COURSE SYLLABUS - Spring 2025

DEPT OF MECHANICAL & INDUSTRIAL ENGINEERING

IE 224 - Production Process Design

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CLASS/LAB SCHEDULE

This course is split between a lecture component and a laboratory component. For most weeks, the lecture component will occur on TUESDAY from 4:00 to 5:20 pm (GITC 2305) and the laboratory component will occur on FRIDAY (GITC 2311).

Several of the labs (mostly in the first half of the semester) need to be done in small groups. There will be flexible time slots during the week when groups can complete the experiments. Some slots will be available during the Friday class. The TA will work with all students to accommodate their schedules.

BSIE PROGRAM EDUCATIONAL OBJECTIVES

I. Program graduates use the fundamental principles and major areas of Industrial Engineering in their classes.
II. Program graduates are lifelong learners, pursuing graduate education, and professional growth in Industrial Engineering and related fields.
III. Program graduates pursue diverse career paths and advance in a variety of industries.

BSIE STUDENT OUTCOMES

1. **An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.**
2. **An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, and economic factors.**
3. **An ability to communicate effectively with a range of audiences.**
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and social contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. **An ability to conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to make analytical conclusions.**
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

IE 224 OUTCOMES OF INSTRUCTION

Students who complete the course will:

1. Learn the differences between materials at the atomic level and how this affects their physical behavior.

2. Be able to identify and list the common metal fabrication processes and the associated machinery.
3. Be able to identify and list the common plastic materials and the common plastic fabrication processes.
4. Be able to identify and list the common electronic materials and the semiconductor fabrication processes.
5. Learn how to operate and program manufacturing equipment and identify the associated issues of quality and efficiency.

COURSE DESCRIPTION

Introduction to the theory and practice of manufacturing processes that are used to produce a wide variety of products. The course covers the fabrication of metallic, plastic, and electrical products, the operation of NC and other automatic equipment, and the economics of the design and production process. Students are introduced to power requirement calculations and the engineering mechanics by which production forces, manufacturing variables, and production rates are calculated.

IE Knowledge Gained: (i) Application of engineering mechanics to production processes (ii) Formulate an industrial engineering process view of the product build process (iii) Relate material properties to the fabrication process and (iv) Operationalize product concepts through the design-build process.

The course is divided into two parts: (i) *Lecture* – which will typically occur during the Tuesday class and (ii) *Lab* – which will be introduced during the Friday class. On both day's class times will be from 4:00 to 5:20 pm. A timetable for group lab experiments throughout the week will also be provided. We will attempt to accommodate individual scheduling requirements.

TEACHING ASSISTANT

Jinghao Cao, Email: jc2687@njit.edu Jinghao will instruct all the IE224 lab sessions and will be the primary contact for all lab-related issues.

CANVAS

The course will make extensive use of the Canvas system to optimize student-instructor communication. All course materials, including lecture slides and homework etc. will be distributed through Canvas. All submissions of homework and other assignments will also be done through Canvas. To access the Canvas system please go to http://Canvas.njit.edu, you will need a valid NJIT UCID to log in.

All course materials will be distributed through the Canvas platform. This includes lectures and assignments.

GRADING

Based on individual and team performance, as follows:

15%	Homework #1	25%	Midterm Exam	10%	Lab Reports
15%	Homework #2	25%	Final Exam	10%	AUTOCAD/3D Printing Project

TEXTBOOK AND LECTURE SLIDES

Manufacturing Engineering & Technology by Serope Kalpakjian. Prentice-Hall

IE 224 Production Process Design lecture slides by Prof. Sanchoy Das will be distributed electronically each week through Canvas.

IE 224 Lab Worksheets – Detailed listing of each laboratory experiment, organized by topic.

LAB TEAMS & SCHEDULES

The course involves several production process experiments and design projects that are to be completed by all students. The experiments complement the instructional material and introduce students to the practical aspects of different design-build processes. All experiments will be completed in teams of 4 students. Please select your teams to match your skills and schedules. You will be given a Lab Worksheet for each experiment, and this provides instructions for all the associated experiments.

During the lab class (Friday) the corresponding experiment will be demonstrated by the course TA and associated videos will be shown. Since each experiment typically requires about 30 minutes to complete, all groups can't complete the experiment on the lab day.

A set of available half-hour slots during the week will be provided at the first lab class. Your group should select a convenient slot and will complete all labs at the same slot every week. Lab Grading will be based on either the experimental report or a quiz.

Topic #	Text Chapter	Weeks	Course Topic (Activity date)
1.	1	1	**Introduction to Manufacturing Processes** - Design Process and Value-Adding Process - Production system configuration and parameters *Slide Set #1 – Introduction (1/21/2025)* *Lab Expt #0 – Introduction to the Lab & Safety Guidelines (1/24/2025)* *LabVideo – Tesla Model S Manufacturing* https://www.youtube.com/watch?v=SJZk9vNS8NE
2.	1,2,4	1	**Material Properties & Mechanical Behavior** - Material Types and Selection - Crystal Structure of Metals - Stress-Strain Analysis - Structure Of Alloys and Phase Diagrams Slide Set #2 – *Material Properties & Mechanic Behavior (1/28/2025)* *Lab Expt #1 - Part Measurement using Vernier Caliper & Micrometer (1/31/2025)* *LabVideo - Materials, Stresses, and Toughness* *https://www.youtube.com/watch?v=GpiBSFMFe-w*

3. 13,16 1 **Sheet Metal Forming Processes**
- Metal Rolling Process
- Sheet Metal Forming and Bending

Slide Set #3 – Sheet Metal Forming Processes (2/4/2025)
Lab Expt #2 – Container Fabrication Using Sheet Metal (2/7/2025) *(Teams 2/7-2/13)*
LabVideo – Sheet Metal Stamping, Punch Presses
https://www.youtube.com/watch?v=r9byGJtbCws
https://www.youtube.com/watch?v=xSB_z4JVPIk
https://www.youtube.com/watch?v=r9byGJtbCws

4. 21,23 24,26 2 **Metal Cutting Processes & Machine Tools**
- Orthogonal Model & Taylor's Formula
- Lathe & Milling Machine
- Grinding & Finishing Operations

Slide Set #4 – Metal Cutting Processes & Machine Tools - Lathe (2/11/2025)
Slide Set #5 – Metal Cutting – Milling Machine (2/18/2025)
Slide Set #6 – Metal Cutting – Grinding & Finishing Operations (2/25/2025)

Lab Expt #3 - Part Fabrication Using a Lathe (2/14/2025) *(Teams 2/14-2/20)*
Lab Expt #4 - Part Fab Using a Milling Machine (2/21/2025) *(Teams 2/21-2/27)*

LabVideo - Cutting Tool Materials, Turning & Lathe Basics
LabVideo- Milling & Machining Center Basics
LabVideo- Basics of Grinding

5. 37 1 **Numerical Control (NC) Machining**
- NC Machine Basics
- Stepper Motors and Machine Control
- G-Code and APT Programming

Slide Set #7 – Numerical Control (CNC) Machines (3/4/2025)

Lab Expt #5 – Programming a CNC Lathe Tool (2/28/2025) *(Teams 2/28-3/6)*
Lab Expt #6 – Programming a CNC Milling Tool (3/7/2025) *(Teams 3/7-3/13)*
LabVideo- Computer Numerical Control

Mid-Term Exam Review (3/7/2025)

6. **MID-TERM EXAM** (3/11/2025)

7. 2 **Introduction to AutoCAD & 3D Printing**
- Basic AutoCAD functions
- Creating advanced designs in AutoCAD
- What is 3D Printing

AutoCAD Slides Sets #1 to #7, 3D Printing Slides (3/25/2025 to 4/4/2025)

Lab Expt #7 – AutoCAD Exercise 1 (3/28/2025)
Lab Expt #8 – AutoCAD Exercise 2 – Team Design (4/1/2025)
Lab Expt #9 – 3D Printing Manufacture – Team Design (4/11/2025)

AutoCAD Tutorial Part #1 –
https://www.youtube.com/watch?v=cmR9cfWJRUU (18 Minutes)
AutoCAD Tutorial Part #2 -
https://www.youtube.com/watch?v=g_jKTv3pLp0 (21 Minutes)
AutoCAD Tutorial Part #3 -
https://www.youtube.com/watch?v=37S-2wZ2r0Q (9 Minutes)
Intro to 3D Printing -
https://www.youtube.com/watch?reload=9&v=MARPSciA2-Y (10 Minutes)

8. 7,19 1 **Processing of Plastic Products**
- Plastic Materials - Polymer and Monomer basics
- Injection Molding, Thermoforming, etc.

Slide Set #8 – Processing of Plastic Products (4/8/2025)

LabVideo- (4/11/2025)
Plastics Processing Overview - https://www.youtube.com/watch?v=qn16JtE_vLc
Injection Molding Animation - https://www.youtube.com/watch?v=b1U9W4iNDiQ
Plastic Injection Molding - https://www.youtube.com/watch?v=RMjtmsr3CqA

9. 28 2 **Manufacture of Microelectronic Devices**
- Semiconductor Fabrication Process
- Integrated Circuits

Slide Set #9 – Manufacture of Microelectronic Devices (4/15/2025 & 4/22/2025)

LabVideo- Making of a Microchip (4/25/2025)
1. Sand to Silicon –
https://www.youtube.com/watch?v=UvluuAIiA50&list=PL9DIvd7kNIA1mBBnFG7sSmNF5bYNvOBbv&index=5&t=0s
2. Making Memory Chips @ Micron Tech –
https://www.youtube.com/watch?v=M-wNC3Z3ZX4
3. Printed Circuit Board Production –
https://www.youtube.com/watch?v=_GVk_hEMjzs

10. 37 1 **Introduction to Manufacturing Automation**

Slide Set #10 – Introduction to Automated Manufacturing Processes (4/29/2025)
Lab Expt #10 – Festo Automatic Line Analysis (4/25/2025) (Teams 4/25-5/1)

11. FINAL EXAM *(Registrar will Assign date/time)*

Final Exam Review - (5/7/2025)