University of Michigan
College of Engineering

EECS 569

Production Systems Engineering

Tue and Thu, 5:00 pm – 6:30 pm
Room: TBA

Instructor: Semyon M. Meerkov
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Office Hours: Tue and Thu, 4:00 – 5:00 p.m.
Room 4230C, EECS bldg.

Course description: Production Systems Engineering (PSE) is an emerging branch of Engineering intended to uncover fundamental laws that govern production systems and utilize them for the purposes of analysis, design, and management. In this course, foundations of PSE will be described, along with PSE Toolbox that implements the algorithms developed. Numerous case studies in large volume manufacturing industries (e.g., automotive, electronics, consumer products, etc.) will be outlined. Within this course, students will learn rigorous engineering methods for analysis, design, and continuous improvement of production systems, rather than recipes "invented" by various manufacturing gurus.

The course is intended for CoE undergraduate and graduate students contemplating a career in manufacturing (e.g., product/process design, circuit/device design, semiconductor manufacturing, production automation and control, planning and scheduling, etc.).

Specific topics include:

1. Mathematical modeling of production systems
2. Performance analysis
3. Bottleneck identification and elimination
4. Continuous improvement by workforce and buffer capacity reallocation
5. Lean buffering design
6. Product quality, rework, and quality inspection
7. Customer demand satisfaction
8. Transients of production lines
9. System-theoretic properties (reversibility, monotonicity, and improvability)
10. PSE Toolbox (see http://www.ProductionSystemsEnginering.com/ for a demo)

All topics are addressed in the framework of stochastic models of production systems. Hence, some familiarity with elementary Probability Theory is required. There are no other prerequisites.

Textbook: J. Li and S.M. Meerkov, *Production Systems Engineering*, Springer, 2009 (see the above mentioned website for additional information on this book).

Homework: Homework sets will be assigned every Thursday and due in class the following Thursday. For off-campus students, homework will be due two business days later, i.e, on Monday, by 5 pm local time. Homework will be performed individually, however constructive discussions with classmates are allowed. All assignments will be graded out of 100 points.

Exams: The course includes one midterm but no final exam; the project presentations will be in lieu of the final.

Exam rules: Closed books and notes; two 3-by-5 "cheat" cards are allowed. The cards must be handwritten on one side only. The exam will be graded out of 100 points.

Project: The project is the most important part of the course. Each project will to be carried out by a team of 2-3 students. It is expected that the project will begin during the third week of the course.

Two types of projects are possible: industrial and theoretical. In an industrial project, students will develop a mathematical model of a selected production system, evaluate its performance, develop and "implement" its continuous improvements or, if necessary, re-design the system. In a theoretical project, students will develop a novel technique for either analysis, or design, or continuous improvement of production systems of interest.

The projects will be graded out of 100 points and will be evaluated on each of the components involved (i.e., the results obtained, quality of the report, and the final presentation).

Course Grading:

Homework	25%
Midterm exam	25%
Project	50%
Total:	100%

Syllabus

Introduction: Production Systems Engineering and Course Overview

Part I: Mathematical Modeling of Production Systems (Chapters 2 and 3)

Overview of relevant topics of Probability Theory
Serial lines, assembly systems, lines with carriers, lines with rework, re-entrant lines
Mathematical models of machines
Mathematical models of material handling devices
Performance metrics: throughput, work-in-process and finished goods inventory, blockages, starvations, product quality,
customer demand satisfaction, transient characteristics
PSE Toolbox and case studies of modeling

Part II: Serial Production Lines with Bernoulli Model of Machine Reliability (Chapters 4-9)

Performance analysis
Continuous improvement
Design of lean buffering
Closed lines
Product quality, rework, and quality inspection
Customer demand satisfaction
Transient behavior
System-theoretic properties
PSE Toolbox and case studies for Bernoulli lines

Part III: Serial Production Lines with Continuous Time Models of Machine Reliability (Chapters 10-15)

Performance analysis
Continuous improvement
Design of lean buffering
Customer demand satisfaction
PSE Toolbox and case studies for continuous lines

Part IV: Assembly Systems (Chapters 16-18)

Performance analysis
Continuous improvement
Design of lean buffering
Customer demand satisfaction
PSE Toolbox and case studies for assembly systems

Part V: Summary and Proofs (Chapters 19 and 20)

Summary of PSE Main Facts
Proofs of main PSE theorems and numerical facts