Maryland CTE Program of Study

## Project Lead The Way (PLTW) Pre-Engineering Program Proposal Form

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.

|  |  |
| --- | --- |
| Local School System (LSS) and Code: |  |
| Name of CTE Local Director: |  | Phone: |  |
| LSS Career Cluster: |  |
| LSS Program Title: | **Project Lead The Way – Pre-Engineering Program** |
| Pathway Options: | 1.  | 2.  | 3. |
| Value Added Options: | [x] 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.  |
| [x]  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 | [x]  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/DCTAL**

|  |  |
| --- | --- |
| Date Program Proposal received by CTE Systems Branch: |  |
| CTE Control Number: |  | Fiscal Year: |  |
| CIP Number: | Program: **15.500**  | PathwayOption 1: | PathwayOption 2:  | PathwayOption 3: |
| MSDE Cluster Title: | **Manufacturing, Engineering and Technology** |

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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

|  |
| --- |
| **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):  |  |
| 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):  |  |
| 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: |
| Title: |  | [ ]  Industry [ ]  Secondary [ ]  Postsecondary  |
| Affiliation: |  |
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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):  |  |
| Name: |  | Representation: |
| Title: |  | [ ]  Industry [ ]  Secondary [ ]  Postsecondary  |
| Affiliation: |  |
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| Email: |  |
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| Role: | [ ]  Work-based Learning [ ]  Curriculum Development [ ]  Skills Standards Validation [ ]  Staff Development |
| [ ]  Program Development  | [ ]  Other (specify):  |  |
| Name: |  | Representation: |
| Title: |  | [ ]  Industry [ ]  Secondary [ ]  Postsecondary  |
| Affiliation: |  |
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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):  |  |
| 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):  |  |

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

[x]  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:** International Technology and Engineering Educators Association, Maryland Mathematics College and Career Readiness Standards, and the Next Generation Science Standards |
| **Program Overview:** Project Lead The Way (PLTW) is a CTE instructional program that incorporates the national standards of The National Council of Teachers of Mathematics, the National Science Standards and the International Technology Education Association. The program prepares students for further education and careers in engineering and engineering technology. There are eight courses in the PLTW program. The CTE program consists of five courses that are divided into three groups:**Three Foundation Courses:*** *Introduction to Engineering Design (IED)* – may be used for Technology Education credit,
* *Principles of Engineering (POE)* – may be used for Technology Education credit and
* Digital Electronics (DE)

**Five Pathway Courses – Schools offer one or more:*** Aerospace Engineering (AE),
* Biotechnical Engineering (BE) – Will be phased out by the end of 2016-2017 school-year and replaced by ES
* Civil Engineering and Architecture (CEA),
* Computer Integrated Manufacturing (CIM),
* Computer Science and Software Engineering (CSE), and
* Environmental Sustainability (ES) – Will be available in the 2015-2016 school-year and is replacing BE. PLTW will support BE through the end of the 2016-2017 school-year.

**Capstone Course:*** Engineering Design and Development (EDD)

**Schools and School Systems are Expected to:**1. Identify a computer lab able to run the current PLTW required software. Refer to the PLTW Engineering Purchasing Manual to review the computer specifications. The most current purchasing manual can be downloaded from the PLTW website.
2. Select teacher(s) with baccalaureate degree(s) who are knowledgeable in Algebra I & II, Geometry, Trigonometry and the Physical Sciences. PLTW instructors must hold the minimum of a bachelor’s degree. They must agree to participate in PLTW Engineering Summer Core Training for each course they intend to teach. The PLTW Engineering Summer Core Training is a two-week professional development experience offered at the University of Maryland, Baltimore County.
3. Agree to participate in and complete the PLTW College Certification process the year that the Digital Electronics Course is offered.
4. Agree to pay the $3,000 annual participation fee to Project Lead The Way. (Grant funds may be used to cover this cost).
5. Submit to MSDE data pertaining to the Perkins Core Indicators of Performance.

**Students are Expected to:**1. Develop thinking skills by solving real-world engineering problems (POE);
2. Produce, analyze, and evaluate models of project solutions using computer software (IED);
3. Test and analyze digital circuitry using industry-standard computer software (DE);
4. Work in teams to complete challenging, self-directed projects. Mentored by engineers, students design and build solutions to authentic engineering problems (EDD); and
5. Depending on the pathway course, students are expected to:
	1. Apply scientific and engineering concepts to design materials and processes that directly measure, repair, improve, and extend systems in different environments (AE);
	2. Produce architectural designs using computer software and work in teams to develop project planning skills (CEA);
	3. Solve problems in bio-engineering and related areas such as bio-medical, bio-molecular and biotechnology using knowledge and skills in biology, physics, technology and mathematics (BE);
	4. Apply skills to solve problems related to genetic engineering, biofuels, and biomanufacturing (BioE);
	5. Solve design problems using three-dimensional computer software. Students assess solutions, modify designs, and use prototyping equipment to produce 3-D models (CIM);
	6. Develop computational thinking and programming experience as well as explore the workings of the internet to work on projects involving App development, cybersecurity, robotics and simulation (CSE)

**Technology Education**If Introduction to Engineering Design (IED) or Principles of Engineering (POE) is used to satisfy the Technology Education graduation requirement, then the program is comprised of four courses and only enrollment in the four courses beyond IED or POE counts toward the PLTW CTE program of study. **College Credit**The **Rochester Institute of Technology** offers PLTW students the opportunity to receive undergraduate credit for five PLTW courses:  Introduction to Engineering Design, Principles of Engineering, Digital Electronics, Civil Engineering & Architecture and Computer Integrated Manufacturing. To qualify, students must earn a Stanine score of 6 or higher on the end-of-year exam (6 equals a C; 7 equals a B; 8 and 9 equal an A).  The cost for each course is $225, and each course is worth three semester credits in **Engineering Technology**.The **University of Maryland, Baltimore County** uses Portfolio Review to award credit by examination for an ENES 100 level course.  |

**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: Introduction to Engineering Design (IED) – This course may be used to satisfy the Technology Education graduation requirement or as one of the courses in the CTE sequence. IT MAY NOT BE USED FOR BOTH.****Course Description:** This foundation course emphasizes the development of a design. Students use computer software to produce, analyze and evaluate models of projects solutions. They study the design concepts of form and function, and then use state-of-the-art technology to translate conceptual design into reproducible products. Students are expected to:* Apply the design process to solve various problems in a team setting and explore career opportunities in design engineering and understand what skills and education these jobs require *(Introduction)*;
* Apply adaptive design concepts in developing sketches, features, parts and assemblies *(Introduction to Design)*;
* Interpret sketches in using computer software to design models *(Sketching and Visualization)*;
* Understand mass property calculations—such as volume, density, mass, surface area, moment of inertia, product of inertia, radii of gyration, principal axes and principal moments—and how they are used to evaluate a parametric model *(Modeling and Model Analysis Verification)*;
* Understand cost analysis, quality control, staffing needs, packing and product marketing *(Marketing)*; and
* Develop portfolios to display their designs and present them properly to peers, instructors and professionals *(Portfolio Development)*.

**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)      [x]  Nationally recognized examination: (specify) PLTW End-of-Course Assessment for IED |
| **Course Title: Principles of Engineering (POE) – This course may be used to satisfy the Technology Education graduation requirement or as one of the courses in the CTE sequence. IT MAY NOT BE USED FOR BOTH.**This foundation course provides an overview of engineering and engineering technology. Students develop problem-solving skills by tackling real-world engineering problems. Through theory and practical hands-on experiences, students address the emerging social and political consequences of technological change. Students are expected to:* Know the types of engineers and their contributions to society *(Overview and Perspective of Engineering)*.
* Solve problems and learn how engineers work in teams to develop products *(Design Process)*.
* Collect and categorize data, produce graphic representations, keep an engineer’s notebook and make written and oral presentations (*Communication and Documentation)*.
* Apply knowledge of mechanical, electrical, fluid, pneumatic and control systems in the design process *(Engineering Systems)*.
* Apply knowledge of measurement, scalars and vectors, equilibrium, structural analysis, and strength of materials in the design process *(Statics).*
* Understand the categories and properties of materials and how materials are shaped and joined in order to perform material testing (*Materials and Materials Testing).*
* Understand units and forms of energy, energy conversion, cycles, efficiency and energy loss, and conservation techniques *(Thermodynamics)*.
* Use precision measurement tools to gather and apply statistics for quality and process control. Students will also learn about reliability, redundancy, risk analysis, factors of safety, and liability and ethics *(Engineering for Quality and Reliability)*.
* Understand the concepts of linear and trajectory motion and the circumstances in which it can be applied *(Dynamics)*.

**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)      [x]  Nationally recognized examination: (specify) PLTW End-of-Course Assessment for POE |
| **Course Title: Digital Electronics (DE)** **Course Description:** This foundation course introduces students to applied digital logic, a key element of careers in engineering and engineering technology. This course explores the smart circuits found in watches, calculators, video games and computers. Students use industry-standard computer software in testing and analyzing digital circuitry. They design circuits to solve problems, export their designs to a printed circuit auto-routing program that generates printed circuit boards, and use appropriate components to build their designs. Students use mathematics and science in solving real-world engineering problems. Students are expected to:* Understand the principles of and laws of electronics and electrical theory *(Fundamentals)*;
* Apply binary and hexadecimal number systems to design and construct digital circuits *(Number Systems)*;
* Use gates to control logic levels *(Gates)*;
* Understand how Boolean algebra is applied to digital systems *(Boolean Algebra)*;
* Interconnect gates to form combinational logic circuits (*Combinational Logic Circuit Design)*;
* Understand that MSI chips perform mathematical operations on binary numbers and use discrete gates or MSI chips to design, test and build adder circuits *(Adding)*;
* Use flip-flops in elementary memory storage and frequency division *(Flip-Flops)*;
* Classify by input and output the four types of shift registers *(Shift Registers and Counters)*;
* Classify the families of logic devices and explain the specifications of each family *(Families and Specifications);*
* Explain the basic elements of a microprocessor and understand how microprocessors are turned into microcomputers *(Microprocessors)*; and
* Select and solve a digital electronics problem using computer simulation software and appropriate parts. Prepare a presentation and write a summarizing report. *(Capstone Project)*

**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)      [x]  Nationally recognized examination: (specify) PLTW End-of-Course Assessment for DE  |
| **Course Title: Aerospace Engineering (AE)****Course Description**: The pathway course introduces students to the world of aeronautics, flight, and engineering. Students in this course will apply scientific and engineering concepts to design materials and processes that directly measure, repair, improve, and extend systems in different environments. Students are expected to:* Understand the many engineering problems faced during the development of flight, research the history of flight and identify the major components of airplanes *(The History of Flight)*.
* Understand the principles of aerodynamics *(Aerodynamics and Aerodynamics Testing)*.
* Explain fundamental theories of lift creation and stability know the names and purposes of aircraft components and create small gliders to understand the design, construction, and testing cycle of engineering *(Flight Systems)*.
* Apply Newton’s Three Laws of Motion, the ideas associated with the design of rocket engines and how the creation of an action results in thrust that enables rockets to move *(Astronautics)*.
* Students investigate the requirements for life support systems at ground level, during high-speed atmospheric travel, and in the zero-pressure, microgravity environment of space. Students design and videotape experiments that create a positive g-force *(Space Life Sciences)*.
* Design composite (layered) plastic test samples using various engineering composite materials. Through laboratory testing, they measure the stiffness of various composite materials and designs and determine the modulus of elasticity *(Aerospace Materials)*.
* Students research types of intelligent vehicles and learn the basic aspects of designing, building, and programming an intelligent vehicle *(Systems Engineering)*.

**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)      [x]  Nationally recognized examination: (specify) PLTW End-of-Course Assessment for AE |
| **Course Title: Biotechnical Engineering (BE) - Will be phased out by the end of 2016-2017 school-year****Course Description:** This pathway course applies and concurrently develops secondary level knowledge and skills in biology, physics, technology, and mathematics. It includes experiences from the diverse fields of bio-technology, bio-engineering, bio-medical engineering, and bio-molecular engineering. Lessons engage students in engineering design problems that can be accomplished in a high school setting related to biomechanics, cardiovascular engineering, genetic engineering, agricultural biotechnology, tissue engineering, biomedical devices, human interface, bioprocess engineering, forensics, and bio-ethics.**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)      [x]  Nationally recognized examination: (specify) PLTW End-of-Course Assessment for BE |
| **Course Title: Civil Engineering and Architecture (CEA)****Course Description:** This pathway course provides an overview of the fields of Civil Engineering and Architecture, while emphasizing the interrelationship and dependence of both fields on each other. Students use state of the art software to solve real world problems and communicate solutions to hands-on projects and activities. Students are expected to: * Understand the history, influence and impact of engineering and architecture; the relationship of civil engineering and architecture; and the responsibilities of both fields, including ethics and values *(The Roles of Civil Engineers and Architects)*.
* Solve a design problem that will introduce them to basic elements of design and software use *(Introduction to Projects)*.
* Work in teams to apply the concepts (Site Discovery, Regulations, and a Generic Viability Analysis) of project planning. *(Project Planning)*.
* Explain the basic concepts of site planning including:
	+ Descriptions of Property,
	+ Site Plan Requirements,
	+ Site Plan Layouts,
	+ Public Ingress and Egress,
	+ Site Grading,
	+ Utilities,
	+ Landscaping, and
	+ Water Supply and Wastewater Management
* Using related software, students explore the application of those concepts *(Site Planning)*.
* Recognize the many aspects of design and understand the responsibilities of the architect along with the related skills that are necessary to appropriately design a structure that will function as intended and be acceptable to the client’s needs and wants *(Architecture)*.
* Understand the basics of structural engineering. Apply structural data to formulas and tables, perform calculations, and add the results in the form of structural details, to the prints *(Structural Engineering)*.
* Prepare presentations and have peer reviews of team and individual work *(Project Documentation and Presentation)*.

**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)      [x]  Nationally recognized examination: (specify) PLTW End-of-Course Assessment for CEA |
| **Course Title: Computer Integrated Manufacturing (CIM)**Course Description: This pathway course teaches the fundamentals of computerized manufacturing technology. It builds on the solid-modeling skills developed in the ***Introduction to Engineering Design*** course. Students use 3-D computer software to solve design problems. They assess their solutions through mass propriety analysis (the relationship of design, function and materials), modify their designs, and use prototyping equipment to produce 3-D models. Students are expected to:* Use 3-D software for mass property analysis (*Computer Modeling);*
* Understand of the operating procedures and programming capabilities of machine tools *(Computer Numerical Control (CNC) Equipment*:
* Convert computer-generated geometry into a program to direct the operation of CNC machine tools *(Computer-aided Manufacturing (CAM);*
* Program robots to handle materials in assembly-line operations *(Robotics*); and
* Work in teams to design manufacturing work cells and tabletop factories to solve complex problems that arise in integrating multiple pieces of computer-controlled equipment *(Flexible Manufacturing Systems)*.

**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)      [x]  Nationally recognized examination: (specify) PLTW End-of-Course Assessment for CIM |
| **Course Title: Computer Science and Software Engineering (CSE)****Course Description:** This pathway course implements the College Board’s CS Principles framework. Using Python® as a primary tool and incorporating multiple platforms and languages for computation, this course aims to develop computational thinking, generate excitement about career paths that use computing, and introduce professional tools that foster creativity and collaboration. CSE helps students develop programming expertise and explore the workings of the Internet. Projects and problems include app development, visualization of data, cybersecurity, and simulation. The course aligns with CSTA 3B standards. Students are expected to:* Algorithms, Graphics, and Graphical User Interfaces to build students’ ability to use algorithmic thinking and abstraction;
* Develop a more concrete understanding of the Internet as a set of computers exchanging bits and the implications of these exchanges;
* Understand the availability of large-scale data collection and analysis and be able to examine the data sets; and
* Make the connections among computing concepts and between computing and society.

**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)      [x]  Nationally recognized examination: (specify) PLTW End-of-Course Assessment for CSE |
| **Course Title: Environmental Sustainability (ES) - Will be available in the 2015-2016 school-year****Course Description**: Environmental Sustainability is a rigorous activity, project, and problem-based course in which students investigate and design solutions to solve real-world challenges related to clean and abundant drinking water, food supply issues, and renewable energy. Students completing ES will develop an understanding of the scientific and technological foundations for each of the problems. Students apply their knowledge and skills as they use an engineering design process to design and test solutions that help solve these global challenges. This course develops students’ thinking skills and prepares them for emerging careers through topics such as genetic engineering, biofuels, and biomanufacturing. Students are expected to:* Learn how the biological engineering of organisms can be used to provide environmentally friendly and sustainable solutions to produce affordable, renewable energy; clean, safe drinking water; and nutritious food sufficient for a growing world population;
* Build models of natural water systems, investigate how these systems become contaminated, explore how contamination can be prevented, and examine how polluted waters can be purified. Laboratory methods for quantitatively measuring water quality are practiced;
* Investigate the role and effectiveness of biological organisms in cleaning up water polluted with crude oil. The physical, chemical, and biological technologies and processes utilized by waste water treatment plants are explored, including optional field trips to these facilities;
* Apply their knowledge of water issues, water treatment technologies, and the associated role of biological organisms, along with their engineering design experience, to the challenge of designing a small-scale water treatment system for rapid deployment within natural disaster zones;
* Learn about the structure and function of DNA, the process of protein synthesis, and determine whether or not familiar food items contain genetically modified organisms (GMOs);
* Investigate various molecular biology techniques while working through the steps necessary to create genetically modified plants;
* Explore PCR, DNA sequencing techniques, restriction enzyme action, ligation, gel electrophoresis, bacterial transformation, and plant transformation;
* Work through the beginning steps of the engineering design process to propose a genetic engineering solution to a global food security issue;
* Explore current global energy consumption patterns and examine futuristic energy consumption models which use different types of energy other than fossil fuels;
* Conduct a household energy audit to contextualize their energy consumption patterns;
* Investigate the process of photosynthesis and its role in the formation of both fossil fuels and biofuels.
* Applying an engineering design process, students design, build, and operate bench-top scale algae bioreactors;
* Design monitoring systems and apply standard laboratory processes in quantifying the efficiency of their systems at producing algae and purifying the end products;
* Learn about the production of ethanol from cellulosic plant sources;
* Investigate the role of enzymes as well as different technologies used to produce ethanol and design an ethanol separation and purification system; and
* Develop a proposal for a commercial scale biofuels manufacturing plant.

**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)      [x]  Nationally recognized examination: (specify) PLTW End-of-Course Assessment for ES |
| **Course Title: Engineering Design and Development (EDD)****Course Description:** This capstone course enables students to apply what they have learned in academic and pre-engineering courses as they complete challenging, self-directed projects. Students work in teams to design and build solutions to authentic engineering problems. An engineer from the school’s partnership team mentors each student team. Students keep journals of notes, sketches, mathematical calculations and scientific research. Student teams make progress reports to their peers, mentor and instructor and exchange constructive criticism and consultation. At the end of the course, teams present their research paper and defend their projects to a panel of engineers, business leaders and engineering college educators for professional review and feedback. This course equips students with the independent study skills that they will need in postsecondary education and careers in engineering and engineering technology.**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)       |

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)

**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 program matrix for the 9-12 program. Include 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. Please update the CTE Completer Program section on the matrix to show which PLTW pathway course(s) the school system plans to offer.**  |
| **Pathway/Program:** | **Pathway to Engineering** | **CIP Number (For MSDE Use)** | **15.5000** |
| **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 -.5Health Education - .5 | .5 PE | .5 Health |  |  |
| Fine Arts - 1 | .5 Fine Arts  | .5 Fine Arts |  |  |
| Technology Education - 1 | Introduction to Engineering Design |  |  |  |
| CTE Completer Program – 4 \*concentrator course |  | Principles of Engineering (1 Credit) | Digital Electronics (1) **and**\*Aerospace Engineering (1) **or**\*Civil Engineering and Architecture (1) **or**\*Computer Integrated Manufacturing (1) **or**\*Computer Science and Software Engineering (1) **or**\*Environmental Sustainability (1)  | Engineering Design and Development (1 Credit) |
| Foreign Language - 2 and/orAdvanced Tech Ed - 2 | Foreign Language **or** Adv. Tech Ed | Foreign Language **or** Adv. Tech Ed |  |  |
| **Provide a list of examples of careers students are preparing to enter and postsecondary options:** Engineering Technician or Engineering Technician Assistant (Provides an engineering background for students who plan to pursue an associate’s or baccalaureate degree in engineering.) |

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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: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_****College/Institution: ­­­­­­­­­­­­­­­­­­­­­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**  |
| **Recommended Core Component 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** |
|   |  |
| **Semester 3** | **Semester 4** |
|  |  |
| **Provide a list of career options for students who complete the program:**  |

|  |
| --- |
| **Four Year College Program Sequence – Program Overview****Complete this matrix if the program includes a four year degree option****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: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_****College/Institution**: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
| **Recommended Core Component 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** |
|  |  |
| **Semester 3** | **Semester 4** |
|  |  |
| **Semester 5** | **Semester 6** |
|  |  |
| **Semester 7** | **Semester 8** |
|  |  |
| **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 Tech Prep.

|  |  |  |  |
| --- | --- | --- | --- |
| **Option** | **Partner** | **Credential** | **Value added for CTE completers** |
| Dual Enrollment |  |  |  |
| Transcripted Credit | Rochester Institute of Technology (PLTW National Affiliate) | BS in Engineering Technology | RIT awards credit for five PLTW courses: IED, POE, DE, CEA, & CIM |
| Articulated Credit |  |  |  |
| Credit by Exam | University of Maryland, Baltimore County (UMBC) | BS in Engineering | UMBC uses Portfolio Review to award credit by exam for an ENES 100 level course. |
| Advanced Placement |  |  |  |
| Apprenticeship Approved by MATC\* |  |  |  |
| Certification(s) |  |  |  |
| 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. [x]  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 [x]  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: |  |

*DATA SHEET - Pathway Options*

|  |  |
| --- | --- |
| **1.** | **Aerospace Engineering** |
| **2.** | **Civil Engineering and Architecture** |
| **3.** | **Computer Integrated Manufacturing** |
| **4.** | **Computer Science and Software Engineering** |
| **5.** | **Environmental Sustainability** |

*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. **PLTW – Engineering**
 |  | **1** | **2** | **1** | **4** |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

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

*DATA SHEET - CAREER AND TECHNOLOGY EDUCATION PROGRAM SITES*

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