# Engineering Courses

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Post-Secondary Connection</th>
<th>Course Code</th>
<th>Recommended Grade Level</th>
<th>Recommended Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Technological Applications</td>
<td></td>
<td>210118</td>
<td>9 10 11 12 13 14 15 16 17 18</td>
<td>1</td>
</tr>
<tr>
<td>Aerospace Engineering (PLTW)</td>
<td>Agreements</td>
<td>219907</td>
<td>x x x x</td>
<td>1</td>
</tr>
<tr>
<td>Civil Engineering and Architecture (PLTW)</td>
<td>Agreements</td>
<td>219905</td>
<td>x x x x</td>
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</tr>
<tr>
<td>Computer Integrated Manufacturing (PLTW)</td>
<td>Agreements</td>
<td>219904</td>
<td>x x x x</td>
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</tr>
<tr>
<td>Digital Electronics (PLTW)</td>
<td>Agreements</td>
<td>219903</td>
<td>x x x x</td>
<td>1</td>
</tr>
<tr>
<td>Electricity and Electronics</td>
<td></td>
<td>210232</td>
<td>x x x x x</td>
<td>1</td>
</tr>
<tr>
<td>Engineering and Engineering Technology Co-op</td>
<td></td>
<td>210330</td>
<td>x x x</td>
<td>1</td>
</tr>
<tr>
<td>Engineering and Engineering Technology Design (Capstone)</td>
<td></td>
<td>210110</td>
<td>x x x</td>
<td>1</td>
</tr>
<tr>
<td>Engineering and Engineering Technology Internship</td>
<td></td>
<td>210331</td>
<td>x x x</td>
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</tr>
<tr>
<td>Engineering Design</td>
<td>UC ENED 1020</td>
<td>210222</td>
<td>x x x x</td>
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<tr>
<td>Engineering Design and Development (Capstone) (PLTW)</td>
<td>Agreements</td>
<td>219906</td>
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</tr>
<tr>
<td>Environmental Sustainability (PLTW)</td>
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<td>219908</td>
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<tr>
<td>Fundamentals of Aerospace Engineering</td>
<td></td>
<td>210229</td>
<td>x x x x</td>
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</tr>
<tr>
<td>Fundamentals of Architectural and Civil Engineering</td>
<td></td>
<td>210223</td>
<td>x x x x</td>
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</tr>
<tr>
<td>Fundamentals of Engineering Design</td>
<td></td>
<td>210221</td>
<td>x x x x</td>
<td>1</td>
</tr>
<tr>
<td>Fundamentals of Mechatronics</td>
<td></td>
<td>210230</td>
<td>x x x</td>
<td>1</td>
</tr>
<tr>
<td>Introduction to Aerospace</td>
<td></td>
<td>210226</td>
<td>x x x</td>
<td>1</td>
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<tr>
<td>Introduction to Engineering Design (PLTW)</td>
<td>Agreements</td>
<td>219901</td>
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</tr>
<tr>
<td>Introduction to Space Systems Engineering</td>
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<td>210235</td>
<td>x x x x</td>
<td>1</td>
</tr>
<tr>
<td>Principles of Engineering (PLTW)</td>
<td>Agreements</td>
<td>219902</td>
<td>x x x x</td>
<td>1</td>
</tr>
<tr>
<td>Robotics Design Essentials and Systems</td>
<td></td>
<td>210239</td>
<td>x x x x</td>
<td>1</td>
</tr>
<tr>
<td>Space Systems Engineering</td>
<td></td>
<td>210236</td>
<td>x x x x</td>
<td>1</td>
</tr>
</tbody>
</table>

(PLTW) courses require an agreement between Project Lead The Way and the local school district.

**Note:** All post-secondary connections are individual agreements that will need to be created between the post-secondary institution and the local school district. Local school districts are also encouraged to reach out to other post-secondary institutions to expand these connections.

UC = University of Cincinnati
K-12 Science, Technology, Engineering and Math (STEM) Pathway

Elementary School STEM Program
School districts are encouraged to explore the concept of a K-12 STEM pipeline. This career pathway would facilitate exploration, the attainment of knowledge and skills necessary for informed participation and gainful employment in a technologically dependent society. This pipeline may include a recommended sequence of courses that would allow integration and interdisciplinary instruction of important concepts. Beginning this pipeline at the elementary level could help the students focus their learning.

Middle School STEM Program
Programs in the middle school provide an exploration into STEM and how it connects skills from other academic disciplines. Students experience the design process as they invent devices to solve various problems. Students learn of system requirements, processes and controls as they wrestle with trade-offs due to design constraints. Students apply scientific and mathematical knowledge as they analyze data to predict performance. Students learn the proper and safe operation of some basic tools as their ideas begin to take shape. Through these experiences, students begin to understand the forces that drive our technological society and how these forces can be controlled and directed. Instructional approaches include problem solving/design briefs where students build projects, small/large group instruction, discussion, research, student presentations, and other successful pedagogy.

STEM at the middle school level should include a local chapter of the Technology Student Association (TSA) and can incorporate many of the TSA activities within the curriculum.

A middle school STEM course is generally offered for six to eighteen weeks for a single class period each day. Alternative schedules that provide for equivalent contact hours may also be implemented. A total program of STEM consists of a minimum of three course offerings, one for each grade level (6-8).

High School Engineering Program
The U.S. has approximately 1.6 million engineering jobs that pay $42 per hour in median wages. Civil engineers account for the most jobs of any engineering field (274,000 in 2014), followed closely by mechanical engineers (264,000) and industrial engineers (229,000). Those three engineering jobs, plus electrical engineers and electronics engineers, make up two-thirds of the American engineering workforce.


The Commonwealth of Kentucky has created high school engineering pathways to excite and drive interest in these top Engineering fields. Special attention is also paid to Aerospace Engineering as this is Kentucky’s top export and only second to Washington State in export dollars.
High School Engineering Technology Program
This program of studies includes the practical application of science and engineering and exposes students to a wide range of real world problems. The Commonwealth of Kentucky offers a wide array of Engineering Technology and Science, Technology, Engineering and Math (STEM) related High School Career Pathways to create a future workforce ready for industry needs.

Career and Technical Education/Engineering Hybrid Pathways
Project Lead The Way (PLTW) and the Office of Career and Technical Education (CTE) worked together to create further opportunities for students that are enrolled in secondary CTE specific programs. These are referred to as Hybrid pathways that consist of courses within the specific program area with the addition of selected Engineering courses relative to that career area. Since their inception, the hybrid pathways now include nonPLTW engineering courses to allow expanded access across the Commonwealth. These pathways blend CTE courses with Engineering courses to help students apply technical skills along with Science, Technology, Engineering, and Math (STEM) skills to solve real-world problems and to meet the demands of industry for individuals with both technical and engineering knowledge and skills.

Student Organizations
Participation in Technology Student Association (TSA) provides a vehicle for students to employ higher order thinking skills, to interact with industry individuals to further enhance their leadership skill through their participation in regional, state and national competitive events and local activities.

Imagine an activity so captivating that your students spend hours working on it after school for weeks at a time. That’s what happens when TSA members engage in TSA’s competitions. Only TSA members have the opportunity to compete at exciting regional, state and national conferences. Expert judging by technology educators and industry representatives inspires the best from participants. Members are rewarded not only with medals or trophies, but also with memories of the camaraderie and the challenge brought on by TSA.

STEM at the middle school level as well as Engineering and Engineering Technology at the high school level should include a local chapter of Technology Student Association (TSA) and can incorporate many of the TSA activities within the curriculum.
Engineering Vs. Engineering Technology

According to the Accreditation Board for Engineering and Technology Inc. (ABET); engineering and engineering technology are separate but closely related professional areas that differ in:

- **Curricular Focus** – Engineering programs often focus on theory and conceptual design, while engineering technology programs usually focus on application and implementation. Engineering programs typically require additional, higher-level mathematics, including multiple semesters of calculus and calculus-based theoretical science courses, while engineering technology programs typically focus on algebra, trigonometry, applied calculus, and other courses that are more practical than theoretical in nature.

- **Career Paths** – Graduates from engineering programs are called engineers and often pursue entry-level work involving conceptual design or research and development. Many continue on to graduate-level work in engineering. Graduates of four-year engineering technology programs are called technologists, while graduates of two-year engineering technology programs are called technicians. These professionals are most likely to enter positions in sectors such as construction, manufacturing, product design, testing, or technical services and sales.


Engineering and Engineering Technology – What is the difference?

This question is asked repeatedly by graduating high school seniors who are considering the field of engineering as a career. They are told that engineering is science-oriented, stressing mathematics, natural and engineering science, engineering design, and the development of engineering research competencies. On the other hand, engineering technology is practice-oriented, stressing applications of engineering science, engineering design, and laboratory experience competencies. The potential student in engineering education is still confused because of the apparent overlap in the definitions. The student must understand that the field of engineering comprises a broad spectrum of occupations requiring different abilities, interest and skills. Both engineering and engineering technology are viable professional paths that lead to rewarding and successful careers. It is important for students to carefully assess their abilities, interests and personal career objectives before deciding between engineering and engineering technology. The student should study the following comparisons in order to decide which career path best fits his or her abilities and interests. All too often, graduating high school seniors enroll in engineering curriculums without realizing there is another alternative in which they could be more successful, during both academic preparation and the career that follows.

According to Payscale.com which gathers salary and employment data for the federal government, the average starting salaries for both Engineering graduates as well as Engineering Technology graduates are almost identical, hovering around $47k* annually as of December 2016. *updated to reflect current pay
Post-Secondary Comparison of Engineering and Engineering Technology

This comparison list is modeled from a brochure, “Mechanical Engineering and Mechanical Engineering Technology, Which Path Will You Take”, published by the American Society of Mechanical Engineers.

### Program Guide Characteristics

<table>
<thead>
<tr>
<th>ENGINEERING</th>
<th>ENGINEERING TECHNOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>An innovator—one who is able to interweave a knowledge of advanced mathematics, the natural and engineering sciences, and engineering principles and practices with considerations of economic, social, environmental, and ethical issues to create new systems and products.</td>
<td>A doer or implementer—one who is able to apply a basic knowledge of mathematics, the natural and engineering sciences, current engineering practices, and an understanding of economic principles of the solution of design problems and to the operation or testing of engineering and manufacturing systems.</td>
</tr>
</tbody>
</table>

### Program Objectives

<table>
<thead>
<tr>
<th>ENGINEERING</th>
<th>ENGINEERING TECHNOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>To provide the knowledge necessary to design and manufacture state-of-the-art products and systems needed to meet the current and future needs of society. To provide the knowledge required to apply state-of-the-art techniques and designs to meet the current needs of society.</td>
<td>To provide the knowledge required to apply state-of-the-art techniques and designs to meet the current needs of society.</td>
</tr>
</tbody>
</table>

### Program Emphasis

<table>
<thead>
<tr>
<th>ENGINEERING</th>
<th>ENGINEERING TECHNOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emphasis is on developing methods of analysis and solutions for open-ended design problems.</td>
<td>Emphasis is on applying current knowledge and practices to the solution of specific technical problems.</td>
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</table>

### Expertise Objectives

<table>
<thead>
<tr>
<th>ENGINEERING</th>
<th>ENGINEERING TECHNOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>To develop conceptual abilities.</td>
<td>To develop application abilities.</td>
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</table>

### Program Length

<table>
<thead>
<tr>
<th>ENGINEERING</th>
<th>ENGINEERING TECHNOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four years.</td>
<td>Four years. Transfer students from community colleges may take longer if they do not have basic math and science courses in freshman and sophomore years.</td>
</tr>
<tr>
<td><strong>Courses in Major Field</strong></td>
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<tr>
<td>----------------------------</td>
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<tr>
<td>Engineering students usually do not begin major field of study until the latter part of sophomore year or junior year.</td>
<td>Engineering technology students begin major field of study in the freshman year.</td>
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<table>
<thead>
<tr>
<th><strong>Degrees Awarded</strong></th>
<th></th>
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<tbody>
<tr>
<td>B.S. in Engineering</td>
<td>B.S. in Engineering Technology</td>
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<table>
<thead>
<tr>
<th><strong>Academic Terminology</strong></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Graduates are referred to as engineers.</td>
<td>Graduates are referred to as engineering technologists. Job titles after entering industry will be “engineers” more often than not.</td>
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<table>
<thead>
<tr>
<th><strong>Program Basis</strong></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>The equivalent of one full year of mathematics and basic science courses provides the foundation for the program that is calculus based.</td>
<td>The equivalent of three-quarters of a year of mathematics and basic science. Engineering Technology programs are algebra-based, but calculus usage is required as a subject.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Emphasis of Technical Courses</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering courses stress the underlying theory of the subject matter.</td>
<td>Technology courses stress the application of technical knowledge and methods in the solution of current industrial type problems.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Emphasis of Laboratory Courses</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory courses provide an intensive overview of experimental methods and of the related underlying theories.</td>
<td>Laboratory courses, an integral component, stress practical design solutions as well as manufacturing and evaluation techniques appropriate for industrial type problems.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Technical Design Emphasis</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>General design principles, applicable to a wide variety of problem situations, are developed.</td>
<td>Current design procedures of a complex, but well-established nature are developed and applied to problems in a specialized technical area.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Transfer Potential</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Transfer to a technology program from an engineering curriculum is possible with a minimum loss of credits and time.</td>
<td>It is generally not possible to transfer to an engineering curriculum from a technology program without a significant loss of credits and time.</td>
</tr>
<tr>
<td>ENGINEERING TECHNOLOGY</td>
<td>ENGINEERING</td>
</tr>
<tr>
<td>------------------------</td>
<td>------------</td>
</tr>
<tr>
<td><strong>Typical Aspirations of the New Graduate</strong></td>
<td></td>
</tr>
<tr>
<td>The engineering graduate entering industry would most likely aspire to an entry-level position in conceptual design, systems engineering, manufacturing, or product research and development.</td>
<td>A graduate entering industry would most likely aspire to an entry-level position in product design, development, testing, technical operations, or technical services and sales.</td>
</tr>
<tr>
<td><strong>Technical Interest</strong></td>
<td></td>
</tr>
<tr>
<td>The engineering graduate is relatively broad and has an analytical, creative mind challenged by open-ended technical problems.</td>
<td>A graduate is relatively specialized and has an applications orientation, challenged by specific technical problems.</td>
</tr>
<tr>
<td><strong>Adaptability to Current Industrial Practices</strong></td>
<td></td>
</tr>
<tr>
<td>An engineering graduate typically requires a period of “internship” since engineering programs stress fundamentals.</td>
<td>A graduate is prepared to immediately begin technical assignments since technology programs stress current industrial practices and design procedures.</td>
</tr>
<tr>
<td><strong>Mobility</strong></td>
<td></td>
</tr>
<tr>
<td>Many engineers move into management positions.</td>
<td>The majority of engineering technologists move into industrial supervisory positions. Many move into management positions.</td>
</tr>
<tr>
<td><strong>Professional Registration</strong></td>
<td></td>
</tr>
<tr>
<td>Graduates of engineering schools are eligible to become registered professional engineers in all states by a process of examination and documentation of experiences.</td>
<td>Graduates of engineering technology schools may become professionally certified in their specific areas of expertise. Technologists may become registered professional engineers in many states; however, the requirements are usually different than those for engineers.</td>
</tr>
<tr>
<td><strong>National Accreditation</strong></td>
<td></td>
</tr>
<tr>
<td>Accredited by the Accreditation Board for Engineering and Technology—Engineering Accreditation Commission (EAC of ABET.)</td>
<td>Accredited by the Accreditation Board for Engineering and Technology—Technology Accreditation Commission (TAC of ABET.)</td>
</tr>
<tr>
<td><strong>Graduate Education Opportunities</strong></td>
<td></td>
</tr>
<tr>
<td>Graduate study in engineering as well as other areas is available for qualified students having a B.S. in engineering.</td>
<td>Graduate study in technology is limited to a few universities and entrance to graduate engineering programs is most often difficult. Advanced degrees in technical education and business are possible.</td>
</tr>
</tbody>
</table>

https://www.suu.edu/cose/et/pdf/eng-vs-et.pdf
Kentucky High School Pathways

Engineering Pathways
- Aerospace Engineering (14.0201.01)
- Civil Engineering (14.0801.00)
- Electrical/Electronics Engineering (14.1001.00)
- Industrial/Mechanical Engineering (14.3501.00)

Career and Technical Education (CTE) and Engineering Hybrid Pathways
- Automotive Engineering (15.0803.00)
- Computerized Manufacturing and Machining (CMM) Engineering (48.0510.00)
- Construction Architectural Engineering (15.0101.02)
- Design Engineering (15.1304.00)
- Electrical Construction Engineering (15.0303.00)
- Fabrication Engineering (14.1901.00)
- Fluid Power Engineering (15.1103.00)
- Industrial Maintenance/Electrical Engineering (14.4101.00)
- Structural Engineering (14.0803.00)
- Welding Engineering (15.0614.00)
- Wood Manufacturing Engineering (03.0509.00)

Engineering Technology Pathways
- Civil Architecture and Construction Technology (15.0101.01)
- Energy Management (15.0503.02)
- Engineering Technology Design (15.1302.00)
- Graphic and Digital Communications (10.0105.00)
- Manufacturing Engineering Technology (15.0613.00)
- Robotics and Automation (15.0405.00)
- Sustainability and Energy Application Technician (15.0503.01)

Flight and Aviation Pathways
- Flight and Aeronautics (49.0102.00)
- Aircraft Maintenance Technician (47.0607.00)
Kentucky Occupational Skill Standards
The Kentucky Occupational Skill Standards are the performance specifications that identify the knowledge, skills, and abilities an individual needs to succeed in the workplace. Identifying the necessary skills is critical to preparing students for entry into employment or postsecondary education. Because of the importance of skill standards, the Office of Career and Technical Education in conjunction with the Kentucky Association of Manufacturers, Toyota, Southern Regional Education Board, Alltech, Cumberland Valley Resources, Alliance Coal, Kentucky Oil & Gas Association, Department of Energy Development & Independence, Tennessee Valley Authority, Appalachian Electric Power, Ashland Oil, Home Builders Association of Kentucky, National Energy Education Development, LGE-KU, and various post-secondary institutions/advisors worked to develop a system to certify that students have attained the necessary skills for employment or postsecondary education. Standards were developed in the areas of Manufacturing, Aerospace and Aeronautics, Engineering and Technical Design, Power-Energy and Transportation. These standards described the necessary occupational, academic, and employability skills needed to enter the workforce or post-secondary education in specific career areas. There is an ongoing effort to continue to refine these standards by which exemplary Engineering and Technology Education Programs are evaluated and certified. The strength of these partnerships insures that curriculum meets industry specifications.

Valid KOSSA and Industry Certification for Career Readiness
The Valid List of KOSSA and Industry Certifications for Career Readiness can be viewed via the following link: [http://education.ky.gov/CTE/kossa/Pages/ValidKOSSAList.aspx](http://education.ky.gov/CTE/kossa/Pages/ValidKOSSAList.aspx). The valid list is reviewed annually through the established process and publishes by June 1 for the corresponding academic year.
ENGINEERING CAREER PATHWAYS  
2017-2018

AEROSPACE ENGINEERING  
CIP 14.0201.01

**PATHWAY DESCRIPTION:** This pathway prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of aircraft, space vehicles, and their systems; applied research on flight characteristics; and the development of systems and procedures for the launching, guidance, and control of air and space vehicles. Aerospace engineers design primarily aircraft, spacecraft, satellites, and missiles. In addition, they test prototypes to make sure that they function according to design.

**NCES Classification of Instructional Programs (CIP)**
Bureau of Labor Statistics

**BEST PRACTICE COURSES**

**Choose (1-2) ONE-TWO CREDIT(S) from the following:**

- 210226 Introduction to Aerospace  
- 210235 Introduction to Space Systems Engineering  
- 210221 Fundamentals of Engineering Design OR 219901 Introduction to Engineering Design (PLTW)  
- 210222 Engineering Design OR 219902 Principles of Engineering (PLTW)

**Complete (1) ONE CREDIT from the following:**

- 219907 Aerospace Engineering (PLTW) OR 210229 Fundamentals of Aerospace Engineering

**Choose (1-2) ONE-TWO CREDIT(S) from the following:**

- 110711 AP Computer Science Principles OR 110730 AP Computer Science Principles (PLTW)  
- 219903 Digital Electronics (PLTW) OR 210232 Electricity and Electronics  
- 210236 Space Systems Engineering  
- 210110 Engineering and Engineering Technology Design (Capstone) OR 219906 Engineering Design and Development (Capstone) (PLTW)

- 210330 Engineering and Engineering Technology Co-op OR 210331 Engineering and Engineering Technology Internship

**Suggested Academic Attainment by Completion of Pathway:**

- Minimum of Pre-Calculus  
- Physics  
- Chemistry

**EXAMPLE ILP-RELATED CAREER TITLES**

| Aerospace Engineer | Aeronautical Engineer | Astronaut | Engineering Tech |

**Note:** 110711 and 110730 exist in the Information Technology Program of Study

**Note:** (PLTW) courses require an agreement between Project Lead The Way and the Local School District.
## ENGINEERING CAREER PATHWAYS  
### 2017-2018

## CIVIL ENGINEERING  
### CIP 14.0801.00

**PATHWAY DESCRIPTION:** This pathway generally prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of structural, load-bearing, material moving, transportation, water resource, and material control systems; and environmental safety measures. Civil engineers design, build, supervise, operate, and maintain construction projects and systems in the public and private sector, including roads, buildings, airports, tunnels, dams, bridges, and systems for water supply and sewage treatment.  

### NCES Classification of Instructional Programs (CIP)  
Bureau of Labor Statistics

### BEST PRACTICE COURSES

<table>
<thead>
<tr>
<th>Choose (1-2) ONE-TWO CREDIT(S) from the following:</th>
<th>EXAMPLE ILP-RELATED CAREER TITLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 210221 Fundamentals of Engineering Design <strong>OR</strong> 219901 Introduction to Engineering Design (PLTW)</td>
<td>Civil Engineer</td>
</tr>
<tr>
<td>• 210222 Engineering Design <strong>OR</strong> 219902 Principles of Engineering (PLTW)</td>
<td>Water Resources Engineer</td>
</tr>
</tbody>
</table>

**Complete (1) ONE CREDIT:**

| • 219905 Civil Engineering and Architecture (PLTW) **OR** 210223 Fundamentals of Architectural and Civil Engineering | Agricultural Engineer |

*Choose (1-2) ONE-TWO CREDIT(S) from the following:*

| 110711 AP Computer Science Principles **OR** 110730 AP Computer Science Principles (PLTW) | Environmental Engineer |
| 219908 Environmental Sustainability (PLTW) | Mining Engineer |
| 210110 Engineering and Engineering Technology Design (Capstone) **OR** 219906 Engineering Design and Development (Capstone) (PLTW) | Engineering Tech |
| 210330 Engineering and Engineering Technology Co-op **OR** 210331 Engineering and Engineering Technology Internship | Civil Engineering Tech |

Suggested Academic Attainment by Completion of Pathway:

- Minimum of Pre-Calculus
- Physics
- Chemistry

Note: (PLTW) courses require an agreement between Project Lead The Way and the Local School District.

Note: 110711 and 110730 exist in the Information Technology Program of Study
## ELECTRICAL/ELECTRONICS ENGINEERING  
**CIP 14.1001.00**

### PATHWAY DESCRIPTION
This pathway prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of electrical, electronic related systems and their components. Electrical engineers design, develop, test, and supervise the manufacturing of electrical equipment, such as electric motors, electrical controls, instrumentation, HMI Interfaces, PLCs, industrial controls, and power generation equipment. Electronics engineers design and develop electronic equipment, such as broadcast and communications systems—from portable music players to global positioning systems (GPSs).

**NCES Classification of Instructional Programs (CIP)**  
Bureau of Labor Statistics

### BEST PRACTICE COURSES

#### Choose (1-2) ONE-TWO CREDIT(S) from the following:
- 210221 Fundamentals of Engineering Design **OR** 219901 Introduction to Engineering Design (PLTW)
- 210222 Engineering Design **OR** 219902 Principles of Engineering (PLTW)

#### Complete (1) ONE CREDIT:
- 219903 Digital Electronics (PLTW) **OR** 210232 Electricity and Electronics

#### Choose (1-2) ONE-TWO CREDIT(S) from the following:
- 110711 AP Computer Science Principles **OR** 110730 AP Computer Science Principles (PLTW)
- 210110 Engineering and Engineering Technology Design (Capstone) **OR** 219906 Engineering Design and Development (Capstone) (PLTW)
- 210330 Engineering and Engineering Technology Co-op **OR** 210331 Engineering and Engineering Technology Internship

### Suggested Academic Attainment by Completion of Pathway:
- Minimum of Pre-Calculus
- Physics
- Chemistry

Note: (PLTW) courses require an agreement between Project Lead The Way and the Local School District.
ENGINEERING CAREER PATHWAYS  
2017-2018

INDUSTRIAL/MECHANICAL ENGINEERING  
CIP 14.3501.00

PATHWAY DESCRIPTION: This pathway prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of physical systems used in manufacturing and end-product systems including, but not limited to, fluid power, robotics, automation, rapid prototyping and machine control. Industrial/Mechanical Engineering is one of the broadest engineering disciplines. Industrial/Mechanical engineers design, develop, build, and test mechanical and thermal sensors and devices, including tools, engines, and machines.

NCES Classification of Instructional Programs (CIP)  
Bureau of Labor Statistics

<table>
<thead>
<tr>
<th>BEST PRACTICE COURSES</th>
<th>EXAMPLE ILP-RELATED CAREER TITLES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Complete (2) TWO CREDITS:</strong></td>
<td>Engineering Technology Education Teacher</td>
</tr>
<tr>
<td>▪ 210221 Fundamentals of Engineering Design OR 219901 Introduction to Engineering Design (PLTW)</td>
<td>Mechanical Engineer</td>
</tr>
<tr>
<td>▪ 210222 Engineering Design OR 219902 Principles of Engineering (PLTW)</td>
<td>Mechanical Engineering Technician</td>
</tr>
<tr>
<td><strong>Choose (1-2) ONE-TWO CREDIT(S) from the following:</strong></td>
<td>Industrial Designer</td>
</tr>
<tr>
<td>▪ 210230 Fundamentals of Mechatronics</td>
<td>Engineering Tech</td>
</tr>
<tr>
<td>▪ 210239 Robotics Design Essentials and Systems</td>
<td>Industrial Engineer</td>
</tr>
<tr>
<td>▪ 210118 Advanced Technological Applications OR 219904 Computer Integrated Manufacturing (PLTW)</td>
<td>Aerospace/Aviation Design</td>
</tr>
<tr>
<td><strong>Choose (1) ONE CREDIT from the following:</strong></td>
<td>Biosystems Engineer</td>
</tr>
<tr>
<td>▪ 110711 AP Computer Science Principles OR 110730 AP Computer Science Principles (PLTW)</td>
<td>Engineering Technology</td>
</tr>
<tr>
<td>▪ 219903 Digital Electronics (PLTW) OR 210232 Electricity and Electronics</td>
<td>Manufacturing Manager</td>
</tr>
<tr>
<td>▪ 210110 Engineering and Engineering Technology Design (Capstone) OR 219906 Engineering Design and Development (Capstone) (PLTW)</td>
<td>Industrial Engineering Tech</td>
</tr>
<tr>
<td>▪ 210330 Engineering and Engineering Technology Co-op OR 210331 Engineering and Engineering Technology Internship</td>
<td>Note: 110711 and 110730 exist in the Information Technology Program of Study</td>
</tr>
</tbody>
</table>

Suggested Academic Attainment by Completion of Pathway:
- Minimum of Pre-Calculus
- Physics
- Chemistry

Note: (PLTW) courses require an agreement between Project Lead The Way and the Local School District.
CAREER and TECHNICAL EDUCATION (CTE) and ENGINEERING HYBRID PATHWAYS

Project Lead The Way (PLTW) and the Office of Career and Technical Education (CTE) worked together to create further opportunities for students that are enrolled in secondary CTE specific programs. These are referred to as Hybrid pathways that consist of courses within the specific program area with the addition of selected Engineering courses relative to that career area. Since their inception, the hybrid pathways now include nonPLTW engineering courses to allow expanded access across the Commonwealth. These pathways blend CTE courses with Engineering courses to help students apply technical skills along with Science, Technology, Engineering, and Math (STEM) skills to solve real-world problems and to meet the demands of industry for individuals with both technical and engineering knowledge and skills.
# Automotive Engineering

**CIP 15.0803.00**

## Pathway Description
This pathway provides the opportunity to blend Career and Technical Education (CTE) courses with Engineering courses to help students apply technical skills along with science, technology, engineering, and math (STEM) skills to solve real-world problems. This pathway prepares individuals to apply engineering principles and technical skills in support of engineers and other professionals engaged in developing, manufacturing and testing self-propelled ground vehicles and their systems. Includes instruction in vehicular systems technology, design and development testing, prototype and operational testing, inspection and maintenance procedures, instrument calibration, test equipment operation and maintenance, and report preparation.

## Best Practice Courses

### Complete (2) Two Credits:
- **210221** Fundamentals of Engineering Design OR **219901** Introduction to Engineering Design (PLTW)
- **219903** Digital Electronics (PLTW) OR **210232** Electricity and Electronics

### Complete (4) Four Credits:
- **470507** Automotive Maintenance and Light Repair Section A and Lab
- **470509** Automotive Maintenance and Light Repair Section B and Lab
- **470511** Automotive Maintenance and Light Repair Section C and Lab
- **470513** Automotive Maintenance and Light Repair Section D and Lab

## Example ILP-Related Career Titles
- Automotive Engineer
- Service Manager

Note: **PLTW** courses require an agreement between Project Lead The Way and the Local School District.
CTE-ENGINEERING HYBRID CAREER PATHWAYS
2017-2018

COMPUTERIZED MANUFACTURING AND MACHINING (CMM) ENGINEERING
CIP 48.0510.00

PATHWAY DESCRIPTION: This pathway provides the opportunity to blend Career and Technical Education (CTE) courses with Engineering courses to help students apply technical skills along with science, technology, engineering, and math (STEM) skills to solve real-world problems. CMM Engineers design, develop and run programs which direct machines to cut and shape metal or plastic for such things as airplanes, automobiles and other industrial machines. CMM Engineers use blueprints and 3-dimensional computer designs to create the programs which result in precisely cut products.

<table>
<thead>
<tr>
<th>BEST PRACTICE COURSES</th>
<th>EXAMPLE ILP-RELATED CAREER TITLES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Complete (2) TWO CREDITS:</strong></td>
<td></td>
</tr>
<tr>
<td>• 210221 Fundamentals of Engineering Design <strong>OR</strong> 219901 Introduction to Engineering Design (PLTW)</td>
<td>Service Manager</td>
</tr>
<tr>
<td>• 210118 Advanced Technological Applications <strong>OR</strong> 219904 Computer Integrated Manufacturing (PLTW)</td>
<td>Machine Operator</td>
</tr>
<tr>
<td><strong>Complete (3) THREE CREDITS:</strong></td>
<td></td>
</tr>
<tr>
<td>• 470913 Fundamentals of Machine Tools-A</td>
<td>Machinist Technician</td>
</tr>
<tr>
<td>• 470914 Fundamentals of Machine Tools-B</td>
<td>Machinist</td>
</tr>
<tr>
<td>• 470915 Manual Programming</td>
<td>Maintenance Machinist</td>
</tr>
<tr>
<td></td>
<td>CNC Machine Operator</td>
</tr>
<tr>
<td></td>
<td>CNC Programmer</td>
</tr>
<tr>
<td></td>
<td>Mechanical Engineer</td>
</tr>
<tr>
<td></td>
<td>Engineer Technician</td>
</tr>
<tr>
<td></td>
<td>Industrial Engineer</td>
</tr>
</tbody>
</table>

Note: 470913, 470914, and, 470915 exist in the Computerized Manufacturing and Machining Technology Program of Study.

Note: 210221, 219901, 210118, and 219904 exist in the Engineering Program of Study.

Note: (PLTW) courses require an agreement between Project Lead The Way and the Local School District.
### PATHWAY DESCRIPTION
This pathway provides the opportunity to blend Career and Technical Education (CTE) courses with Engineering courses to help students apply technical skills along with science, technology, engineering, and math (STEM) skills to solve real-world problems. This pathway prepares individuals to apply engineering principles and technical skills in support of architects, engineers and planners engaged in designing and developing buildings, urban complexes, and related systems. Includes instruction in design testing procedures, building site analysis, model building and computer graphics, structural systems testing, analysis of prototype mechanical and interior systems, report preparation, basic construction and structural design, architectural rendering, computer-aided drafting (CAD), layout and designs, architectural blueprint interpretation, building materials, and basic structural wiring diagramming.

### BEST PRACTICE COURSES

<table>
<thead>
<tr>
<th>Complete (2) TWO CREDITS:</th>
<th>EXAMPLE ILP-RELATED CAREER TITLES</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="https://via.placeholder.com/150" alt="Image" /></td>
<td>Structural Engineer</td>
</tr>
<tr>
<td><img src="https://via.placeholder.com/150" alt="Image" /></td>
<td>Flooring Engineer</td>
</tr>
<tr>
<td><img src="https://via.placeholder.com/150" alt="Image" /></td>
<td>Construction Engineer</td>
</tr>
<tr>
<td><img src="https://via.placeholder.com/150" alt="Image" /></td>
<td>Note: 460201, 460213, and, 460212 exist in the Construction Carpentry Technology Program of Study.</td>
</tr>
<tr>
<td><img src="https://via.placeholder.com/150" alt="Image" /></td>
<td>Note: 210221, 219901, 219905, and 210223 exist in the Engineering Program of Study.</td>
</tr>
<tr>
<td><img src="https://via.placeholder.com/150" alt="Image" /></td>
<td>Note: (PLTW) courses require an agreement between Project Lead The Way and the Local School District.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Complete (3) THREE CREDITS:</th>
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<td><img src="https://via.placeholder.com/150" alt="Image" /></td>
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<td><img src="https://via.placeholder.com/150" alt="Image" /></td>
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</tbody>
</table>
# CTE-ENGINEERING HYBRID CAREER PATHWAYS
## 2017-2018

### DESIGN ENGINEERING
**CIP 15.1304.00**

**PATHWAY DESCRIPTION:** This pathway provides the opportunity to blend Career and Technical Education (CTE) courses with Engineering courses to help students apply technical skills along with science, technology, engineering, and math (STEM) skills to solve real-world problems. Design Engineers have a working knowledge of mechanical parts as well as computer-aided design (CAD) software, such as AutoCAD, Autodesk Inventor, or Solidworks. Mechanical designers begin a project by meeting with project managers, engineers, and clients to understand the needs and requirements for a new product or mechanical system. For example, designers working on a project to create an automobile engine may consult engineers regarding which structural materials to use or clients regarding engine efficiency requirements. Once materials and specifications have been determined, designers begin using CAD software to plan and develop models.

### BEST PRACTICE COURSES

**Complete (2) TWO CREDITS:**

- **210221** Fundamentals of Engineering Design **OR**
  - **219901** Introduction to Engineering Design (PLTW)
- **210222** Engineering Design **OR**
  - **219902** Principles of Engineering (PLTW)

**Choose (3) THREE CREDITS from the following:**

- 480110 Introduction to Computer Aided Drafting
- 480113 Engineering Graphics
- 480135 Mechanical Design
- 480136 Parametric Modeling

### EXAMPLE ILP-RELATED CAREER TITLES

- Engineer Technician
- Electrical Engineer
- Industrial Engineer
- Mechanical Engineer
- Civil Engineer
- Mechanical Designer

Note: 480110, 480113, 480135, and 480136 exist in the Computer Aided Design Technology Program of Study.

Note: 210221, 219901, 210222, and 219902 exist in the Engineering Program of Study.

Note: (PLTW) courses require an agreement between Project Lead The Way and the Local School District.
## CTE-ENGINEERING HYBRID CAREER PATHWAYS
### 2017-2018

### ELECTRICAL CONSTRUCTION ENGINEERING

**CIP 15.0303.00**

**PATHWAY DESCRIPTION:** This pathway provides the opportunity to blend Career and Technical Education (CTE) courses with Engineering courses to help students apply technical skills along with science, technology, engineering, and math (STEM) skills to solve real-world problems. This pathway prepares individuals to apply technical knowledge and skills to install, operate, maintain, and repair electric apparatus and systems such as residential, commercial, and industrial electric-power wiring; and DC and AC motors, controls, and electrical distribution panels. Includes instruction in the principles of electronics and electrical systems, wiring, power transmission, safety, industrial and household appliances, job estimation, electrical testing and inspection, and applicable codes and standards.

### BEST PRACTICE COURSES

#### Complete (2) TWO CREDITS:

- **210221** Fundamentals of Engineering Design **OR**
  - **219901** Introduction to Engineering Design (PLTW)
- **219903** Digital Electronics (PLTW) **OR**
  - **210232** Electricity and Electronics

#### Complete (3) THREE CREDITS:

- **460316** Circuits I (1.5 credits)
- **460319** Circuits II (1.5 credits)

<table>
<thead>
<tr>
<th>EXAMPLE ILP-RELATED CAREER TITLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Engineer</td>
</tr>
<tr>
<td>Electrical Engineering Tech</td>
</tr>
<tr>
<td>Electrician</td>
</tr>
</tbody>
</table>

Note: 460316, and 460319 exist in the Electrical Technology Program of Study.

Note: 210221, 219901, 219903, and 210232 exist in the Engineering Program of Study.

Note: (PLTW) courses require an agreement between Project Lead The Way and the Local School District.
# CTE-ENGINEERING HYBRID CAREER PATHWAYS
## 2017-2018

### FABRICATION ENGINEERING
**CIP 14.1901.00**

**PATHWAY DESCRIPTION:** This pathway provides the opportunity to blend Career and Technical Education (CTE) courses with Engineering courses to help students apply technical skills along with science, technology, engineering, and math (STEM) skills to solve real-world problems. Fabrication Engineers design parts to engineering specifications that are required for the development of metal parts and interior metal structures. Fabrication Engineers work with Sheet Metal Technicians in the development of complex geometrical parts. The Fabrication Engineer provides direct support to the manufacturing industry in the areas of design, fabrication, modification and development of metal assemblies, components and sub-assemblies.

<table>
<thead>
<tr>
<th>BEST PRACTICE COURSES</th>
<th>EXAMPLE ILP-RELATED CAREER TITLES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Complete (2) TWO CREDITS:</strong></td>
<td>Manufacturing Engineer</td>
</tr>
<tr>
<td>▪ <a href="#">210221</a> Fundamentals of Engineering Design <strong>OR</strong> <a href="#">219901</a> Introduction to Engineering Design (PLTW)</td>
<td>Sheet Metal Engineer</td>
</tr>
<tr>
<td>▪ <a href="#">210222</a> Engineering Design <strong>OR</strong> <a href="#">219902</a> Principles of Engineering (PLTW)</td>
<td>Note: 480816, 480813, 480817, and 480818 exist in the Metal Fabrication Program of Study.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Choose (3) THREE CREDITS from the following :</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ 480816 Metal Trade Information &amp; Metals</td>
<td>Note: 210221, 219901, 210222, and 219902 exist in the Engineering Program of Study.</td>
</tr>
<tr>
<td>▪ 480813 Parallel Line Layout</td>
<td>Note: (PLTW) courses require an agreement between Project Lead The Way and the Local School District.</td>
</tr>
<tr>
<td>▪ 480817 Sheet Metal 1-A</td>
<td></td>
</tr>
<tr>
<td>▪ 480818 Sheet Metal 1-B</td>
<td></td>
</tr>
</tbody>
</table>
# FLUID POWER ENGINEERING
CIP 15.1103.00

**PATHWAY DESCRIPTION:** This pathway provides the opportunity to blend Career and Technical Education (CTE) courses with Engineering courses to help students apply technical skills along with science, technology, engineering, and math (STEM) skills to solve real-world problems. Fluid Power Engineers design, fabricate, and test industrial hydraulic equipment. Fluid Power Engineers apply knowledge of hydraulic, pneumatic, and electrical principles to test equipment, and analyzes and records data, such as fluid pressure, flow measure, and power loss due to friction and parts wear. Fluid Power Engineers understand hydraulic symbols, reads system schematics, understands electrical principles, and is skilled in test procedures and instrumentation.

## BEST PRACTICE COURSES

### Complete (2) TWO CREDITS:
- [210221](#) Fundamentals of Engineering Design **OR** [219901](#) Introduction to Engineering Design (PLTW)
- [210222](#) Engineering Design **OR** [219902](#) Principles of Engineering (PLTW)

### Complete (3) THREE CREDITS:
- 470316 Advanced Hydraulic Systems
- 470326 Advanced Pneumatic Systems
- 470321 Fluid Power

<table>
<thead>
<tr>
<th>EXAMPLE ILP-RELATED CAREER TITLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Hydraulic Technician</td>
</tr>
<tr>
<td>Mechanical Engineer</td>
</tr>
<tr>
<td>Industrial Engineer</td>
</tr>
<tr>
<td>Pneumatic Specialist</td>
</tr>
<tr>
<td>Fluid Power Supervisor</td>
</tr>
<tr>
<td>Hydraulic Engineer</td>
</tr>
</tbody>
</table>

Note: 470316, 470326, and 470321 exist in the Industrial Maintenance Technology Program of Study.

Note: 210221, 219901, 210222, and 219902 exist in the Engineering Program of Study.

Note: (PLTW) courses require an agreement between Project Lead The Way and the Local School District.
**CTE-ENGINEERING HYBRID CAREER PATHWAYS**  
2017-2018

### INDUSTRIAL MAINTENANCE/ELECTRICAL ENGINEERING  
CIP 14.4101.00

**PATHWAY DESCRIPTION:** This pathway provides the opportunity to blend Career and Technical Education (CTE) courses with Engineering courses to help students apply technical skills along with science, technology, engineering, and math (STEM) skills to solve real-world problems. Electrical Engineers apply electrical theory and related knowledge to diagnose and modify developmental or operational electrical machinery and electrical control equipment and circuitry in industrial or commercial plants and laboratories. Electrical Engineers experiment with motor-control devices, switch panels, transformers, generator windings, solenoids, and other electrical equipment and components according to engineering data and knowledge of electrical principles.

<table>
<thead>
<tr>
<th>BEST PRACTICE COURSES</th>
<th>EXAMPLE ILP-RELATED CAREER TITLES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Complete (2) TWO CREDITS:</strong></td>
<td>Electrical Technician</td>
</tr>
<tr>
<td>210221 Fundamentals of Engineering Design <strong>OR</strong> 219901 Introduction to Engineering Design (PLTW)</td>
<td>Electrical Supervisor</td>
</tr>
<tr>
<td>219903 Digital Electronics (PLTW) <strong>OR</strong> 210232 Electricity and Electronics</td>
<td>Electrical Engineer</td>
</tr>
<tr>
<td><strong>Complete (3) THREE CREDITS:</strong></td>
<td>Note: 470348, 470322, and 470330 exist in the Industrial Maintenance Technology Program of Study.</td>
</tr>
<tr>
<td>470348 Industrial Maintenance Electrical Motor Controls</td>
<td>Note: 210221, 219901, 219903, and 210232 exist in the Engineering Program of Study.</td>
</tr>
<tr>
<td>470322 Industrial Maintenance Electrical Principles</td>
<td>Note: (PLTW) courses require an agreement between Project Lead The Way and the Local School District.</td>
</tr>
<tr>
<td>470330 Industrial Maintenance of PLC’s</td>
<td></td>
</tr>
</tbody>
</table>
# CTE-ENGINEERING HYBRID CAREER PATHWAYS
## 2017-2018

### STRUCTURAL ENGINEERING
#### CIP 14.0803.00

**PATHWAY DESCRIPTION:** This pathway provides the opportunity to blend Career and Technical Education (CTE) courses with Engineering courses to help students apply technical skills along with science, technology, engineering, and math (STEM) skills to solve real-world problems. This pathway prepares individuals to apply engineering principles and technical skills in support of architects, engineers, and planners engaged in designing and developing buildings, urban complexes, and related systems. Includes instruction in design testing procedures, building site analysis, model building and computer graphics, structural systems testing, analysis of prototype mechanical and interior systems, report preparation, basic construction and structural design, architectural rendering, architectural-aided drafting (CAD), layout and designs, architectural blueprint interpretation, building materials, and basic structural wiring diagramming.

## BEST PRACTICE COURSES

**Complete (2) TWO CREDITS:**

- [210221](#) Fundamentals of Engineering Design **OR** [219901](#) Introduction to Engineering Design (PLTW)
- [219905](#) Civil Engineering and Architecture (PLTW) **OR** [210223](#) Fundamentals of Architectural and Civil Engineering

**Complete (3) THREE CREDITS:**

- [460201](#) Introduction to Construction Technology
- [460218](#) Construction Forms
- [460214](#) Site Layout and Foundations

## EXAMPLE ILP-RELATED CAREER TITLES

<table>
<thead>
<tr>
<th>Architect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior Designer</td>
</tr>
<tr>
<td>Home Improvement Contractor</td>
</tr>
<tr>
<td>Carpenter</td>
</tr>
<tr>
<td>Construction Laborer</td>
</tr>
<tr>
<td>Construction Manager</td>
</tr>
<tr>
<td>Construction Supervisor</td>
</tr>
<tr>
<td>Project Manager</td>
</tr>
</tbody>
</table>

Note: 470201, 460218, and 460214 exist in the Construction Carpentry Technology Program of Study.

Note: 210221, 219901, 219905, and 210223 exist in the Engineering Program of Study.

Note: (PLTW) courses require an agreement between Project Lead The Way and the Local School District.
# WELDING ENGINEERING

## CIP 15.0614.00

### PATHWAY DESCRIPTION:
This pathway provides the opportunity to blend Career and Technical Education (CTE) courses with Engineering courses to help students apply technical skills along with science, technology, engineering, and math (STEM) skills to solve real-world problems. Welding Engineers design and develop metal components for products for the pipeline, automotive, boiler making, ship building, aircraft and mobile home industry. Welding Engineers must have knowledge of cutting processes and gas metal arc welding procedures for efficient development of these industrial processes.

### BEST PRACTICE COURSES

<table>
<thead>
<tr>
<th>Complete (2) TWO CREDITS:</th>
<th>EXAMPLE ILP-RELATED CAREER TITLES</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="210221" alt="Course Code" /> Fundamentals of Engineering Design OR <img src="219901" alt="Course Code" /> Introduction to Engineering Design (PLTW)</td>
<td>Pipe Welder</td>
</tr>
<tr>
<td><img src="210222" alt="Course Code" /> Engineering Design OR <img src="219902" alt="Course Code" /> Principles of Engineering (PLTW)</td>
<td>Certified Welding Inspector (CWI)</td>
</tr>
</tbody>
</table>

Choose (3) THREE CREDITS from the following:

- 480505 Blueprint Reading for Welding
- 480501 Cutting Processes
- 480522 Gas Metal Arc Welding
- 480521 Shielded Metal Arc Welding (SMAW)

### EXAMPLE ILP-RELATED CAREER TITLES

- Welding Engineer
- Structural Engineer
- Mechanical Engineer

Note: 480505, 480501, 480522, and 480521 exist in the Welding Technology Program of Study.

Note: 210221, 219901, 210222, and 219902 exist in the Engineering Program of Study.

Note: (PLTW) courses require an agreement between Project Lead The Way and the Local School District.
## WOOD MANUFACTURING ENGINEERING  
CIP 03.0509.00

**PATHWAY DESCRIPTION:** This pathway provides the opportunity to blend Career and Technical Education (CTE) courses with Engineering courses to help students apply technical skills along with science, technology, engineering, and math (STEM) skills to solve real-world problems. Wood Manufacturing Engineers design and create interior cabinets and wood products for homes and businesses. Wood Manufacturing Engineers consult with clients and Cabinetmakers for cutting, shaping wood, preparing surfaces and forming a completed product.

### BEST PRACTICE COURSES

<table>
<thead>
<tr>
<th>Complete (2) TWO CREDITS:</th>
<th>EXAMPLE ILP-RELATED CAREER TITLES</th>
</tr>
</thead>
</table>
| • **210221** Fundamentals of Engineering Design **OR**  
  **219901** Introduction to Engineering Design (PLTW) | Wood Product Supervisor |
| • **210118** Advanced Technological Applications **OR**  
  **219904** Computer Integrated Manufacturing (PLTW) | Wood Technologist |

**Choose (3) THREE CREDITS from the following:**

- 480731 Cabinet Making Technology
- 480725 CAD for Wood Technology
- 480721 Furniture Technology
- 480716 Lumber Grading and Drying
- 480740 Wood Product Manufacturing
- 480733 Advanced Wood Processing

**Note:** 480731, 480725, 480721, 480716, 480740, and 480733 exist in the Wood Manufacturing Technology Program of Study.

**Note:** 210221, 219901, 210118, and 219904 exist in the Engineering Program of Study.

**Note:** (PLTW) courses require an agreement between Project Lead The Way and the Local School District.
## COMPLEMENTARY OR ADVANCED COURSEWORK BEYOND ENGINEERING PATHWAY(s)

Upon completion of a pathway, additional coursework to enhance student learning is encouraged.

Credits earned in Advanced or Complementary Coursework “Beyond the Pathway” may not be substituted for pathway courses in order to achieve Preparatory or Completer status.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>210290</td>
<td>Special Topics, Engineering</td>
</tr>
</tbody>
</table>
Project Lead The Way (PLTW) Engineering Courses

Access to curriculum for PLTW Engineering Program requires a District/School Agreement with PLTW. Updated course content and information can be obtained from PLTW via: https://www.pltw.org/our-programs/pltw-engineering-curriculum.

<table>
<thead>
<tr>
<th>Aerospace Engineering (PLTW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid Course Code: 219907</td>
</tr>
<tr>
<td><strong>Course Description:</strong> This course propels students’ learning in the fundamentals of atmospheric and space flight. As they explore the physics of flight, students bring the concepts to life by designing an airfoil, propulsion system, and rockets. They learn basic orbital mechanics using industry-standard software. They also explore robot systems through projects such as remotely operated vehicles. Participation in Kentucky Technology Student Association will greatly enhance instruction.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Civil Engineering and Architecture (PLTW)</th>
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</thead>
<tbody>
<tr>
<td>Valid Course Code: 219905</td>
</tr>
<tr>
<td><strong>Course Description:</strong> Students learn important aspects of building and site design and development. They apply math, science, and standard engineering practices to design both residential and commercial projects and document their work using 3-D architectural design software. Participation in Kentucky Technology Student Association will greatly enhance instruction.</td>
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<thead>
<tr>
<th>Computer Integrated Manufacturing (PLTW)</th>
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</thead>
<tbody>
<tr>
<td>Valid Course Code: 219904</td>
</tr>
<tr>
<td><strong>Course Description:</strong> Manufactured items are part of everyday life, yet most students have not been introduced to the high-tech, innovative nature of modern manufacturing. This course illuminates the opportunities related to understanding manufacturing. At the same time, it teaches students about manufacturing processes, product design, robotics, and automation. Students can earn a virtual manufacturing badge recognized by the National Manufacturing Badge system. Participation in Kentucky Technology Student Association will greatly enhance instruction.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Digital Electronics (PLTW)</th>
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</thead>
<tbody>
<tr>
<td>Valid Course Code: 219903</td>
</tr>
<tr>
<td><strong>Course Description:</strong> From smartphones to appliances, digital circuits are all around us. This course provides a foundation for students who are interested in electrical engineering, electronics, or circuit design. Students study topics such as combinational and sequential logic and are exposed to circuit design tools used in industry, including logic gates, integrated circuits, and programmable logic devices. Participation in Kentucky Technology Student Association will greatly enhance instruction.</td>
</tr>
</tbody>
</table>
### Engineering Design and Development (Capstone) (PLTW)
Valid Course Code: 219906

**Course Description:** The knowledge and skills students acquire throughout PLTW Engineering come together in Engineering Design and Development as they identify an issue and then research, design, and test a solution, ultimately presenting their solution to a panel of engineers. Students apply the professional skills they have developed to document a design process to standards, completing Engineering Design and Development ready to take on any post-secondary program or career. Participation in Kentucky Technology Student Association will greatly enhance instruction.

### Environmental Sustainability (PLTW)
Valid Course Code: 219908

**Course Description:** Students investigate and design solutions in response to real-world challenges related to clean and abundant drinking water, food supply, and renewable energy. Applying their knowledge through hands-on activities and simulations, students research and design potential solutions to these true-to-life challenges. Participation in Kentucky Technology Student Association will greatly enhance instruction.

### Introduction to Engineering Design (PLTW)
Valid Course Code: 219901

**Course Description:** Students dig deep into the engineering design process, applying math, science, and engineering standards to hands-on projects. They work both individually and in teams to design solutions to a variety of problems using 3-D modeling software, and use an engineering notebook to document their work. Participation in Kentucky Technology Student Association will greatly enhance instruction.

### Principles of Engineering (PLTW)
Valid Course Code: 219902

**Course Description:** Through problems that engage and challenge, students explore a broad range of engineering topics, including mechanisms, the strength of structures and materials, and automation. Students develop skills in problem solving, research, and design while learning strategies for design process documentation, collaboration, and presentation. Participation in Kentucky Technology Student Association will greatly enhance instruction.

### Connections
- Kentucky Technology Student Association (KYTSA)
- Kentucky Occupational Skill Standards (KOSSA) OR Appropriate Industry Certification
- Standards for Technological Literacy
- Kentucky Academic Standards
**Advanced Technological Applications**
*Valid Course Code: 210118*

**Course Description:** This course includes activities and real world projects with state-of-the-art equipment and trainers. Students explore and study an introduction to engineering, engineering design problem solving, and engineering graphics with a 3D parametric modeling software. Students prototype a part design and prepare the manufacturing process using a 3D printer, CNC Vertical Mill, CNC turning center, a material handling robot and/or plastic molding machine. **Participation in Kentucky Technology Student Association will greatly enhance instruction.**

### Content/Process

**Students will:**
1. Apply the design process involving problem identification, conceptualization, and research, refinement of preliminary ideas, design analysis, development and implementation, detailed documentation of final design, optimization and final presentation.
2. Demonstrate an understanding of manufacturing, its history, models, and procedures.
3. Demonstrate an understanding of control systems and methods to describe or document their processes.
4. Demonstrate an understanding of the cost of manufacturing.
5. Demonstrate proficiency in designing products for manufacturability.
6. Demonstrate an understanding of manufacturing processes.
7. Demonstrate an understanding of computer numeric control (CNC) as it relates to product design and development.
8. Demonstrate an understanding of automation and robotics relative to the manufacturing process.
9. Demonstrate an understanding of the elements of power and the associated mathematics.
10. Build, program, and configure a robot to perform predefined tasks.
11. Demonstrate an understanding of the elements of Computer Integrated Manufacturing (CIM).
12. Demonstrate proficiency in designing an efficient flexible manufacturing system (FMS) that contains CIM elements.

### Connections
- Kentucky Technology Student Association (KYTSA)
- Kentucky Occupational Skill Standards (KOSSA) OR
  Appropriate Industry Certification
- Standards for Technological Literacy
- Kentucky Academic Standards
## Electricity and Electronics
### Valid Course Code: 210232

**Course Description:** In this course students will gain skills and knowledge through classroom and lab activities in the areas of basic DC and AC circuits, circuit components, codes, testing, electromagnetism and inductance, capacitance, power supplies, power generation and distribution, amplification, digital circuits, and computer fundamentals. Students will develop a basic understanding of the various types of energy and how energy is obtained. Students will learn the safe use of the tools, test instruments, equipment and supplies used in this course plus information on career opportunities in this field. Hands-on and problem solving activities will expose students to areas of electron theory, Ohm’s Law, insulators, conductors, electronic components, oscillators, and electronic fabrication.

**Participation in Kentucky Technology Student Association will greatly enhance instruction.**

### Content/Process

**Students will:**
1. Apply the design process involving problem identification, conceptualization, and research, refinement of preliminary ideas, design analysis, development and implementation, detailed documentation of final design, optimization and final presentation.
2. Develop knowledge and understanding of programmable logic controllers and electrical motors.
3. Demonstrate safe and appropriate use of tools, machines, and materials in electrical and electronic technology.
4. Understand and apply knowledge of direct current circuits and alternating current circuits as related to electrical technology.
5. Describe, construct, conduct, and analyze experiments with basic DC and AC circuits and with circuits using magnetism.
6. Describe the structure of matter related to electricity and electronics.
7. Use Ohm's law and Watt's law to analyze and experiment with resistive circuits.
8. Describe, construct, analyze and experiment with capacitive circuits.
9. Demonstrate the use of electrical and electronic equipment.
10. Demonstrate proper electronic assembly methods.
11. Demonstrate an understanding of basic electrical circuits and electronic systems.
12. Describe and experiment with integrated circuits.
13. Describe, construct, and experiment with circuits using semiconductors.

### Connections

- Kentucky Technology Student Association (KYTSA)
- Kentucky Occupational Skill Standards (KOSSA) OR Appropriate Industry Certification
- Standards for Technological Literacy
- Kentucky Academic Standards
# Engineering and Engineering Technology Co-op

**Valid Course Code:** 210330

| Course Description | | |
|--------------------|-------------------------------------------------|
| Cooperative education is a paid educational program consisting of in-school instruction combined with the program related on-the-job work experience in a business or industrial establishment. These are planned experiences supervised by the school and the employer to ensure that each phase contributes to the students Individual Learning Plan (ILP). Refer to the KDE Work Based Learning Manual for further specifications. | | |
| Participation in Kentucky Technology Student Association will greatly enhance instruction. | | |

## Content/Process

**Students will:**
- Gain career awareness and the opportunity to test career choice(s).
- Receive work experience related to career interests prior to graduation.
- Integrate classroom studies with work experience.
- Receive exposure to facilities and equipment unavailable in a classroom setting.
- Increase employability potential after graduation.
- Earn funds to help finance education expenses.

## Connections
- Kentucky Technology Student Association (KYTSA)
- Kentucky Occupational Skill Standards (KOSSA) **OR**
  - Appropriate Industry Certification
- Standards for Technological Literacy
- Kentucky Academic Standards
Engineering and Engineering Technology Design (Capstone)
Valid Course Code: 210110

Course Description: Engineering scope, content, and professional practices are presented through practical applications in this capstone course. Students in engineering teams apply technology, Kentucky Academic Standards, and skills to solve engineering design problems and create innovative designs. Students research, develop, test and analyze engineering designs using criteria such as design effectiveness, public safety, human factors and ethics. Participation in Kentucky Technology Student Association will greatly enhance instruction.

Content/Process

Students will:
1. Apply the design process involving problem identification, conceptualization, and research, refinement of preliminary ideas, design analysis, development and implementation, detailed documentation of final design, optimization and final presentation.
2. Identify, define, and justify a technical design problem for resolution.
3. Conduct research and investigation into the stated problem.
4. Perform and graphically represent an evaluation of proposed design solutions using specific criteria, including product specifications.
5. Design a solution to the problem and create a working prototype for testing.
6. Evaluate and select appropriate testing methodologies for testing the product, conduct product testing, refine the design as needed, and document the process and results.
7. Create and deliver a formal presentation of the solution to the problem to community stakeholders.

Connections
- Kentucky Technology Student Association (KYTSA)
- Kentucky Occupational Skill Standards (KOSSA) OR Appropriate Industry Certification
- Standards for Technological Literacy
- Kentucky Academic Standards
# Engineering and Engineering Technology Internship

**Valid Course Code:** 210331

<table>
<thead>
<tr>
<th>Course Description: Internship for CTE courses provides supervised work-site experience for high school students associated with their identified career pathway. Internship experiences consist of a combination of classroom instruction and field experiences. Participation in Kentucky Technology Student Association will greatly enhance instruction.</th>
</tr>
</thead>
</table>

## Content/Process

**Students will:**
1. Gain career awareness and the opportunity to test career choice(s).
2. Receive work experience related to career interests prior to graduation.
3. Integrate classroom studies with work experience.
4. Receive exposure to facilities and equipment unavailable in a classroom setting.
5. Increase employability potential after graduation.

## Connections

- Kentucky Technology Student Association (KYTSA)
- Kentucky Occupational Skill Standards (KOSSA) **OR** Appropriate Industry Certification
- Standards for Technological Literacy
- Kentucky Academic Standards
## Engineering Design
Valid Course Code: 210222

**Course Description:** A project and research based course that extends the learning experiences where students focus on mechanical, electrical, fluid and thermal systems allowing in depth exploration in selected disciplines of engineering areas such as manufacturing, power/energy/transportation, bio-medical, robotics, hydraulics, electricity/electronics, communications, construction systems, alternative energy, computer aided design and problem solving. **Participation in Kentucky Technology Student Association will greatly enhance instruction.**

### Content/Process

**Students will:**
1. Apply the design process involving problem identification, conceptualization, and research, refinement of preliminary ideas, design analysis, development and implementation, detailed documentation of final design, optimization and final presentation.
2. Recognize how the history of design (including artistic periods, styles, and form and function) influences product development.
3. Research information about professional engineering-related organizations.
4. Develop and demonstrate competencies with various engineering drawings.
5. Research selected disciplines of engineering areas such as manufacturing, power/energy/transportation, bio-medical, robotics, hydraulics, electricity/electronics, communications, construction systems, and/or alternative energy, and incorporate computer aided design and problem solving.
6. Develop solutions to problems within engineering areas such as manufacturing, power/energy/transportation, bio-medical, robotics, hydraulics, electricity/electronics, communications, construction systems, and/or alternative energy, and incorporate computer aided design and problem solving.
7. Apply geometric relationships of forms and shapes, lines, various polygons, geometric constraints, Cartesian coordinate system, and origin planes.
8. Perform modeling using conceptual, graphical, physical, mathematical, and computer generated techniques, including 3-dimensional software.
9. Develop knowledge and understanding of basic electric, welding and industrial process and symbols.
10. Develop knowledge and understanding of concepts of CAD, construction/fabrication techniques, structural systems, hydraulics, and pneumatics systems.
11. Conduct model analysis and verification.
12. Create model documentation including working drawings, dimensioning, and annotations.
13. Develop product presentations using proper communication techniques and appropriate presentation aids.

### Connections

- Kentucky Technology Student Association (KYTSA)
- Kentucky Occupational Skill Standards (KOSSA) **OR** Appropriate Industry Certification
- Standards for Technological Literacy
- Kentucky Academic Standards
Fundamentals of Aerospace Engineering  
Valid Course Code: 210229

**Course Description**: The fundamental concepts and approaches of aerospace engineering are highlighted through lectures on aeronautics, astronautics, and design. Project based course where students will design, build and test projects such as lighter-than-air (LTA) vehicle or various wing designs. The connections between theory and practice are realized in the design exercises. Required design reviews precede the LTA race competition. **Participation in Kentucky Technology Student Association will greatly enhance instruction.**

**Content/Process**

**Students will:**  
1. Apply the design process involving problem identification, conceptualization, and research, refinement of preliminary ideas, design analysis, development and implementation, detailed documentation of final design, optimization and final presentation.  
2. Identify the various vehicles used for human flight.  
3. Identify and explain the forces acting on an airplane, how the main components of the airplane control these forces, and how changes to the design of the airplane affect performance.  
4. Conduct model analysis and verification.  
5. Create model documentation including working drawings, dimensioning, and annotations.  
6. Use modeling and spreadsheet software to design and analyze data from various airfoil shapes.  
7. Identify the various instruments used to measure the lift and drag forces generated by an airfoil in a wind tunnel.  
8. Communicate test results through a technical report and a presentation to the class.  
9. Develop knowledge about the evolving technology of aerial navigation including VFR, IFR, VOR, Wide Area Augmentation System (WAAS), Local Area Augmentation Systems (L.A.A.S.), and Synthetic Vision systems to the Global Positioning System.  
10. Define terms and concepts of the design, flight, and forces on a rocket and be able to explain how they interact.  
11. Use trigonometry to calculate performance of rockets.  
12. Explain basic orbit theory satellite motion and orbit parameters.  
13. Work cooperatively in a team to design and conduct experiments related to positive G-force.  
14. Analyze various materials to determine their appropriate application in space craft.  
15. Design a computer-driven system for a robot to perform a series of predetermined functions without having anything impede its progress while successfully delivering a payload to a predetermined location.  
16. Design, build, and test an intelligent vehicle that will meet criteria determined by students.  

**Connections**

- Kentucky Technology Student Association (KYTSA)  
- Kentucky Occupational Skill Standards (KOSSA) OR  
  Appropriate Industry Certification  
- Standards for Technological Literacy  
- Kentucky Academic Standards
Fundamentals of Architectural and Civil Engineering  
Valid Course Code: 210223

**Course Description:** This is an introduction to residential and light commercial building construction and design. Students will learn basic sketching, architectural drafting skills with an emphasis on computer aided drafting. In this class, students will design a structure relevant to today’s modern architecture and create models of their designs with various materials and tools. Students will experience and solve many problems in designing or building structures with regards to environment and community impact and limitations from town planning, urban design and landscape architecture to furniture and objects. **Participation in Kentucky Technology Student Association will greatly enhance instruction.**

## Content/Process

**Students will:**
1. Apply the design process involving problem identification, conceptualization, and research, refinement of preliminary ideas, design analysis, development and implementation, detailed documentation of final design, optimization and final presentation.
2. Perform basic computer aided drafting functions and develop knowledge and skills in the use of various software programs.
3. Create project planning documentation including site information and development options.
4. Conduct site planning including grading, public ingress/egress, utilities, landscaping, water supply, and wastewater management.
5. Develop architecture plans reflecting various architectural styles that include floor plans, elevations, sections and details, schedules, HVAC, plumbing, and electrical systems, as well as communication and protection systems.
6. Define and evaluate structural engineering components including foundations, columns, beams, and roof systems.
7. Develop presentations of potential construction projects.
8. Use principles and elements of design including portfolio development containing various written work, drawings, models, and other documentation.
9. Perform sketching and visualization using proper techniques and tools to produce pictorial, annotated sketches, multi-view or orthographic drawings using proper and accurate measurements.
10. Perform modeling using conceptual, graphical, physical, mathematical, and computer generated techniques, including 3-dimensional software.
11. Conduct model analysis and verification.
12. Create model documentation including working drawings, dimensioning, and annotations.
13. Develop product presentations using proper communication techniques and appropriate presentation aids.

## Connections
- Kentucky Technology Student Association (KYTSA)
- Kentucky Occupational Skill Standards (KOSSA) OR Appropriate Industry Certification
- Standards for Technological Literacy
- Kentucky Academic Standards
Fundamentals of Engineering Design  
Valid Course Code: 210221

**Course Description:** This course applies the skills, concepts, and principles of engineering. Students explore various technological systems and engineering processes in related career fields. Topics include investigating technological system, design optimization, and problem solving. Students utilize CAD and physical and virtual modeling concepts to construct, test, collect, and report data. **Participation in Kentucky Technology Student Association will greatly enhance instruction.**

### Content/Process

**Students will:**

1. Apply the design process involving problem identification, conceptualization, and research, refinement of preliminary ideas, design analysis, development and implementation, detailed documentation of final design, optimization and final presentation.
2. Perform basic computer aided drafting functions and develop knowledge and skills in the use of CAD software.
3. Research information about professional engineering-related organizations.
4. Use principles and elements of design including portfolio development containing various written work, drawings, models, and other documentation.
5. Perform sketching and visualization using proper techniques and tools to produce pictorial, annotated sketches, multi-view or orthographic drawings using proper and accurate measurements.
6. Apply geometric relationships of forms and shapes, lines, various polygons, geometric constraints, Cartesian coordinate system, and origin planes.
7. Perform modeling using conceptual, graphical, physical, mathematical, and computer generated techniques, including 3-dimensional software.
8. Conduct model analysis and verification.
9. Create model documentation including working drawings, dimensioning, and annotations.
10. Develop product presentations using proper communication techniques and appropriate presentation aids.

### Connections

- Kentucky Technology Student Association (KYTSA)
- Kentucky Occupational Skill Standards (KOSSA) **OR** Appropriate Industry Certification
- Standards for Technological Literacy
- Kentucky Academic Standards
# Fundamentals of Mechatronics

**Valid Course Code:** 210230

## Course Description:
Electro-Mechanical Systems courses provide students with instruction and experience with mechanical devices, actuators, sensors, electronics, intelligent controllers and computers. Students gain an understanding of the principles of electricity and mechanics and their application to gears, including hydraulic/pneumatic equipment, cams, levers, circuits, and other devices used in the manufacturing process or within manufactured goods. **Participation in Kentucky Technology Student Association will greatly enhance instruction.**

## Content/Process

Students will:
1. Apply the design process involving problem identification, conceptualization, and research, refinement of preliminary ideas, design analysis, development and implementation, detailed documentation of final design, optimization and final presentation.
2. Define engineering systems including mechanisms, thermodynamics, fluid systems, electrical systems and control systems.
3. Demonstrate a fundamental understanding of electronics and electricity.
4. Apply troubleshooting and critical thinking skills to define the problem.
5. Identify material classifications and properties utilizing appropriate testing methods.
6. Calculate work and power in mechanical systems.
7. Measure forces and distances related to simple machines and mechanisms.
8. Calculate mechanical advantage and drive ratios of mechanisms.
9. Design, create, analysis and produce a mechanical system.
10. Demonstrate proficiency in using tools, instruments and testing devices.
11. Demonstrate a fundamental understanding of AC/DC electrical and electrical control.
12. Demonstrate an understanding of industrial safety, health, and environmental requirements.
13. Apply the principles of robotics to industrial automation systems.
14. Demonstrate proficiency in computer control and robotics.
15. Operate, troubleshoot, pneumatic, hydraulic and electromechanical components and/or systems.
16. Use machine interfaces to control automated systems.
17. Define dynamics/kinematics including linear and trajectory motion.

## Connections
- Kentucky Technology Student Association (KYTSA)
- Kentucky Occupational Skill Standards (KOSSA) **OR** Appropriate Industry Certification
- Standards for Technological Literacy
- Kentucky Academic Standards
Introduction to Aerospace  
Valid Course Code: 210226

**Course Description:** The course covers the exploration of aerospace including, flight/aeronautics, aircraft maintenance, aeronautical engineering, and space. Students will learn about the forces that affect controlled flight, investigate properties of lift, and explore flight through a flight simulator. Students will also learn about aerospace standard materials, aviation safety, aircraft and wing design, and elements of a space mission resource system. **Participation in Kentucky Technology Student Association will greatly enhance instruction.**

<table>
<thead>
<tr>
<th>Content/Process</th>
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<tbody>
<tr>
<td><strong>Students will:</strong></td>
</tr>
<tr>
<td>1. Apply the design process involving problem identification, conceptualization, and research, refinement of preliminary ideas, design analysis, development and implementation, detailed documentation of final design, optimization and final presentation.</td>
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<tr>
<td>2. Demonstrate an understanding of the history and development of aviation and space transportation.</td>
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<tr>
<td>3. Describe the aviation/aerospace environment.</td>
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<tr>
<td>4. Describe and demonstrate an understanding of the forces that affect flight.</td>
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<tr>
<td>5. Describe and demonstrate an understanding of lift through Bernoulli’s Principle and Newton’s Third Law of Motion.</td>
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<tr>
<td>6. Describe and demonstrate an understanding of the principles of flight.</td>
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<tr>
<td>7. Describe and demonstrate how flight simulators are used for training.</td>
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<tr>
<td>8. Demonstration flight maneuvers in a simulator: straight and level, turns, and climbs and descents.</td>
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<tr>
<td>9. Demonstrate technical knowledge of computer control as it is related to aviation/aerospace projects.</td>
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<tr>
<td>10. Describe and demonstrate an understanding of the materials that are used in aircraft design/development.</td>
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<tr>
<td>11. Describe and demonstrate an understanding of airfoils and their use in aviation.</td>
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<tr>
<td>12. Describe and demonstrate an understanding of rocketry/satellite technology and its application in space environments.</td>
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<tr>
<td>13. Describe and demonstrate an understanding of the process for deploying space assets through mission operation models.</td>
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<tr>
<td>14. Explore the role of civilian spacecraft in the exploration and colonization of space.</td>
</tr>
<tr>
<td>15. Demonstrate an understanding of career opportunities and requirements in the field of aerospace technologies.</td>
</tr>
</tbody>
</table>

**Connections**

- Kentucky Technology Student Association (KYTSA)
- Kentucky Occupational Skill Standards (KOSSA) **OR** Appropriate Industry Certification
- Standards for Technological Literacy
- Kentucky Academic Standards
## Introduction to Space Systems Engineering

**Valid Course Code:** 210235

### Course Description
The course introduces students to satellites and space systems: orbital mechanics; the space environment; satellite application; spacecraft design consideration; the roles universities, industry and government play in space exploration, and future technologies of spacecraft and satellites. **Participation in Kentucky Technology Student Association will greatly enhance instruction.**

### Content/Process

**Students will:**

1. Apply the design process involving problem identification, conceptualization, and research, refinement of preliminary ideas, design analysis, development and implementation, detailed documentation of final design, optimization and final presentation.
2. Demonstrate an understanding of the history and development of aviation and space transportation.
3. Demonstrate an understanding of power systems including, internal combustion engines, jet engines, rocket engines, solar cells and nuclear power used in aviation/aerospace applications.
4. Describe the space environment and types of spacecraft.
5. Demonstrate an understanding of electrical, mechanical, fluid, and pneumatic systems that could be used on/in aerospace environments.
6. Demonstrate a knowledge and understanding of processing skills on materials and composites as they relate to aerospace technologies.
7. Describe orbital motion and compute orbital elements and calculations.
8. Explore the role of civilian spacecraft in the exploration and colonization of space.
9. Acquire a number of technical skills that are in high demand in the workforce: the ability to work as a member of a team, to write good quality technical reports, and to give formal oral presentations.
10. Attain extensive experience in computer programming, modeling, and data acquisition and analysis.
11. Use computers and high-tech instrumentation to monitor and control technical systems, including the large structures of space tracking antennas.
12. Demonstrate an understanding of career opportunities and requirements in the field of aerospace technologies.
13. Demonstrate science and mathematics knowledge and skills.
14. Explore various career opportunities and requirements in the field of aerospace engineering, technicians, and scientists.
15. Use oral and written communication skills in creating, expressing and interpreting information and ideas.

### Connections

- Kentucky Technology Student Association (KYTSA)
- Kentucky Occupational Skill Standards (KOSSA) **OR** Appropriate Industry Certification
- Standards for Technological Literacy
- Kentucky Academic Standards
Course Description: This course provides students with content and skills essential to the design and operation of robotic systems. Students activities will include artificial intelligence, specialized sensors, electronic applications, engineering technologies, environmental physics, manufacturing, topographical considerations, programming, motions physics, electric motors, communications, simulations, simulation and modeling, and critical thinking skills. Participation in Kentucky Technology Student Association will greatly enhance instruction.

Content/Process

Students will:
1. Apply the design process involving problem identification, conceptualization, and research, refinement of preliminary ideas, design analysis, development and implementation, detailed documentation of final design, optimization and final presentation.
2. Correlate elements of artificial intelligence to their functions in robotics.
3. Describe the various classification schemes of sensors applicable to robotics.
4. Explain how electronic devices are used in the operation of a robotic assembly.
5. Demonstrate an understanding of various technologies used in the design of robotic assemblies.
6. Demonstrate an understanding of advanced mathematics and physics associated with the design of a robotic assembly.
7. Create a program to control a robotic mechanism.
8. Describe the operation and use of various forms of electrical motors in robotic assemblies.
9. Demonstrate an understanding of basic 3D modeling concepts as it relates to robotics.
10. Analyze and apply data and measurements to solve problems and interpret documents.
11. Design, build, program, and configure a robot to perform predefined tasks.
12. Formulate scientifically investigable questions, construct investigations, collect and evaluate data, and develop scientific recommendations based on findings.
13. Describe the approaches, challenges, and problem-solving methodologies involved with integrating artificial intelligence into robotic systems.
14. Describe the role of specialized sensors in the design and operation of robotic systems.
15. Describe the use of specialized electronic applications used in robotic systems.
16. Demonstrate an understanding of the impact of robotics on the manufacturing process.
17. Create a program to control a robotic system.
18. Demonstrate an understanding of technologies for communication with and among robotic systems.

Connections

- Kentucky Technology Student Association (KYTSA)
- Kentucky Occupational Skill Standards (KOSSA) OR Appropriate Industry Certification
- Standards for Technological Literacy
- Kentucky Academic Standards
## Course Description

An instructional program in astronautics designed to develop basic knowledge of space systems and to gain practical experience in designing, fabricating, and testing space type experiments. Students will learn and understand the constraints on device design to operate in the LEO (Low Earth Orbit) space environment. Students will also get hands-on experience in a laboratory environment and in the safe use of shop equipment. **Participation in Kentucky Technology Student Association will greatly enhance instruction.**

### Content/Process

**Students will:**

1. Apply the design process involving problem identification, conceptualization, and research, refinement of preliminary ideas, design analysis, development and implementation, detailed documentation of final design, optimization and final presentation.
2. Demonstrate an understanding of the history and development of aviation and space transportation.
3. Demonstrate an understanding of electrical, mechanical, fluid, and pneumatic systems that could be used on/in aerospace environments.
4. Describe various space-rated materials and structures utilized for spacecraft.
5. Understand space vehicle control systems, attitude control, attitude determination, passive and active control systems.
6. Demonstrate how manufacturing processes are utilized in space technology.
7. Develop an understanding of launch procedures, payload requirements, pre-flight testing and flight operations.
8. Describe orbital motion and compute orbital elements and calculations.
9. Explore the role of civilian spacecraft in the exploration and colonization of space.
10. Acquire a number of technical skills that are in high demand in the workforce: the ability to work as a member of a team, to write good quality technical reports, and to give formal oral presentations.
11. Attain extensive experience in computer programming, modeling, and data acquisition and analysis.
12. Use computers and high-tech instrumentation to monitor and control technical systems, including the large structures of space tracking antennas.
13. Develop an understanding of concepts of physics, space science, communications electronics, and mathematics.
14. Demonstrate an understanding of the effects of flight as it relates to physiology.
15. Demonstrate an understanding of career opportunities and requirements in the field of aerospace technologies.

### Connections

- Kentucky Technology Student Association (KYTSA)
- Kentucky Occupational Skill Standards (KOSSA) [OR](http://www.kytc.org) Appropriate Industry Certification
- Standards for Technological Literacy
- Kentucky Academic Standards