ISyE 6201 Manufacturing Systems
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Spyros Reveliotis
e-mail: spyros@isye.gatech.edu
Homepage: www.isye.gatech.edu/~spyros

Course Objective

This course concerns the modeling, analysis, design and control of contemporary production systems. Emphasis is placed on the design and operation of manufacturing facilities, but many of the presented results apply also to the design, planning and control of operations taking place in the service sector.

More specifically, the course seeks to offer:

- A systematic exposition of the workflow design and control problems that arise in the context of the aforementioned operations.
- A formal analysis of these problems based on concepts and models borrowed from Queueing theory and the broader field of Discrete Event Systems.
- Practical guidelines for the design and operation of these systems that derive from the aforementioned analysis.

Tentative Course Outline

1. Introduction: Course Objectives, Context, and Outline
   - Contemporary organizations and the role of Operations Management (OM)
   - The basic organizational structure and the scope of the OM issues addressed in this course
   - Corporate strategy and its connection to operations
   - The basic course structure
   - An introduction to multi-echelon models (time permitting)
2. Workflow Analysis and Control in Contemporary Production Systems
   - The basic workflow structure in Discrete Part Manufacturing
   - Manufacturing System layouts
   - Flow lines as the preferred layout for discrete-part, repetitive manufacturing
   - Flow line classification: Push vs. Pull, Synchronous vs. Asynchronous transfer lines, KANBAN and CONWIP-based production systems
3. An introduction to Queueing theory
   - Little's law and some other fundamental properties of queueing systems
   - Single-station Exponential models
   - Networks of Queues
   - The M/G/1 queue and its variations
   - The G/G/1 queue
   - Multi-server queues
4. Factory Physics
   - Modeling of asynchronous transfer lines as series of G/G/m queues
   - Incorporating operational detractors
   - Employing the derived model for ATL diagnosis and design
   - Design of synchronous transfer lines: the Assembly Line Balancing problem
   - Modeling and analysis of CONWIP lines as closed queueing networks

- A unifying framework: the fundamental exchange curves of manufacturing flow lines and their implications
- Batching and its impact on the performance of manufacturing systems: Optimal batching policies

5. Introduction to scheduling theory
   - Overview of prevailing practices in sequencing and scheduling
   - Dispatching rules: motivation and some basic analytical results
   - Some more sophisticated approaches to production scheduling
     - Branch & bound based approaches
     - The Shifting bottleneck heuristic
     - Workload-based dynamic scheduling policies
6. The philosophy of Just-In-Time and its current evolution to Lean Manufacturing
7. Introduction to DES-based models of flexible manufacturing systems (time permitting)

Course Prerequisites: ISYE 6650 (Probabilistic Models)

Course Policies

Homework A set of homework problems will be assigned at the end of each course unit. The main role of this homework will be to strengthen the student understanding of the material presented in class and to help them prepare for the exams, but it will not be graded.

Exams: There will be one midterm and a final exam. Exams will be closed-book, with 3 pages of notes allowed for the midterm and 6 pages for the final. The final exam will be comprehensive, while the exact date of the midterm and the material to be covered by it will be specified during the course development. Naturally, it is expected that the *Academic Honor Code* will be respected.

Grading:

- Midterm: 40%
- Final: 60%

Course Reading Material

- **Textbook:** W. Hopp and M. Spearman, *Factory Physics,3rd ed.,* IRWIN / McGraw-Hill, 2008
- Course slides and any other material posted at my homepage and/or the library electronic reserves.

It should also be noticed that the textbook will have a complementary role to the material presented in class.