SCOPE AND SEQUENCE

Course Name: Advanced Manufacturing and Engineering Blue Year

Instructor: Dan Arensmeyer

Career Cluster: Advanced Manufacturing

Sub-Cluster: Engineering, Industrial Machinery, Production and Automation, Robotics, Safety and Quality Assurance.

HS Course Credits: 1 Math, 1 Science, 1 Elective

Fast Forward Optional Credits: Qualified students can earn the following college credits from Community College of Vermont: MEC-1310 (3 credits) Principles of Manufacturing, MEC-1330 (3 credits) Fundamentals Engineering and Design, MEC-1030 (3 credits) Sketching, Blueprint Reading, Geometric Dimensioning, and Tolerancing, MEC-2220 (3 credits) Parametric Solid Modeling, MEC-1320 (3 credits) Manufacturing Technology.

Tier 2 Credentials: Autodesk Fusion 360 Certified User, SME Certified Manufacturing Associate, SME Additive Manufacturing, Haas Mill and Lathe Operator.

Tier 1 Credentials: None

CTSO/Enrichment: SkillsUSA

Recommended for Success in this Course: This course includes extensive college-level material. Students must possess basic algebra and computer skills and be able to add, subtract, multiply, and divide decimals to three places; understand and work with fractions; employ basic customary and metric measuring skills; be able to read a tape measure; be able to perform physical labor in the classroom; and have strong fine and gross motor skills.

Tagline: Precision Manufacturing in the modern age!

Student appeal: Transform your ideas into real-world innovations with our Advanced Manufacturing and Engineering program! Master 3D parametric modeling, blueprint creation, and cutting-edge manufacturing processes to bring your designs to life. Get ready to shape the future of engineering with hands-on experience in the latest technology!

Course Description: This project-based course provides a hands-on introduction to the multi-stage design process for students interested in entering various engineering fields and high-tech manufacturing professions. Class experiences focus on critical analysis of real-world problems, developing design solutions, and evaluating their effectiveness using advanced Computer Aided Design and computer-controlled manufacturing processes including CNC milling and turning, 3D printing, laser cutting and engraving, and water-jet cutting technologies. Students work in teams, explore interdisciplinary solutions, and effectively communicate results while developing the skills and techniques necessary to model and fabricate complex parts, surfaces, and assemblies for rapid prototyping. Students also study the basic concepts and practices of annotated sketching, print reading, and geometric dimensioning and tolerancing (GD&T) to interpret and create blueprints and schematic diagrams as well as free-hand sketching and the use of basic drafting tools and techniques. Students have the opportunity to earn the Autodesk Fusion 360 Certified Associate, Haas Basic Mill and Lathe Operator, and the Society of Manufacturing Engineers Certified Manufacturing Technologist certifications.

Proficiencies/Learning Targets:

LT 1: Academic and Technical Foundations: Computer Aided Design, Manufacturing Processes, Electrical, Mechanical, Fluid, and Control systems

LT 1.1: Applied math and science: Applying algebra, and geometric principles in the analysis of basic engineering and manufacturing problems

-Use basic algebraic techniques to solve equations

-Understand common engineering and manufacturing units of measure and make conversions between units

-Use geometric and trigonometric techniques to solve engineering and manufacturing problems

LT 2: Technical Communication

LT 3: Problem Solving and Critical Thinking

LT 4: Safety, Health and Environmental

LT 5: Leadership and Teamwork

LT 6: Ethics and Responsible Design and Manufacturing

LT 7: Career Development

Standards: Standards are aligned with Vermont's CTE Advanced Manufacturing Critical Proficiencies Anchor Standards (VT), which derive from and are aligned with the Common Career Technical Core Standards for the Advanced Manufacturing Career Cluster and Engineering, Industrial Machinery, Production and Automation, Robotics, Safety and Quality Assurance sub-clusters.

Additional standards alignment includes:

PAHCC Habits of Work: Safety, Work Ethic, Reliability, People Skills

PAHCC Transferable Skills: Creative and practical problem solving; Inquiry; Informed and Integrated Thinking.

CCTC - Career Ready Practices

Unit and Essential Question(s)	Estimated # of Classes Periods *(assumes 120-minute classes)*	Learning Targets
Unit 1: Basic manual machining *How are engineering drawings (blueprints) interpreted.* *What safety measures applied in the advanced manufacturing industry?* *How are basic parts manufactured by manual milling and turning?* *How are parts measured to determine adherence to design criteria?*	25 (Weeks 1-5)	**Learning Targets: LT 1, LT1.1, LT3, LT4, LT7** ● Interpret basic engineering drawings ● Use geometric and trigonometric calculations to properly lay out a part for manufacturing ● Understand various units of measure and be able to convert measurements between different units of measure ● Manufacture basic parts and assemblies utilizing manual milling and turning techniques ● Understand how material composition and properties affect machinability (materials science) ● Inspect parts utilizing basic measuring and inspection techniques to verify compliance to specification ● Demonstrate appropriate safety measures and techniques ● Explore career opportunities in manual machining **Unit Projects:** **Manufacture air-driven motor using manual milling and turning techniques.** **Manufacture C-clamp using manual milling and turning techniques.**

Unit 2: Basic Computer Aided Design and Manufacturing *How are basic 2D and 3D objects modeled in Fusion 360?* *How are 2D and 3D CAD designs manufactured using CNC cutting and FDM printing techniques?*	30 (Weeks 6-11)	**Learning Targets: LT1, LT1.1, LT2, LT3, LT7** ● Interpret, and create basic engineering drawings ● Design, model, and manufacture 2D components utilizing CNC cutting and engraving techniques ● Design, model, and manufacture 3D components utilizing FDM additive manufacturing techniques ● Explain the science of FDM printing (filament properties, properties of thermoplastics, properties of composite filaments) ● Inspect parts utilizing basic measuring and inspection techniques to verify compliance to specification ● Demonstrate appropriate safety measures and techniques ● Explore career opportunities in CAD and manufacturing **Unit Projects:** **Design and manufacture a complex 2D (involving multiple interlocking parts) assembly.** **Design and manufacture a 3D object utilizing basic FDM printing techniques.**
Unit 3: Engineering Design Process *What are the steps of the Engineering Design Process and why is each step critical to the success of a project?* *How are engineering designs involving multiple contributors documented and tracked across work groups?*	15 (Weeks 12-14)	**Learning Targets: LT1, LT 1.1, LT2, LT3, LT4, LT5, LT6, LT7** ● Describe, apply, and document the Engineering Design Process to address a real-world application ● Employ advanced manufacturing techniques in prototype and testing ● Incorporate safety, environmental, and sustainability into the form, fit, and function of a design ● Present designs to customers for approval

		Unit Project: **In teams of 2 or 3, utilize the engineering design process to develop and manufacture a product to a customer's specifications. This project will include written documentation of the design process and oral design presentations.**
Unit 4: Evolution of Manufacturing and Manufacturing Processes. *How have manufacturing processes developed over time to meet the needs of society?* *How are things made? What manufacturing processes are used in the creation of everyday objects?* *How are safe workplaces established and maintained?* *How is product quality measured and maintained?*	15 (Weeks 15-17)	**Learning Targets: LT1, LT2, LT3, LT4, LT5, LT6, LT7** ● How, and why, have manufacturing processes evolved over time ● How do modern manufacturing processes work ● How scientific advancements affected the evolution of manufacturing, and how manufacturing advances scientific progress ● What factors affect the choice of manufacturing processes ● What processes, procedures, and regulations are in place to ensure workplace safety **Unit Project:** **In teams of 2, choose a modern manufacturing process and research its evolution over time focusing on the social, economic, and environmental factors that affected its development. Deliverables for this project will include a written research paper and an oral presentation.** **Complete MSSC or OSHA safety certification.** **Manufacture a basic part and perform measurements to ensure compliance to specifications.**
Unit 5: Advanced Computer Aided Design and Manufacturing	40 (Weeks 18-25)	**Learning Targets: LT1, LT1.1, LT2, LT3, LT4, LT5, LT6, LT7**

How are complex assemblies modeled and analyzed using CAD applications? *How are organic shapes modeled and manufactured?* *How are CNC milling and turning machines programmed and operated?*		• Utilize 3D solid and surface techniques to model assemblies utilizing movable joints • Apply algebra and trigonometry in the design and configuration of a component • Understand how forces are transferred through mechanisms, how energy and work are converted through mechanisms, and how mechanisms affect the overall system efficiency • Analyze stress distribution in a structure under load • Utilize advanced 3D printing techniques to manufacture multi-color and print-in-place movable assemblies • Write G&M code to manufacture a basic part utilizing a CNC mill • Use CAD/CAM systems to program basic toolpaths and create G&M code for use in CNC milling machine **Unit Project:** **In teams of two, incorporated advanced CAD techniques (parametric, surface and T-spline modeling) and multi-color FDM printing, to design and manufacture a model car to be raced in a "Pinewood Derby" style event. The design must consist of an assembly, with components designed by each team member – extra credit for moving parts (other than the wheels) like hood, truck, doors, etc…** **Manufacture a basic part utilizing CNC milling techniques.**

Unit 6: Electrical Theory, Robotics and Automation *How are robotic, drone, and automated systems utilized to enhance manufacturing quality and productivity?* *How are automated systems designed, programmed, and integrated?*	30 (Weeks 26-31)	**Learning Targets: LT1, LT1.1, LT2, LT3, LT4, LT5, LT6, LT7** ● Understand basic electrical principles of voltage, current and resistance. Apply Ohm's law to analyze basic circuits. Measure basic circuit parameters ● Write basic programs utilizing block, Arduino, and Python programming languages ● Use mathematical modeling to program the operation of an automated device ● Understand how automation is revolutionizing modern manufacturing. ● Describe how automation enhances safety, efficiency, and productivity of manufacturing systems ● Describe career opportunities in automation **Unit Projects:** **Utilizing block and Python languages, program an autonomous aerial drone to navigate an obstacle course to simulate package delivery to a remote location.** **In teams of 2 or 3, design, build, program, and integrate a simulated manufacturing work cell incorporating at least two devices.**
Unit 7: Capstone Project *Putting it all together!*	35 (Weeks 32-38)	**Learning Targets: LT1, LT1.1, LT2, LT3, LT4, LT5, LT6, LT7** **Unit Project:** **In teams of 3 or 4, design, build, program, and integrate a simulated manufacturing process involving at least two work cells and incorporating at least two programmable devices. This**

		project will demonstrate CAD, advanced manufacturing processes, the engineering design process and documentation, project management techniques, and programming and integration. Teams will present their final project for evaluation by members of the Program Advisory Committee.