



Project No.
27007

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المكتب الهندسي لخدمات التكنولوجيا والبرمجيات



Engineering office for Technology and Software Services

Math Simulation



Course Plan: Math Simulation

Course Code: 27008-COs

Course Objectives:

- Understand the fundamentals of **mathematical simulation** and its models.
- Utilize essential **software tools** for performing simulations.
- Apply simulation techniques to **analyze and solve complex mathematical and engineering problems**.

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- Interpret and analyze simulation results in a **scientific and structured way**.



Duration:

- **6 weeks**
- **2 sessions per week**
- **Each session:** approximately 2 hours (1 hour lecture + 1 hour practical work)



Prerequisites:

- Basic knowledge of **Mathematics** (Calculus and Linear Algebra).
- Basic understanding of **Programming** (preferably MATLAB or Python).
- Familiarity with **Physics and Engineering** concepts (optional but recommended).

Detailed Curriculum:

Week 1: Introduction to Mathematical Simulation

- **Lecture 1: What is Mathematical Simulation?**
 - Definition and importance of mathematical simulation.
 - Types of simulation: **Discrete** vs. **Continuous**.
 - Applications in engineering, physics, economics, and social sciences.
- **Lecture 2: Fundamental Mathematical Models**
 - Building mathematical models for simulation.
 - Differential and difference equations (ODEs, PDEs).
 - Probability and statistical models.

Week 2: Methods and Techniques in Simulation

- **Lecture 3: Numerical Methods for Simulation**
 - Introduction to **numerical analysis** and solving differential equations.
 - Numerical techniques: **Euler, Runge-Kutta** methods.
 - Simulating dynamic systems.
- **Lecture 4: Discrete and Continuous Simulation Techniques**
 - Discrete Event Simulation (DES).
 - Continuous Simulation.
 - Practical examples and demonstrations.

Week 3: Software Tools for Simulation

- **Lecture 5: Simulation Programming with MATLAB**
 - Introduction to **MATLAB** environment.
 - Writing codes to build simulation models.

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- Solving differential equations and implementing simulations.
- **Lecture 6: Simulation with Python (Optional)**
 - Introduction to **Python** and libraries like **NumPy**, **SciPy**.
 - Hands-on applications in mathematical simulation.
 - Comparison: **MATLAB** vs. **Python** in simulation tasks.

Week 4: Applications in Mathematics and Engineering

- **Lecture 7: Simulating Physical and Engineering Systems**
 - Mechanical and dynamic system simulations.
 - Electrical circuit and electronics simulations.
 - Applications in mechanics and hydraulics.
- **Lecture 8: Simulating Natural and Scientific Phenomena**
 - Simulating disease spread (e.g., **SIR Model**).
 - Simulating thermal and fluid phenomena.
 - Applications in environmental and natural sciences.

Week 5: Analyzing and Interpreting Simulation Results

- **Lecture 9: Data Analysis from Simulations**
 - Visualizing results (graphs, plots, charts).
 - Data analysis techniques using **MATLAB** or **Python**.
 - Evaluating model accuracy and validation.
- **Lecture 10: Interpreting Results and Decision-Making**
 - Interpreting simulation results within real-world contexts.
 - Using simulation results for scientific and engineering decisions.
 - Practical examples and case studies.

Week 6: Advanced Projects and Final Review

- **Lecture 11: Applied Simulation Projects**
 - Selecting a real-world simulation project.
 - Building, executing, and analyzing a simulation using **MATLAB** or **Python**.
 - Final project presentation and reporting.
- **Lecture 12: Comprehensive Review and Course Assessment**
 - Full review of simulation concepts and methods.
 - Solving common challenges and advanced problems.
 - Final course evaluation and project discussions.

Materials and Resources:

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- Educational handbooks and practical exercises.
- Video tutorials covering programming and simulation practices.
- Ready-to-use simulation models and project examples.
- Access to MATLAB and Python software (with necessary simulation libraries).

🎓 Course Outcomes:

- Comprehensive understanding of mathematical simulation principles.
- Ability to **design, implement, and analyze** simulation models.
- Scientific interpretation of results for decision-making.
- Practical programming skills using **MATLAB** or **Python** for simulation.

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