Course number and name	END 411 / Integrated Manufaturing Systems
Credits, contact hours, categorization of credits	2 credits / 28 hours / Engineering Topic
Instructor or course coordinator	M. Bülent DURMUŞOĞLU, Emre ÇEVİKCAN
Text book and other supplemental materials	• Ustundag, A., Cevikcan, E. (2018) *Industry 4.0: Managing The Digital Transformation*, Springer, Switzerland. • Wilson, M. (2015) *Implementation of Robot Systems: An introduction to robotics, automation, and successful systems integration in manufacturing*, Elsevier, London • Groover, M. P. (2007) *Automation, Production Systems, and Computer Integrated Manufacturing*, Prentice-Hall • Rehg, J.A. and Kraebber, H.W., 2005, *Computer Integrated Manufacturing*, Prentice Hall, New Jersey

Course information	
Content	The course covers pillars of Computer Integrated Manufacturing (CIM) as well as digital transformation of manufacturing systems. The course begins with introducing fundamental concepts and critical issues for CIM. The integration of information technology to design and manufacturing (CNC technology, CAD/CAM), transportation (automated guided vehicles and conveyors) and storage (Automated Storage and Retrieval Systems) is addressed. Industry 4.0 and its reflection to product, factory and business models as well as modern measurement techniques are also addressed within the course.
Prerequisites	END 112E – Introduction to Manufacturing
Type	Required

Course learning outcomes
Students who pass the course will be able to I. design computer integrated manufacturing system II. execute basic part programming for CNC systems III. design material handling systems with automated guided vehicles, robots and conveyor systems IV. design computer aided quality system V. design automated storage systems VI. integrate Information & Communication Technologies to manufacturing systems VII. adapt modern measurement techniques to manufacturing processes VIII. design appropriate identification and traceability system for manufacturing environment.

Student outcomes	Level of contribution
SO1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	Little
SO2. 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, environmental, and economic factors.	Not applicable
SO3. An ability to communicate effectively with a range of audiences.	Not applicable
SO4. 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 societal contexts.	Partial
SO5. 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.	Not applicable
SO6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	Partial
SO7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	Partial

Week	Topics	Learning outcome(s)
1	Introduction; Development of Computer, Overview of CIM and its modules	I
2	Flexible Manufacturing Systems	I
3	Robot Systems for Material Handling, Analysis, Design and Evaluation of Cells with Robot Systems	III
4	Automated Guided Vehicles (AGV): AGV Types; AGV Requirement Calculation.	III
5	Conveyor Systems; Accumulating and Non-Accumulating Systems; Serial and Modular Conveyor Systems	III
6	Warehousing /Storage and Automated Warehouse Systems; Warehouse/Storage Layouts; Space Determination	V
7	CNC Programming Commands and an Application	II
8	Computer Integrated Part Programming; Introduction to CAD/CAM Systems	II
9	Computer Aided Quality Systems and Computer Aided Process Planning	IV
10	Digital Traceability Through Value Chain	VIII
11	Industry 4.0: Conceptual Framework and Design Principles	VI
12	Managerial Issues for Industry 4.0	VI
13	Pillar Technologies for Industry 4.0 (Augmented Reality, Internet of Things, Simulation, Adaptive Robotics, Additive Manufacturing etc.)	VI
14	Modern Measurement Techniques (Coordinate Measuring Machine etc.)	VII