School District of Marshfield Course Syllabus

Course Name: Engineering Capstone H
Length of Course: Year
Credit: 1 Credit

Program Goal:

Empower learners to be college and career ready through standards-based experiences in the classroom and career-based learning experiences with business and industry partners. Learners will engage through technology in design, building, problem-solving, repair or service, in a collaborative environment through theory and hands-on experiences.

Course Description:

This course is designed for learners interested in STEAM (Science, Technology, Engineering, Art and Mathematics). This course's main focus is to provide students with both problem/ project-based learning and to challenge them to work to solve the problems of our community. Learners may work with community and industrial leaders to create new products and solve interesting problems in specific areas of study. Learners will be expected to work in small groups and create leadership and task-oriented guidelines to further their work in engineering. Projects

will vary based upon student/team interest and will revolve around any number of engineering fields.

Wisconsin Standards for Technology and Engineering (TE)	
Broad-Based (BB)	
BB1: Students will analyze the core concepts of technology.	
Analyze and use technological systems BB1.a	1.a.5.h: Describe how systems can fail because of design flaws, defective parts, poorly matched parts, or they were used beyond their design capabilities. 1.a.6.h: Describe how the outputs of one subsystem are the inputs of another subsystem given a prominent energy, power, and transportation system.
Analyze and use tools and materials BB1.b	1.b.5.h: Select appropriate resources and explain how trade-offs between competing values, such as availability, cost, desirability, and waste influenced their decision. 1.b.6.h: Choose and perform the material processing operations of forming (e.g., bending, pressing, drawing, rolling), bonding (e.g., gluing, soldering, brazing, spot welding, gas welding, arc welding), fastening (e.g., screws, nuts & bolts, rivets, clips, pins, nails) and finishing (e.g., surface preparation, cleaning, treatment, coating).
Analyze and use mechanisms BB1.c	1.c.4.h: Build, test and trouble shoot simple linear, rotary and compound mechanisms. 1.c.5.h: Given a linear, rotary and/or compound motion mechanism, students will measure and calculate units such as work, power, torque, gear ratios and mechanical advantage.
Analyze and use electricity and electronic systems BB1.d	1.d.5.h: Describe the role of thermal, optical, and mechanical transducers in sending electrical control signals to modify how a system performs. 1.d.6.h: Perform a voltage drop test and describe the relationship between voltage, current and resistance with a multimeter. 1.d.7.h: Inspect and test components such as switches, connectors, relays, solid state devices and conductors and take appropriate action.
Analyze, explain, and use control systems BB1.e	1.e.5.h: Identify the multiple controls that sense information from a number of areas, evaluate the system and act accordingly given a flawed complex system. 1.e.6.h: Select and perform appropriate maintenance in order for the product or system to continue functioning properly, to extend its life or to upgrade its capability given a flawed product or system.
Identify and analyze structures BB1.f	1.f.5.h: Calculate and define the different loads acting on structures (i.e., static, dynamic, stress, strain, compression, tension).

	1.f.6.h: Justify the application of structural materials and their trade-offs in the design of structures based on design requirements through optimization (i.e., engineering design process).
Engineering (ENG)	
ENG1: Students will analyze and demonstrate the attributes of design.	
Analyze engineering design theory ENG1.a	1.a.9.h: Examine how the design needs to continually be evaluated and the ideas of the design must be redefined and improved. 1.a.10.h: Interpret design problems are seldom presented in a clearly defined form. 1.a.11.h: Argue design processes vary slightly. However, key elements of any design process include: defining a problem, identifying criteria, generating solutions, creating a model or prototype, testing and evaluating, refining the design and communicating processes and results. 1.a.12.h: Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other.
ENG2: Students will analyze and demonstrate engineering design.	
Analyze the attributes of engineering design ENG2.a	2.a.6.h: Established design principles are used to evaluate existing designs, to collect data and to guide the design process. 2.a.7.h: Recognize that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. 2.a.8.h: Analyze the process of engineering design accounts for a number of factors to make decisions.
Describe and apply engineering design ENG2.b	2.b.4.h: A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.
ENG3: Students will demonstrate and analyze the role of troubleshooting, research and development, invention and innovation and experimentation in problem solving.	
Discuss the importance of the problem solving process ENG3.a	3.a.5.h: Explain technological problems must be researched before they can be solved. 3.a.6.h: Not all problems are technological and not every problem can be solved using technology. 3.a.7.h: Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace.
Analyze the procedures for innovation and invention ENG3.b	3.b.5.h: Describe how many technological problems require a multidisciplinary approach.
ENG4: Students will develop abilities to apply the design process.	

Research the background information of a proposed design ENG4.a	4.a.5.h: Identify the design problem to solve and determine how to address it. 4.a.6.h: Identify criteria and constraints and determine how these will affect the design process.
Design solutions based on gathered information ENG4.b	4.b.4.h: Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product. 4.b.5.h: Develop and produce a product or system using a design process.
Evaluate completed solutions and provide feedback ENG4.c	4.c.6.h: Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual and written means, in addition to design models. 4.c.7.h: Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed.
ENG5: Students will develop the abilities to use and maintain technological products and systems.	
Use information to describe and design systems ENG5.a	5.a.6.h: Diagnose a system that is malfunctioning and use tools, materials, or machines to repair it. 5.a.7.h: Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.
Use tools to maintain systems ENG5.b	5.b.6.h: Operate systems so that they function in the way they were designed. 5.b.7.h: Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate. 5.b.8.h: Troubleshoot, analyze, and maintain systems to ensure proper function, accuracy, and precision.
ENG6: Students will develop the abilities to assess the impact of products and systems.	
Collect information about products and systems ENG6.a	6.b.3.h: Collect information and evaluate its quality.
Interpret data from collected information to assess impacts of products and systems ENG6.b	6.b.7.h: Synthesize data, analyze trends, and draw conclusions regarding the effects of technology on the individual, society, and the environment. 6.b.8.h: Use assessment techniques, such as trend analysis and experimentation, to make decisions about the future development of technology. 6.b.9.h: Design forecasting techniques to evaluate the results of altering natural systems.
Wisconsin Common Career Technical Standards (WCCTS)	
Creativity, Critical Thinking, Communication and Collaboration (4C)	
4C1: Students will think and work creatively to develop innovative solutions to problems and opportunities.	

Develop original solutions, products, and services to meet a given need 4C1.a	1.a.7.h: Develop original ways to solve a given problem. 1.a.8.h: Design a product or service that could fulfill a human need or desire. 1.a.9.h: Apply past experiences to current problems in developing innovative solutions.
Work creatively with others to develop solutions, products, and services 4C1.b	1.b.7.h: Incorporate the skills and experiences of others to develop a new solution to a problem. 1.b.8.h: Work as part of a team to design a product or service that could fulfill a human need or desire. 1.b.9.h: Work as part of a team to improve an existing product or process.
4C2: Students will formulate and defend judgments and decisions by employing critical thinking skills.	
Develop effective resolutions for a given problem, decision or opportunity using available information 4C2.a	2.a.11.h: Determine the information needed to address an identified problem. 2.a.12.h: Contrast the benefits and drawbacks of various proposed resolutions to a given situation. 2.a.13.h: Predict how an action could result in unintended consequences, both positive and negative. 2.a.14.h: Analyze the impact of a decision using a systems thinking model. 2.a.15.h: Determine the best resolution for a problem, decision or opportunity based on given criteria. 2.a.16.h: Defend an action taken or a decision implemented.
Develop and implement a resolution for a new situation using personal knowledge and experience 4C2.b	2.b.5.h: Apply past experience to develop a course of action for a new situation. 2.b.6.h: Use existing knowledge to develop a resolution for a new situation, problem, or opportunity.
4C3: Students will communicate and collaborate with others to accomplish tasks and develop solutions to problems and opportunities.	
Communicate thoughts and feelings with others using verbal and non-verbal language 4C3.a	3.a.9.h: Develop a mutually acceptable response to a question or problem. 3.a.11.h: Communicate effectively in the presence of a language barrier. 3.a.12.h: Utilize effective listening skills in creating consensus in a group.
Work collaboratively with others 4C3.b	3.b.7.h: Participate in group processes to generate consensus. 3.b.8.h: Lead group processes to generate consensus.
Use interpersonal skills to resolve conflicts with others in an ethical manner 4C3.c	3.c.7.h: Resolve conflicts productively with individuals as they arise. 3.c.8.h: Lead a team or group through a conflict resolution process to reach a productive outcome.
Career Development (CD)	
CD1: Students will consider, analyze, and apply an awareness of self, identity, and culture to identify skills and talents.	

Identify person strengths, aptitudes, and passions CD1.a	1.a.3.h: Evaluate various occupations and career pathways to identify personal, academic and career goals based on personal strengths, aptitudes, and passions.
Demonstrate effective decision-making, problem solving and goal setting CD1.b	1.b.5.h: Use a decision-making and problem-solving model.
Interact effectively with others in similar and diverse teams CD1.c	1.c.11.h: Evaluate how the personal strengths and assets of others contribute to a cooperative group atmosphere. 1.c.12.h: Assess how respect and appreciation for individual and cultural differences impacts group processes.
Apply a range of relevant decision-making strategies CD1.d	1.d.5.h: Predict the outcome of various decisions on personal, social and career success. 1.d.6.h: Evaluate the impact of personal decision-making strategies on specific outcomes.
CD2: Students will identify the connection between educational achievement and work opportunities in order to reach personal and career goals.	
Apply academic experiences to the world of work, inter-relationships, and the community CD2.a	2.a.3.h: Evaluate how performance and connections within the learning community enhance future opportunities. 2.a.4.h: Determine those opportunities that best support attainment of a specific career goal.
Assess attitudes and skills that contribute to successful learning in school and across the life span CD2.b	2.b.7.h: Interpret and analyze the impact of current education, training, and work trends on life, learning and career plans. 2.b.8.h: Assess education and training opportunities to acquire new skills necessary for career advancement. 2.b.9.h: Analyze local and regional labor market and job growth information to select a career pathway for potential advancement.
CD3: Students will create and manage a flexible and responsive individualized learning plan to meet their career goals.	
Investigate the world of work in order to gain knowledge of self in order to make informed career decisions CD3.a	3.a.10.h: Analyze how career plans may be affected by personal growth, external events and changes in motivations and aspirations. 3.a.11.h: Apply academic and employment readiness skills in work-based learning situations such as internships, shadowing and/or mentoring experiences. 3.a.12.h: Evaluate changes in local, national, and global employment trends, societal needs and economic conditions related to career planning. 3.a.14.h: Implement an individual learning plan to maximize academic ability and achievement.
Examine and evaluate opportunities that could enhance life and career plans and articulate plans to guide decisions and actions CD3.b	3.b.4.h: Implement strategies for responding to transition and change with flexibility and adaptability. 3.b.5.h: Evaluate the relationship between educational achievement and career development.

Employ career management strategies to achieve future career success and satisfaction CD3.c	3.c.5.h: Determine how principles of equal opportunity, equity, respect, inclusiveness, and fairness, affect career planning and management. 3.c.6.h: Discuss how adaptability and flexibility, especially when initiating or responding to change, contributes to career success.
CD4: Students will identify and apply employability skills.	
Identify and demonstrate positive work behaviors and personal qualities needed to be employable CD4.a	4.a.6.h: Evaluate how self-discipline, self-worth, positive attitude, and integrity displayed in a work situation affect employment status. 4.a.7.h: Assess how flexibility and willingness to learn new knowledge and skills affect employment status. 4.a.8.h: Apply communication strategies when adapting to a culturally diverse environment. 4.a.9.h: Use positive work-qualities typically desired in each of the career cluster's pathways. 4.a.10.h: Manage work roles and responsibilities to balance them with other life roles and responsibilities.
Demonstrate skills related to seeking and applying for employment to find and obtain a desired job CD4.b	4.b.5.h: Use multiple resources to locate job opportunities. 4.b.6.h: Prepare a resume, cover letter, employment application. 4.b.7.h: Employ critical thinking and decision-making skills to exhibit qualifications to a potential employer in an interview.
Identify and exhibit traits for retaining employment CD4.c	4.c.4.h: Model behaviors that demonstrate reliability and dependability. 4.c.5.h: Maintain appropriate dress and behavior for the job to contribute to a safe and effective workplace/jobsite. 4.c.6.h: Complete required employment forms and documentation. 4.c.7.h: Summarize key activities necessary to retain a job in an industry.
Develop positive relationships with others CD4.d	4.d.5.h: Participate in co-curricular and community activities to enhance the school experience. 4.d.6.h: Evaluate the best method to assist co-workers in accomplishing goals and tasks. 4.d.7.h: Examine the skills required to enable students to successfully transition to post-secondary opportunities. 4.d.8.h: Use a systematic approach to academic and career planning for students to achieve their learning, socio-cultural and work goals.
Environment, Health, and Safety (EHS)	
EHS1: Students will identify the importance and interrelationships of health, safety and environmental systems and evaluate the impacts of these systems on organizational performance for continuous improvement.	
Implement personal and jobsite safety rules and regulations to maintain and improve safe and healthful working conditions and environments	1.d.7.h: Assess workplace conditions with regard to personal and environmental health and safety.

EHS1.d	1.d.8.h: Identify different workplace systems that protect and enhance personal and environmental health and safety. 1.d.9.h: Describe employee rights and responsibilities to maintain workplace health and safety, including compliance with rules and laws.

Key Vocabulary:			
Accuracy	Constraint	Design Statement	Purpose
Assembly	Decision Matrix	Designer	Sketch
Brainstorming	Design Brief	Open-Ended	Solid Modeling
Component	Design Modification	Pictorial Sketch	Target Consumer
Consensus	Design Process	Problem Statement	Team

Topics/Content Outline- Units and Themes:

Quarter 1:

Problem Solving Process

- Engineering Notebook
- Sketching
- Autodesk Inventor
  - 3D printing
- Arduino labs
  - Sensors
  - Programming
- Engineering Job Shadow

Quarter 2:

- Elementary Engineering Classroom
  - Teacher/classroom pairing
  - Lesson length
  - Community involvement
  - *One Day Engineering - Elementary Lesson*
- Material Processes (3 weeks)
  - Manufacturing
  - Construction
  - Automotive/Small Engines
  - Electricity/Electronics/Computing

    - Graphical Communications
- Intro to Engineering Capstone Project (2 weeks)
    - Project Procedure
    - Expectations
    - Timeline/Gantt Chart
    - Prototypes and Models

Quarter 3 and Quarter 4:

- Engineering Capstone Project (15 weeks)
    - Partnership with Community
    - Henderson project
    - Student-based project
- Senior Capstone

Primary Resource(s):
Arduino Online References: https://www.arduino.cc/