Syllabus: IE 361, Production Planning and Control (Spring 2024)

Instructor:	Prof. Qiong Wang (qwang04@illinois.edu)
Lectures:	Jan 17 - May 1, MW 1-1:50pm, TB 103
Office hour:	Monday 2:10-3:30pm, TB-201B.
TA:	Mingxuan Cui (mc96@illinois.edu) Thomas Hoevener (th39@illinois.edu) Samiran Kawtikwar (samiran2@illinois.edu) Hao Qin (haoqin3@illinois.edu)
Lab:	Jan 26 - Apr 26, Friday (noon/1pm/2pm/3pm), TB 316 while lab attendance is expected, you are free to choose a session that fits with your schedule **No lab on Jan 19, Friday**
TA Office hour:	Wednesday 3:00-4:00pm, Student Lounge, TB 202 TAs will take turn to teach labs and hold office hours

Course site on Canvas: https://canvas.illinois.edu/courses/45025

Course Objectives:

- explore theory and practice of supply chain management in general;
- learn to use tools and algorithms for many tasks involved in managing production processes: demand forecasting, inventory and production control, project management and job scheduling;
- develop a basic understanding of economic principles that govern the organization, operation, and interaction in production systems.

Teaching Materials

- Course contents are covered in slides, which will be posted online before the class.
- Reference Book (not required): L. V. Snyder and Z.-J. M. Shen (2011), *Fundamentals of Supply Chain Theory*, John Wiley.
- Additional notes and other contents will be added as needed.

Assessment and Grades

- unannounced, short (5-10 min), in-class quiz (15%): you will receive full 15 points in your final grade by default. A fixed number of points will be deducted for each quiz you miss, starting from the second missed quiz.

- mid-term exam (25%): in class, during the week of March 4.
- Final exam (35%) to be scheduled by the registrar's office.
- Homework grade: 25% of the final grade.

A- or above for those who are in the top 30% of the class **or** with final grade ≥ 90; B- or above for those with final grade ≥ 75; others will be graded according to their grades relative to class average.

Homework

- assignments will be posted online after Monday's class and due on midnight next Monday.
- TAs will lead weekly lab discussions on assignments.
- homework should be submitted online. Late submission will be accepted with 10% point deduction until midnight Wednesday of the same week. Submissions afterwards will not be accepted and you will receive zero point on that homework.
- **Integrity:** zero point for copied homework. Those who caught plagiarizing twice receive ZERO homework grade for the entire course.

Course Schedule (tentative)

- **Jan 17, Introduction:** we will review the history of supply chain management, give an overview of different topic areas, and discuss trends and market needs.
- **Jan 22, Lot sizing problems:** we will develop an understanding of the fundamental trade-offs choosing order quantities and of how to capture this tradeoff with simple models. We derive and discuss the formula for determining economic order quantities.
- **Jan 24, Stochastic inventory management:** we will explain concepts and processes for managing inventory systems, introducing basic notions such as lead times, inventory positions, and presenting general formulas for determining inventory and backlog levels.
- **Jan 29, Guest lecture:** our guest speaker, Kyle Harshbarger, a senior innovation manager at Dow, will share with the class his knowledge and experience in supply chain management

  (https://www.aiche.org/community/bio/kyle-harshbarger).
- **Jan 31, Theoretic foundation of inventory management:** we will discuss different versions of the Newsvendor model, derive their solutions, and explain basic properties of the model.

- **Feb 5, Inventory policies for backlog systems:** we will explain why controlling the inventory position is the key to managing an inventory system, show the dynamic control problem can reduced to a simple base stock policy, and demonstrate the use of the Newsvendor model to determine the optimal base stock level.
- **Feb 7, Other inventory policies:** we will discuss inventory management in more complex environments: fixed ordering cost, minimum batch size, and lost sales. We will show how to deal with these situations with more general policies such as (s, S) and (r, nQ) policies.
- **Feb 12, Inventory coordination:** we will discuss systems in which a product is made of multiple components with different lead times and costs. We will demonstrate the needs to coordinate inventory ordering decisions and show how to calculate coordinated inventory positions.
- **Feb 14, Component commonality:** we will demonstrate the benefit of using a single type of component to serve multiple demands (when possible), and show how to quantify this benefit to help with product design decisions.
- **Feb 19, Supply chain contracts:** we will discuss the need for different companies to coordinate their pricing and ordering decisions to maximize the profit of the entire supply chain. We will present different types of contracts used to achieve this objective.
- **Feb 21, Slack:** we will conclude material management subject at this point, this lecture is reserved to accommodate spillovers from previous lectures on the subject. If there is more time, we will discuss more general topic such as combined decisions of pricing and inventory management.
- **Feb 26, Production planning:** we will introduce the problem of managing production hours, model the tradeoff between keeping inventory and using expedited productions, and use the model to make decisions to minimize the total cost.
- **Feb 28, Wagner-Whitin Model:** we will present this classical model for managing production processes, show its relationship to the shortest path problem, and explain the process of obtaining its optimal solution.
- **Mar 4:** Mid-term review
- **Mar 6:** In-class mid-term exam
- **Mar 18, Auction:** we will start from the incentive issue in supply chain procurement processes, and demonstrate why the problems can be addressed by the second-price auction protocol.

- **Mar 20, Project management, part 1:** we will develop different representations of projects, introduce the notion of critical paths, and discuss standard procedures for identifying these paths.
- **Mar 25, Project management, part 2:** built upon part 1, we discuss how to minimize the total cost of a project when expedited processes are allowed but expensive. We will also show how PERT methods are used to address uncertainties about task completion times in managing a project.
- **Mar 27, Single machine sequencing:** we will present algorithms to sequence jobs in a single-machine production process, to address different objectives: minimizing total sojourn time, tardy jobs, and the maximum delay over all tardy jobs (Hutchinson's rule).
- **Apr 1, Multi-machine scheduling:** we will extend the sequencing decisions to scheduling decision on multiple parallel machine, involving both sequencing and assignment decisions.
- **Apr 3, Scheduling for sequential systems:** we will consider systems in which a single job is to be completed by going through two machines sequentially. We will derive lower bounds on total processing time and present Johnson's rule for minimizing the actual processing times.
- **Apr 6, Regression Models I:** we will review basics of regression methods, and show the development of regression models to make demand forecast.
- **Apr 8, Regression Models II:** we will get more details on the use of regression and other parameterized models to forecast demand, and common metrics to evaluate forecasting quality.
- **Apr 15, Time Series analysis:** we will discuss model-free forecasting of demand by using adaptive procedures to update forecast based on online data (exponential smoothing). We will discuss tradeoffs in the choice of the smoothing parameter.
- **Apr 17, Trend and seasonal effect:** we will discuss how to make combined use of different forecasting methods to forecast more complex demand patterns that involve season effects and other trends.
- **Week of Apr 22, slack and addition materials:** This week is reserved to cover spillovers from previous lectures. If there is more time, we will use it to discuss some contemporary issues in supply chain management.
- **May 1:** Final review