

I6400: System Modeling & Simulation (42 hours total)
(Instructor: *Kaliappa ('Ravi') Ravindran* — Spring ~~2022~~ '23)
City University of New York and Graduate School & University Center

[Each lecture hour (*hr*) is 50 minutes long]

CC 86120

Introduction to system modeling concepts (4 *hrs*)

Role of system models, mathematical representations, accuracy versus simplicity, continuous and discrete time systems, human-in-the-loop simulation.

Formalisms for system representation (6 *hrs*)

- Discrete event systems (DEVS): State Transition Methods, Petrinets
- I/O behaviors, function-based descriptions, dataflow models
- Blackbox-type of descriptions, Subsystem-level interactions

Model-based engineering of system adaptation (6 *hrs*)

- Observers and controllers
- Error-driven control; learning methods
- Control laws: linearity and non-linearity
- Case studies: Internet video transport systems

DEVS specification and analysis methods (6 *hrs*)

- State-transition methods
- I/O ports and buffers
- Hierarchical decomposition, object-orientated approach
- Declarative methods
- Simulation modeling languages (UML, Simulink)

Model-checking systems (4 *hrs*)

- PROMELA from AT&T
- Arena from Rockwell Automation
- Decision-making tools for enterprise systems: ProModel

Queuing models of discrete event systems (6 *hrs*)

- Performance analysis, fault modeling
- Markov chains
- Dependability analysis
- Case studies: packet flow in computer networks, web server transaction flows

Discrete event simulation (6 hrs)

- Event management: event queues, random number generators, state-transition rules
- I/O traces: testing and verification
- Distributed/parallel Simulation of large-scale systems (e.g., eco-monitoring systems, content delivery networks, intelligent transportation systems)

• *Event causality and Data Analytics*

Case studies of networked systems (4 hrs)

- Collaborative operation of autonomous cars;
- UAV-based surveillance systems;
- Supply-Chain based product distribution networks.

Reference Books

I: *Theory of Modeling and Simulation* by **B. P. Zeigler, H. Praefhofer** and **T. G. Kim**; Academic Press, 2nd Ed., 2000.

II: *Introduction to Discrete Event Systems* by **C. G. Cassandras** and **S. Lafortune**, Springer publ., 2008.

III: *Simulation* by **S. M. Ross**, Elsevier Inc., 2006.

(IV) *Research Papers on Causal Inference and Data-Science*
Evaluation procedure (100 points total)

- Mid-term examination (3rd week of March): 20 points
- Programming project (due by mid-May): 40 points
- Final exam (2nd/3rd week of May): 40 points