

Text of Proposed New 19 TAC

**Chapter 130. Texas Essential Knowledge and Skills for Career and Technical Education**

**Subchapter M. Manufacturing**

**§130.351. Implementation of Texas Essential Knowledge and Skills for Manufacturing, Adopted 2015.**

- (a) The provisions of this subchapter shall be implemented by school districts beginning with the 2017-2018 school year.
- (b) No later than August 31, 2016, the commissioner of education shall determine whether instructional materials funding has been made available to Texas public schools for materials that cover the essential knowledge and skills for career and technical education as adopted in §§130.352-130.366 of this subchapter.
- (c) If the commissioner makes the determination that instructional materials funding has been made available under subsection (b) of this section, §§130.352-130.366 of this subchapter shall be implemented beginning with the 2017-2018 school year and apply to the 2017-2018 and subsequent school years.
- (d) If the commissioner does not make the determination that instructional materials funding has been made available under subsection (b) of this section, the commissioner shall determine no later than August 31 of each subsequent school year whether instructional materials funding has been made available. If the commissioner determines that instructional materials funding has been made available, the commissioner shall notify the State Board of Education and school districts that §§130.352-130.366 of this subchapter shall be implemented for the following school year.

**§130.352. Principles of Manufacturing (One Credit), Adopted 2015.**

- (a) General requirements. This course is recommended for students in Grades 9-12. Recommended prerequisite: Algebra I or Geometry. At the discretion of the school district, students shall be awarded one-half credit for successful completion of one semester of this course. Students shall be awarded one credit for successful completion of two semesters of this course. The standards for each option are the same; however, full-year courses shall address the standards to a greater degree.
- (b) Introduction.
  - (1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
  - (2) The Manufacturing Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.
  - (3) In Principles of Manufacturing, students are introduced to knowledge and skills used in the proper application of principles of manufacturing. The study of manufacturing technology allows students to reinforce, apply, and transfer academic knowledge and skills to a variety of interesting and relevant activities. Students will gain an understanding of what employers require to gain and maintain employment in manufacturing careers.
  - (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
  - (5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.
- (c) Knowledge and skills.

- (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:

  - (A) identify and comply with appropriate dress for manufacturing activities;
  - (B) demonstrate positive work behaviors and personal qualities such as punctuality;
  - (C) demonstrate the ability to work in teams such as developing work schedules and measuring team performance;
  - (D) demonstrate an understanding of employers' application and interview processes; and
  - (E) identify federal laws and rules applicable to the workplace and enforcement agencies such as the Equal Employment Opportunity Commission and the Occupational Safety and Health Administration (OSHA).
- (2) The student applies manufacturing concepts to specific problems. The student is expected to:

  - (A) distinguish between disciplines such as engineering, science, manufacturing, and technology;
  - (B) use tools such as calculators and computers to solve problems; and
  - (C) use a variety of measuring instruments.
- (3) The student applies communication, mathematics, and science knowledge and skills to manufacturing activities. The student is expected to:

  - (A) demonstrate communication techniques consistent with industry standards;
  - (B) locate relevant information needed to solve problems;
  - (C) apply mathematics concepts to solve manufacturing problems;
  - (D) analyze science principles used to solve problems; and
  - (E) use the appropriate units of measure.
- (4) The student manufactures products using the appropriate tools, equipment, machines, materials, and technical processes. The student is expected to:

  - (A) analyze the processes needed to complete a project; and
  - (B) use a variety of tools and equipment to produce an item.
- (5) The student practices safe work habits. The student is expected to:

  - (A) master relevant safety tests based on OSHA guidelines and principles; and
  - (B) use Material Safety Data Sheets (MSDS) to analyze, store, and safely dispose of hazardous materials.
- (6) The student describes the importance of maintenance. The student is expected to:

  - (A) perform maintenance on selected equipment; and
  - (B) analyze the results of improper maintenance.
- (7) The student describes the factors that affect the evolution of technology. The student is expected to:

  - (A) analyze how changes in technology affect manufacturing practices;
  - (B) evaluate how the development of technology in manufacturing is influenced by past events;
  - (C) analyze the international effects of technology;
  - (D) demonstrate how advancements in technology have affected the field of engineering; and

- (E) evaluate the factors that affect the implementation of new ideas.
- (8) The student selects and reports on career opportunities, requirements, and expectations in manufacturing and technology. The student is expected to:
  - (A) investigate an area of interest in manufacturing;
  - (B) analyze the various specializations in manufacturing; and
  - (C) describe the functions of engineers, technologists, and technicians.

**§130.353. Diversified Manufacturing I (One Credit), Adopted 2015.**

- (a) General requirements. This course is recommended for students in Grades 10-12. Recommended prerequisite: Algebra I. Students shall be awarded one credit upon successful completion of this course.
- (b) Introduction.
  - (1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
  - (2) The Manufacturing Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.
  - (3) In Diversified Manufacturing I, students gain knowledge and skills in the application, design, production, and assessment of products, services, and systems and how those knowledge and skills are applied to manufacturing. The study of manufacturing systems allows students to reinforce, apply, and transfer academic knowledge and skills to a variety of interesting and relevant activities, problems, and settings in a manufacturing setting. Diversified Manufacturing I allows students the opportunity to understand the process of mass production by using a wide variety of materials and manufacturing techniques. Knowledge about career opportunities, requirements, and expectations and the development of skills prepare students for workplace success.
  - (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
  - (5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.
- (c) Knowledge and skills.
  - (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:
    - (A) demonstrate skills related to health and safety in the workplace as specified by appropriate government regulations;
    - (B) demonstrate the standards required in the workplace such as interviewing skills, flexibility, willingness to learn new skills and acquire knowledge, self-discipline, self-worth, positive attitude, and integrity in a work situation;
    - (C) use teamwork to solve problems;
    - (D) identify employers' work expectations; and
    - (E) use time-management techniques to develop work schedules.
  - (2) The student applies academic skills to the requirements of manufacturing. The student is expected to:
    - (A) demonstrate effective oral and written communication skills with individuals from varied cultures, including fellow workers, management, and customers;

- (B) interpret engineering drawings, charts, diagrams, and welding symbols; and
  - (C) select algebraic and geometric principles and formulas required for precision measuring operations.
- (3) The student differentiates between the technical concepts that form the knowledge and skills of manufacturing. The student is expected to:
  - (A) use tools and equipment commonly employed in manufacturing in a safe manner;
  - (B) demonstrate an understanding of the safety regulations for the different types of manufacturing equipment such as cutting, abrasive, boring, turning, shaping, and forming tools;
  - (C) execute procedures using the different types of manufacturing equipment such as cutting, abrasive, boring, turning, shaping, and forming tools;
  - (D) research the modern materials used in manufacturing; and
  - (E) perform varied measurements, including precision measurements.
- (4) The student investigates emerging and innovative applications of technology in engineering. The student is expected to:
  - (A) report on innovative applications of technology in engineering;
  - (B) experiment with new technologies; and
  - (C) experiment with different manufacturing materials such as plastic, composites, fiberglass, stone, and wood.
- (5) The student manufactures products or systems using the appropriate tools, equipment, machines, materials, and technical processes. The student is expected to:
  - (A) analyze the processes needed to complete a project; and
  - (B) use a variety of equipment and machines to produce an item to specification.
- (6) The student practices safe work habits. The student is expected to:
  - (A) master safety tests developed from Occupational Safety and Health Administration regulations;
  - (B) analyze hazardous materials;
  - (C) dispose of hazardous materials safely; and
  - (D) store all materials correctly.
- (7) The student participates in a mass manufacturing project. The student is expected to:
  - (A) participate in the manufacturing of a mass produced project; and
  - (B) develop a method to check and maintain quality control throughout the manufacturing process.
- (8) The student identifies the factors that influence the cost of an item or service. The student is expected to:
  - (A) develop a budget for a project; and
  - (B) determine the most effective strategies to minimize costs.
- (9) The student describes the relationship between manufacturing and marketing. The student is expected to:
  - (A) prepare a marketing plan for a product;
  - (B) analyze the effect of customer satisfaction on the image of a product; and

- (C) analyze how customer demands influence the design of an object.
- (10) The student applies communication, mathematics, and science knowledge and skills to manufacturing activities. The student is expected to:
  - (A) demonstrate communication techniques consistent with industry standards;
  - (B) locate relevant information needed to solve problems;
  - (C) apply mathematics concepts to solve manufacturing problems;
  - (D) analyze science principles used to solve problems; and
  - (E) use appropriate units of measure.

**§130.354. Diversified Manufacturing II (One Credit), Adopted 2015.**

- (a) General requirements. This course is recommended for students in Grades 11 and 12. Prerequisite: Diversified Manufacturing I. Recommended prerequisite: Algebra I. Students shall be awarded one credit upon successful completion of this course.
- (b) Introduction.
  - (1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
  - (2) The Manufacturing Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.
  - (3) In Diversified Manufacturing II, students will gain knowledge and skills in the application, design, production, and assessment of products, services, and systems and how those knowledge and skills are applied to manufacturing. The study of manufacturing systems allows students to reinforce, apply, and transfer academic knowledge and skills to a variety of interesting and relevant activities, problems, and settings in a manufacturing setting. Diversified Manufacturing II allows students the opportunity to understand the process of mass production by using a wide variety of materials and manufacturing techniques. Knowledge about career opportunities, requirements, and expectations and the development of skills prepare students for workplace success.
  - (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
  - (5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.
- (c) Knowledge and skills.
  - (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:
    - (A) demonstrate skills related to health and safety in the workplace as specified by appropriate government regulations;
    - (B) demonstrate the standards required in the workplace such as interviewing skills, flexibility, willingness to learn new skills and acquire knowledge, self-discipline, self-worth, positive attitude, and integrity in a work situation;
    - (C) use teamwork to solve problems;
    - (D) identify employers' work expectations;
    - (E) use time-management techniques to develop work schedules;
    - (F) explore advanced knowledge and skills required for postsecondary education; and

- (G) identify employers' expectations to foster positive customer satisfaction.
- (2) The student applies academic skills to the requirements of manufacturing. The student is expected to:
  - (A) demonstrate effective oral and written communication skills with individuals from varied cultures, including fellow workers, management, and customers;
  - (B) interpret engineering drawings, charts, diagrams, and welding symbols;
  - (C) select algebraic and geometric principles and formulas required for precision measuring operations;
  - (D) develop the information needed to mass produce a simple project such as flow charts, schedules, equipment lists, and material lists; and
  - (E) explore the use of jigs and fixtures in mass production.
- (3) The student differentiates among the technical concepts that form the knowledge and skills of manufacturing. The student is expected to:
  - (A) use tools and equipment commonly employed in manufacturing in a safe manner;
  - (B) adhere to safety regulations for the different types of manufacturing equipment such as cutting, abrasive, boring, turning, shaping, and forming tools;
  - (C) execute procedures using the different types of manufacturing equipment such as cutting, abrasive, boring, turning, shaping, and forming tools;
  - (D) perform varied measurements, including precision measurements;
  - (E) design and develop the jigs and fixtures for a simple four (or fewer) part product; and
  - (F) participate in the production run off of the product.
- (4) The student learns skills in production and programming of computer numerical control (CNC) operations. The student is expected to:
  - (A) develop a CNC program using a computer-aided manufacturing (CAM) program; and
  - (B) execute the CNC program to machine a product or run a simulation of the program.
- (5) The student investigates emerging and innovative applications of technology in manufacturing. The student is expected to:
  - (A) research innovative technologies in manufacturing; and
  - (B) experiment with different manufacturing materials such as plastic, composites, fiberglass, stone, and wood.
- (6) The student manufactures products or systems using the appropriate tools, equipment, machines, materials, and technical processes. The student is expected to:
  - (A) analyze engineering properties such as chemical, mechanical, and physical;
  - (B) analyze the processes needed to complete a project; and
  - (C) use a variety of tools and equipment to produce a product to specification.
- (7) The student practices safe work habits. The student is expected to:
  - (A) master safety tests based on Occupational Safety and Health Administration regulations;
  - (B) analyze hazardous materials;
  - (C) dispose of hazardous materials; and
  - (D) store all materials safely.

- (8) The student participates in the manufacturing of a mass-produced product. The student is expected to:
  - (A) participate in the manufacturing of products; and
  - (B) develop a method to check and maintain quality control throughout the manufacturing process.
- (9) The student identifies the factors that influence the cost of an item. The student is expected to:
  - (A) calculate costs associated with production of a mass-produced product; and
  - (B) re-examine the manufacturing process to maximize efficiency and minimize costs without compromising the integrity and marketability of the product.
- (10) The student describes the relationship between manufacturing and marketing. The student is expected to:
  - (A) prepare a marketing plan for a product;
  - (B) analyze the effect of customer satisfaction on the image of a product; and
  - (C) analyze how customer demands influence the design of an object.
- (11) The student applies communication, mathematics, and science knowledge and skills to manufacturing activities. The student is expected to:
  - (A) demonstrate communication techniques consistent with industry standards;
  - (B) locate relevant information needed to solve problems;
  - (C) apply mathematics concepts to solve manufacturing problems;
  - (D) analyze science principles used to solve problems; and
  - (E) use appropriate units of measure.

**§130.355. Manufacturing Engineering Technology I (One Credit), Adopted 2015.**

- (a) General requirements. This course is recommended for students in Grades 10-12. Recommended prerequisite: Algebra I. Students shall be awarded one credit upon successful completion of this course.
- (b) Introduction.
  - (1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
  - (2) The Manufacturing Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.
  - (3) In Manufacturing Engineering Technology I, students will gain knowledge and skills in the application, design, production, and assessment of products, services, and systems and how those knowledge and skills are applied to manufacturing. Students will prepare for success in the global economy. The study of manufacturing engineering will allow students to reinforce, apply, and transfer academic knowledge and skills to a variety of interesting and relevant activities, problems, and settings in a manufacturing setting.
  - (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
  - (5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.
- (c) Knowledge and skills.

- (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:

  - (A) describe how teams function;
  - (B) explain employers' work expectations; and
  - (C) demonstrate knowledge of the concepts and skills related to health and safety in the workplace as specified by appropriate government regulations.
- (2) The student applies software skills to manufacturing. The student is expected to:

  - (A) use computer-aided design (CAD) software to complete a design;
  - (B) analyze the results of product testing in a simulated modeling environment; and
  - (C) fabricate a prototype design of a mechanical part.
- (3) The student gains skills in writing programmable logic controls so that a robot can work in coordination with a machine. The student is expected to:

  - (A) use computer-integrated manufacturing techniques to simulate a manufacturing process; and
  - (B) troubleshoot programmable logic circuit devices.
- (4) The student performs functions and solves problems in the electricity and electronics field. The student is expected to:

  - (A) research the use control devices; and
  - (B) demonstrate the use control devices.
- (5) The student learns skills in production and programming of computer numerical control (CNC) operations. The student is expected to:

  - (A) design a product using computer-aided manufacturing (CAM) software for production on a CNC lathe;
  - (B) produce a product on the CNC lathe or a simulation;
  - (C) design a product using CAM software for production on a CNC mill;
  - (D) produce a product on the CNC mill or a simulation; and
  - (E) complete data sheets for plan, do, check, and act forms and projects.
- (6) The student knows mechanical and fluid systems. The student is expected to:

  - (A) identify, describe, and demonstrate the use of mechanical devices; and
  - (B) identify, describe, and demonstrate the use of fluid devices.
- (7) The student knows electrical and thermal systems. The student is expected to:

  - (A) identify and describe electrical devices;
  - (B) demonstrate the use of electrical devices; and
  - (C) research the effects of heat energy and temperature on products.
- (8) The student understands quality-control systems. The student is expected to:

  - (A) research and recognize industrial standards such as International Standards Organization and Military Specifications;
  - (B) explain attribute and Pareto charts; and
  - (C) apply statistical process control.



**§130.356. Manufacturing Engineering Technology II (One Credit), Adopted 2015.**

- (a) General requirements. This course is recommended for students in Grades 11 and 12. Prerequisite: Manufacturing Engineering Technology I. Recommended prerequisite: Algebra II, Computer Science I, or Physics. This course satisfies a high school mathematics graduation requirement. Students shall be awarded one credit for successful completion of this course.
- (b) Introduction.
- (1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
  - (2) The Manufacturing Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.
  - (3) In Manufacturing Engineering Technology II, students will gain knowledge and skills in the application, design, production, and assessment of products, services, and systems and how those knowledge and skills are applied to manufacturing. The study of Manufacturing Engineering Technology II will allow students to reinforce, apply, and transfer academic knowledge and skills to a variety of interesting and relevant activities, problems, and settings.
  - (4) The process standards describe ways in which students are expected to engage in the content. The placement of the process standards at the beginning of the knowledge and skills listed for each grade and course is intentional. The process standards weave the other knowledge and skills together so that students may be successful problem solvers and use mathematics efficiently and effectively in daily life. The process standards are integrated at every grade level and course. When possible, students will apply mathematics to problems arising in everyday life, society, and the workplace. Students will use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution. Students will select appropriate tools such as real objects, manipulatives, paper and pencil, and technology and techniques such as mental math, estimation, and number sense to solve problems. Students will effectively communicate mathematical ideas, reasoning, and their implications using multiple representations such as symbols, diagrams, graphs, and language. Students will use mathematical relationships to generate solutions and make connections and predictions. Students will analyze mathematical relationships to connect and communicate mathematical ideas. Students will display, explain, or justify mathematical ideas and arguments using precise mathematical language in written or oral communication.
  - (5) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
  - (6) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.
- (c) Knowledge and skills.
- (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:
    - (A) use teamwork to solve problems;
    - (B) demonstrate a work ethic that meets common employers' expectations;
    - (C) use time-management techniques to develop work schedules;
    - (D) describe how teams measure results;

- (E) demonstrate the skills required in the workplace such as interviewing skills, flexibility, willingness to learn new skills and acquire knowledge, self-discipline, self-worth, positive attitude, and integrity in a work situation;
  - (F) communicate effectively with others in the workplace to clarify objectives; and
  - (G) apply skills related to health and safety in the workplace as specified by appropriate government regulations.
- (2) The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:
- (A) apply mathematics to problems arising in everyday life, society, and the workplace;
  - (B) use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution;
  - (C) select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems;
  - (D) communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate;
  - (E) create and use representations to organize, record, and communicate mathematical ideas;
  - (F) analyze mathematical relationships to connect and communicate mathematical ideas; and
  - (G) display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication.
- (3) The student applies design skills to manufacturing. The student is expected to:
- (A) use computer-aided design (CAD) software to complete a design;
  - (B) analyze the results of product testing in a simulated modeling environment;
  - (C) fabricate a prototype design of a mechanical part; and
  - (D) use computer-integrated manufacturing techniques to simulate a manufacturing process.
- (4) The student performs functions and solves problems in the electricity and electronics field. The student is expected to:
- (A) develop solutions to use control devices; and
  - (B) troubleshoot control devices such as programmable logic circuit devices.
- (5) The student learns skills in production and programming of computer numerical control (CNC) operations. The student is expected to:
- (A) design a project using computer-aided manufacturing (CAM) software for a CNC lathe;
  - (B) produce a product on a CNC lathe or simulator;
  - (C) design a project using CAM software for a CNC mill;
  - (D) produce a product on a CNC mill or simulator; and
  - (E) complete data sheets for plan, do, check, and act forms and projects.
- (6) The student demonstrates an understanding of mechanical and fluid systems. The student is expected to:
- (A) use mechanical devices;
  - (B) use pneumatics devices; and

- (C) use hydraulics devices.
- (7) The student demonstrates an understanding of electrical and thermal systems. The student is expected to:
  - (A) use electrical controls;
  - (B) analyze the effects of heat energy and temperature on products; and
  - (C) develop an understanding of ventilation such as heating, air conditioning, and refrigeration.
- (8) The student analyzes quality-control systems. The student is expected to:
  - (A) apply statistical process control;
  - (B) determine hardness values of different materials; and
  - (C) analyze attribute and Pareto charts.
- (9) The student develops a system using electrical controls and pneumatics or hydraulics devices. The student is expected to:
  - (A) design a system that incorporates electrical controls and either a pneumatic or hydraulic device;
  - (B) build a system that incorporates electrical controls and either a pneumatic or hydraulic device; and
  - (C) test and troubleshoot the system that incorporates electrical controls and either a pneumatic or hydraulic device.

**§130.357. Metal Fabrication and Machining I (Two Credits), Adopted 2015.**

- (a) General requirements. This course is recommended for students in Grades 10-12. Recommended prerequisite: Algebra I or Geometry. Students shall be awarded two credits for successful completion of this course.
- (b) Introduction.
  - (1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
  - (2) The Manufacturing Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.
  - (3) Metal Fabrication and Machining I provides the knowledge, skills, and certifications required for equal employment opportunities in the metal production industry. Students must have opportunities to reinforce, apply, and transfer knowledge and skills to a variety of settings and problems.
  - (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
  - (5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.
- (c) Knowledge and skills.
  - (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:

- (A) demonstrate skills related to health and safety in the workplace as specified by appropriate government regulations;
  - (B) use teamwork to solve problems; and
  - (C) demonstrate the standards required in the workplace such as interviewing skills, flexibility, willingness to learn new skills and acquire knowledge, self-discipline, positive attitude, and integrity in a work situation.
- (2) The student applies academic skills to the requirements of metal manufacturing. The student is expected to:
- (A) demonstrate effective oral and written communication skills with individuals from varied cultures, including fellow workers, management, and customers;
  - (B) interpret engineering drawings, charts, diagrams, and welding symbols; and
  - (C) select algebraic and geometric principles and formulas required for precision measuring operations.
- (3) The student differentiates the technical concepts that form the knowledge and skills of metal manufacturing. The student is expected to:
- (A) analyze the resources found in *The Machinery's Handbook* as well as the specifications and codes written by the American Welding Society (AWS), Canadian Welding Bureau (CWB), American National Standards Institute (ANSI), and American Petroleum Institute (API);
  - (B) examine the theory of shielded metal arc welding and gas metal arc welding;
  - (C) examine the sheet metal industry; and
  - (D) examine the nomenclature of abrasive wheels.
- (4) The student differentiates the function and application of the tools, equipment, technologies, and materials used in metal manufacturing. The student is expected to:
- (A) use hand and power tools and equipment commonly employed in metal manufacturing; and
  - (B) dispose of environmentally hazardous materials used in metal manufacturing.
- (5) The student applies the technical concepts and skills of the machining industry to simulated and actual work situations. The student is expected to:
- (A) use various work mounting procedures on all appropriate machines;
  - (B) operate machine tools such as drill press, lathe, saw, grinders, and milling machines;
  - (C) execute lathe procedures such as cutting threads, turning tapers, drilling, reaming, polishing, knurling, and boring; and
  - (D) execute milling procedures such as milling flat surfaces, bevels, chamfers, grooves, and key-way seats needed to machine precision pieces.
- (6) The student applies the technical concepts and skills of the welding industry to simulated and actual work situations. The student is expected to:
- (A) perform cutting processes such as straight cuts, bevel cuts, and hole piercing with oxy-fuel and plasma;
  - (B) use the common types of electrodes with the shield metal arc welding process;
  - (C) practice using gas metal arc welding to weld in multiple positions to produce groove and fillet welds; and
  - (D) inspect groove and fillet welds to AWS, CWB, ANSI, and API codes.

- (7) The student applies the technical concepts and skills of the sheet metal industry to simulate actual work situations. The student is expected to:
  - (A) use mathematics in precision measuring operations; and
  - (B) interpret, engineering drawings, charts, and diagrams as related to the sheet metal industry.
- (8) The student differentiates the concepts that form the technical knowledge and skills of sheet metal manufacturing. The student is expected to:
  - (A) analyze the types, sizes, and properties of sheet metal materials;
  - (B) analyze the fundamentals of oxy-fuel processes as related to sheet metal; and
  - (C) analyze the fundamentals of shielded metal arc welding and gas metal arc welding as related to sheet metal under various AWS codes.
- (9) The student understands the function and application of the tools, equipment, technologies, and materials used in sheet metal manufacturing. The student is expected to:
  - (A) practice safe use of equipment; and
  - (B) dispose of hazardous materials used in sheet metal manufacturing.
- (10) The student applies the knowledge and skills of sheet metal manufacturing in simulated and actual work situations. The student is expected to:
  - (A) draw simple metal layouts; and
  - (B) construct common sheet metal seams.

**§130.358. Metal Fabrication and Machining II (Two Credits), Adopted 2015.**

- (a) General requirements. This course is recommended for students in Grades 11 and 12. Prerequisite: Metal Fabrication and Machining I. Recommended prerequisites: Geometry and Algebra II. Students shall be awarded two credits upon successful completion of this course.
- (b) Introduction.
  - (1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
  - (2) The Manufacturing Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.
  - (3) Metal Fabrication and Machining II builds on the knowledge, skills, and certifications students acquire in Metal Fabrication and Machining I. Students will develop advanced concepts and skills as related to personal and career development. This course integrates academic and technical knowledge and skills. Students will have opportunities to reinforce, apply, and transfer knowledge and skills to a variety of settings and problems.
  - (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
  - (5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.
- (c) Knowledge and skills.
  - (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:

- (A) determine advanced knowledge and skills required to gain industry-recognized certifications;
- (B) identify employers' work expectations;
- (C) demonstrate the standards required in the workplace such as interviewing skills, flexibility, willingness to learn new skills and acquire knowledge, self-discipline, positive attitude, promptness, attendance, and integrity in a work situation;
- (D) evaluate personal career goals;
- (E) communicate effectively with others in the workplace to clarify objectives; and
- (F) demonstrate skills related to health and safety in the workplace as specified by the Occupational Safety and Health Administration and other appropriate agencies.
- (2) The student describes the importance of teamwork, leadership, integrity, honesty, work habits, and organizational skills. The student is expected to:
  - (A) use teamwork to solve problems;
  - (B) distinguish among team roles such as team leaders and team members;
  - (C) discuss Equal Employment Opportunity law in the workplace; and
  - (D) use time-management techniques to develop work schedules.
- (3) The student applies advanced academic skills to the requirements of metal fabrication and machining. The student is expected to:
  - (A) demonstrate effective communication skills with individuals from varied cultures such as fellow workers, management, and customers;
  - (B) successfully complete work orders;
  - (C) estimate labor costs using various algebraic formulas;
  - (D) interpret advanced engineering drawings, charts, diagrams, and welding symbols; and
  - (E) demonstrate calculation of precision measuring operations using algebra, geometry, and trigonometry.
- (4) The student knows the advanced concepts that form the technical knowledge and skills of metal fabrication and machining. The student is expected to:
  - (A) analyze the resources found in various manufacturing reference materials;
  - (B) demonstrate knowledge of the various welding processes;
  - (C) examine the sheet metal industry; and
  - (D) examine the advanced use of abrasives.
- (5) The student knows the function and application of the tools, equipment, technologies, and materials used in metal fabrication and machining. The student is expected to:
  - (A) operate various welding machines, cutting equipment, and grinding equipment commonly employed in metal fabrication;
  - (B) demonstrate knowledge of computer numerical control (CNC) machines;
  - (C) demonstrate knowledge of the concepts of automated welding machines;
  - (D) demonstrate knowledge of emerging technologies that may affect metal manufacturing; and
  - (E) dispose of environmentally hazardous materials associated with and used in metal fabrication manufacturing.

- (6) The student applies the advanced concepts and technical knowledge and skills of the machining industry to simulated and actual work situations. The student is expected to:
- (A) use various work mounting procedures on appropriate machines;
  - (B) examine the cutting operations such as drill press, lathe, saw, grinders, and milling machines;
  - (C) execute lathe procedures such as cut threads, turn tapers, drills, reams, polishes, knurls, and bores;
  - (D) mill flat surfaces, bevels, chamfers, grooves, and key-seats; and
  - (E) machine precision pieces.
- (7) The student applies the advanced concepts and technical knowledge and skills of the welding industry to simulated and actual work situations. The student is expected to:
- (A) demonstrate cutting processes such as oxy-fuel and plasma;
  - (B) demonstrate the use of the common types of electrodes using the shielded metal arc welding process;
  - (C) use shielded metal arc welding, gas metal arc welding, and gas tungsten arc welding to weld fillet and groove welds using various positions; and
  - (D) inspect welds to the American Welding Society (AWS), Canadian Welding Bureau (CWB), American National Standards Institute (ANSI), and American Petroleum Institute (API) codes.
- (8) The student applies the advanced concepts and technical knowledge and skills of the sheet metal industry to simulated and actual work situations. The student is expected to:
- (A) estimate labor costs;
  - (B) use advanced mathematics in precision measuring operations; and
  - (C) interpret industrial standard blueprints, drawings, charts, and diagrams.
- (9) The student knows the advanced concepts and technical knowledge and skills of sheet metal manufacturing. The student is expected to:
- (A) analyze properties of sheet metal materials and fasteners;
  - (B) analyze oxy-fuel processes as related to sheet metal; and
  - (C) demonstrate knowledge of shielded metal arc welding, gas metal arc welding, and gas tungsten arc welding as related to sheet metal under AWS code.
- (10) The student knows the function and application of the tools, equipment, technologies, and materials used in sheet metal. The student is expected to:
- (A) use equipment commonly employed in sheet metal safely;
  - (B) dispose of environmentally hazardous materials used in sheet metal manufacturing properly; and
  - (C) demonstrate knowledge of emerging technologies that may affect sheet metal.
- (11) The student applies the advanced concepts and technical skills in simulated and actual work situations. The student is expected to:
- (A) draw advanced sheet metal layouts;
  - (B) construct sheet metal seams;
  - (C) construct transitions and offsets;
  - (D) use the gas tungsten arc welding process in sheet metal construction;

- (E) apply the principles of sheet metal construction to the fabrication of various sheet metal products; and
- (F) apply skills in sheet metal to career preparation learning experiences.

**§130.359. Precision Metal Manufacturing I (Two Credits), Adopted 2015.**

- (a) General requirements. This course is recommended for students in Grades 10-12. Recommended prerequisite: Principles of Manufacturing and completion of or concurrent enrollment in Algebra I or Geometry. Students shall be awarded two credits upon successful completion of this course.
- (b) Introduction.
  - (1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
  - (2) The Manufacturing Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.
  - (3) Precision Metal Manufacturing I will provide the knowledge, skills, and technologies required for employment in precision machining. While the course is designed to provide necessary skills in machining, it also provides a real-world foundation for any engineering discipline. This course may address a variety of materials such as plastics, ceramics, and wood in addition to metal. Students will develop knowledge of the concepts and skills related to precision metal manufacturing to apply them to personal and career development. This course supports integration of academic and technical knowledge and skills. Students will have opportunities to reinforce, apply, and transfer knowledge and skills to a variety of settings and problems. Knowledge about career opportunities, requirements, and expectations and the development of workplace skills prepare students for success. This course is designed to provide entry-level employment for the student or articulated credit integration into a community college and dual credit with a community college with completion of the advanced course.
  - (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
  - (5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.
- (c) Knowledge and skills.
  - (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:
    - (A) express ideas to others in a clear, concise, and effective manner through written and verbal communication;
    - (B) convey written information that is easily understandable to others;
    - (C) demonstrate acceptable work ethics in reporting for duty and performing assigned tasks as directed;
    - (D) conduct oneself in a manner acceptable for the profession and work site such as suitable dress and polite speech;
    - (E) choose the ethical course of action and comply with all applicable rules, laws, and regulations;
    - (F) review the fine, detailed aspects of both quantitative and qualitative work process and end products;



- (G) evaluate systems and operations; identify causes, problems, patterns, or issues; and explore workable solutions or remedies to improve situations;
  - (H) follow written and oral instructions and adhere to established business practices, policies, and procedures, including health and safety rules; and
  - (I) prioritize tasks, follow schedules, and work toward goal-relevant activities in an effective, efficient manner.
- (2) The student explores the employability characteristics of a successful worker in the global economy. The student is expected to:
  - (A) determine academic knowledge and skills required for postsecondary education;
  - (B) identify employers' expectations to foster positive customer satisfaction;
  - (C) demonstrate the professional standards required in the workplace such as interviewing skills, flexibility, willingness to learn new skills and acquire knowledge, self-discipline, self-worth, positive attitude, and integrity in a work situation;
  - (D) evaluate personal career goals;
  - (E) communicate effectively with others in the workplace to clarify objectives; and
  - (F) demonstrate skills related to health and safety in the workplace as specified by appropriate government regulations.
- (3) The student applies advanced academic skills to the requirements of precision metal manufacturing. The student is expected to:
  - (A) demonstrate technical writing skills related to writing requirements found in manufacturing;
  - (B) demonstrate mathematical skills such as algebra, geometry, trigonometry, statics, and conversion as applied to machining;
  - (C) interpret engineering drawings, including drawings using geometric dimensioning and tolerancing;
  - (D) describe orthographic and isometric views of three-dimensional figures;
  - (E) evaluate mathematics as it applies to precision machining operations; and
  - (F) discuss basic concepts of physics as applied to machining.
- (4) The student recognizes the concepts and skills that form the technical knowledge required in precision machining. The student is expected to:
  - (A) examine the resources found in recognized manufacturing reference materials such as *The Machinery's Handbook*; and
  - (B) demonstrate knowledge of the uses of reference charts such as tap drill charts, drill size charts, and feed-speed charts.
- (5) The student evaluates the function and application of the tools, equipment, technologies, and materials used in precision machining. The student is expected to:
  - (A) practice safety while running equipment commonly employed in machine shops;
  - (B) identify and properly dispose of environmentally hazardous materials used in machine shops;
  - (C) demonstrate knowledge of computer numerical control (CNC) operations;
  - (D) demonstrate knowledge of emerging technologies that may affect the machine shop;
  - (E) demonstrate knowledge of heating metals such as hardening, tempering, annealing, normalizing, and case hardening steel;

- (F) apply technical knowledge and skills in a machine shop to career preparation experiences;
  - (G) identify basic metallic and non-metallic materials; and
  - (H) compare various abrasives for type, structure, bond, and use.
- (6) The student employs skills necessary to perform bench work and layout. The student is expected to:
  - (A) use equipment commonly employed in bench work and layout in a safe manner;
  - (B) develop the ability to use a file to cut flats, angles, and radiuses;
  - (C) employ standard layout tools to transfer a part design to the actual part;
  - (D) perform center punching and hand drilling of holes using an electric or air hand drill;
  - (E) perform hand tapping of holes;
  - (F) perform hand reaming of holes using an electric or air hand drill;
  - (G) develop a detailed layout part such as the National Institute for Metalworking Skills (NIMS) Level 1 layout part;
  - (H) develop a detailed bench work part such as the NIMS Level 1 bench work part; and
  - (I) employ basic housekeeping skills as applied to a machine shop.
- (7) The student employs skills necessary to perform precision measurement. The student is expected to:
  - (A) use equipment commonly used during precision measurement in a safe manner;
  - (B) write an inspection plan;
  - (C) identify and select the required measuring instrument(s) to conduct the required inspection procedure(s); and
  - (D) describe statistical process control.
- (8) The student employs skills necessary to perform manual lathe work. The student is expected to:
  - (A) use in a safe manner equipment such as accessories commonly implemented on and around a lathe;
  - (B) analyze the advantages and disadvantages between a four-jaw independent chuck, a three-jaw universal chuck, and a collet workholding system;
  - (C) indicate a part in a four-jaw independent chuck within .003" total indicated runout (TIR) using a standard indicator;
  - (D) identify and describe the function of the components of a lathe;
  - (E) identify and use most accessories and tooling for turning operations;
  - (F) demonstrate the standard turning operations of boring, chamfering, cutting tapers, drilling, facing, grooving, knurling, polishing, threading, and turning on a manual lathe;
  - (G) write a detailed process plan for turning, including appropriate processes such as feeds, speeds, tool selection, and sequencing;
  - (H) develop a detailed turning part such as the NIMS Level 1 turning, chucking or turning between centers part; and
  - (I) employ basic preventative maintenance on the lathe.
- (9) The student employs skills necessary to perform manual milling work. The student is expected to:
  - (A) use equipment commonly used with a milling machine in a safe manner;

- (B) analyze the advantages and disadvantages of various work holding methods such as using a vise, clamping to a table, and clamping to an angle plate;
- (C) contrast the various ancillary tools used on milling machines such as a rotary table, indexing head, and super spacer;
- (D) identify or describe the function of the components of a milling machine;
- (E) tram in the head of a vertical milling machine;
- (F) indicate in a milling vise employing a dial indicator;
- (G) develop a square block in the milling machine to close tolerances;
- (H) demonstrate various hole-making activities such as spot drilling, drilling, reaming, tapping, countersinking, and boring on the milling machine;
- (I) demonstrate various milling activities such as climb milling, conventional milling, slotting, grooving, cutting angles, and chamfering;
- (J) write a detailed process plan, including appropriate feeds, speeds, tool selection, work holding methods, and sequencing for milling;
- (K) develop a detailed milling part such as the NIMS Level 1 milling part; and
- (L) employ basic preventative maintenance on the milling machine.
- (10) The student employs skills necessary to perform work on various support equipment commonly found in a machine shop. The student is expected to:
  - (A) use various support equipment commonly found in a machine shop in a safe manner;
  - (B) understand basic pedestal grinder functions such as wheel selection criteria and requirements;
  - (C) understand basic sawing functions such as band type, speed, and feeds for various types of material;
  - (D) understand basic drill press operations, including work holding, appropriate speeds, and feeds; and
  - (E) use proper, safe procedures for surface grinding operations.

**§130.360. Precision Metal Manufacturing II (Two Credits), Adopted 2015.**

- (a) General requirements. This course is recommended for students in Grades 11 and 12. Prerequisite: Precision Metal Manufacturing I. Recommended corequisite: Precision Metal Manufacturing II Lab. Students shall be awarded two credits upon successful completion of this course.
- (b) Introduction.
  - (1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
  - (2) The Manufacturing Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.
  - (3) Precision Metal Manufacturing II will provide students the knowledge, skills, and technologies required for employment in precision machining. While this course is designed to provide necessary skills in machining, it also provides a real-world foundation for any engineering discipline. This course addresses a variety of materials such as plastics, ceramics, and wood in addition to metal. Students will develop knowledge of the concepts and skills related to these systems to apply them to personal and career development. This course supports integration of

academic and technical knowledge and skills. Students will have opportunities to reinforce, apply, and transfer knowledge and skills to a variety of settings and problems. Knowledge about career opportunities, requirements, and expectations and the development of workplace skills prepare students for success. This course is designed to provide entry-level employment for the student or articulated credit integration into a community college and dual credit with a community college with completion of the advanced course.

- (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
- (5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(c) Knowledge and skills.

- (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:
  - (A) express ideas to others in a clear, concise, and effective manner through written and verbal communication;
  - (B) convey written information that is easily understandable to others;
  - (C) demonstrate acceptable work ethics in reporting for duty and performing assigned tasks as directed;
  - (D) conduct oneself in a manner acceptable for the profession and work site such as suitable dress and polite speech;
  - (E) comply with all applicable rules, laws, and regulations;
  - (F) review with a critical eye the fine, detailed aspects of both quantitative and qualitative work process and end products;
  - (G) evaluate systems and operations; identify causes, problems, patterns, or issues; and explore workable solutions or remedies to improve situations;
  - (H) follow written and oral instructions and adhere to established business practices, policies, and procedures, including health and safety rules; and
  - (I) prioritize tasks, follow schedules, and tend to goal-relevant activities in a way that uses time in an effective, efficient manner.
- (2) The student explores the employability characteristics of a successful worker in the global economy. The student is expected to:
  - (A) determine academic knowledge and skills required for postsecondary education;
  - (B) identify employers' expectations to foster positive customer satisfaction;
  - (C) demonstrate the standards required in the workplace such as interviewing skills, flexibility, willingness to learn new skills and acquire knowledge, self-discipline, self-worth, positive attitude, and integrity in a work situation;
  - (D) evaluate progress toward personal career goals;
  - (E) communicate effectively with others in the workplace to clarify objectives; and
  - (F) demonstrate skills related to health and safety in the workplace as specified by appropriate government regulations.
- (3) The student applies the technical knowledge and skills of advanced precision metal manufacturing. The student is expected to:
  - (A) apply the technical aspects found in *The Machinery's Handbook* resource; and
  - (B) select appropriate resources from the Internet as applied to manufacturing.

- (4) The student builds on the manual machining skills gained in Precision Metal Manufacturing I. The student is expected to:
- (A) develop a detailed turning part such as the National Institute for Metalworking Skills (NIMS) Level 1 turning, chucking, or turning between centers part with zero defects (100% to the print) in a safe manner; and
  - (B) develop a detailed milling part such as the NIMS Level 1 milling part with zero defects (100% to the print) in a safe manner.
- (5) The student learns about standard computer numerical control (CNC) machinery. The student is expected to:
- (A) research the history of numerical control machines;
  - (B) distinguish among different types of CNC machines used in the industry;
  - (C) demonstrate safety rules for CNC operation;
  - (D) demonstrate the methods by which programs can be entered into a controller; and
  - (E) use appropriate machining terminology to enhance CNC vocabulary.
- (6) The student appraises various CNC systems to differentiate the development and implementation of those systems. The student is expected to:
- (A) examine the types of drive motors used on CNC machinery;
  - (B) explain the Cartesian coordinate system;
  - (C) differentiate between absolute and incremental positioning; and
  - (D) illustrate the difference between datum and delta dimensioning.
- (7) The student learns the process planning and tool selection within a CNC lab environment. The student is expected to:
- (A) develop a detailed process plan, including proper tool selection, feeds, and speeds, for the material being cut and finish specifications on the engineering drawing, logical sequence of operations, and appropriate inspection points;
  - (B) develop a logical sequence of operations and appropriate inspection points;
  - (C) demonstrate use of carbide inserts; and
  - (D) apply various carbide inserts by determining the correct type, grade, style, feed, and speed for the most common materials machined in a basic machine shop.
- (8) The student evaluates tool changing and tool offset registers in the CNC lab environment. The student is expected to:
- (A) perform various types of tool changes;
  - (B) demonstrate quick change tooling used on CNC milling machines;
  - (C) demonstrate appropriate tool storage;
  - (D) demonstrate the proper use of tool offset registers;
  - (E) determine tool offset length; and
  - (F) incorporate tool offsets for a set up.
- (9) The student operates a CNC lathe. The student is expected to:
- (A) use equipment commonly associated with a CNC lathe in a safe manner;
  - (B) recognize, name, and describe the function of the primary components of a CNC lathe;

- (C) perform preventative maintenance checks on a CNC lathe such as checking all fluid levels, system pressure, tooling wear, and component lubrication and cleaning;
  - (D) test the coolant for proper density and adjust accordingly in order to reach the correct mixture;
  - (E) perform a power up on a standard CNC lathe;
  - (F) demonstrate the use of the jog controls on the operator panel to jog the lathe's axes;
  - (G) demonstrate the ability to locate, assemble, and measure tooling according to work instructions and job documentation;
  - (H) install tools and tool holders in the automatic tool changer locations according to work instructions and job documentation;
  - (I) locate and set workpiece zero on a CNC lathe;
  - (J) set any required work offsets for the part to be machined after a basic tool setting process has been completed;
  - (K) set the proper geometry/tool offsets for each tool in a standard tool setting process;
  - (L) operate a CNC lathe in automatic mode; and
  - (M) illustrate the proper power down process on a CNC lathe.
- (10) The student operates a CNC mill. The student is expected to:
- (A) use equipment commonly found on and around a CNC mill in a safe manner;
  - (B) recognize, name, and describe the function of the primary components of a CNC mill;
  - (C) perform preventative maintenance checks on a CNC mill such as checking all fluid levels, system pressure, tooling wear, and component lubrication and cleaning;
  - (D) test the coolant for proper density and adjust accordingly in order to reach the correct mixture;
  - (E) perform a power up on a standard CNC mill;
  - (F) demonstrate the use of the jog controls on the operator panel to jog the mill's axes;
  - (G) demonstrate the ability to locate, assemble, and measure tooling using a presetter or other means according to work instructions and job documentation;
  - (H) install tools and tool holders in the automatic tool changer locations according to work instructions and job documentation;
  - (I) locate and set workpiece zero on a CNC mill;
  - (J) set any required work offsets for the part to be machined after a basic tool setting process has been completed;
  - (K) set the proper geometry/tool offsets for each tool in a standard tool-setting process;
  - (L) operate a CNC mill in automatic mode; and
  - (M) illustrate the proper power down process on a CNC mill.
- (11) The student learns to manually program a CNC lathe without the help of computer-aided design or manufacturing (CAD/CAM) software. The student is expected to:
- (A) calculate trigonometry to determine coordinates from technical drawings to cut arcs and angles;
  - (B) use trigonometry for determining cutter offsets;
  - (C) use appropriate mathematical skills to solve problems while programming a CNC lathe;

- (D) write a simple program to face and turn;
  - (E) write a simple program to cut radiuses, angles, grooves, and threads;
  - (F) write a program using cutter radius compensation;
  - (G) write a program using canned cycles such as G71; and
  - (H) write a program and produce a complex part such as a NIMS Level 1 CNC lathe part with zero defects.
- (12) The student learns to manually program a CNC mill (without the help of CAD/CAM software). The student is expected to:
- (A) use trigonometry to determine coordinates from technical drawings to cut arcs and angles;
  - (B) use trigonometry for determining cutter offsets;
  - (C) use appropriate mathematical skills to solve problems while programming a CNC lathe;
  - (D) write a simple program to perform hole operations;
  - (E) write a simple program to cut radiuses and angles;
  - (F) write a program using cutter radius compensation and ramping; and
  - (G) write a program and produce a complex part such as a NIMS Level 1 CNC milling part with zero defects.
- (13) The student develops a deeper understanding of quality control. The student is expected to:
- (A) evaluate engineering drawings using geometric dimensioning and tolerancing;
  - (B) discuss the American Society of Mechanical Engineers (ASME) Y14.5M standard that defines geometric dimensioning and tolerancing; and
  - (C) appraise various quality control/management programs.

**§130.361. Precision Metal Manufacturing II Lab (One Credit), Adopted 2015.**

- (a) General requirements. This lab course is recommended for students in Grades 11 and 12. Prerequisite: Precision Metal Manufacturing I. Recommended corequisite: Precision Metal Manufacturing II. Districts are encouraged to offer this lab in a consecutive block with Precision Metal Manufacturing II to allow students sufficient time to master the content of both courses. Students shall be awarded one credit for successful completion of this course.
- (b) Introduction.
  - (1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
  - (2) The Manufacturing Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.
  - (3) Precision Metal Manufacturing II Lab provides the knowledge, skills, and technologies required for employment in precision machining. While Precision Metal Manufacturing II Lab is designed to provide necessary skills in machining, it also provides a real-world foundation for any engineering discipline. This course may address a variety of materials such as plastics, ceramics, and wood in addition to metal. Students will develop knowledge of the concepts and skills related to these systems to apply them to personal and career development. This course supports integration of academic and technical knowledge and skills. Students will have opportunities to reinforce, apply, and transfer knowledge and skills to a variety of settings and problems.

Knowledge about career opportunities, requirements, and expectations and the development of workplace skills prepare students for success. This course is designed to provide entry-level employment for the student or articulated credit integration into a community college and dual credit with a community college with completion of the advanced course.

- (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
- (5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(c) Knowledge and skills.

- (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:
  - (A) express ideas to others in a clear, concise, and effective manner through written and verbal communication;
  - (B) convey written information that is easily understandable to others;
  - (C) demonstrate acceptable work ethics in reporting for duty and performing assigned tasks as directed;
  - (D) conduct oneself in a manner acceptable for the profession and work site such as suitable dress and polite speech;
  - (E) choose the ethical course of action and comply with all applicable rules, laws, and regulations;
  - (F) review with a critical eye the fine, detailed aspects of both quantitative and qualitative work process and end products;
  - (G) evaluate systems and operations; identify causes, problems, patterns, or issues; and explore workable solutions or remedies to improve situations;
  - (H) follow written and oral instructions and adhere to established business practices, policies, and procedures, including health and safety rules; and
  - (I) prioritize tasks, follow schedules, and work on goal-relevant activities in a way that uses time wisely in an effective, efficient manner.
- (2) The student builds on the manual machining skills gained in Precision Metal Manufacturing I. The student is expected to:
  - (A) develop a detailed turning part such as the National Institute for Metalworking Skills (NIMS) Level 1 turning, chucking, or turning between centers part with zero defects (100% to the print) in a safe manner; and
  - (B) develop a detailed milling part such as the NIMS Level 1 milling part with zero defects (100% to the print) in a safe manner.
- (3) The student evaluates tool changing and tool offset registers in a computer numerical control (CNC) lab environment. The student is expected to:
  - (A) perform various types of tool changes;
  - (B) demonstrate quick change tooling used on CNC milling machines;
  - (C) demonstrate appropriate tool storage;
  - (D) demonstrate the proper use of tool offset registers;
  - (E) determine tool offset length; and
  - (F) enter tool offsets for a set up.



- (4) The student operates a CNC lathe. The student is expected to:
- (A) use equipment commonly found on and around a CNC lathe in a safe manner;
  - (B) recognize, name, and describe the function of the primary components of a CNC lathe;
  - (C) perform preventative maintenance checks on a CNC lathe such as checking all fluid levels, system pressure, tooling wear, and component lubrication and cleaning;
  - (D) test the coolant for proper density and adjust accordingly in order to reach the correct mixture;
  - (E) perform a power up on a standard CNC lathe;
  - (F) demonstrate the use of the jog controls on the operator panel to jog the lathe's axes;
  - (G) demonstrate the ability to locate, assemble, and measure tooling according to work instructions and job documentation;
  - (H) install tools and tool holders in the automatic tool changer locations according to work instructions and job documentation;
  - (I) locate and set workpiece zero on a CNC lathe;
  - (J) set any required work offsets for the part to be machined after a basic tool setting process has been completed;
  - (K) set the proper geometry/tool offsets for each tool in a standard tool setting process;
  - (L) operate a CNC lathe in automatic mode; and
  - (M) illustrate the proper power down process on a CNC lathe.
- (5) The student operates a CNC mill. The student is expected to:
- (A) use equipment commonly found on and around a CNC mill in a safe manner;
  - (B) recognize, name, and describe the function of the primary components of a CNC mill;
  - (C) perform preventative maintenance checks on a CNC mill such as checking all fluid levels, system pressure, tooling wear, and component lubrication and cleaning;
  - (D) test the coolant for proper density and adjust accordingly in order to reach the correct mixture;
  - (E) perform a power up on a standard CNC mill;
  - (F) demonstrate the use of the jog controls on the operator panel to jog the mill's axes;
  - (G) demonstrate the ability to locate, assemble, and measure tooling using a presetter or other means according to work instructions and job documentation;
  - (H) install tools and tool holders in the automatic tool changer locations according to work instructions and job documentation;
  - (I) locate and set workpiece zero on a CNC mill;
  - (J) set any required work offsets for the part to be machined after a basic tool setting process has been completed;
  - (K) set the proper geometry/tool offsets for each tool in a standard tool setting process;
  - (L) operate a CNC mill in automatic mode; and
  - (M) illustrate the proper power down process on a CNC mill.
- (6) The student learns to manually program a CNC lathe without the help of computer-aided design or manufacturing (CAD/CAM) software. The student is expected to:

- (A) use trigonometry to determine coordinates from technical drawings to cut arcs and angles;
  - (B) use trigonometry for determining cutter offsets;
  - (C) use appropriate mathematical skills to solve problems while programming a CNC lathe;
  - (D) write a simple program to face and turn;
  - (E) write a simple program to cut radiuses, angles, grooves, and threads;
  - (F) write a program using cutter radius compensation;
  - (G) write a program using canned cycles such as G71; and
  - (H) write a program and produce a complex part such as a NIMS Level 1 CNC lathe part with zero defects.
- (7) The student learns to manually program a CNC mill (without the help of CAD/CAM software). The student is expected to:
- (A) use trigonometry to determine coordinates from technical drawings to cut arcs and angles;
  - (B) use trigonometry to determine cutter offsets;
  - (C) use appropriate mathematical skills to solve problems while programming a CNC lathe;
  - (D) write a simple program to perform hole operations;
  - (E) write a simple program to cut radiuses and angles;
  - (F) write a program using cutter radius compensation and ramping; and
  - (G) write a program and produce a complex part such as a NIMS Level 1 CNC milling part with zero defects.

**§130.366. Practicum in Manufacturing (Two to Three Credits), Adopted 2015.**

- (a) General requirements. This course is recommended for students in Grade 12. The practicum course is a paid or unpaid capstone experience for students participating in a coherent sequence of career and technical education courses in the Manufacturing Career Cluster.
  - (1) A student shall be awarded two credits for successful completion of this course when the student participates in at least an average of 10 hours, but less than 15 hours, per week of a paid or unpaid, laboratory- or work-based application of previously studied knowledge and skills related to the Manufacturing Career Cluster.
  - (2) A student shall be awarded three credits for successful completion of this course when the student participates in an average of 15 hours per week of a paid or unpaid, laboratory- or work-based application of previously studied knowledge and skills related to the Manufacturing Career Cluster.
- (b) Introduction.
  - (1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
  - (2) The Manufacturing Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.

- (3) The Practicum in Manufacturing course is designed to give students supervised practical application of previously studied knowledge and skills. Practicum experiences can occur in a variety of locations appropriate to the nature and level of experience.
  - (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
  - (5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.
- (c) Knowledge and skills.
- (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:
    - (A) identify and apply the employer's standard operating procedures;
    - (B) demonstrate positive work behaviors such as attitudes, punctuality, time management, initiative, and cooperation;
    - (C) communicate appropriately and accept constructive criticism;
    - (D) research and discuss business ethics;
    - (E) complete tasks such as quality products and services with the highest standards;
    - (F) model professional appearance such as dress, grooming, and personal protective equipment as appropriate; and
    - (G) comply with safety rules such as regulations to maintain safe working conditions and environments appropriate to the work setting.
  - (2) The student applies concepts of critical thinking and problem solving. The student is expected to:
    - (A) analyze elements of a problem;
    - (B) analyze information critically to determine its value; and
    - (C) conduct technical research to gather information for decision making.
  - (3) The student demonstrates leadership and teamwork skills in collaborating with others to accomplish goals and objectives. The student is expected to:
    - (A) analyze leadership characteristics such as trust, positive attitude, integrity, and willingness to accept key responsibilities in a work situation;
    - (B) demonstrate teamwork skills through working cooperatively with others to achieve tasks;
    - (C) demonstrate teamwork processes such as promoting team building, consensus, continuous improvement, respect for the opinions of others, cooperation, adaptability, and conflict resolution;
    - (D) demonstrate responsibility for organization tasks such as shared group and individual work tasks; and
    - (E) establish and maintain effective working relationships.
  - (4) The student demonstrates oral and written communication skills. The student is expected to:
    - (A) demonstrate the use of content such as technical concepts and vocabulary;
    - (B) employ verbal skills when obtaining and conveying information;
    - (C) use informational texts such as Internet websites and technical materials for occupational tasks;
    - (D) evaluate the reliability of information such as Internet websites, technical materials, and resources;

- (E) interpret verbal and nonverbal cues and behaviors to enhance communication;
  - (F) apply active listening skills such as obtaining and clarifying the information; and
  - (G) use academic skills such as effective written and oral communication.
- (5) The student demonstrates technical knowledge and skills required to pursue a career in the manufacturing cluster. The student is expected to:
  - (A) use information literacy skills such as accessing, evaluating, and disseminating information;
  - (B) describe information management;
  - (C) maintain records to facilitate ongoing business operations;
  - (D) develop goals;
  - (E) prioritize tasks;
  - (F) develop timelines using time-management skills;
  - (G) use project-management skills to improve workflow;
  - (H) evaluate proficiencies in technical skills; and
  - (I) accept critical feedback provided by the supervisor.
- (6) The student documents technical knowledge and skills using a professional portfolio. The student is expected to:
  - (A) demonstrate growth of technical skill competencies;
  - (B) earn licensures or certifications;
  - (C) develop an abstract of key points of the practicum;
  - (D) create a job-skills resume;
  - (E) collect representative work samples;
  - (F) maintain copies of evaluations from the practicum supervisor and/or industrial representative; and
  - (G) present the portfolio to all interested stakeholders.