MERCURY

Computational Modeling of Complex Systems

23 – 27 November 2026
London (UK)



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Computational Modeling of Complex Systems

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Introduction

The Computational Modeling of Complex Systems course equips professionals with advanced theoretical knowledge in designing, analyzing, and simulating complex electronic and engineering systems using mathematical modeling techniques implemented through computer programs. The course focuses on building predictive models that accurately replicate real-world system behavior and provide analytical depth. Participants will explore how simulation software and computational tools support data-driven decision-making in engineering and applied sciences. It emphasizes mathematical modeling, system dynamics, numerical methods, and predictive analytics for interpreting real data. The course bridges theory and structured analytical application without relying on physical prototyping. Participants will understand how computational simulation enhances system optimization, risk reduction, and performance forecasting.

Targeted Groups

This Computational Modeling of Complex Systems training targets professionals seeking knowledge and skills:

- Electrical and electronics engineers.
- Systems engineers and design analysts.
- Researchers in applied physics and engineering sciences.
- Data analysts working with simulation models.
- Graduate students in computational engineering fields.
- Professionals involved in predictive modeling projects.
- R&D specialists in complex electronic systems.

Course Objectives

Participants will achieve the following objectives by completing the Computational Modeling of Complex Systems course:

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- Understand principles of computational modeling and simulation.
- Analyze complex systems using mathematical representations.
- Develop system models using numerical methods.
- Apply system dynamics in electronic modeling environments.
- Interpret real-world data through predictive modeling techniques.
- Evaluate model accuracy using validation and verification methods.
- Design simulation experiments for performance analysis.
- Assess uncertainty and sensitivity in complex systems.
- Compare modeling strategies for engineering optimization.
- Integrate data modeling with computational tools.
- Examine stability and nonlinearity in dynamic systems.
- Formulate scalable simulation frameworks for electronics design.
- Improve decision-making using computational analysis outputs.

Targeted Competencies

Participants will gain the following competencies during the Computational Modeling of Complex Systems program:

- Proficiency in mathematical modeling of complex systems.
- The capability to simulate electronic systems using computer programs.
- Skill in interpreting simulation results for real data prediction.
- Competence in numerical analysis and system dynamics.
- Ability to validate computational models against real datasets.
- Analytical thinking for system optimization and forecasting.
- Structured evaluation of multi-variable system interactions.
- Application of predictive analytics in engineering contexts.
- Confidence in designing digital prototypes through simulation.

Studying Scenarios

In this Computational Modeling of Complex Systems training, participants develop skills through the following scenarios:

- Modeling an advanced electronic circuit to predict real-time performance under varying loads.
- Simulating a nonlinear dynamic system to analyze stability and system response.
- Developing a predictive computational model using real operational data.
- Evaluating system sensitivity to parameter changes in a multi-component design.
- Conducting verification and validation of simulation outputs against actual measurements.

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Course Content

Unit 1: Foundations of Computational Modeling and Mathematical Systems

- Introduction to computational modeling principles.
- Overview of complex systems theory.
- Mathematical representation of physical and electronic systems.
- Deterministic and stochastic modeling approaches.
- Linear and nonlinear system modeling fundamentals.
- System boundaries and abstraction levels.
- Model assumptions and limitations.

Unit 2: Numerical Methods and Simulation Techniques

- Introduction to numerical methods for engineering systems.
- Differential equations in system modeling.
- Discretization techniques for continuous systems.
- Stability analysis in numerical simulation.
- Iterative methods for solving large-scale systems.
- Error estimation and convergence analysis.
- Time-domain and frequency-domain simulation approaches.
- Computational efficiency and algorithm optimization.

Unit 3: Modeling and Simulation of Complex Electronic Systems

- Modeling of electronic circuits using computational tools.
- Signal processing and system response simulation.
- Power system modeling and dynamic analysis.
- Multi-component electronic system integration.
- Thermal and electromagnetic modeling basics.
- Predictive modeling for electronic performance evaluation.
- Digital twin concepts in electronics engineering.
- System optimization using simulation data.

Unit 4: Predictive Modeling and Real Data Integration

- Data-driven modeling techniques.
- Regression models and parameter estimation.
- Machine-assisted modeling foundations.
- Sensitivity analysis and uncertainty quantification.
- Calibration of computational models with real data.
- Validation and verification methodologies.
- Performance forecasting using predictive simulation.
- Scenario-based analytical modeling.

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Unit 5: Advanced System Dynamics and Optimization

- Complex adaptive systems modeling.
- Feedback loops and dynamic interactions.
- Nonlinear dynamics and chaos in engineering systems.
- Multi-scale modeling strategies.
- Optimization algorithms for system performance.
- Risk modeling and reliability analysis.
- Model scalability and computational complexity.
- Ethical and professional considerations in computational analysis.

Final Insights & Key Takeaways

Computational Modeling of Complex Systems enables professionals to translate mathematical theory into predictive, data-driven analyses. Mastery of simulation and modeling techniques enhances accuracy, efficiency, and strategic decision-making in engineering.