

The University of Michigan  
Department of Mechanical Engineering

**MFG 502 Manufacturing System Design**

**COURSE CONTENT**

**Course Description:**

An introduction to the procedures and methodologies for designing manufacturing systems. Topics covered include: paradigms of manufacturing; building blocks of manufacturing systems; numerical control and robotics; task allocation and line balancing; system configurations; performance of manufacturing systems including quality, productivity and responsiveness; economic models and optimization of manufacturing systems; launch and reconfiguration of manufacturing systems; Lean manufacturing.

**1. Introduction (3 hours)**

- a. Importance of manufacturing
- b. Types of industry
- c. Manufacturing System performance
  - i. Cost (fixed cost, variable cost)
  - ii. Productivity (system efficiency, system availability)
  - iii. Quality
  - iv. Responsiveness
  - v. Safety
- d. Paradigms of manufacturing
  - i. Craft
  - ii. Mass production
  - iii. Lean
  - iv. Flexible
  - v. Mass customization
  - vi. Reconfigurable Manufacturing
- e. Exercises

**2. Building Blocks of Manufacturing Systems (3 hours)**

- a. Types of manufacturing processes.
  - i. Machining
  - ii. Assembly
  - iii. Welding and Joining
  - iv. Forming
  - v. Special processes: EDM, ECM, etc.
- b. Components of Manufacturing Systems
  - i. Processing Machines (workstations)
  - ii. Material Handling

- iii. Fixtures
- iv. Pallets
- v. Buffers
- vi. controls
- vii. Measurement and inspection
- c. Examples manufacturing systems
  - i. Engine block machining
  - ii. Automobile body assembly
  - iii. Stamping
  - iv. Aircraft final assembly
  - v. Computer assembly
  - vi. Painting processes

### **3. Computer Numerical Control (1.5 hours)**

- a. CNC system architecture
- b. G-Code
- c. Controllers
- d. Interpolators
- e. Exercises

### **4. Robotics (1.5 hours)**

- a. Types of robotics
- b. Robot motion
- c. Robot applications
  - i. Welding
  - ii. Painting
  - iii. Material handling
  - iv. Fixturing
- d. Exercises

### **5. Procedure in manufacturing system design (4.5 hours)**

- a. From machines to systems
  - i. Station level design issues: fixturing
  - ii. Layout vs. volume and variety
  - iii. Configurations: Serial, Parallel, and Hybrid
- b. Product to process planning
- c. Exercises
- d. Task allocation and sequencing
- e. Line balancing
- f. Exercises

### **6. System Productivity (3 hours)**

- a. Machine level performance
  - i. Component failures
  - ii. Failure Mode Effect Analysis
  - iii. Reliability Analysis

- b. Reliability vs productivity
- c. Productivity analysis
  - i. Productivity of serial and parallel configurations
  - ii. Productivity of general mfg systems
  - iii. Role of buffers
  - iv. Bottleneck analysis and theory of constraints
- d. Impact of Material Handling systems on productivity
- e. Exercises

**7. Quality of manufacturing systems (3 hours)**

- a. Sources of variability
- b. Propagation of quality variation in Mfg Systems
  - i. Descriptive statistics
  - ii. Addition of Variance
- c. Impact of Configuration on Quality
- d. Process stability
- e. Tolerance and Process Capability
  - i. Cp, Cpk, Cpm
- f. Exercises

**8. Responsiveness (1.5 hours)**

- a. Just in-time
- b. Convertibility
  - i. Quick die change
- c. Scalability

**9. Cost of manufacturing system (3 hours)**

- a. Cost of manufacturing systems
  - i. Investment cost
  - ii. Operations cost
- b. Life cycle economics
- c. Exercises

**10. System Selection (1.5 hours)**

- a. Criteria
- b. Trade-off analysis
- c. Analytic Hierarchy Process

**11. Manufacturing System Launch (3 hours)**

- a. Ramp-up issues
- b. Variation Reduction
  - i. Assembly example
  - ii. Machining example

**12. Reconfiguration of Manufacturing System (3 hours)**

- a. Needs for system reconfiguration

- b. Principles of Reconfiguration
- c. Examples of Reconfiguration
  - i. Machines
  - ii. Cells
  - iii. Systems

**13. Lean Manufacturing (6 hours)**

- a. Toyota production system
  - i. JIT, Pull, Flow
- b. Lean cell design as example of manufacturing system design

**TEXTBOOK:** Course Notes.

**COURSE GRADE:**

**On-campus students:**

- Homework – 20%
- Class Participation – 5%
- Term Project – 15%
- Exam 1 – 30%
- Exam 2 – 30%

**Off-campus students:**

- Homework – 20%
- Term Project – 20%
- Exam 1 – 30%
- Exam 2 – 30%

**LECTURES:** M, W 8:30 – 10:00 a.m.

**INSTRUCTOR:** Prof. Kannatey-Asibu, Jr. ([asibu@umich.edu](mailto:asibu@umich.edu))

**Office Hours:** M 4:00 – 5:30 p.m.  
W 10:00 - 11:30 p.m.  
Or by appointment

**Office:** 3134 GGBrown. Phone: 936-0408

**Office Hours:** TBA or by appointment

All reading assignment must be completed ahead of time.

**No make-up exams**