Maryland CTE Program of Study

**Manufacturing Engineering Technology – National Institute of Metalworking Skills Program Proposal**

**Maryland State Department of Education**

Division of Career and College Readiness

200 West Baltimore Street

Baltimore, Maryland 21201-2595

This agreement is between the Division of Career and College Readiness (DCCR), Maryland State Department of Education (MSDE), and the local school system listed below.

**LOCAL SCHOOL SYSTEM INFORMATION –** Complete the information requested below, including the original signature of the CTE Local Director.

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| Local School System (LSS) and Code: | | | | | | | | |  | | | | | | | |
| Name of CTE Local Director: | | | | | | |  | | | | | Phone: | | |  | |
| LSS Career Cluster: | | | | |  | | | | | | | | | | | |
| LSS Program Title: | | |  | | | | | | | | | | | | | |
| Pathway Options: | 1. Manual Machining Operations | | | | | | | | | 1. CNC Programming and Operations | | | 1. Manual Machining/ CNC Programming and Operations | | | |
| Value Added Options: | | yes  no | | | | This program provides students the opportunity to earn early college credit. The academic and technical course sequences for both secondary and postsecondary programs are included herein. | | | | | | | | | | |
| yes  no | | | | Enclosed is a copy of the articulation agreement (Copy required for CTE program approval if the program is articulated with a postsecondary education provider). | | | | | | | | | | |
| yes  no | | | | This program provides students with the opportunity to earn an industry-recognized credential. The credential is identified herein. | | | | | | | | | | |
| Program Start Date: | | | |  | | | | | | |  | | |  | | |
| Signature of CTE Local Director: | | | | | | | |  | | | | | | Date: | |  |
| Signature of Local Superintendent: | | | | | | | |  | | | | | | Date: | |  |

**TO BE COMPLETED BY MSDE/DCCR**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Date Program Proposal received by CTE Systems Branch: | | | |  | | | | |
| CTE Control Number: | |  | | | Fiscal Year: | |  | |
| CIP Number: | Program: **15.0650** | | Pathway  Option 1: | | | Pathway  Option 2: | | Pathway  Option 3: |
| MSDE Cluster Title: | |  | | | | | | |

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| **Approval Starts FY: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |  |  | | |
|  |  |  | | |
| Signature, Assistant State Superintendent, Career and College Readiness | | |  | Date |

**CTE Secondary Program Proposal Contents**

**STEP 1A: PROGRAM ADVISORY COMMITTEE MEMBERS AND THEIR AFFILIATIONS**

Complete the list of the Program Advisory Committee (PAC) members. Members should include employers, local workforce development representatives, economic development personnel, business, or labor representatives, and the remainder should include secondary and postsecondary, academic and technical educators and other stakeholders. Place a check in the appropriate box to indicate the role each person plays. Include all of the information requested for each entry. Use this form or a locally developed form – either one is acceptable as long as all information is provided.

# Program Advisory Committee List

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Membership: First entry should be the industry representative who is leading the PAC.** | | | | | | | | |
| PAC Leader Name: | |  | | | | Representation: | | |
| Title: | |  | | | | Industry  Secondary  Postsecondary | | |
| Affiliation: | |  | | | | | | |
| Address1: | |  | | | | | | |
| Address2: | |  | | | | | | |
| City, State, Zip: | |  | | State: | |  | Zip |  |
| Phone: | |  | | Fax: | |  | | |
| Email: | |  | | | | | | |
| Area of Expertise: | |  | | | | | | |
| Role: | Work-based Learning  Curriculum Development  Skills Standards Validation  Staff Development | | | | | | | |
| Program Development | | Other (specify): | |  | | | |

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| Name: | |  | | | | Representation: | | |
| Title: | |  | | | | Industry  Secondary  Postsecondary | | |
| Affiliation: | |  | | | | | | |
| Address1: | |  | | | | | | |
| Address2: | |  | | | | | | |
| City, State, Zip: | |  | | State: | |  | Zip |  |
| Phone: | |  | | Fax: | |  | | |
| Email: | |  | | | | | | |
| Area of Expertise: | |  | | | | | | |
| Role: | Work-based Learning  Curriculum Development  Skills Standards Validation  Staff Development | | | | | | | |
| Program Development | | Other (specify): | |  | | | |

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| Name: | |  | | | | Representation: | | |
| Title: | |  | | | | Industry  Secondary  Postsecondary | | |
| Affiliation: | |  | | | | | | |
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| Address2: | |  | | | | | | |
| City, State, Zip: | |  | | State: | |  | Zip |  |
| Phone: | |  | | Fax: | |  | | |
| Email: | |  | | | | | | |
| Area of Expertise: | |  | | | | | | |
| Role: | Work-based Learning  Curriculum Development  Skills Standards Validation  Staff Development | | | | | | | |
| Program Development | | Other (specify): | |  | | | |

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| Name: | |  | | | | Representation: | | |
| Title: | |  | | | | Industry  Secondary  Postsecondary | | |
| Affiliation: | |  | | | | | | |
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| Address2: | |  | | | | | | |
| City, State, Zip: | |  | | State: | |  | Zip |  |
| Phone: | |  | | Fax: | |  | | |
| Email: | |  | | | | | | |
| Area of Expertise: | |  | | | | | | |
| Role: | Work-based Learning  Curriculum Development  Skills Standards Validation  Staff Development | | | | | | | |
| Program Development | | Other (specify): | |  | | | |

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| Name: | |  | | | | Representation: | | |
| Title: | |  | | | | Industry  Secondary  Postsecondary | | |
| Affiliation: | |  | | | | | | |
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| Address2: | |  | | | | | | |
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| Email: | |  | | | | | | |
| Area of Expertise: | |  | | | | | | |
| Role: | Work-based Learning  Curriculum Development  Skills Standards Validation  Staff Development | | | | | | | |
| Program Development | | Other (specify): | |  | | | |

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| Name: | |  | | | | Representation: | | |
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| Phone: | |  | | Fax: | |  | | |
| Email: | |  | | | | | | |
| Area of Expertise: | |  | | | | | | |
| Role: | Work-based Learning  Curriculum Development  Skills Standards Validation  Staff Development | | | | | | | |
| Program Development | | Other (specify): | |  | | | |

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| Name: | |  | | | | Representation: | | |
| Title: | |  | | | | Industry  Secondary  Postsecondary | | |
| Affiliation: | |  | | | | | | |
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| Address2: | |  | | | | | | |
| City, State, Zip: | |  | | State: | |  | Zip |  |
| Phone: | |  | | Fax: | |  | | |
| Email: | |  | | | | | | |
| Area of Expertise: | |  | | | | | | |
| Role: | Work-based Learning  Curriculum Development  Skills Standards Validation  Staff Development | | | | | | | |
| Program Development | | Other (specify): | |  | | | |

**STEP 1B: DOCUMENTED LABOR MARKET DEMAND** – Check the appropriate box below.

⌧ Demand exists

The PAC will review labor market information on a local, regional and/or state basis. Check this box if demand exists for the identified occupations. The labor market information does not need to be provided with the proposal as long as there is a demand for employees according to data provided by the Department of Labor, Licensing and Regulation (DLLR) or documented by employers in letters or other correspondence.

If evidence for labor market demand is not readily available, attach documentation to the proposal. Check this box if there is a unique labor market demand for a program and data are not available from the DLLR. If the occupation is new or emerging and no data exist, supporting evidence is submitted with the proposal (i.e., document local, national, or regional trends, local circumstances, or provide letters from employers or local economic/workforce development offices documenting employment demand including the projected number of openings by pathway).

**STEP 2A: PROGRAM OVERVIEW** – After determining the cluster and pathway options, identify the standards used to develop the CTE program of study. Describe the program to be developed in detail based on what students are expected to know and be able to demonstrate as a result of participating in the program

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| **Indicate the title and source of the skills standards for this program: National Institute of Metalworking Skills (NIMS) Credentials** for Machining Level I Certification: *Measurement, Materials and Safety*; *Job Planning, Benchwork, and Layout*; Manual Milling; Manual Turning Between Centers; Manual Turning with Chucking; Manual Surface Grinding; Manual Drill Press Operations; CNC Turning: Programming Set-up & Operations; CNC Milling: Programming Set-up & Operations. |
| **Program Overview:** This program prepares students for a beginning career in manufacturing and machine technologies and aligns to the National Institute of Metalworking Skills (NIMS) Machining Level I Credentials. Students will progress through a program that includes hands-on education in precision machining while developing competency in process control, manual operations, process adjustment, part inspection as well as demonstrate usage of machine safety. School systems looking to implement MET-NIMS CTE program of study must complete the NIMS accreditation process. This includes the identification of four credentialing areas – two required by NIMS and two selected by the school system. Additional information about the process may be found on the NIMS website: [www.nims-skills.org/--](http://www.nims-skills.org/--) click on credentialing. Where available, students can advance their understanding of manufacturing concepts through the use of ToolingU, a self-paced, online learning management system for manufacturing education that supports the NIMS certification.  There are three program pathway options in this program of study. Each pathway consists of two courses with the Principles of Competitive Manufacturing serving as the foundation course for all three pathways:   * Principles of Competitive Manufacturing (2 credits) **and** * Manual Machining Operations (2 credits) **or** * Computer Numerically Controlled (CNC) Programming and Operations (2 credits) **or** * Manual Machining/CNC Programming and Operations (2 credits)   **End-of-Course Assessments and Certification**  The first course, Principles of Competitive Manufacturing, prepares students to take exams for the required NIMS credentialing areas: *Measurement, Materials and Safety* and *Job Planning, Benchwork, and Layout*. School systems then identify two additional credentialing areas. The two areas may be in Manual Machining Operations Pathway, the CNC Programming and Operations Pathway or one from each.   |  |  |  | | --- | --- | --- | | **Option 1:** **Machining Operations (select two)** | **Option 2: CNC Programming and Operations (select two)** | **Option 3:** **Machining/CNC Programming and Operations (select two)** | | * Manual Milling, * Turning Operations Between Centers, * Turning with Chucking, * Grinding, and * Drilling Operations | * CNC Turning Operations * CNC Turning: Programming Set-up & Operations, * CNC Milling Operations, and * CNC Milling: Programming Set-up & Operations | * Choose one credentialing area from Option 1 and from Option 2. * Schools systems must indicate on the program proposal the two areas. |   The assessments are standards-based—meaning they are drawn from the NIMS national metalworking standards.  Both performance and theory assessments are developed by the industry and piloted in the industry. The NIMS credentials are awarded on satisfactory completion of both performance tests and related theory exams. The performance will be the manufacturing of a part, the set-up and operation of a machine or the writing of a program that will manufacture a specific part. The theory test is an online exam and has a $40.00 fee at the time of registration. Additional information can be found on the NIMS website; click the tab labeled, “credentialing.”  **Accreditation**  Although it is not necessary for programs that prepare students for the NIMS certifications to be NIMS accredited, schools that are considering accreditation should be aware of the following program requirements:  Accreditation involves a three-step process: registration of the program with NIMS, the completion of a self-study analysis and an on-site audit. There are also credentialing requirements.   1. The Self-Study - Candidate programs rate themselves against NIMS quality measures in the areas of administrative support, instructional quality and capacity, curriculum, equipment and tooling, advisory council roles, safety and the integration of the national standards. 2. The On-Site Audit - A three -person team comprised of industry and education personnel conduct an on-site review,  verifying the self-study report and documentation. The team interviews administrative and corporate personnel, instructors, students/workers, advisory council members and industry leaders. The team also inspects the facility and equipment and analyzes safety practices. 3. Credentials -Instructors must earn NIMS credentials in the modules that they instruct. Students/workers must have earned credentials in the modules for which accreditation is sought. These requirements are prior to accreditation.   The accreditation is for a five-year period and may be renewed subject to further review and audit as part of continuous improvement.  Students enrolled in this program are expected to:   * Understand the role of machining in society; * Identify and safely use the major hand tools in the process of manufacturing/machining; * Discuss potential careers and the workplace skills needed in modern manufacturing/machining; * Understand English and Metric measurement systems, and perform conversions between the two; * Demonstrate quality assurance, process planning and quality control in the machining process; * Demonstrate the process of layout in machining operations;   Depending on the credentialing area, students are expected to:   * Safely perform machining operations on the lathe; * Safely perform drill press operations; * Demonstrate vertical milling using indexing and rotary table operations; * Safely perform machining operations on the vertical mill; * Perform surface grinding operations; and * Use a computer numerical control (CNC) machine to manufacture a product. |

**STEP 2B: COURSE DESCRIPTIONS AND END OF COURSE ASSESSMENTS – Insert each CTE completer course title. Describe each course based on what students are expected to know and be able to demonstrate as a result of their participation. Check the assessment instrument(s) that will be used to document student attainment of the knowledge and skills included in each course and specify additional information as appropriate.**

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| **Course Title:** Principles of Competitive Manufacturing (2 credits)  **Course Description:** This course is designed to prepare students for the required initial NIMS certification in: *Measurement, Materials and Safety* and *Job Planning, Benchwork and Layout.* Students will be introduced to the fundamental concepts and professional standards of the machining industry, including safety, precision measurement, milling, grinding, industry equipment as well as the vocabulary and terminology of the profession. This course includes in-class activities and lab activities. In-class activities include lectures, discussions, student presentations, and research. Lab activities include completing designated procedures by working in teams with industrial tools. During lab activities students will apply knowledge obtained from in-class discussions and readings to further advance their understanding of manufacturing and machine technologies. Team projects are based on real-world scenarios and include group exercises that supplement students’ development of their technical skills and knowledge. Where available, students will use the ToolingU online learning management system to supplement their classroom instruction. Upon completion of this course, students are expected to:  *Measurement, Materials and Safety*   * Discuss potential careers and the workplace skills (personal and technical) needed in modern manufacturing/machining; * Understand English and Metric measurement systems and perform conversions between the two; * Appropriately apply algebra, geometry and/or trigonometry to precision machining; * Understand the role of machining in society; * Demonstrate the use of machine safety and personal protective equipment; * Identify and safely use the major hand tools in the process of manufacturing/machining; * Demonstrate and document lock-out and tag-out procedures as well as OSHA and NIOSH guidelines; * Handle and store hazardous materials while adhering to safe practices in accordance with OSHA and EPA requirements; * Develop an inspection plan and compliance report as well as inspect simple parts using precision tools and techniques; * Use a sampling plan to enter and graph data in response to warning conditions identified within a process chart; * Analyze the performance of a single-part production process, making adjustments or improvements where appropriate; * Analyze the performance of a production process, while working as a member of a process team, make adjustments or improvements where appropriate; * Differentiate between tasks that require semi-precision measurement and precision measurement and accurately use the tools needed for precision measurement; * Demonstrate quality assurance, process planning and quality control in the machining process, including: material selection, machine selection, tooling selection, speed and feed calculation, sampling plan, inspection plan and statistical process control; and * Perform routine maintenance processes, such as lubrication, maintenance inspection points and cutting fluids.   *Job Planning, Benchwork and Layout*   * Read and develop technical drawings, including understanding types of tolerances as well as determining classes of fit; * Use semi-precision and precision layout tools to perform layout procedures within a given tolerance; * Layout the location of hole centers and surfaces within an accuracy of +/- 0.015 inch; * Produce a part with holes prepared for hand tapping, for press fit of a bushing (reamed), and a stud for tapped holes; * Finish a part, which includes deburring the part, hand drill and hand tap holes, press a bushing, and install a stud; * Perform sawing to a layout while choosing and mounting appropriate blades; * Develop a process plan and operation sheet which outlines the required speeds and feeds for a part which requires milling, drilling, turning or grinding; * Identify and safely use the hand tools that are common to the machining/manufacturing process; and * Perform benchwork drilling, threading, tapping and reaming operations;   **End of Course Assessment:** Check the assessment instruments that will be used to document student attainment of the course knowledge and skills.  Teacher-designed end-of-course assessment  School system-designed end-of-course assessment  Partner-developed exam: (specify)  Licensing exam: (specify)  Certification or credentialing exam: (specify)  Nationally recognized examination: (specify) NIMS Machining Level I Exams for: *Measurement, Materials and Safety* and *Job*  *Planning, Benchwork and Layout* |
| **Course Title:** Machining Operations (2 credits)  **Course Description:** This course is designed to prepare students for two credentialing areas in the Machining Operations pathway. School systems and schools identify two areas from the following NIMS Machining Level I credentials:   * + Manual Milling,   + Turning Operations Between Centers,   + Turning with Chucking,   + Grinding, and   + Drilling Operations   Students increase the knowledge and skills they gained in the Principles of Competitive Manufacturing by performing basic process planning, set-up, and operation of common classes of machine tools such as turning, milling, drilling, or surface grinding machines. Students work cooperatively with others and contribute to work efforts with ideas, suggestions, and feedback to improve the process, resolve a problem or improvise a new method. They follow basic quality assurance responsibilities for both single and multiple part production including statistical process control, and they are competent in all safety procedures for all machining operations and material handling and disposal. Students read and comprehend information on orthographic prints and job process sheets for routine manufacturing operations, and where available, they will use the ToolingU online learning management system to supplement their classroom instruction. Upon completion of this course, students are expected to:  Manual Milling   * Set-up and carry out milling operations which require the selection of appropriate tools, toolholding devices and workholding devices; * Perform squaring up the six surfaces of a block to within +/- 0.002 inch and 0.002 inch over 4.5 inches squareness; * Produce a part matching a process plan and the print specifications; * Produce a part which requires squaring up stock from its raw state; * Set-up and operate vertical milling machines and identify essential components, their functions and basic machine adjustment; * Perform routine milling, and location of hole centers to within +/- 0.005 inch; * Produce a part which requires a milled slot, drilled and reamed holes within +/- 0.005 inch and have three steps controlled by tolerances of +/- 0.005 inch; and * Safely perform indexing and rotary table operations.   Turning Operations Between Centers   * Set-up and carry out center operations for turning and identify essential components, their functions and basic machine adjustments; * Perform centers turning operations for straight turning; * Produce a part matching a process plan and the print specifications using appropriate trade techniques and speeds and feeds; * Produce a part which requires a UNC external thread, UNF external thread, and an end-for-end swap. * Demonstrate basic knowledge of the types of fits and be able to reference the *Machinery’s Handbook* to determine the size of each component; * Use measurement tools such as a micrometer and dial indicator to evaluate tolerance; and * Demonstrate basic knowledge of process control techniques, such as inspection sheets, Pareto charts, capability studies and statistical process control using the X bar / R charts.   Turning with Chucking   * Set-up and carry out chucking operations for turning and identify essential components, their functions and basic machine adjustments; * Perform chucking operations for turning; * Produce a part matching a process plan and the print specifications using appropriate trade techniques and speeds and feeds; * Produce a part which requires bores, UNC external thread and chucking or other workholding set-up; * Demonstrate basic knowledge of the types of fits and be able to reference the *Machinery’s Handbook* to determine the size of each component; * Use measurement tools such as a micrometer and dial indicator to evaluate tolerance; and * Demonstrate basic knowledge of process control techniques, such as inspection sheets, Pareto charts, capability studies and statistical process control using the X bar / R charts.   Grinding   * Set-up grinding wheels in preparation for surface grinding, including performing a ring test and visual safety inspection; * Demonstrate knowledge of the grinding wheel code and the standard wheel marking system; * Demonstrate knowledge of balancing, mounting and dressing the grinding wheel; * Identify and safely use grinders that are used to perform precision grinding operations; * Perform routine surface grinding, location of surfaces, and squaring of surfaces; and * Produce a part which requires the precision finishing of the six faces of the block to tolerances common to precision grinding for squareness, size, and surface finish characteristics.   Drilling Operations   * Set-up and operate drill presses and perform routine drill press operations; * Use the appropriate tools, toolholding devices and workholding devices to safely operate a drill press; * Produce a part matching a given process plan and blueprint specifications; * Finish a part which requires reaming, spot facing, countersinking, counterboring, and counterdrilling; * Finish a part which requires producing a blind hole, a through hole and a hole that is power tapped; * Demonstrate knowledge of threads to properly set-up a workpiece and cutting tool for threading; and * Choose measurement instruments dependent upon the tolerance range for a specific dimension.   **End of Course Assessment**  Check the assessment instruments that will be used to document student attainment of the course knowledge and skills.  Teacher-designed end-of-course assessment  School system-designed end-of-course assessment  Partner-developed exam: (specify)  Licensing exam: (specify)  Certification or credentialing exam: (specify)  Nationally recognized examination: (specify) NIMS Machining Level I (select two)  NIMS Machining Level I - Manual Milling  NIMS Machining Level I - Turning Operations Between Centers  NIMS Machining Level I - Turning with Chucking  NIMS Machining Level I - Grinding  NIMS Machining Level I - Drill Press Operation |
| **Course Title:** CNC Programming and Operations (2credits)  Course Description: This course is designed to prepare students for two credentialing areas in the CNC Programming and Operations pathway. School systems and schools identify two areas from the following NIMS Machining Level I credentials:   * + CNC Turning Operations,   + CNC Turning: Programming Set-up & Operations,   + CNC Milling Operations, and   + CNC Milling: Programming Set-up & Operations   Students increase the knowledge and skills they gained in the Principles of Competitive Manufacturing by performing CNC turning and milling functions including programming and set-up operations. Students work cooperatively with others and contribute to work efforts with ideas, suggestions, and feedback to improve the process, resolve a problem or improvise a new method. They follow basic quality assurance responsibilities for both single and multiple part production including statistical process control, and they are competent in all safety procedures for CNC machining operations and material handling and disposal. Students read and comprehend information on orthographic prints and job process sheets for computerized manufacturing operations, and where available, they will use the ToolingU online learning management system to supplement their classroom instruction. Upon completion of this course, students are expected to:  CNC Turning Operations   * Create a qualified CNC program, set-up and operate a CNC lathe, change tool values as necessary, replace and qualify tooling as necessary; * Demonstrate knowledge and functions of basic G and M codes; * Identify coordinates on a blueprint with respect to origin; * Calculate and implement speeds and feeds for proper tool life and surface finish; * Write a program using the appropriate format for a particular machine control, and work from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc.; * Install and qualify the required tool for the program; * Mount, locate and set the origin of the work piece on a CNC lathe; * Load a program, create a DNC-link, or enter a program via control keyboard into a CNC lathe control; and * Safely execute a program for its first run (debugging).   CNC Turning: Programming Set-up & Operations   * Use the principles of Cartesian coordinates to develop a program for the manufacturing of a simple part; * Apply the principles of three-dimensional coordinate planes in the development a simple program for the production of the part on a CNC lathe or CNC turning center; * Demonstrate knowledge and functions of basic G and M codes; * Identify coordinates on a blueprint with respect to origin; * Implement linear interpolation into a program to cut straight lines between two points; * Implement circular interpolation into a program to cut true arcs and circles, using I and J (arc vector), and R (radium value) methods; and * Write a program using the appropriate format for a particular machine control, and work from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc.   CNC Milling Operations   * Create a qualified CNC program, set-up and operate a CNC mill, change tool values as necessary, replace and qualify tooling as necessary; * Demonstrate knowledge and functions of basic G and M codes; * Identify coordinates on a blueprint with respect to origin; * Calculate and implement speeds and feeds for proper tool life and surface finish; * Write a program using the appropriate format for a particular machine control, and work from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc.; * Install and qualify the required tool for the program; * Mount, locate and set the origin of the work piece on a CNC milling machine; * Load a program, create a DNC-link, or enter a program via control keyboard into a CNC milling machine control; and * Safely execute a program for its first run (debugging).   CNC Milling: Programming Set-up & Operations   * Use the principles of Cartesian coordinates to develop a program for the manufacturing of a simple part; * Apply the principles of three-dimensional coordinate planes in the development a simple program for the production of the part on a CNC milling machine; * Demonstrate knowledge and functions of basic G and M codes; * Identify coordinates on a blueprint with respect to origin; * Implement linear interpolation into a program to cut straight lines between two points; * Implement circular interpolation into a program to cut true arcs and circles, using I and J (arc vector), and R (radium value) methods; and * Write a program using the appropriate format for a particular machine control, and work from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc.   **End of Course Assessment**  Check the assessment instruments that will be used to document student attainment of the course knowledge and skills.  Teacher-designed end-of-course assessment  School system-designed end-of-course assessment  Partner-developed exam: (specify)  Licensing exam: (specify)  Certification or credentialing exam: (specify)  Nationally recognized examination: (specify) NIMS Machining Level I (select two)  NIMS Machining Level I - CNC Turning Operations  NIMS Machining Level I - CNC Turning: Programming Set-up & Operations  NIMS Machining Level I - CNC Milling Operations  NIMS Machining Level I - CNC Milling: Programming Set-up & Operations |
| **Course Title:** Manual Machining/CNC Programming and Operations (2 credits)  **Course Description:**  This pathway options allows school systems to choose one credentialing area from the Manual Machining Operations pathway and one from the CNC Programming and Operations pathway.  **If choosing this pathway option, copy and paste the selected credentialing areas from the above pathway descriptions— please see the following example.**  **End of Course Assessment**  Check the assessment instruments that will be used to document student attainment of the course knowledge and skills.  Teacher-designed end-of-course assessment  School system-designed end-of-course assessment  Partner-developed exam: (specify)  Licensing exam: (specify)  Certification or credentialing exam: (specify)  Nationally recognized examination: (specify) NIMS Machining Level I (select two)  NIMS Machining Level I - Manual Milling  NIMS Machining Level I - Turning Operations Between Centers  NIMS Machining Level I - Turning with Chucking  NIMS Machining Level I - Grinding  NIMS Machining Level I - Drill Press Operation  NIMS Machining Level I - CNC Turning Operations  NIMS Machining Level I - CNC Turning: Programming Set-up & Operations  NIMS Machining Level I - CNC Milling Operations  NIMS Machining Level I - CNC Milling: Programming Set-up & Operations |
| **EXAMPLE**  **Course Title:** Manual Machining/CNC Programming and Operations (2 credits)  **Course Description:** This pathway options allows school systems to choose one credentialing area from the Manual Machining Operations pathway and one from the CNC Programming and Operations pathway. The credentialing areas selected for this pathway are: Manual Milling and CNC Milling Operations. Upon completion of this course, students are expected to:  Manual Milling   * Set-up and carry out milling operations which require the selection of appropriate tools, toolholding devices and workholding devices; * Perform squaring up the six surfaces of a block to within +/- 0.002 inch and 0.002 inch over 4.5 inches squareness; * Produce a part matching a process plan and the print specifications using appropriate trade techniques and speeds and feeds; * Produce a part which requires squaring up stock from its raw state; * Set-up and operate vertical milling machines and identify essential components, their functions and basic machine adjustment; * Perform routine milling, and location of hole centers to within +/- 0.005 inch; * Produce a part which requires a milled slot, drilled and reamed holes within +/- 0.005 inch and have three steps controlled by tolerances of +/- 0.005 inch; and * Safely perform indexing and rotary table operations.   CNC Milling Operations   * Create a qualified CNC program, set-up and operate a CNC mill, change tool values as necessary, replace and qualify tooling as necessary; * Demonstrate knowledge and functions of basic G and M codes; * Identify coordinates on a blueprint with respect to origin; * Calculate and implement speeds and feeds for proper tool life and surface finish; * Write a program using the appropriate format for a particular machine control, and work from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc.; * Install and qualify the required tool for the program; * Mount, locate and set the origin of the work piece on a CNC milling machine; * Load a program, create a DNC-link, or enter a program via control keyboard into a CNC milling machine control; and * Safely execute a program for its first run (debugging).   **End of Course Assessment**  **Check the assessment instruments that will be used to document student attainment of the course knowledge and skills.**  Teacher-designed end-of-course assessment  School system-designed end-of-course assessment  Partner-developed exam: (specify)  Licensing exam: (specify)  Certification or credentialing exam: (specify)  Nationally recognized examination: (specify) NIMS Machining Level I (select two)  NIMS Machining Level I - Manual Milling  NIMS Machining Level I - Turning Operations Between Centers  NIMS Machining Level I - Turning with Chucking  NIMS Machining Level I - Grinding  NIMS Machining Level I - Drill Press Operation  NIMS Machining Level I - CNC Turning Operations  NIMS Machining Level I - CNC Turning: Programming Set-up & Operations  NIMS Machining Level I - CNC Milling Operations  NIMS Machining Level I - CNC Milling: Programming Set-up & Operations |

**STEP 2C: END-OF-PROGRAM ASSESSMENT** - Check the assessment instruments that will be used to document student attainment of the program knowledge and skills. Include and identify assessments leading to industry recognized credentials if available and appropriate.

Teacher-designed end-of-program assessment

School system-designed end-of-program assessment

Partner-developed exam: (specify)

Licensing exam: (specify)

Certification or credentialing exam: (specify)

Nationally recognized examination: (specify)

Certification or credentialing exam: **NIMS Machining Level I**

Measurement, Materials and Safety

Job Planning, Benchwork and Layout

Manual Milling Skills I

Turning Operations: Turning Between Centers

Turning Operations: Turning Chucking Skills

Grinding Skills I

Drill Press Skills I

CNC Turning: Programming Set-up and Operations

CNC Milling: Programming Set-up and Operations

CNC Turning: Operations

CNC Milling: Operations

**STEP 2D: Program Sequence Matrix (Include the program sequences for High School, Associate’s Degree, and Bachelor’s Degree programs) Identify the pathway options. Complete the matrix for the 9-12 CTE program of study, and the articulated program sequence in the matrix for the two- or four-year college program of study. Indicate which courses receive CTE credit by placing the number of credits in parentheses after each CTE course title. Place an asterisk (\*) next to the course identified as the concentrator course indicating that the student has completed 50% of the program**.

The CTE program matrix defines a planned, sequential program of study that consists of a minimum of four credits in CTE coursework in high school including work-based learning and/or industry-mentored projects. Work-based learning (WBL) experiences or industry-mentored projects must be included in the program to obtain approval. The program matrix includes the recommended academic and CTE courses identified for the pathway and postsecondary linkages (i.e., dual enrollment, transcripted and articulated credit).

CTE programs typically begin after ninth grade and do not include career exploration courses. Courses such as computer applications and keyboarding are not included in the completer sequence because they provide prerequisite skills for both academic courses and CTE programs. Academic courses are counted only if they are tailored to serve mainly CTE students and have been revised to reflect industry skill standards. Technology Education or Advanced Technology Education and Personal Financial Literacy courses are not acceptable for credit in the career and technology education program sequence.

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| **The LSS program title should be the same one that appears on the cover page. If more than one pathway option is offered in the program, complete a matrix for each program option (MSDE will insert the CIP number). Example: An Academy of Information Technology program may include options in web design & programming.** | | | | | | | | |
| **Pathway/Program:** | | Manual Machining Operations, CNC Programming and Operations or Manual Machining/ CNC Programming and Operations | | | | | **CIP Number  (For MSDE Use)** | **15.0650** |
| **Graduation Requirements** | | **Grade 9** | **Grade 10** | | | **Grade 11** | | **Grade 12** |
| English - 4 | | English 9 | English 10 | | | English 11 | | English 12 |
| Social Studies - 3 | | US Government | World History | | | US History | | Government and Economics |
| Mathematics - 3 | | Algebra 1 | Geometry | | | Algebra 2 | | Trigonometry or Pre-calculus |
| Science - 3 | | Physical Science | Biology | | | Chemistry | | Physics |
| Physical Education -.5  Health Education - .5 | | Physical Education (.5) | Health (.5) | | |  | |  |
| Fine Arts - 1 | | Fine Arts (.5) | Fine Arts (.5) | | |  | |  |
| Technology Education - 1 | | Foundations of Technology |  | | |  | |  |
| CTE Completer Program – 4  \*concentrator course | |  |  | | | Principles of Competitive Manufacturing (2 credits) | | Manual Machining Operations (2 credits)  **or**  CNC Programming and Operations (2 credits)  **or**  Manual Machining/ CNC Programming and Operations (2 credits) |
| Foreign Language - 2 and/or Advanced Tech Ed - 2 | | Foreign Language | Foreign Language | | |  | |  |
| **Provide a list of examples of careers students are preparing to enter and postsecondary options:**  Machinist, Production Operator, Quality Control Technician, or Manufacturing Engineering Technologist | | | | | | | | |
| **Two Year College Program Sequence – Program Overview**  **Many local school systems provide postsecondary matrices in their program of study guides to inform students, parents, and counselors of the opportunities available to those enrolled in the program. Section 2E must be completed before an articulated CTE program of study can be approved. *A copy of the Articulation Agreement is also required to be submitted with the proposal prior to program approval.***  **Describe the program to be developed in detail based on what students are expected to know and be able to demonstrate as a result of participating in the program.** | | | | | | | | | |
| **Program Title: Engineering Technology: Manufacturing, AAS**  **College/Institution: College of Southern Maryland** | | | | | | | | | |
| **Recommended Sequence – Complete the program matrix for the postsecondary sequence for the articulated CTE program of study. Indicate which courses receive articulated or transcripted credit by PLACING THE NUMBER OF CREDITS IN PARENTHESES after each course title.** | | | | | | | | | |
| **Semester 1** | | | | **Semester 2** | | | | | |
| EGT 1015  ENG 1010  ITS 1015 ***MFT 1010***  MTH 1120 | Exploring Engineering Technology (3)\*  Composition and Rhetoric (3)\*  The Information Age: Emerging Technologies (3) ***Manufacturing Technology I (3)***  College Algebra (3)\* or higher | | | ENG 2050 ***MFT 1020*** MFT 2010 MTH 1120  GEN ED | Business and Technical Writing (3)\*  ***CAD/CAM Drawing Designs in Manufacturing (3)\****  Manufacturing Technology II (3) \*  College Algebra (3)\* or higher Social/behavioral sciences (3) | | | | |
| **Semester 3** | | | | **Semester 4** | | | | | |
| EGT 1300 ELT 1015 MFT 1120 ***MFT 1160***  GEN ED | Basic Mechanics (3)\*  Basic Electronics (4)\*  CAD/CAM: Drawing Designs in Manufacturing (3)\*  ***Computer Numerical Controls (3)\**** Arts/humanities (3) | | | CHE 1200 CHE 1200L EGT 2910 PHY 1010 PHY 1010L  GEN ED | General Chemistry I (3) \* and  General Chemistry I Lab (1) \*  Cooperative Education I: Engineering Technology (3) \*  Fundamentals of Physics I (3) \*  Fundamentals of Physics I - Lab (1) \* Communication (3) | | | | |
| **Provide a list of career options for students who complete the program:** | | | | | | | | | |

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| **Two Year College Program Sequence – Program Overview**  **Many local school systems provide postsecondary matrices in their program of study guides to inform students, parents, and counselors of the opportunities available to those enrolled in the program. Section 2E must be completed before an articulated CTE program of study can be approved. *A copy of the Articulation Agreement is also required to be submitted with the proposal prior to program approval.***  **Describe the program to be developed in detail based on what students are expected to know and be able to demonstrate as a result of participating in the program.** | | | |
| **Program Title: Manual Machinist Certificate**  **College/Institution: Community College of Baltimore County** | | | |
| **Recommended Sequence – Complete the program matrix for the postsecondary sequence for the articulated CTE program of study. Indicate which courses receive articulated or transcripted credit by PLACING THE NUMBER OF CREDITS IN PARENTHESES after each course title.** | | | |
| **Semester 1** | | **Semester 2** | |
| ***CAMM 111***  EMET 105  CAMM 142  CAM 251 | ***Machine Tool Process (4)***  Technical Blueprints and Schematics (3)  Principles of Manufacturing (3)  Measuring and Gauging (3) | ***CAMM 112***  ***CAM 152***  ***CAMM 161***  CAMM 156 | ***Machine Tool Processes II (4)***  ***Turning Technology (3)***  ***Milling Machine Operations (3)***  Geometric Dimensioning and Tolerancing (3) |
| **Provide a list of career options for students who complete the program:** | | | |

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| **Two Year College Program Sequence – Program Overview**  **Many local school systems provide postsecondary matrices in their program of study guides to inform students, parents, and counselors of the opportunities available to those enrolled in the program. Section 2E must be completed before an articulated CTE program of study can be approved. *A copy of the Articulation Agreement is also required to be submitted with the proposal prior to program approval.***  **Describe the program to be developed in detail based on what students are expected to know and be able to demonstrate as a result of participating in the program.** | | | |
| **Program Title: CNC Machinist Certificate**  **College/Institution: Community College of Baltimore County** | | | |
| **Recommended Sequence – Complete the program matrix for the postsecondary sequence for the articulated CTE program of study. Indicate which courses receive articulated or transcripted credit by PLACING THE NUMBER OF CREDITS IN PARENTHESES after each course title.** | | | |
| **Semester 1** | | **Semester 2** | |
| ***CAMM 111***  EMET 105  CAMM 142  CAMM 101  or  CAMM 102 | ***Machine Tool Process (4)***  Technical Blueprints and Schematics (3)  Principles of Manufacturing (3)  Introduction to CADD (3)  Intermediate AutoCAD (3) | ***CAMM 112***  CAMM 101  CAMM 156  CAMM 251 | ***Machine Tool Processes II (4)***  Numerically Controlled Machines (3)  Geometric Dimensioning and Tolerancing (3)  Measuring and Gauging (3) |
| **Semester 3** | | | |
| CAMM 201  CAMM 206  ***CAMM 252***  ***CAMM 253*** | CNC Programming (3)  CNC Specialization Programming (3)  ***CNC Milling Machine Operation (3)***  ***CNC Lathe Operation (3)*** | | |
| **Provide a list of career options for students who complete the program:** | | | |

STEP 2E: VALUE-ADDED OPTIONS – Fill in the name of the partnering college or agency. Specify the credential that students will earn. Under value-added, indicate the number of credits or hours granted. This information is required before a program can be designated as a CTE articulated program of study.

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| **Option** | **Partner** | **Credential** | **Value added for CTE completers** |
| Dual Enrollment |  |  |  |
| Transcripted Credit |  |  |  |
| Articulated Credit | College of Southern Maryland |  | Up to 9 Credits |
| Community College of BaltimoreCounty | Up to 12 Credits |
| Wor-Wic Community College | Pending |
| Credit by Exam |  |  |  |
| Advanced Placement |  |  |  |
| Apprenticeship Approved by MATC\* |  |  |  |
| Certification(s) | National Institute of Metalworking Skills (NIMS) |  | NIMS Machining Level I |
| License |  |  |  |
| Degree |  |  |  |
| Other (specify) |  |  |  |

\*MD Apprenticeship and Training Council

**STEP 2F: INDUSTRY-MENTORED PROJECT OR WORK-BASED LEARNING OPPORTUNITIES  
Check each box that applies.**

PAC members and other industry partners provide supervised WBL experiences and/or industry-mentored projects for all students who demonstrate performance of the competencies necessary to enter into this phase of the program. Supervised work-based learning experiences are required for all students demonstrating readiness to participate. For the few who do not participate, alternative capstone experiences should be provided (i.e., in school work experiences, a culminating project, or another experience comparable in rigor). Each type of work-based learning is defined in the glossary. Job shadowing is **not** acceptable for credit in a CTE program.

1.  Integrated WBL 2.  Capstone WBL 3.  Registered Apprenticeship  
4.  Internship 5.  Industry-Mentored Project 6.  In-school clinic or school-based enterprise

**STEP 2G: STUDENT ORGANIZATIONS PROVIDED TO STUDENTS IN THE PROGRAM – Check each box that applies or specify if “Other” is selected.**

Students will develop and apply technical and academic skills, as well as Skills for Success, through participation in:

DECA  FFA  SkillsUSA  FBLA  OTHER (specify)

STEP 3: COMPLETE THE INSTRUCTIONAL PROGRAM DATA SHEET

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Local School System (LSS) and Code: | | |  | | | |
| Name of CTE Local Director: | |  | | Phone: |  | |
| LSS Program Title: |  | | | | CIP Code: |  |

*STEP 3.1 – DATA SHEET: PATHWAY OPTIONS*

|  |  |
| --- | --- |
| **1.** | **Manual Machining Operations** |
| **2.** | **CNC Programming and Operations** |
| **3.** | **Manual Machining/CNC Programming and Operations** |
| **.** |  |

*STEP 3.2 – DATA SHEET: INSTRUCTIONAL PROGRAM CREDIT BY GRADE(S)*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Credits per year per pathway option as reflected by Course Sequences** | **9** | **10** | **11** | **12** | **TOTAL** |
| 1. **Manual Machining Operations** |  |  | **2** | **2** | **4** |
| 1. **CNC Programming and Operations** |  |  | **2** | **2** | **4** |
| 1. **Manual Machining/CNC Programming and Operations** |  |  | **2** | **2** | **4** |
|  |  |  |  |  |  |

**Total number of credits for program completion:   4**

*STEP 3.3 – DATA SHEET: CAREER AND TECHNOLOGY EDUCATION PROGRAM SITES*

|  |  |  |
| --- | --- | --- |
| **Pathway Options** | **School Name(s) Sites** | **School Number** |
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