**MC133**
**Verification and Validation in Scientific Computing**

**Day 1**
- Introduction, Background, and Motivation

- Terminology and Fundamental Concepts
    - Brief history of terminology
    - Present definitions and interpretations
    - Alternate definitions used by related communities
    - Additional important terms
    - Who should conduct verification, validation, and uncertainty quantification?

- Code Verification
    - Software engineering
    - Criteria and definitions
    - Order of accuracy
    - Order of verification procedures
    - Traditional exact solutions
    - Method of manufactured solutions
    - Approximate solution methods

- Solution Verification
    - Round-off error
    - Iterative convergence
    - Iterative error estimation
    - Classification of discretization error estimators
    - Reliability of discretization error estimators
    - Discretization error and uncertainty estimation
    - Solution adaption procedures

**Day 2**
- Validation Experiments
    - Validation fundamentals
    - Validation experiment hierarchy
    - Validation experiments vs. traditional experiments
    - Six characteristics of validation experiments
    - Detailed example of a wind tunnel validation experiment

- Model Accuracy Assessment
    - What are validation metrics?
    - Various approaches to validation metrics
    - Recommended characteristics for validation metrics
    - Confidence interval approach
    - Cumulative distribution functions approach

- Predictive Capability of Modeling and Simulation
    - Identify all sources of uncertainty
    - Characterize each source of uncertainty
    - Estimate solution error in system responses of interest
    - Estimate uncertainty in system responses of interest
    - Procedures for updating model parameters
    - Types of sensitivity analyses

- Final Topics
    - Planning and prioritization in modeling and simulation
    - Maturity assessment of modeling and simulation
    - Difficulties in implementing verification, validation, and uncertainty quantification (VVUQ)