

ISE 552 Course Syllabus

ISE 552 – Design and Control of Production and Service Systems

Section 601

Spring 2024

3 Credit Hours

Course Description

In order to achieve the flexible, cost-effective manufacturing systems required to survive in today's volatile, global markets, a thorough understanding of the basic dynamics of factories is essential. This course focuses on understanding the behavior of manufacturing plants and service systems through a thorough, generalizable, and fundamental understanding of the factors affecting their behavior. We do this by discussing the basic techniques of production and inventory control in use in industry today, and then focusing on material flow through the plant to examine a number of alternative approaches.

Learning Outcomes

By the end of this course, students will be able to:

1. Apply basic time-series forecasting methods for predicting demand faced by production and service systems.
2. Describe and implement commonly used production control methodologies including Material Requirements Planning, queueing models and demand forecasting.
3. Apply data-driven analysis methods to evaluate the capabilities of a production line in terms of work in process inventory, throughput and cycle time.
4. Quantify the impact of limited capacity and stochastic variability on the cycle time, work in process inventories and throughput of production lines and service systems.
5. Use queueing models to compute performance estimates for simple serial production lines, and to interpret the results to drive continuous improvement of the system.
6. Use the quantitative tools developed in the class to design and analyze lean manufacturing systems, including Kanban for production control, load leveling for production planning, and the central role of variability reduction.
7. Compute effective line balances and sequences for single and mixed model assembly lines.

Course Structure

The material in the course is delivered by face-to-face lectures and re-enforced through active learning and participation in in-class exercises.

The course will have in-class exercises, homework assignments, and case study projects. Case study projects will be done in teams. Homework assignments will be done individually. There will be two mid-term exams and a final exam. See Grading section for details.

Course Policies

Texting and cell phone use are not allowed in class. In addition, no eating and drinking is allowed in the classroom.

Course Administration: All materials, assignments and grades will be distributed via Moodle, which will also be used for announcements to the class. Moodle will also be used to submit assignments. It is the student's responsibility to become familiar with Moodle and to access it in a timely manner; see particularly the regrade policy below.

Computer Usage: You will be expected to use computer tools, particularly Microsoft Excel, throughout the semester in the homework and the case studies. The course will have a Moodle site, which will be used for announcements, grades, etc. and most other communication with students.

Homework: Homework will be assigned roughly each week. Students can collaborate on homework but must submit the names of those with whom they worked. Note, however, that collaboration provides many opportunities for learning, but learning does not take place when one student does the work and other copies it. Homework will be submitted via Moodle. Late homework will not be accepted since solutions will be posted as soon as submission closes.

Case Studies: The purpose of the case studies is to expose you to open-ended, ill-structured real-world applications of the concepts and methods learned in class. One to two case study-based projects will be assigned. Students will work on these in groups of at most (TBD). The engineering analysis performed must be submitted in the form of a formal technical report, which will be graded for organization, presentation, and English in addition to technical content. Examples of project reports will be made available to students at the time of assignment. Details on how to obtain the case studies will be given in class.

Instructors

Subramanian Pazhani (spazhan) - *Instructor*

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Office Location: Fitts-Woolard Hall

Office Hours: Mondays and Thursdays and 4:00 - 4:45 pm

Office Hours are by appointment. All office hours will be via Google Meet. Google Meet link will be provided.

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Course Meetings

Lecture

Delivery method: Online

Course Materials

Textbooks

Factory Physics - *W.J. Hopp and M.L. Spearman*

Edition: Third edition

ISBN: 978-1-57766-739-1

Cost: ~\$120.00 (New) Used copies are also OK

This textbook is required.

The Goal - *E.M. Goldratt (and J. Cox)*

Edition: Any edition

ISBN: 978-1-57766-739-1

Cost: ~\$12. Used copies are also OK.

<https://www.amazon.com/Goal-Process-Ongoing-Improvement/dp/0884271951>

This textbook is optional.

Fundamentals of Supply Chain Theory - *Lawrence .V Snyder, Zuo-Jun Max Shen*

Edition: 2nd edition

ISBN: 978-1119024842

Cost: Used copies are also OK.

This textbook is optional.

Expenses

Case Studies - There might be a cost for accessing case studies

This expense is required.

Materials

None.

Requisites and Restrictions

Prerequisites

This course will assume knowledge of probability and statistics at the level of ST370 and 371, as well as basic engineering mathematics at the level of MA 141, 241, and 242.

Co-requisites

None.

Restrictions

None.

Transportation

This course will not require students to provide their own transportation.

Safety & Risk Assumptions

None.

Grading

Grade Components

Component	Weight	Details
Homework Assignments (total of 10 scheduled)	20	Late submissions will lead to 20% reduction in score. Scoring scale: 0 (0%) - Did not turn in homework 1 (40%) - Homework turned in, but very little effort 2 (70%) - Homework turned in, significant effort, but still some significant errors 3 (85%) - Homework turned in, solutions mostly correct (some insignificant errors) 4 (100%) - Homework turned in, solutions to all problems correct
Case Study Projects	15	Late submissions will lead to 20% reduction in score. Case study projects will be done in teams (max. 4 students / team). Evaluation: (i) 50% for approach and originality of the work, (ii) 50% for analysis, results, and clarity of presentation.
Mid-term exam 1	20	TBD: Take-home examination: Week of Monday, Feb 5, 2024.

Component	Weight	Details
		(OR) Wednesday, Feb 7, 2024 - 6:00 PM - 7:30 PM (TENTATIVE). In-class examination.
Mid-term exam 2	20	TBD: Take-home examination: Week of Monday, March 18, 2024. (OR) Wednesday, March 20, 2024 - 6:00 PM - 7:30 PM (TENTATIVE). In-class examination.
Final Exam	25	Monday, April 29, 2024 - 7:00 PM - 9:30 PM. In-class examination.

Letter Grades

This Course uses Standard NCSU Letter Grading:

97 ≤	A+	≤	100
93 ≤	A	<	97
90 ≤	A-	<	93
87 ≤	B+	<	90
83 ≤	B	<	87
80 ≤	B-	<	83
77 ≤	C+	<	80
73 ≤	C	<	77
70 ≤	C-	<	73
67 ≤	D+	<	70
63 ≤	D	<	67
60 ≤	D-	<	63
0 ≤	F	<	60

Requirements for Credit-Only (S/U) Grading

Performance in research, seminar and independent study types of courses (6xx and 8xx) is evaluated as either "S" (Satisfactory) or "U" (Unsatisfactory), and these grades are not used in computing the grade point average. For credit only courses (S/U) the requirements necessary to obtain the grade of "S" must be clearly outlined.

Requirements for Auditors (AU)

Information about and requirements for auditing a course can be found at <http://policies.ncsu.edu/regulation/reg-02-20-04>.

Since all case studies, homework assignments and exams are an integral part of the learning experience auditing of this class will not be permitted.

Policies on Incomplete Grades

If an extended deadline is not authorized by the Graduate School, an unfinished incomplete grade will automatically change to an F after either (a) the end of the next regular semester in which the student is enrolled (not including summer sessions), or (b) by the end of 12 months if the student is not enrolled, whichever is shorter. Incompletes that

change to F will count as an attempted course on transcripts. The burden of fulfilling an incomplete grade is the responsibility of the student. The university policy on incomplete grades is located at <http://policies.ncsu.edu/regulation/reg-02-50-03>. Additional information relative to incomplete grades for graduate students can be found in the Graduate Administrative Handbook in Section 3.17.G at <http://www.ncsu.edu/grad/handbook/index.php>

Late Assignments

Assignments will not be accepted after the due date unless approved by the instructor

Attendance Policy

For complete attendance and excused absence policies, please see <http://policies.ncsu.edu/regulation/reg-02-20-03>

Attendance Policy

You are expected to be in class. You should note that in-class assignments will be made and considerable material not directly from the book will be presented in class. Failure to attend class will severely limit your maximum possible grade.

For complete attendance and excused absence policies, please see <https://policies.ncsu.edu/regulation/reg-02-20-03-attendance-regulations/>

Absences Policy

You are expected to be in class. You should note that in-class assignments will be made and considerable material not directly from the book will be presented in class. Failure to attend class will severely limit your maximum possible grade.

Excused absences will be granted based upon the university policy on excused absences which can be found at http://www.ncsu.edu/policies/academic_affairs/courses_undergrad/REG02.20.3.php

Makeup Work Policy

Any work missed during an unexcused absence cannot be made up unless approved by the instructor.

Additional Excuses Policy

None.

Academic Integrity

Academic Integrity

Violations of academic integrity will be handled in accordance with the Student Discipline Procedures (NCSU REG 11.35.02) (<https://policies.ncsu.edu/regulation/reg-11-35-02/>).

Students are required to comply with the university policy on academic integrity found in the Code of Student Conduct found at <http://policies.ncsu.edu/policy/pol-11-35-01>

Discussions are encouraged, but do not copy from other's work, use your own language and images.

Honor Pledge

Your signature on any test or assignment indicates "I have neither given nor received unauthorized aid on this test or assignment."

Digital Course Components

Students may be required to disclose personally identifiable information to other students in the course, via digital tools, such as email or web-postings, where relevant to the course. Examples include online discussions of class topics and posting of student coursework. All students are expected to respect the privacy of each other by not sharing or using such information outside the course.

Accommodations for Disabilities

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the Disability Resource Office at Holmes Hall, Suite 304, 2751 Cates Avenue, Campus Box 7509, 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation (NCSU REG 02.20.01) (<https://policies.ncsu.edu/regulation/reg-02-20-01/>)

Non-Discrimination Policy

NC State provides equal opportunity and affirmative action efforts, and prohibits all forms of unlawful discrimination, harassment, and retaliation ("Prohibited Conduct") that are based upon a person's race, color, religion, sex (including pregnancy), national origin, age (40 or older), disability, gender identity, genetic information, sexual orientation, or veteran status (individually and collectively, "Protected Status"). Additional information as to each Protected Status is included in NCSU REG 04.25.02 (Discrimination, Harassment and Retaliation Complaint Procedure). NC State's policies and regulations covering discrimination, harassment, and retaliation may be accessed at <http://policies.ncsu.edu/policy/pol-04-25-05> or <https://oied.ncsu.edu/divweb/>. Any person who feels that he or she has been the subject of prohibited discrimination, harassment, or retaliation should contact the Office for Institutional Equity and Diversity (OIED) at 919-515-3148.

Additional NC State Rules and Regulations

Students are responsible for reviewing the NC State University Policies, Rules, and Regulations (PRRs) which pertain to their course rights and responsibilities, including those referenced both below and above in this syllabus:

Equal Opportunity and Non-Discrimination Policy Statement <https://policies.ncsu.edu/policy/pol-04-25-05> with additional references at <https://oied.ncsu.edu/divweb/policies/>

Code of Student Conduct <https://policies.ncsu.edu/policy/pol-11-35-01>.

Course Schedule

NOTE: The course schedule is subject to change.

Part 0: Course Introduction and Overview

Sources: Hopp and Spearman – CHAPTERS 0 and 1; Powerpoint

Topics:

1. Overview of Course Policies
2. Overview of Course Topics

Part 1: Demand Forecasting and Regression

Sources: Hopp and Spearman – CHAPTER 13.3; Hodgson/King EBook SECTIONS 16-17; Powerpoint

Topics:

1. Demand Forecasting
2. Forecasting Evaluation Metrics (MSD, MSE, etc.)
3. Linear Regression Models

4. Adaptive Models (Moving Average; Exponential Smoothing; Holt's Model; Winter's Model)

Part 2: Factory Dynamics

Sources: Hopp and Spearman - CHAPTER 7; Hodgson/King EBook SECTION 19; Powerpoint

Topics:

1. Definitions
2. Best, Worst, Practical Worst Case Performance
3. Labor Constrained Systems

Part 3: Inventory Basics

Sources: Hopp and Spearman - CHAPTER 2; Hodgson/ King EBOOK SECTIONS 5, 6, 7, 9, 11, 12 ,13;

Powerpoint

Topics:

1. Single Product/Multiple Periods
 - a) EOQ/EMQ - Continuous Review, Level Demand
 - b) Wagner-Whitin Model - Continuous Review, Variable Demand
 - c) (Q,r) Model - Continuous Review, Stochastic Demand d) Base Stock Model - Periodic Review, Stochastic Demand
2. Single Product/Single Period
 - a) Newsvendor Model - Stochastic Demand
3. Multiple Products/Multiple Periods
 - a) Lotsize Scheduling

MIDTERM 1

Covers parts 1, 2, 3.

Part 4: MRP, MRP II, ERP

Sources: Hopp and Spearman - CHAPTER 3; Powerpoint

Topics:

1. MRP
2. Intro. to MRP II, ERP

Part 5: JIT/Lean Six Sigma

Sources: Sources: Hopp and Spearman - CHAPTER 4; Hodgson/King EBook SECTION 15; Powerpoint

Topics:

1. Origins of JIT
2. JIT Goals
3. Implementing JIT
4. TQM
5. Pull Systems and Kanbans
6. Lean, Six Sigma

Part 6: Theory of Constraints

Sources: Powerpoint, The Goal by Goldratt and Cox; The Race by Goldratt and Fox Topics:

1. Insights
2. JIT Goals
3. Implementing JIT
4. TQM

5. Pull Systems and Kanbans
6. Lean, Six Sigma

Part 7: Variability basics

Sources: Hopp and Spearman - CHAPTER 8

Topics:

1. Variability and Randomness
2. Process Time Variability
3. Causes of Variability
4. Flow Variability
5. Variability Interactions
6. Effects of Blocking
7. Variability Pooling

MIDTERM 2

Covers parts 4, 5, 6, 7

Part 8: Corrupting Influence of Variability

Sources: Hopp and Spearman - CHAPTER 9

Topics:

1. Variability Laws
2. Flow Laws
3. Batching Laws
4. Cycle Time
5. Performance and Variability
6. Diagnostics and Improvements

Part 9: Shop Floor Control

Sources: Hopp and Spearman - CHAPTER 14

Topics:

1. Push Systems
2. Pull Systems
3. CONWIP
4. Hybrid systems

Part 10: Production Scheduling

Sources: Hopp and Spearman – CHAPTER 15; Hodgson/King EBook SECTION 2; Powerpoint

Topics:

1. Single Machine
2. Multiple Machines
3. Stochastic Systems
4. Push/Pull Systems
5. Shop Floor Control

FINAL EXAM

Covers parts 8, 9, 10