New Jersey Institute of Technology

COURSE SYLLABUS - Spring 2025
DEPT OF MECHANICAL & INDUSTRIAL ENGINEERING

MnE 654 - Design for Manufacturability

A TOP 100 NATIONAL UNIVERSITY

Instructor: Prof. Sanchoy Das
Tel: (973) 596-3654
Office: 319 MIE Building
Email: das@njit.edu

Hybrid Course Delivery

This course combines In-Class (face-to-face) and Online class sessions. The course content has been designed for delivery in a hybrid learning mode. The detailed weekly schedule below identifies specifically which weeks are In-Class and which weeks are online.

COURSE DESCRIPTION

Design and build new products quickly and ensure these products meet cost targets and incorporate proven efficient manufacturing methods and digital design analysis tools. This course focuses on tools and methods for evaluating new and existing product designs to reduce production costs, improve quality, and improve sustainability. Innovation-driven design is central to this objective.

Specifically, the course introduces methodologies used in the synthesis and analysis of design specifications and utilizes parametric models to relate them to cost and quality. The role of creativity and innovation in new product development methods and the relationship of design to production processes, product material, material handling, quality costs, and CAD/CAM are presented. Emphasis is primarily on assembled products.

Cost estimation software and other design analysis tools are employed. Lean manufacturing and Six Sigma concepts in the design context are also introduced. A key course activity is a project in which teams of students play both management and engineering design analysis roles to improve an existing commercial product. The course introduces the ideation process which is being used to foster fast innovation in design, and student teams will complete an associated project.

GRADING

Based on individual and team performance as follows:

15% **Homework #1**	20% **Midterm Exam**	10% **Design Ideation Project**
15% **Homework #2**	20% **Final Exam**	20% **Disruptive Design Project**

TEXTBOOK AND COURSE READINGS

There is no required textbook for the course. Several articles and papers have been selected to complement the course material and will be distributed through the course website. *The following are suggested textbook readings, other readings are listed by week:*

- *MnE 654 lecture slides by Prof. Sanchoy Das* will be distributed electronically through Canvas
- *Product Design for Manufacture & Assembly* - by Peter Dewhurst, Winston Knight, Geoffrey Boothroyd, Marcel Dekker; 2nd edition, **ISBN:** 082470584X
- *Fast Fulfillment: The Machine that Changed Retailing,* by Sanchoy Das, Business Expert Press, 2021, ISBN-13: 978-1637420768 https://www.amazon.com/author/sanchoydas, *Chapters 5, 7, 10 & 11*
- *Design for Six Sigma: A Roadmap for Product Development* - by Kai Yang, Basem S. El-Haik McGraw-Hill Professional, **ISBN:** 0071412085
- *Steve Jobs* – by Walter Isaacson, 2011, Simon & Schuster: New York

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 through Canvas. To access the system please go to http://canvas.njit.edu/, you will need a valid UCID to log in.

This is a hybrid course and during the semester we will have both in-class and online class sessions (Check the schedule below). During these sessions I will discuss course material, have discussions with students, and deliver lectures.

Online class sessions will be conducted through the ZOOM platform which is integrated with Canvas. To enter the ZOOM class, click on ONLINE CLASS EVENT at the top of the course Canvas page. As and when needed the online sessions and associated lectures will be recorded. These will be made available to the students for asynchronous viewing.

TEAM PROJECTS

The course will require all students to complete two team projects: (i) Design Ideation Project and (ii) Disruptive Redesign Project. Projects will be done in teams of four students. You can create your teams or wait for the instructor to create teams. The same team will execute both projects and will collaborate using available online and mobile technologies. Teams are expected to communicate digitally through email, text messages, and Skype. You are encouraged to use Google Drive (part of NJIT WebMail) to share project documents.

Design Ideation Project – Ideate a new product design such that it disrupts the current designs that are dominant in the market and/or provides currently unmet functionalities. Integrates the knowledge in Lecture # 2A&B, including several innovation templates, the BM-Idea Generator, and the AC-Analysis. The team will be required to make a 10-minute Ideation presentation.

Disruptive Design Project - Each team will be assigned an example commercial product. The products are currently being sold in the market and are readily available at a well-known retailer. The team will take the role of in-house disruptors tasked with redesigning the product to improve

the production economics and design innovativeness of the product. The project will use the Pro-DFM software for costing and manufacturability analysis. Design drawings can be done in either ProE, AutoCAD, or any other design creation tool. Each team will make a presentation and submit a report. Projects will be assigned after the midterm. Presentations

will be scheduled as noted in the outline below. Each team will also be assigned an Executive Role for another project. That is, they will be allocated 5 minutes for Q&A of that project.

#	WEEKS	TOPIC

Click on the Zoom link at the top of the Canvas page to connect with the Online Class Session

1. 1 **Introduction to Design for Assembly and Manufacturability (DFA/DFM)**
   - Designing A New Product – Innovation (Dyson, Apple, Ring)
   - DFMA Definitions and Objectives
   - Introduction to Design Analysis tools
   - Design+Manufacturing+Technology Innovation

   Class Date: January 27, 2025 ***(In-Class)***

   Slides: Lecture #1 – Introduction
   Video: *Tesla Model S Head of Product Design*
   Reading #1: Smaller Businesses Struggle to Make It in the USA
   Reading #2: Sir Jonathan Ive: The iMan Cometh
   Reading #3: Made in America, Again

2. 2 **New Product Design (NPD) & Design Innovation**
   - Functional requirement (FR), design parameter (DP), and process variable (PV)
   - Stage-Gate Review Process and Innovation
   - Three innovative value creators
   - Physio-Digital Design Innovation
   - Pushing the Probability Frontier
   - Alpha, Gamma and Sigma Automation
   - Brownian Multiplier to Idea Generator (BM-Idea)
   - Automation Challenge Analysis (AC-Analysis)

   Class Date: February 3, 2025 ***(In-Class)*** **and February 10, 2025** ***(Online)***

   Slides: Lecture #2A – New Product Development
   Slides: Lecture #2B – Design Innovation
   Video: Shark Tank – QBall Episode
   Video: Shark Tank – Ring Doorbell Episode + Amazon Buyout
   Reading #4: Perspective: Stage Gate Idea to Launch Process

   Design Ideation Project – *Assigned on 2/6/2025 – Presentations on 3/4/2025.*

3. 1 **Design for Assembly –Assembly Method Selection**
   - Automatic Feeding & Part Orientation
   - Vibratory Bowl Feeders
   - Selecting the Assembly Method

Class Date: February 17, 2025 ***(In-Class)***

Slides: Lecture #3 – Boothroyd-Dewhurst Method-1
Video: CouchCoaster - Design, Prototype & Manufacture
Reading #5: Factory of the Future – Proto Labs
Reading #6: NPD Process in High Tech
Boothroyd-Dewhurst DFA Online Tutorials

HW# 1 Assigned

4. 2 **Design for Assembly - Boothroyd-Dewhurst Method**
   - Orienting and Insertion Efficiency
   - Design Efficiency Calculation
   - Combining and Eliminating Parts

Class Date: February 24, 2025 ***(In-Class)*** **and March 3, 2025** ***(Online)***

Slides: Lecture #3 – Boothroyd-Dewhurst Method-1 (Continued)
Slides: Lecture #4 – Boothroyd-Dewhurst Method-2
Reading #7: Podcast Patrick Daly Interlinks

5. 1 **Manufacturing Cost Estimation for New Products**
   - Setting Cost Targets
   - Pro-DFM Cost Analyzer

Class Date: March 10, 2025 ***(In-Class)***

Slides: Lecture #5A – Design to Cost
Slides: Lecture #5B – The Pro-DFM Method

MIDTERM EXAM - March 24, 2025 ***(In-Class)***

6. 1 **Lean Manufacturing & Design**
   - Lean Manufacturing Principles
   - Toyota Production System & the Seven Wastes
   - Design for Environmental Sustainability

Class Date: March 31, 2025 ***(Online)***

Slides: Lecture #10 – Lean Manufacturing
Reading #8: The Cisco Connected Factory
Reading #9: The New Practice of Global Product Development

7. 2 **Design for Six Sigma**
   - The Six Sigma Concept
   - DMADV Methodology and IDOV Methodology
   - Monte Carlo Simulation

Class Date: April 7, 2025 ***(In-Class)*** **and April 14, 2025** ***(Online)***

Slides: Lecture #6A and #6B – Design for Six Sigma
Reading #10: DFM and Design for X

8. 2 **Design for Quality & Reliability**
   - Robust Design and Quality
   - Quality Loss Function
   - Tolerance Design and Allocation
   - Taguchi Methods & Orthogonal Arrays

Class Date: April 21, 2025 ***(Online)*** **and April 28, 2025** ***(In-Class)***

Slides: Lecture #7 – Design for Quality
Reading #11: Manufacturing the Future

HW# 2 Assigned

9. 1 **Design Innovation – Machine Building**
   - The Seven Design-Build Investigations
   - Could we, should we, must we design it?
   - The Design Innovation Teams

Class Date: May 5, 2025 ***(Online)***

Slides: Lecture #8 – Design Innovation: Machine Building
Reading #12: Using 3D Printing to Make Jet Engines

10. **Project Presentations – April 28, 2025** ***(In-Class)***

All Disruptive Design Projects will require an in-class presentation.

FINAL EXAM (5/12/2025) ***(In-Class)***