ISyE 4803-REV Advanced Manufacturing Systems Modeling and Analysis
Fall 2023

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Course Meeting Times: TR 3:30-4:45 pm
Course Classroom: Groseclose 119
Instructor Office Hours: TR 10:30-11:45am or by appointment

Course Objective

This "Advanced Manufacturing" course will introduce the students to an in-depth modeling and analysis of the workflow dynamics that shape the operation and the performance of contemporary production systems. Building upon the analytical background on stochastic modeling that is provided in 2027, 2028 and 3232, this course will develop systematic and rigorous models for the study of the considered environments.

At the same time, it will offer the students the experience of applying their formal background in stochastic modeling and analysis to practical problems and applications. In fact, a further intention of the course is to teach the students not only the particular models and algorithms that are covered in it, but also the thinking processes and the broader methodology that underlie the development of the presented results. Developing this skill is important for an effective application of the course material, in the face of the extensive complexities and intricacies of the modern production systems.

Finally, it must be pointed out that, while the course material will be motivated and presented primarily through applications drawn from the manufacturing domain, for specificity and concreteness, this material finds further applicability in any other application domain involving a structured workflow, like in health care and other service-related industries.

Tentative Course Outline

1. Introduction: Course Objectives, Context, and Outline. Here are some more specific topics that are covered in this introductory part:
   - The Manufacturing System as a Transformation Process, Operations Management, and the role of Corporate Strategy.
   - A brief introduction to layout theory.
   - Contemporary high-volume (discrete-part) manufacturing systems, and their modeling as stochastic systems.
   - A taxonomy of the considered manufacturing systems based on their workflow management: Synchronous vs. Asynchronous, and Push vs. Pull and CONWIP models.
   - Course overview.
2. Design of Synchronous Manufacturing Systems / Assembly Line Balancing.
3. A review of some key results from Markovian Queueing Theory, and their use in the modeling and the analysis of some simple workflows.
4. Stability characterization and Mean Value Analysis (MVA) of the M/G/1, G/G/1 and G/G/m queues.
5. Modeling, Analysis and Design of Push-Controlled Manufacturing Systems as a series of G/G/m queues.

6. Modeling of the operational outages of the system servers, and of some other operational features of the considered facilities.
7. The role of batching in modern production systems, and queueing-theoretic modeling of some batched operations.
8. Extension of the aforementioned theory to the modeling of workflows that evolve over more complex network structures.
9. Introduction to (combinatorial) scheduling theory.
10. Modeling and analysis of some pull-controlled manufacturing systems as closed queueing networks.

Course Prerequisites
The main course prerequisite is ISyE 3232. More specifically, you are expected to be comfortable with the stochastic/probabilistic models and the basic queueing theory that are covered in that course. Also, it is expected that you are familiar with some basic concepts and techniques coming from deterministic optimization theory.

Course Reading Material
Textbook: G. L. Currry and R. M. Feldman, *Manufacturing Systems Modeling and Analysis* (2nd ed.), Springer, 2011.

The above text will be a substantial base for the course development. Additional supplementary material will be provided through a course website accessed from the instructor's homepage and through CANVAS.

Course Policies
Homework: Homework will be assigned every time that a course unit is covered, and its primary intention is to help the students internalize the material by applying it on a number of problem instances. Some of the assigned questions and problems might also serve the additional objective of strengthening the modeling and analytical capabilities of the students by asking them to provide certain extensions and modifications of the results presented in class. Homework can be worked out in teams, but each student must turn in his/her own write-up and any occurring collaboration and interaction must be reported in the write-up itself.

Exams: There will be three exams spread out quite evenly along the semester but their exact dates will be determined based on the course progress. **No collaboration or any other type of interaction is allowed for the exams.**

Grading Scheme:
- Homework: 20% (provided that we shall get a grader)
- Midterm Exam I: 25%
- Midterm Exam II: 25%
- Final Exam: 30%

It is expected that throughout the course development, students will abide by the Georgia Tech Honor Code (http://osi.gatech.edu/content/honor-code).

Finally, please, notice the following link regarding the available disability services at the Georgia Tech campus: http://disabilityservices.gatech.edu