Advanced Manufacturing Technology

Strand 2: Technical Knowledge and Skills

2.A	**Fundamentals of Safety in Machine Tool Technology**	
	Hours of Instruction	80
2.A.01	**Demonstrate machine tool safety**	**SKILL LEVEL**
2.A.01.01	Utilize personal protective equipment (PPE), following OSHA regulations and industry standards.	B, E
2.A.01.02	Explain and implement machine guarding.	B
	Demonstrate safe operation of equipment, following OSHA regulations and industry standards.	B
	Performance Example: Students will demonstrate safe operation of equipment, following the rules of the shop. Personal Protective Equipment (PPE) rules will be strictly adhered to. Students will pass safety tests for all equipment before they are allowed to operate said equipment.	
2.B	**Problem Solving**	
	Hours of Instruction	10
2.B.01	**Demonstrate skills in problem solving**	**SKILL LEVEL**
2.B.01.01	Identify the problem or source of the problem.	B, E, A
2.B.01.02	Predict solutions using a structured problem-solving process.	B, E, A
2.B.01.03	Apply designated strategies to remedy the given problem.	B, E, A
	Performance Example: Using appropriate shop project designs, students will identify problems in the manufacturing process. Students will solve these problems using strategies in a group setting or alone.	
2.C	**Machine Maintenance**	
	Hours of Instruction	10
2.C.01	**Manage equipment and machinery**	**SKILL LEVEL**
2.C.01.01	Identify appropriate person(s) for maintenance and repair of equipment.	B
2.C.01.02	Review and state equipment indicators to ensure that equipment is operating according to manufacturer's specifications.	A
2.C.01.03	Demonstrate ability to maintain equipment.	B, E, A
2.C.01.04	Report and maintain a written log for service and recommend process repair of equipment.	E
	Performance Example: Students will follow a preventative maintenance program developed by the instructors according to machine specifications.	
2.D	**Quality Control - Measuring/Inspection**	
	Hours of Instruction	50
	Equipment Needed – (Must Meet Industry Standards)	

	Coordinate Measuring Machines, Profilometer, Optical Comparator, Height Gauge	
2.D.01	**Review inspection procedures**	**SKILL LEVEL**
2.D.01.01	Measure work piece with a scale within a tolerance of +/- 1/64".	B
2.D.01.02	Measure work piece outside diameter, inside diameter and depth with the precision instrument to a tolerance of +/- .001".	B
2.D.01.03	Measure work piece with a precision caliper within a tolerance of +/- .005".	B
2.D.01.04	Measure radius on a work piece**.**	B, E, A
2.D.01.05	Measure angle(s).	B, E, A
2.D.01.06	Measure location and size of a feature to a tolerance of at least +/- .001".	E, A
2.D.01.07	Identify a thread and measure outside and pitch diameter to design specifications.	E
2.D.01.08	Compare and/or measure surface finish quality of a part to print specification.	E, A
2.D.01.09	Describe clean room and climate-controlled environments and their purpose in the Manufacturing Industry.	B
	Performance Example: Students will demonstrate the ability to distinguish among the appropriate precision measuring tools according to allowable tolerances on a given design. Using appropriate measuring tools and a print with specifications, the student will measure and document all dimensions to determine if a product passes inspection.	
2.E	**Material Sciences**	
	Hours of Instruction	10
2.E.01	**Describe material properties**	**SKILL LEVEL**
2.E.01.01	Identify types of metals and advanced materials. (i.e. carbon fiber, plastics, composites).	E, A
2.E.01.02	Identify properties that affect machinability.	E, A
2.E.01.03	Describe heat treatment processes: harden, temper, anneal, normalize, and case harden.	A
	Performance Example: Through research and discovery, students will identify material properties that have a direct effect on its machinability.	
2.F	**Blueprints/Detail Drawings**	
	Hours of Instruction	80
2.F.01	**Read Blueprints/Detail Drawing and create sketches**	**SKILL LEVEL**
2.F.01.01	Read and interpret detail drawings to meet American National Standards Institute (ANSI) and International Organization for Standards (ISO) standards.	B, E, A
2.F.01.02	Read and interpret assembly drawings.	B, E, A
2.F.01.03	Design and sketch a basic work piece including mathematical annotation.	B, E, A
	Performance Example: Students will build and assemble products according to detailed drawings and annotated hand sketches. This will include the	

	interpretation of prints with geometric dimensioning and tolerancing symbols, and fitment and weldment callouts that meet ANSI and ISO specifications.	
2.G	**Process Planning**	
	Hours of Instruction	20
2.G.01	**Plan production process**	**SKILL LEVEL**
2.G.01.01	Determine and select appropriate material, size and quantity needed to complete specified product(s).	B, E, A
2.G.01.02	Formulate an order of operations, proper tooling and workholding devices.	B, E, A
2.G.01.03	Describe LEAN principles	E, A
	Performance Example: Students will research all materials and tooling needed to build a product from the curriculum. Students will design a LEAN production plan that will satisfy the steps needed to create the project from start to completion.	
2.H	**Machining Operations**	
	Hours of Instruction	50
2.H.01	**Demonstrate general machining operations**	**SKILL LEVEL**
	Drill a hole to the designated size and in the predetermined location.	B
2.H.01.02	Countersink a hole to depth and diameter specified by blueprint and/or standard.	E
2.H.01.03	Machine a hole to a specified tolerance of +/- .001".	E, A
2.H.01.04	Tap a hole to specified depth and thread size.	B, E, A
2.H.01.05	Counter bore a hole to the specified diameter and depth according to the blueprint.	E
2.H.0106	Calculate speeds and feeds for given tooling and material.	B
	Performance Example: Using shop developed projects and tasks, students will perform machining operations that are relevant to a multitude of machines.	
2.I	**Power Saw Processes**	
	Hours of Instruction	10
	Equipment Needed – (Must Meet Industry Standards) Power Saw	
2.I.01	**Operate a Power Saw**	**SKILL LEVEL**
2.I.01.01	Identify the appropriate blade and speed for specified task.	B
2.I.01.02	Cut material using power saws to specified length.	B
	Performance Example: Students will demonstrate the use of power saw equipment and cut material for the creation of shop designed projects and tasks.	
2.J	**Finishing Processes**	
	Hours of Instruction	10
2.J.01	**Demonstrate finishing operations**	**SKILL LEVEL**
2.J.01.01	Explain the selection and process of finishing techniques.	B, E, A
2.J.01.02	Deburr work piece.	B
	Performance Example:	

	Through classroom work and shop projects, students will demonstrate the operations of finishing processes for the completion of a product.	
2.K	**Grinding Processes**	
	Hours of Instruction	10
	Equipment Needed – (Must Meet Industry Standards) Surface Grinder, Bench Grinder	
2.K.01	**Operate precision grinding equipment**	**SKILL LEVEL**
2.K.01.01	Demonstrate mounting of a grinding wheel according to industry standards.	A
2.K.01.02	Demonstrate precision grinding operations.	A
2.K.02	**Off-hand Grinding**	**SKILL LEVEL**
2.K.02.01	Dress wheel, set tool rest and spark guard on pedestal grinder to proper height and clearance.	B
2.K.02.02	Explain and demonstrate the grinding of tools for specific application and use.	B
	Performance Example: Using industry standard equipment and classroom theory, students will demonstrate precision grinding operations using the tools associated with the production of square and cylindrical finished products. Through classroom work and shop projects, students will demonstrate the operations of offhand grinding for the completion of a product and sharpening of tools associated with the trade.	
2.L	**Lathe Processes**	
	Hours of Instruction	150
	Equipment Needed – (Must Meet Industry Standards) Conversational and CNC Lathes	
2.L.01	**Operate precision turning equipment**	**SKILL LEVEL**
2.L.01.01	Identify and setup work-holding devices including universal and independent chucks and collets.	B, E, A
2.L.01.02	Demonstrate outside turning procedures, including facing, grooving, turning diameters to a shoulder, and tapering to a specified tolerance.	B, E, A
2.L.01.03	Demonstrate inside turning procedures, including boring, grooving and tapering to a specified tolerance.	E, A
2.L.01.04	Demonstrate single-point threading to a specified tolerance.	E, A
2.L.01.05	Demonstrate cut-off techniques.	E, A
2.L.01.06	Machine a form into the work piece.	A
2.L.01.07	Knurl a piece to design specifications from blue print.	B
2.L.01.08	File and polish a work piece.	B, E, A
	Performance Example: Students will demonstrate skills in the turning of cylindrical and square stock through the completion of shop designed projects and tasks. Through the selection of appropriate work holding devices, students will demonstrate a working knowledge set up and fixtures needed for the completion of machining processes.	
2.M	**Milling Processes**	
	Hours of Instruction	150
	Equipment Needed – (Must Meet Industry Standards)	

	Conversational and CNC Mills	
2.M.01	**Operate precision milling equipment**	**SKILL LEVEL**
2.M.01.01	Indicate vise within a tolerance of .0005” over a 6" span.	B, E
2.M.01.02	Tram milling head within a tolerance of .001” over a 6" diameter sweep.	E, A
2.M.01.03	Locate a datum feature using an edge finder.	B, E
2.M.01.04	Locate and indicate holes and pins.	E, A
2.M.01.05	Mill a flat surface within a specified surface finish using a variety of tooling.	B, E
2.M.01.06	Mill a variety of angles within a specified tolerance.	E, A
2.M.01.07	Square a work piece within a specified tolerance.	E
2.M.01.08	Apply climb and conventional milling strategies.	B
2.M.01.09	Mill a shoulder, slots and pockets within a specified tolerance.	B
2.M.01.10	Setup and Bore a hole to size and location within a tolerance of +/- .001”.	A
2.M.01.11	Describe the operation of keys and keyways.	B
2.M.01.12	Mill keyways and keyseats to specifications.	A
	Performance Example: Students will demonstrate skills in the set up and milling of shapes and surfaces using cylindrical and square material through the completion of shop designed projects and tasks. Using industry standard locating tools, students will demonstrate a working knowledge of datums to setup and machine a finish product.	
2.N	**Computer Aided Drafting and Design (CAD)**	
	Hours of Instruction	200
	Equipment Needed – (Must Meet Industry Standards) Computers, CAD Software	
2.N.01	**Demonstrate and apply basic CAD operations using current industry standard software**	**SKILL LEVEL**
2.N.01.01	Create solid three-dimensional models.	B, E, A
2.N.01.02	Create three-dimensional assembly models.	A
2.N.01.03	Create part level design or drawing specifications.	B, E, A
2.N.01.04	Create assembly level design and drawing specifications.	A
2.N.01.05	Convert files to generic formats i.e. (.pdf, .dxf, .igs, .stp, .stl, etc.).	B
	Performance Example: Modify or create model based on requirements, record CAD data and create output file.	
2.O	**Additive Manufacturing Process**	
	Hours of Instruction	20
	Equipment Needed Additive Manufacturing Equipment	
2.O.01	**Use additive manufacturing**	**SKILL LEVEL**
2.O.01.01	Demonstrate manufacturing a part using an additive manufacturing machine.	A
	Performance Example: Students will produce an additive manufacturing part based on CAD model they have created.	
2.P	**CNC Programming**	

	Hours of Instruction	90
	Equipment Needed – (Must Meet Industry Standards) Conversational and CNC Mills/Lathes, and Respective Simulators	
2.P.01	**Demonstrate basic programming strategies at the machine control**	**SKILL LEVEL**
2.P.01.01	Define G and M codes.	B, E, A
2.P.01.02	Construct a safe and effective part program using G and M codes.	B, E, A
2.P.01.03	Construct a safe and effective part program using conversational programming strategies.	B, E, A
2.P.01.04	Transfer part program to and from a machine control.	B, E, A
	Performance Example: Using industry standard CNC equipment and classroom theory, students will demonstrate a working knowledge of a written program and the different codes that are associated within it.	
2.Q	**Computer Aided Manufacturing (CAM)**	
	Hours of Instruction	200
	Equipment Needed – (Must Meet Industry Standards) CAM Software, Computers, CNC Machines	
2.Q.01	**Demonstrate and apply the Computer Aided Manufacturing (CAM) process using industry standard software**	**SKILL LEVEL**
2.Q.01.01	Use computer aided manufacturing (CAM) software to apply machining processes to design (e.g., speeds, feeds, cutter compensation, etc.).	B, E, A
2.Q.01.02	Post process program and transfer to and from CNC machine.	B, E, A
	Performance Example: Using industry standard software, students will design and apply machining processes for the completion of shop projects and tasks. Students will demonstrate the process of posting and receiving of programs to a CNC machine to properly complete a project to shop specifications.	
2.R	**CNC Machine Set up and Operations**	
	Hours of Instruction	200
	Equipment Needed – (Must Meet Industry Standards) CNC Mills and CNC Lathes	
2.R.01	**Operate CNC and conversational machines**	**SKILL LEVEL**
2.R.01.01	Use Manual Data Input (MDI) and control panel operations including simple programming, tool changes and spindle speeds.	B, E, A
2.R.01.02	Demonstrate sequential start-up and shut-down operations.	B
2.R.01.03	Set up datum point, tool length offsets and tool geometry offsets.	B, E, A
2.R.01.04	Set cutter compensation.	B, E, A
2.R.01.05	Load programs, dry run, edit, and execute program.	B, E, A
	Performance Example: Students will demonstrate the operation of the control panel to set up, run, and edit a program for a shop designed project.	
2.S	**Advanced CNC Set up and Operations***	
	Hours of Instruction	40
	Equipment Needed – (Must Meet Industry Standards) 4 and 5 Axis Mills, Live Tooling Lathes, Probing Systems	
2.S.01	**Advanced Multiple Axis and Live Tooling**	**SKILL LEVEL**

2.S.01.01	Set up a workpiece on a CNC milling 4th axis rotary table.	A+
2.S.01.02	Set up a workpiece on a 5-axis CNC milling machine.	A+
2.S.01.03	Set up live tooling on a CNC mill/turn center.	A+
2.S.01.04	Set part origin on a CNC milling machine using a probing system.	A+
2.S.01.05	Set tool length and diameter offsets on a CNC milling machine using a table mounted tool setter.	A+
2.S.01.06	Set multi-axis offsets with a CNC lathe tool presetter.	A+
	Performance Example: Students will demonstrate the operation of the control panel to set up, run, and edit a program for a shop designed project using 4 axis, 5 axis milling as well as live tooling.	
2.T	**Electrical Discharge Machining (EDM) (A+)**	
	Hours of Instruction	40
2.T.01	**Use Electrical Discharge Machining Equipment (A+)**	**SKILL LEVEL**
2.T.01.01	Demonstrate manufacturing a part using an electrical discharge machine.	A+
	Performance Example: Students will produce a part utilizing EDM technology.	
2.U	**Robotics (A+)**	
	Hours of Instruction	40
2.U.01	**Describe how robotics are used in the manufacturing process**	**SKILL LEVEL**
2.U.01.01	Describe a Computer Integrated Manufacturing (CIM) system utilizing appropriate safety precautions. (i.e cages, light curtains).	A+
2.U.01.02	Describe automated systems engineering introductory knowledge and skills.	A+
2.U.01.03	Define an automated system and a robot.	A+
2.U.01.04	Identify individual components used in CIM systems.	A+
2.U.01.05	Describe the working relationship between the CNC equipment and the robot.	A+
2.U.01.06	Describe and identify various grippers: standard, servo, non-servo, vacuum, and magnetic (end effector).	A+
2.U.01.07	Define the following robot terms: degrees of freedom, position axes, orientation axes, work envelope, tool center point.	A+
2.U.01.08	Define and give an example of the following specifications for industrial robots: payload, repeatability, memory capacity, and environmental requirements.	A+
2.U.01.09	Describe open-loop and close-loop control systems.	A+
	Performance Example: Student will describe the integration of robotics into the manufacturing process.	