ME 59700
A Convergent Training Program for Autonomous Connected Mobility Networks* (Celik-CS, Malshe-PI-ME, Sutherland-EE, Xu-CS)

Course Outcomes [Related ME Program Outcomes in brackets]

1. Industry 4.0 driven manufacturing processes for autonomous vehicles. [1,2]
2. Hard- and software infrastructure for interconnection. [1,2]
3. Life-cycle, smart manufacturing, and smart vehicle. [1,2]
4. Cybersecurity of interconnected vehicles, especially for the urban area. [1,2]

Industry 4.0 driven manufacturing processes for autonomous vehicles (Malshe; 3 weeks)

Module: 1
1. Lightweight materials and manufacturing processes such as super-plastic forming.
2. Energy/battery management.
3. LIDAR-digital interfaces (devices).
4. Interconnected production machines and data-driven optimization

Life-cycle, smart manufacturing, and smart vehicle (Sutherland; 3 weeks)

Module: 2
1. Technologies supporting Industry 4.0.
2. Automobile and manufacturing equipment life cycles,
3. Sensor technologies for products
4. Data analytics methods; machine learning.
5. Smart vehicles and systems
6. Smart manufacturing for predictive maintenance.

Hard- and software infrastructure for interconnection (Xu, 3 weeks)

Module: 3
1. Autonomous vehicles (including a vehicle's major cyber and physical components and their interactions.
2. CAN bus architecture and protocol, ECUs and their interfaces with CAN bus.
3. In-vehicle controllers, sensors, and actuators, communications and control security, CAN/ECU attacks and defense, EIMI attacks and defense.

Cybersecurity of interconnected vehicles, especially for the urban area (Celik; 3 weeks)

Module: 4
1. Machine learning;
2. Autonomous vehicles, manufacturing applications
3. Data collection, processing and analytics
4. Adversarial machine learning, threat model, security analytics.

Social Implications (Celik, Malshe, Sutherland, Xu; 3 weeks)

Module: 5
1. Gen-Z users and interconnected and autonomous networks.
2. Cognitive and decision-making abilities of human to be a part of machines driven network and human-centric social innovations in this space.

* Course developed as a result of grant from DENSO North America (2020-22)

COURSE NUMBER: ME 59700	**COURSE TITLE:** A Convergent Training Program for Autonomous Connected Mobility Networks (3 credits: 2 for the class-room work and 1 for the project)
REQUIRED COURSE OR ELECTIVE COURSE: Elective	**TERMS OFFERED:** Spring semester (once in a year)
TEXTBOOK/REQUIRED MATERIAL: None. Reading material provided by the instructors.	**PRE-REQUISITIES:** Fundamental of knowledge of design, materials, manufacturing, networks, network security **ATTRIBUTES**: 1. Senior undergraduate students and 2. Graduate students
COORDINATING FACULTY: Ajay P. Malshe	
COURSE DESCRIPTION: The objective of this educational proposal is to develop a learning program for undergraduate students (US) in the age of Industry 4.0 (I4.0) and interconnected mobile vehicle networks. The special objective of US4.0 is to converge and teach fundamentals and advanced knowledge at the intersection of (1) I4.0 driven manufacturing processes for autonomous vehicles, (2) hard- and software infrastructure for interconnection, (3) life-cycle, smart manufacturing, and smart vehicle, and (4) cybersecurity of interconnected vehicles, especially for the urban area.	**COURSE OUTCOMES** [Related ME Program Outcomes in brackets]: 1. Fundamentals of Industry 4.0 driven manufacturing processes and materials for autonomous vehicles. [1,2] 2. Understanding life-cycle, smart manufacturing, and smart vehicles. [1,2] 3. Understanding hard- and software infrastructure for interconnection. [1,2] 4. Fundamentals of cybersecurity of interconnected vehicles, especially for the urban area aimed for a product innovation. [1,2] 5. Introduction to social implications of connected vehicles. [1,2]
ASSESSMENTS TOOLS: 1. Homework 2. Project** reports 3. Project presentations 4. Participation in Guest lectures ** Design and manufacturing subject project examples: 1. Digital twin for connected manufacturing; 2. Life-cycle analysis and maintenance; 3. CAN bus network security and vulnerabilities; 4. Data management and analytics; 5. Social implications of autonomous connected mobility networks	**COURSE IMPLEMENTATION ASSESSMENT PLAN:** The program will be assessed every six months by a committee of six members including 1 representative from the teaching instructor team, 1 participant from the Purdue Administration, 1 representative from the Minority in Engineering Program, 2 industry representatives and 1 student. The program will be assessed using the evaluation matric set by the above committee and outcomes. The evaluation will be based upon meeting 1. the Program Objective, 2. the technical learning goals of this program and learning objectives per ABET guidelines, 3. successful launch, and execution of the program timeline, 4. population of students this program is impacting and how students are proficient at the end of the curriculum (goal is at least 70%), 5. clarity of established teaching material and the structure of the program, 6. participation of the number of industry members.
NATURE OF DESIGN CONTENT: 1. Design considerations of autonomous vehicles; 2. design considerations of autonomous vehicles network; 3. Socially conscious design considerations of autonomous vehicles for equity.	**RELATED ME PROGRAM OUTCOMES:** 1. Engineering fundamentals 2. Design 3. Communication skills

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PROFESSIONAL COMPONENT: 1. Engineering Topics: Materials and manufacturing science – 50% Engineering design and innovations – 50%	4. Ethical/Prof. responsibilities 5. Teamwork skills 6. Experimental skills 7. Critical thinking and innovation skills 8. Knowledge acquisition and importance of philosophy of convergence
COMPUTER USAGE: The design, manufacturing and network software projects require students to apply computer programs.	
COURSE STRUCTURE/SCHEDULE: TBD	
PREPARED BY: Celik-CS, Malshe-PI-ME, Sutherland-EE, Xu-CS	**REVISION DATE:** September 12, 2021

** This course is delivered in two complementary parts, including class lectures and hands-on projects.

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