Course Title: Introduction to Systems Engineering - 2

Course Length: 3 days, in-person

Time in Class per day (hours): 6.5 hours of in-person instruction

Time in Laboratory: 10 hours

Number of Laboratory Projects: 1 laboratory project, completed in 4 separate modules

Class Size: Minimum 6 / Maximum 20

Price Per Student: $835.00

Location: Wayne County *or* Company Site

Course Description:

The successful engineering of complex systems such as connected and autonomous vehicles requires that the design and methodology of these "systems of systems" follow a disciplined approach. Systems engineering focuses on developing the appropriate framework for successful design, testing, validation, and management of complex systems over the entire life cycle of a product by carefully considering the needs and functionality of the product at the start of the development process. In this course students will be introduced to the concepts and tools of systems engineering and how systems engineering relates to other engineering disciplines. The course is largely activity based with concepts introduced to support the activities and put them in the appropriate context. The course includes a group project that covers concept, stakeholders, use cases, requirements, interfaces, verification & validation, and quality assurance for a system.

Lab Project Description:

Group project covering: stakeholder identification, use cases, requirements definition, verification & validation, testing, and quality assurance for a CAV system or subsystem.

Course Learning Objectives:

- Understand the role and responsibilities of the system engineer.
- Understand systems engineering as a multi-discipline field.
- Understand use cases, concept of operations, and identification of stakeholders.
- Understand the "system of systems" viewpoint of systems engineering.
- Understand the importance of interfaces and proper documentation.
- Understand the concept of a requirement and the different sub-types of requirements (functional, design, derived, etc.).
- Practice writing meaningful requirements from the consideration of use cases, concept of operations, stakeholder needs.
- Understand the "V" and "double V" models for system design

- Understand and be able to create system boundary diagram and system P-Diagrams
- Understand the relationship between requirements and testing.
- Understand the difference between verification and validation.
- Practice with test definition and creating a Design Verification Plan.
- Understand the FMEA as a quality assurance tool.
- Practice creating an FMEA using an appropriate worksheet.
- Complete a project that includes elements from both sides of the V-model.

Course Content/Syllabus:

Day 1:

- Why does systems engineering matter?
    - Managing complexity
    - "Systems of systems"
    - The "V-model" as a design process
    - Life cycle management of a product
- Case study: Hubble space telescope
- Who is the systems engineer?
- The utility of use cases and system functions and how to establish them
    - Defining the goal of the use case
    - Identifying the user
    - Creating the scenario
    - Defining ideal functions of the system
- Small group activity (project module 1): creating use cases, identifying stakeholders for a prescribed system. Outputs presented to class for discussion
- Requirements
    - What is a requirement?
    - Where do they come from?
    - Identifying stakeholders
    - Identifying requirements from use cases
    - Requirements from system modeling
    - Other types of requirements analysis
    - Types of requirements: Functional, structural, derived, others
    - Individual activity: reading and evaluating requirements. Class discussion follows
    - Small group activity (project module 2): writing requirements for a prescribed system

Day 2:

- Review of V-model, requirements
- Present and discuss requirements created in project module 2
- Verification and validation
    - The requirements/verification feedback loop
    - Defining tests based on requirements
    - The difference between verification and validation
    - The Design Verification Plan (DVP)
- Individual activity: evaluating test cases against requirements. Class discussion follows
- Small group activity (project module 3): creating a DVP from a template. Outputs presented to class for discussion
- Project work time (opportunity to advance, refine work done in previous project work sessions

Day 3:

- Failure analysis and quality assurance
    - System boundary diagram
    - System P-Diagrams
    - Failure Mode Effects and Analysis (FMEA)
    - What an FMEA tells you
    - What an FMEA does not tell you
    - Example FMEA using a template
    - Alternatives to FMEA
- Small group activity (project module 4): Partial FMEA
- Work time to integrate and complete group project
- Presentation of stakeholders, use cases, requirements, design verification plan, and FMEA for each small group. Class discussion follows presentation
- Course summary

Course Assessment:

- Quality of and contributions to final project

Course Materials:

- Prescribed by the subject matter expert full-time instructor responsible for curricular development and implementation of this course.

MAGMA short courses are held on a rolling basis, based on industry demand. Please complete this **short form** to express interest for yourself, or your organization.