Machine Learning, Modeling, and Simulation Principles Schedule

All Graded Assignments are due the last day of the course.
Items preceded by a star (★) are graded.

MODULE 1: GET STARTED (15 min)

- Entrance Survey (2 min)
- Welcome (3 min)
- The New Computational Paradigm (4 min)
- Schedule (1 min)
- Introduce Yourself (3 min)
- Teaching Team (2 min)

MODULE 2: MODELING AND SIMULATION FUNDAMENTALS (4 hrs)

- Key Takeaways (5 min)
- Ordinary Differential Equations (ODEs) (30 min)
- The Forward Euler Method (45 min)
- Higher-Order Methods (45 min)
- Implicit Methods (45 min)
- ★ Graded Assignment (60 min)
- Module 2 Content Questions / Discussion Forum (10 min)

MODULE 3: SPATIAL MODELING (4 hrs)

- Key Takeaways (5 min)
- Partial Differential Equations (PDEs) (5 min)
- Spatial Discretization and Design Considerations (25 min)
- Explicit and Implicit PDE Solutions (30 min)
- Boundary Conditions (5 min)
- Linear Systems: Direct and Indirect Methods (30 min)
- Nonlinear Systems and Root Finding (40 min)
- ★ Graded Assignment (90 min)
- Module 3 Content Questions / Discussion Forum (10 min)

MODULE 4: OPTIMIZATION AND DATA-DRIVEN MODELING (4 hrs)

- Key Takeaways (5 min)
- Introduction to Modeling (15 min)
- Least Squares Problems (15 min)
- Gradient Descent (40 min)
- Newton's Method (40 min)
- Parameter Estimation and Nonlinear Least Squares (25 min)
- ★ Graded Assignment (90 min)
- Module 4 Content Questions / Discussion Forum (10 min)

MODULE 5: FROM OPTIMIZATION TO MACHINE LEARNING (4 hrs)

- Key Takeaways (5 min)
- Regression Problems (15 min)
- Regression Methods and Least Squares (10 min)
- Regularization (30 min)
- Classification Problems (5 min)
- Logistic Regression (40 min)
- Stochastic Gradient Descent (15 min)
- Assessing Model Fit (20 min)
- ★ Graded Assignment (90 min)
- Module 5 Content Questions / Discussion Forum (10 min)

MODULE 6: PROBABILISTIC METHODS (4 hrs)

- Key Takeaways (5 min)
- Introduction to Probabilistic Methods (5 min)
- Monte Carlo Simulation (45 min)
- Probabilistic Forecasting (15 min)
- Sensitivity Forecasting (45 min)
- Simulating Rare Events (25 min)
- ★ Graded Assignment (90 min)
- Module 6 Content Questions / Discussion Forum (10 min)

MODULE 7: CASE STUDIES (5 hrs)

- ★ Aurora Flight Sciences (2.5 hrs)
- ★ Schlumberger (90 min)
- ★ BASF (90 min)
- Module 7 Content Questions / Discussion Forum (10 min)

MODULE 8: CONCLUSION (10 min)

- Where to Go Next (2 min)
- Exit Survey (2 min)
- Module 8 Content Questions / Discussion Forum (10 min)