Course Objective
This course seeks to familiarize the students with an array of problems and methods that pertain to the modeling, analysis and control of contemporary production and service systems. More specifically, it is expected that by the end of this course, the students will have

- a profound understanding and appreciation of the different resource allocation and coordination problems that underlie the behavioral management and the performance enhancement of the considered class of systems;
- the ability to formally characterize and study these problems by referring them to pertinent analytical abstractions and modeling frameworks;
- an appreciation of the inherent complexity of (many of) these problems, the complications arising from this complexity, the resulting need for simplifying approximations, and the ensuing trade-off between modeling accuracy and computational / analytical tractability;
- familiarity with some typical approaches for developing pertinent approximations for the considered class of problems;
- an understanding and appreciation of the multi-faceted role of simulation in the study of the considered systems.

Furthermore, it is expected that the aforementioned experience will

- define a “research frontier” for the addressed areas, and in this way,
- assist the students in developing the perspectives and strengthening the skills that are necessary for the definition and successful execution of a Ph.D. research program.

Tentative Course Outline

1. Introduction: Course Objectives, Context, and Outline
   - Contemporary organizations and the role of Operations Management (OM)
   - Corporate strategy and its connection to operations
   - The organization as a resource allocation system (RAS)
   - The underlying RAS management problems and the basic course structure

2. Qualitative / Behavioral modeling of the considered RAS
   - Languages and (Finite State) Automata
   - An introduction to (Ramadge & Wonham) Supervisory Control theory
   - Petri nets
   - Application of the above frameworks to the liveness-enforcing supervision of RAS

3. Timed models: towards performance analysis of the considered RAS
   - Timed Automata and Petri nets
   - Dioid / (max, +) Algebras
   - Applications in Queueing Systems and in the development of efficient cyclical schedules for contemporary cluster tools

4. Stochastic Timed Automata
   - Stochastic Clock Structures and Stochastic Timed Automata
   - Generalized Semi-Markov Process (GSMP) and its connection to Simulation
• Markov and Semi-Markov Processes as specializations of the GSMP model
• Generalized Stochastic Petri nets (GSPN)

5. The stochastic scheduling problem in the considered RAS
• Formulation of the scheduling problem for RAS with Markovian Dynamics in the GSPN modeling framework
• Approximation of non-Markovian dynamics through the method of stages
• Introduction to Markov Decision Process (MDP) theory and Dynamic Programming (DP)
• Approximate DP: current trends and their potential application in the RAS scheduling problem

6. Queueing-theoretic-based analysis and control of the considered RAS
• Introduction to the theory of Open and Closed Markovian Queueing networks
• BCMP networks
• Performance evaluation and stability analysis of multi-class queueing networks
• An introduction to fluid-based modeling, analysis and control of queueing systems

7. Application of MDP theory in inventory control
• The optimality of (S,s) policies
• Introduction to the theory of multi-echelon inventory systems
• Hedging point strategies

Course Prerequisites: Familiarity with Stochastic / Probabilistic Modeling and Deterministic Optimization at the respective levels of ISYE 6650 and ISYE 6669.

Course Reading Material


Additional supplementary material will be provided either in class, or through a course website accessed from my homepage, or through the library electronic reserves (in case that copyright clearance is necessary).

Course Policies

Homework: A number of homework assignments, consisting of conceptual, theoretical and computationally oriented problems, will be assigned at certain points of the course development. These assignments will have the nature of “take-home” exams, and therefore, you are expected to observe the *Georgia Tech Honor Code* in the preparation of their solutions. In particular, each student must work independently on the assigned problems and the preparation of the submitted report. Also the specified due dates must be strictly observed.

Project: Each student must also perform a project that will take place in the second half of the course. The topic of the project will be defined on the basis of the student interests and must be approved by the instructor. In general, the selected topics should extend the class experience by researching further some of the material presented in class. The developed results must be written up in a proper report that will be shared with the rest of the class. Finally, group projects are also possible, provided that the undertaken research topic justifies the size of the group.

Grading:
• Class participation: 25%
• Homework: 50%
• Project: 25%