Final Examination (Milestone 4), must be taken within 2 months after the journal article is accepted for publication. The candidate defends the dissertation before a committee of faculty members. The EMSE-OP Office schedules the Final Examination in consultation with Professor Sarkani and the candidate. When the Final Examination committee is convinced of the quality and originality of the candidate's contribution to knowledge as well as his or her mastery of the scholarship and research techniques of the field, the committee recommends the candidate for the degree of Doctor of Philosophy.

#### COST

All classes meet live online through synchronous distance learning technologies. Classes are recorded for future viewing. Tuition is billed at \$1550 per credit hour for the 2020-2021 academic year. Required textbooks and software are provided at no additional cost. A non-refundable tuition deposit of \$1550, which is applied to tuition in the first semester, is required when the student accepts admission.

#### COURSE DESCRIPTIONS FOR THE DP5 PROGRAM

See also <http://bulletin.gwu.edu/courses/emse/>.

**EMSE 6115 Uncertainty Analysis for Engineers.** Basics of probability theory and statistics, with a focus on engineering applications, particularly in the realm of systems. Topics include simulation, uncertainty analysis, central limit theorem, systems examination and analysis, and application to systems design and management.

**EMSE 6760 Discrete Systems Simulation.** Simulation of discrete stochastic models. Simulation languages. Random-number/ random-variate generation. Statistical design and analysis of experiments, terminating/nonterminating simulations; comparison of system designs. Input distributions, variance reduction, validation of models.

**EMSE 6765 Data Analysis for Engineers and Scientists.** Design of experiments and data collection. Regression, correlation, and prediction. Multivariate analysis, data pooling, data compression. Model validation.

**EMSE 6807 Advanced Systems Engineering.** Analysis of advanced systems engineering topics; system lifecycle models, INCOSE Vision 2025, requirements types and processes, architectural design processes and frameworks, DoDAF artifacts, enterprise architecture and enterprise systems engineering, complex adaptive systems (CAS), modeling languages and SysML, and Model Based Systems Engineering (MBSE). Applications of systems engineering tools and techniques.

**EMSE 6817 Model-Based Systems Engineering.** Model-based systems engineering (MBSE) and its derivative, evidence-based systems engineering (EBSE), are techniques with strong potential for improving the technical integrity of complex systems. The foundation to these model- and research-based techniques for system definition and analysis as applied to lifecycle SE. Practical applications.

**EMSE 6710. Applied Optimization Modeling.** Analysis of linear, integer, and nonlinear optimization models of decision problems that arise in industry, business, and government. Modeling techniques and applications; use of optimization software to solve models.

**EMSE 6769 Machine Learning for Engineers.** A broad introduction to fundamental concepts and techniques in machine learning from the perspective of the systems engineer. The field of machine learning explores algorithms that can learn from examples (e.g. experience) without pre-programmed rules or that can make predictions based automated analysis of prior data. This course provides students with knowledge of the theory and practice of machine learning leveraging an open source framework to explore the ideas, algorithms and techniques, without a prior background in programming. Topics covered in the course include the relationship between Data Mining and Machine Learning, Machine Learning and Statistics, Fundamental concepts (preparing/cleansing input data, attribute selection, sampling), linear models, clustering, training/testing/cross-validation, decision trees, probabilistic methods, deep learning, auto-encoders, convolutional neural networks and ensemble learning methods.

**EMSE 8000 Research Formulation in Engineering Management and Systems Engineering.** Doctoral seminar designed to give students their first exposure to the process of formulating and executing empirical research. Class format includes discussion, field experiments, data analysis, and theorizing. Study of core concepts in building theory from empirical data and classic works in technically-oriented management theory. Participants design and execute a research project. Restricted to EMSE PhD students.

*The University reserves the right to adjust course offerings, schedules, and tuition rates.*

