Learning that works for South Dakota CTE™

STEM Cluster

Foundation Courses

Cluster Courses
Introduction to Technology Education – Introduction to STEM – Middle School Mechatronics/Robotics

Pathway Courses

Aviation

PLTW: Aerospace Engineering

Other: Aviation

Computer Science

PLTW: Intro to Computer Science

Other: Information Systems

Robotics

Electronics

Engineering Design and Development

Computer Programming 1

Computer Programming 2

Robotics

Energy

Introduction to Energy/Power

Alternate Energy Systems

Engineering

Other:
- Intro to Engineering
- Intro to Manufacturing
- Intro to Drafting & Design
- Architectural Drafting
- Mechanical Drafting & Design
- Industrial & Bioprocess Engineering

PLTW:
- Intro to Engineering Design
- Principles of Engineering
- Digital Electronics
- Civil Engineering & Architect
- Biotechnical Engineering

Capstone Experience

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Middle School Introduction to STEM

Career Cluster	Middle School
Course Code	21050
Prerequisite(s)	None
Credit	.5
Program of Study and Sequence	Cluster course
Student Organization	None
Coordinating Work-Based Learning	field trips
Industry Certifications	None
Dual Credit or Dual Enrollment	None
Teacher Certification	Technology Education
Resources	https://Vimeo.com/67277269

Course Description: This course serves as an introduction to Science, Technology, Engineering and Mathematics (STEM) with primary areas of focus on aviation, energy, engineering, and robotics. It will provide a basic background to allow students to identify interests which may assist students in pathway and course selection at the secondary level.

Program of Study Application

This is a STEM Cluster Course in the STEM Engineering Pathway. It is recommended that the course be preceded by a series of foundation courses followed by additional cluster courses and more specialized pathway courses at the secondary level. These pathways may include courses related to Robotics, Energy, Engineering and Aviation.

Course Standards

Indicator # STEM 1 Understand the components of STEM

Webb Level	*Sub-indicator*	*Integrated Content*
	STEM 1.1 Understand the components of STEM and the impact of STEM on society	
	Examples:	
Three Strategic Thinking	• Investigate and explore the components of STEM and its global impact.	
One Recall	• Identify components of STEM and explore the role of STEM in society	
Two Skill/ Concept	• Observe and Investigate where STEM appears in daily life	
Three Strategic Thinking	• Analyze how STEM has impacted the student's life	
	STEM 1.2 Explore the impact of STEM related careers	
	Examples:	
Two Skill/ Concept	• Research, explore and analyze how STEM is involved in careers globally	
One Recall	• Explore different fields of work related to STEM based career	
Two Skill/ Concept	• When given a STEM based career, research education commitment, cost requirements and financial benefits	Research, language arts, math
Three Strategic Thinking	• Research and create a presentation related to a STEM based career of interest **May be used as an introductory or culminating course activity*	Research, soft skills (teamwork, communication)

Notes:

Indicator # STEM 2 Understand the foundation of STEM in aviation.

Webb Level	*Sub-indicator*	*Integrated Content*
	STEM 2.1 Identify how STEM is applied in the field of aviation.	
	Examples:	
One Recall	• List the different types of aviation	Research
Two Skill/ Concept	• Explore the role of aerodynamics in flight	Physics, math, soft skills (communication), design process
Three Strategic Thinking	• Investigate how the shape of a wing impacts flight dynamics	Physics, math, soft skills (communication)
Four Extended Thinking	• Analyze weight in relation to flight	
	STEM 2.2 Evaluate careers related to aviation	
	Examples:	
Three Strategic Thinking	• Investigate the importance of STEM in an aviation career	
One Recall	• Explore multiple careers in aviation	
Two Skill/ Concept	• Compare and contrast salary options for various aviation careers	Math, soft skills (communication)
Three Strategic Thinking	• Analyze the key component of STEM in a given aviation career.	Math, computer skills

Notes:

Indicator # STEM 3 Understand the foundation of STEM in relation to Energy

Webb Level	*Sub-indicator*	*Integrated Content*
	STEM 3.1. Identify the application of STEM in the field of energy and/or energy production.	
	Examples:	
One Recall	• Identify multiple types of energy sources and their applications	
One Recall	• List different types of energy and energy sources.	*research*
Two Skill/ Concept	• Compare and contrast renewable and nonrenewable energy	Design process, soft skills (communication), energy
Three Strategic Thinking	• Create a solar cooker to cook an egg	Math
Four extended Thinking	• Generate wind energy by creating a turbine using given materials	Engineering, soft skills (communication)
	STEM 3.2 Explore the career opportunities in the field of energy related to STEM	
	Examples:	
One Recall	• List the type of career options related to energy	
Two Skill/ compact	• Evaluate the career opportunities related to energy and its uses.	
Two Skill/ compact	• Compare and contrast the salaries for different types of energy production careers	

Three Strategic Thinking	• Analyze new/alternative energy sources and the positive and negative aspects of each	Research, soft skills (communication)			

Notes:

Indicator # STEM 4 Understand the foundation of STEM in Engineering.

Webb Level	*Sub-indicator*	*Integrated Content*
	STEM 4.1 Understand how STEM is a part of all aspects of engineering	
	Examples:	
One Recall	• Name the different fields of engineering	
Two Skill/ Concept	• Identify how STEM is applied to different engineering fields	
Three Strategic Thinking	• Create a prototype of a design idea. After testing prototype, follow the revision process to improve the design.	Design process, soft skills (communication, problem solving, teamwork)
Four extended Thinking	• When given a problem, create a design plan, create a course of action and communicate intentions with other.	

	STEM 4.2 Evaluate the career opportunities associated with engineering	Soft skills (Communication), analysis of information, engineering) Career Development
	Examples:	
One Recall	• Identify the types of engineers	Soft skills (Communication), analysis of information, engineering
Two Skill/ Concept	• Evaluate the career opportunities related to different fields of engineering	Career Development
Three Strategic Thinking	• When given a product, research the type of engineering necessary for the product to have been created.	Research, soft skill (communication)

Notes:

Indicator # STEM 5 Understand the foundation of STEM in robotics.

Webb Level	*Sub-indicator*	*Integrated Content*
	STEM 5.1 Explore the relationship between STEM and robotics	
	Examples:	
One Recall	• Identify the uses of robots	Design process, basic coding, soft skills (communication)
Two Skill/ Concept	• Demonstrate understanding of basic components of a robot	Soft skills (Communication) economics
Three Strategic Thinking	• When given a problem, brainstorm potential solutions that could be carried out by a robot	
Four extended Thinking	• Design and/or program a robot to follow a set of commands	
	STEM 5.2 Evaluate the career opportunities associated with the field of robotics.	
	Examples:	
One Recall	• Identify jobs that may be created or enhanced by robots	
Two Skill/ Concept	• Describe how the robotics field may influence the job market	Soft skills (Communication) economics
Three Strategic Thinking	• Compare and contrast career opportunities related to different fields of robotics.	

Notes:

Middle School Mechatronics/Robotics

Career Cluster	STEM
Course Code	21016
Prerequisite(s)	None
Credit	.5
Program of Study and Sequence	Foundational Courses, Cluster Courses, Pathway Courses, Capstone Experience
Student Organization	FIRST Lego League and FIRST Tech Challenge
Coordinating Work-Based Learning	tours of local businesses with robotics virtual tours of industrial robots http://highered.mheducation.com/sites/dl/free/0078308291/223250/robot.html
Industry Certifications	None
Dual Credit or Dual Enrollment	None
Teacher Certification	Technology Education
Resources	

Course Description:

Middle School Robotics/Mechatronics course allows students to develop an understanding of how robots function, their applications, and how to program them to perform specified tasks.

Program of Study Application

This course is a STEM Cluster course, which may be followed by the STEM Pathway course of Mechatronics/Robotics, followed by a Senior Capstone course.

Career Cluster: STEM

Course: Middle School Mechatronics/Robotics

Course Standards

Indicator # MSMR 1 Understand the components that make up a robot

Webb Level	*Sub-indicator*	*Integrated Content*
Two Skill/ Concept	MSMR 1.1. Know the equipment used in robotics *Example:* • Identify types of electronic sensors. • Explain various functions of motors. • Explain the role of a computer as a robotic control device.	
Two Skill/ Concept	MSMR 1.2. Identify various mechanical systems used in robotics *Example:* • Describe a belt and pulley speed reduction system. • Recognize the importance and application of mechanical advantages.	Science
Three Strategic Thinking	MSMR 1.3. Demonstrate the use of programming commands *Example:* • Compile a program to demonstrate a robotic "dance." • Develop a program to move a robot along a particular path.	Computer Coding

Notes:

Indicator # MSMR 2 Investigate the impact of robotics on our society

Webb Level	*Sub-indicator*	*Integrated Content*
Three Strategic Thinking	MSMR 2.1. Compare and contrast robotics labor vs. human labor *Example:* • Explain the economic advantages/disadvantages of robotic labor. • Evaluate the decision of hiring 4 humans vs. 1 robot to do the same job.	Social Science
Two Skill/ Concept	MSMR 2.2. Explore career outlook for robotic applications *Example:* • Identify jobs that will be created/eliminated by robotics. • Predict potential robotics related careers.	Career Development
Two Skill/ Concept	MSMR 2.3. Explore new entrepreneurial opportunities using robotics *Example:* • Discuss a fictitious business venture utilizing robotic labor. • Identify a business that could be improved using a robotic system.	

Notes:

Indicator # MSMR 3 Design a robot to solve a particular problem

Webb Level	*Sub-indicator*	*Integrated Content*
Three Strategic Thinking	MSMR 3.1. Identify robotic applications *Example:* • In group discussion, consider the application of robotics. • Draw a robot. Present the drawings and discuss the various differences in the drawings.	Soft Skills: communication, team-work, presentation
Four Extended thinking	MSMR 3.2. Propose a robotic design *Example:* • Sketch a diagram of a robot that completes a task; e.g. disk jockey, trash collector, welder, transporter, etc. • Present an idea to the class of how a robot can make your quality of life better.	Soft Skills: presentation
Four Extended thinking	MSMR 3.3. Construct a functional robot. *Example:* • Build a Lego robot. • Use an Erector set to construct a robot. • Use a VEX set to construct a robot.	
Four Extended thinking	MSMR 3.4. Program a robot to perform a specific task. *Example:* • Write and upload a program to navigate a robot through a maze. • Write a program to make a robot follow a line.	Computer Coding
Four Extended thinking	MSMR 3.5. Evaluate robot programming *Example:* • Record data on the precision of a program that operates a robot. • Analyze inconsistencies in the completion of a particular repetitive task performed by a robot.	

Notes:

Introduction to Technology Education

Career Cluster	STEM
Course Code	21051
Prerequisite(s)	None
Credit	.5
Program of Study and Sequence	Foundational course
Student Organization	None
Coordinating Work-Based Learning	Field trips
Industry Certifications	None
Dual Credit or Dual Enrollment	None
Teacher Certification	Technology Education
Resources	http://www.iste.org/standards/ISTE-standards/standards-for-students; www.google/earth.com

Course Description:

Technology is a significant part of society. Most careers call for some type of technology skills, knowledge, and abilities. Technology education brings deeper meaning to core content concepts while introducing students to various technologies, technical skills, critical thinking processes, and hands-on experiences. Students will increase their technological literacy, problem solving, and creative/critical thinking skills. Within this course the following topics of study will be addressed: nature of technology, technology and society, design process, energy and power, manufacturing, construction, transportation, communication, professionalism, health, safety and the environment.

Program of Study Application- This is a STEM Cluster Course in the STEM Engineering Pathway. It is recommended that the course be preceded by a series of foundation courses and a cluster course(s) in STEM, and followed by a more specialized pathway course such as Industrial and Bioprocess Engineering, Mechanical Drafting & Design, Architectural Drafting, and/or Robotics.

Note: Each standard has been addressed at four Webb levels. This differentiation may be used to determine appropriateness for grade level use or progression of learning.

Course Standards

Indicator # ITE 1 Analyze the scope and nature of technology

Webb Level	*Sub-indicator*	*Integrated Content*
	ITE.1.1 Examine the relationship between technology and other areas of study.	
	Examples:	
Level 2: Skill/ Concept	Conduct investigations to examine the relationship between technology and other areas of study.	
Level 1: Recall	Describe how technology has impacted life and or society.	
Level 2: Skill/ Concept	Construct a technological product and identify scientific principles in the design.	
Level 3: Strategic Thinking	Demonstrate an understanding of technology by evaluating the use of multiple technologies.	
Level 4: Extended Thinking	Evaluate the impact of technological advances and/or innovation on history.	American history, world history

	ITE.1.2. Understand the effects of technology on the natural environment.	
	Examples:	
Level 1: Recall	Understand how technology affects the natural environment.	
Level 1: Recall	List ways technology positively and negatively affects the natural environment.	Environmental science
Level 2: Skill/ Concept	Identify five types of energy and a primary source of each of these energy types.	Energy, renewable/non-renewable resources, Earth Science
Level 3: Strategic Thinking	Assess the relationship between technology and/or energy source and pollution production.	Environmental science
Level 4: Extended Thinking	Strategize ways to reduce adverse effects of pollution on the environment.	Environmental science

	ITE.1.3. Examine the relationship between the cultural, social, economic, and political effects of technology on society.	
	Examples:	
Level 3: Strategic Thinking	Observe and analyze connections between technology and cultural, social, economic and political aspects of society and vice versa.	
Level 1: Recall	Identify current technological factors that have influenced societal, economic or political decision making.	
Level 2: Skill/ Concept	Identify the relationship between a law, policy or best practice involving technology and its impact on culture, society, economics and/or political issues.	
Level 3: Strategic Thinking	Investigate an invention and its impact on society.	
Level 4: Extended Thinking	Design a technological invention that would have a positive cultural, social, economic or political benefit.	

Notes:

Indicator # ITE 2 Apply the system-thinking model (the feedback loop) to technology

Webb Level	*Sub-indicator*	*Integrated Content*
	ITE.2.1 Apply the design process to engineering design process.	
	Examples:	
Level 2: Skill/ Concept	Demonstrate understanding of an appropriate engineering design process.	
Level 1: Recall	Draw, label and define the components of the system-thinking model.	Engineering
Level 2: Skill/ Concept	Propose improvement to the design of a simple technological product based on performance data.	
Level 3: Strategic Thinking	Construct a product based upon specification and build a prototype.	
Level 4: Extended Thinking	Create an original design.	Teamwork, engineering, graphing, math, algebra

Notes:

Indicator # ITE 3 Solve problems using innovation, research, experimentation and design

Webb Level	*Sub-indicator*	*Integrated Content*
	ITE.3.1 Use research and experimentation methods to solve problems.	
	Examples:	
Level 2: Skill/ Concept	Apply data and information to solve a problem.	
Level 1: Recall	Use existing information to identify a problem within a system to be solved.	
Level 2: Skill/ Concept	Utilize data to find possible solutions to a problem.	Teamwork, communication, analysis, computer skills, math, statistics, problem solving
Level 3: Strategic Thinking	Compare and contrast a functional and non-functional problem solving system.	
Level 4: Extended Thinking	Design a research method and conduct research to collect and analyze data.	Data collection, analyzation, physical science

	ITE.3.2. Use innovative and/or troubleshooting methods to solve problems.	
	Examples:	
Level 2: Skill/ Concept	Examine a problem and find an appropriate solution using innovative and/or troubleshooting methods.	
Level 1: Recall	Identify potential troubleshooting techniques.	Troubleshooting, problem solving
Level 2: Skill/ Concept	Apply appropriate troubleshooting techniques	Troubleshooting, problem solving
Level 3: Strategic Thinking	Troubleshoot a system that is malfunctioning and use tools and/or systems to repair it.	Scientific methods, data collections, survey, social sciences
Level 4: Extended Thinking	Analyze a problem and implement a troubleshooting method using a given set of materials	

Notes:

Indicator # ITE 4 Apply appropriate skill sets to various ranges of technology

Webb Level	*Sub-indicator*	*Integrated Content*
	ITE.4.1. Understand biotechnologies	
	Examples:	
Level 2: Skill/ Concept	Demonstrate an understanding of biotechnology and its applications.	
Level 1: Recall	Define biotechnology and identify specific areas of application.	
Level 2: Skill/ Concept	Identify industrial uses of bacteria and yeast.	Microbiology, chemistry, life science, high school/college microbiology visit
Level 3: Strategic Thinking	Design and implement an experiment to show differences in growing conditions for fuel crops.	Ag education, field visit
Level 4: Extended Thinking	Conduct an experiment to produce ethanol from food crops.	

	ITE.4.2 Understand energy and power technologies	
	Examples:	
Level 2: Skill/ Concept	Understand the sources and application of power technologies	
Level 1: Recall	Define the law of conservation of energy.	
Level 2: Skill/ Concept	Demonstrate or explain how one source of energy can be used for multiple applications.	
Level 3: Strategic Thinking	Compare and contrast different sources of energy and power	
Level 4: Extended Thinking	Design and construct a solar collector from household items	Engineering
	ITE.4.3 Understand information and communication technologies	
	Examples:	
Level 3: Strategic Thinking	Evaluate a situation to identify the appropriate digital communication.	
Level 1: Recall	Demonstrate use of different means of digital communication.	Communication skills
Level 2: Skill/ Concept	Determine the appropriate means of communication based on tasks given, e.g., email, text, interpersonal, social media, networking and interaction.	Communication skills
Level 3: Strategic Thinking	Distinguish between reliable and non-reliable digital information.	Language arts

Level 4: Extended Thinking	Design a webpage or audiovisual presentation to communicate information.	Software development, software use, English, art and design
	ITE.4.4 Understand transportation technologies	
Examples:		
Level 2: Skill/ Concept	Demonstrate understanding of the connection between technology and transportation needs.	
Level 1: Recall	Explain different types of transportation needed to get an agricultural product from the field to consumer	
Level 2: Skill/ Concept	Compare the cost differences between personal and public transportation.	Math, geography
Level 3: Strategic Thinking	Create a student traffic pattern to improve the safety of student traffic around the parking lots of the high school.	Math, design, google earth
Level 4: Extended Thinking	Design a transportation plan and cost analysis for storing and delivering a perishable product over an extended time period.	Ice cream/cold storage manufacturing visit
	ITE.4.5 Understand manufacturing technologies and materials	
	Examples:	
Level 2: Skill/ Concept	Apply different manufacturing technologies to meet a given situation.	
Level 1: Recall	List different types of manufacturing technologies.	
Level 2: Skill/ Concept	Compare and contrast manufacturing technologies to determine appropriate system for a process.	
Level 3:	Evaluate how an assembly line system can affect the efficiency of a	Visit manufacturing

Strategic Thinking	manufacturing process	industry with/without assembly line
Level 4: Extended Thinking	Construct a simple cost benefit analysis for a given product	
	ITE.4.6 Understand construction technologies	
	Examples:	
Level 2: Skill/ Concept	Evaluate and apply construction methods to build the necessary infrastructure component(s).	
Level 1: Recall	List multiple types of construction for infrastructure, e.g., types of construction needed to build a new city.	
Level 2: Skill/ Concept	Estimate the amount of material needed to build a structure.	
Level 3: Strategic Thinking	Assess the effectiveness of using the same materials for different structures.	
Level 4: Extended Thinking	Given a budget, design and construct a bridge that can hold the most weight, using available materials	

Notes:

Indicator # ITE 5 Understand ethics and professionalism in technology

Webb Level	*Sub-indicator*	*Integrated Content*
	ITE.5.1 Investigate and demonstrate understanding of professionalism and ethics in the technological environment.	
Examples:		
Level 3: Strategic Thinking	Investigate and demonstrate understanding of professionalism and ethics in the technological environment.	
Level 1: Recall	Identify different technological work environments and recognize appropriate professional attire.	Health, hygiene, personal attire
Level 2: Skill/ Concept	Demonstrate an understanding of ethics issues such as plagiarism, copyright and intellectual property rights in technological environments.	Language arts, English Teamwork
Level 3: Strategic Thinking	Differentiate between possible ethical choices. Role play to model different possible outcomes. Compare and contrast outcomes of different ethical situations in a work environment.	ethics
Level 4: Extended Thinking	Brainstorm potential responses to various workplace ethics violations.	Sensitivity training

Notes:

Indicator # ITE 6 Understand safety and health in technology

Webb Level	*Sub-indicator*	*Integrated Content*
	ITE.6.1. Understand implication of health and public safety standards	
	Examples:	
Level 2: Skill/ Concept	Communicate the importance of health and safety standards in technological environment.	
Level 1: Recall	List the safety procedures and equipment used in various technology sectors.	
Level 2: Skill/ Concept	Demonstrate and understand the importance and use of safety equipment.	
Level 3: Strategic Thinking	Evaluate the effectiveness of safety tools available for a given task.	
Level 4: Extended Thinking	Analyze potential consequences to self and others of not following health and safety standards. • Design a plan to improve the safety of a work environment.	Work place visit

Notes: Please refer to OSHA safety guidelines for more information and resources

Aviation

Career Cluster	STEM
Course Code	20053
Prerequisite(s)	None
Credit	.5
Program of Study and Sequence	Foundation Courses, Cluster Courses, Pathway Courses, Capstone Experiences
Student Organization	Skills USA
Coordinating Work-Based Learning	local airports
Industry Certifications	None
Dual Credit or Dual Enrollment	TBD
Teacher Certification	Technology Education
Resources	https://www.faa.gov/education/ https://www.faa.gov/education/educator_resources/curriculum/high_school/ https://www.osha.gov/SLTC/airline_industry/

Course Description: This course provides students with an understanding of the science of flight and the history, regulations, and possible career paths within the aviation industry. It also covers the relationships of weight and balance, principles of navigation and flight control, ground and airport operations and services, and Federal Aviation Agency regulations.

Program of Study Application

Aviation is a pathway course in the aviation pathway. Students in this pathway would generally complete foundation courses and one of the STEM cluster courses prior to participating in aviation.

Course Standards

Indicator # AV 1: Identify events in the history of flight.

Webb Level	*Sub-indicator*	*Integrated Content*
Two Skill/ Concept	AV 1.1 Identify flight in the ancient world *Examples:* • Identify the history of flight in Greek Myths. • Identify the importance of Kites and Balloons in China during the third century.	
Two Skill/ Concept	AV 1.2 Identify the development of flight in the early 1900s. *Examples:* • Distinguish the difference between lighter-than-air and heavier than-air vehicles. • Identify the importance of blimps. • Identify the importance of the Wright brothers.	
Two Skill/ Concept	AV 1.3 Identify the development of flight during the Golden Age of Flight (1918 to 1939) *Examples:* • Identify the importance of Charles Lindbergh. • Identify the importance of the Airmail Act (Kelly Act of 1925).	
Two Skill/ Concept	AV 1.4 Identify the development of flight innovation during World War II (1939 to 1945) *Examples:* • Identify the importance of the V-2 rocket. • Identify the importance of early jets.	

Two Skill/ Concept	AV 1.5 Identify the development of flight innovation during the Cold War (1945 to 1991) *Examples:* • Identify the importance of commercial aviation. • Identify the importance of space flight.	
Two Skill/ Concept	AV 1.6 Identify the development of flight innovation (1991 to present) *Examples:* • Identify the importance of military aviation. • Identify the importance of the space shuttle program.	
Three Strategic Thinking	AV 1.7 Analyze current trends in flight. *Examples:* • Investigate the importance of unmanned flight. • Evaluate challenges that arise with emerging flight technologies.	Code of Conduct for unmanned flight: http://www.auvsi.org/conduct

Notes:

Indicator # AV 2 Investigate the principles of flight.

Webb Level	*Sub-indicator*	*Integrated Content*
Three Strategic Thinking	AV 2.1 Investigate the basic parts and control surfaces on aircraft. *Examples:* • Examine the utilization of the airfoil. • Examine the utilization of the wings. • Examine the utilization of the tail. • Examine the utilization of the propeller.	
Three Strategic Thinking	AV 2.2 Investigate the four forces of flight. *Examples:* • Explore the concept of lift versus weight. • Explore the concept of thrust versus drag.	Physical Science
Four Extended Thinking	AV 2.3 Investigate basic aerodynamics. *Examples:* • Apply Newton's Three Laws of Motion to flight. • Understand the impact of the Bernoulli Effect on airfoil. • Understand the impact of the Venturi Effect on propulsion. • Compare Static versus Dynamic Pressure.	Physical Science & Physics
Three Strategic Thinking	AV 2.4 Investigate airplane stability. *Examples:* • Explore the concept of pitch. • Explore the concept of roll. • Explore the concept of yaw.	Physics

Notes:

Indicator # AV 3 Understand the flight environment.

Webb Level	*Sub-indicator*	*Integrated Content*
Two Skill/ Concept	AV 3.1 Comprehend air safety. *Examples:* • List air safety concerns. • Demonstrate an understanding of the Federal Aeronautics Administration (FAA) regulations.	
Two Skill/ Concept	AV 3.2 Comprehend the airport layout, inclusive of safety elements. *Examples:* • List types of airports. • Identify causes of runway accidents. • Design a safe and effective airport layout.	
Three Strategic Thinking	AV 3.3 Comprehend airspace control. *Examples:* • Complete a flight plan. • Comprehend air-traffic control procedures.	
Two Skill/ Concept	AV 3.4 Comprehend radio communications. *Examples:* • Demonstrate procedures of radio communications during conduct of a flight. • Demonstrate cockpit management of radio systems.	Soft skills: communication

Notes:

Indicator # AV 4 Understand aircraft systems and performance

Webb Level	*Sub-indicator*	*Integrated Content*
Two Skill/ Concept	AV 4.1 Know the basic aircraft instruments. *Examples:* • Identify the six basic aircraft instruments (airspeed indicator, attitude indicator, altimeter, turn coordinator, heading indicator, and vertical speed indicator). • Interpret the reading of each instrument to confirm an accurate 'instrument scan'.	
Two Skill/ Concept	AV 4.2 Know aircraft systems. *Examples:* • List the basic flight control systems (mechanical, hydromechanical and fly-by-wire). • Describe the latest innovations in fly-by-wire flight control systems.	
Three Strategic Thinking	AV 4.3 Predict aircraft performance. *Examples:* • Solve percentage problems (percent of power for turbine engines, flap position percent indicators) • Solve ratio and proportion problems (compression ratios of an aircraft, glide ratios)	Algebra 1
Three Strategic Thinking	AV 4.4 Calculate weight and balance. *Examples:* • Compute empty weight center of gravity on an aircraft. • Compute loaded weight and loaded weight center of gravity of an aircraft.	Physical Science, Algebra 1

Notes:

Indicator # AV 5 Understand the relationships between weather and flight

Webb Level	*Sub-indicator*	*Integrated Content*
Two Skill/ Concept	AV 5.1 Explain basic weather theory. *Examples:* • Explain the composition of the Earth's atmosphere. • Explain how temperature variation influences flight performance.	Physical Geography, Earth Science
Two Skill/ Concept	AV 5.2 Describe weather patterns and clouds. *Examples:* • Analyze pressure systems at different attitudes on a surface map. • Identify the types of clouds (stratus, cumulonimbus, and cirrus) at different elevations and the potential hazards that may exist.	Physical Geography, Earth Science
Two Skill/ Concept	AV 5.3 Explain weather hazards. *Examples:* • Compare and contrast the common weather hazards when flying • Identify safe and corrective actions for common weather hazards as suggested by the Federal Aeronautics Administration (FAA)	
Three Strategic Thinking	AV 5.4 Interpret weather data. *Examples:* • Interpret current weather conditions using a weather map. • Collect and analyze local weather data.	Physical Geography, Earth Science
Two Skill/ Concept	AV 5.5 Identify sources of weather information. *Examples:* • Understand Significant Meteorological Information Service (SIGMET) • Define the role of the Aviation Data Service (ADDS)	

Notes:

Indicator # AV 6 Understand navigation in aviation

Webb Level	*Sub-indicator*	*Integrated Content*
One Recall	AV 6.1. Understand basic navigation. *Examples:* • List and describe the essential navigational information a pilot needs to know (starting point, ending point, direction, distance, speed, fuel capacity, and weight and balance) • List the advantages and disadvantages of Visual Flight Rules (VFR) flying.	
One Recall	AV 6.2 Understand dead-reckoning and pilotage. *Examples:* • Define dead-reckoning and pilotage. • Calculate a flight course using the elements of course line, airspeed, course heading and elapsed time.	Geometry, Physics
Two Skill/ Concept	AV 6.3 Utilize a flight computer. *Examples:* • Understand the basic concepts of a flight computer. • Use a flight computer to file a flight plan.	
Three Strategic Thinking	AV 6.4 Utilize aeronautical charts. *Examples:* • Plot a course using an aeronautical chart. • Evaluate flight plans for improved efficiency.	Geometry

Two Skill/ Concept	AV 6.5 Comprehend radio navigation. *Examples:* • Distinguish between the types of Radio Navigation: Very High Frequency Omnidirectional Range (VOR), Distance Measuring Equipment (DME), Instrument Landing System (ILS), Global Positioning System (GPS), Inertial Navigations Systems (INS)	

Notes:

Indicator # AV 7 Understand aviation physiology

Webb Level	*Sub-indicator*	*Integrated Content*
One Recall	AV 7.1 Know the effect on the body in the flight environment. *Examples:* • Identify the potential hazards on the body during flight. • List and describe the safety procedures to prevent aviation accidents due to physical distress.	Biology

Notes:

Indicator # AV 8 Understand aerospace science and technology

Webb Level	*Sub-indicator*	*Integrated Content*
Two Skill/ Concept	AV 8.1 Understand key concepts affecting exploration of space. *Examples:* • Identify the effect of zero gravity on flight. • Identify the effect of lack of atmosphere on flight. • Identify the effect of friction on flight.	Physical Science, Physics
Two Skill/ Concept	AV 8.2 Understand basic rocket theory and space flight. *Examples:* • Understand the history of rocketry. • Identify the major developments in space flight.	Physical Science, Physics
One Recall	AV 8.3 Analyze existing space platforms. *Examples:* • Analyze the stages of development and importance of the International Space Station. • Summarize the development and impact of the Hubble Space Telescope. • List the scientific purposes of unmanned space explorations. • Compare and contrast the privatization of the space program and the space shuttle program.	

Notes:

Career Cluster: STEM

Course: Aviation

Indicator # AV 9 Explore the multiple careers in aviation.

Webb Level	*Sub-indicator*	*Integrated Content*
Two Skill/ Concept	AV 9.1 Investigate aviation career fields and occupations. *Examples:* • Interview a professional working in an occupation that is of interest to them. • Research aerospace career opportunities of interest by participating in career exploration activities. • Explore the requirements, skills, wages, education, and geographic opportunities in one career associated with aerospace. • Present the results of your career exploration and resources. • Identify employability skills preferred by different aviation occupations.	Code of Ethics: http://www.alpa.org/about-alpa/what-we-do/code-of-ethics Soft Skills: Communication, Group Work, time-management, personal and professional responsibility

Notes:

Electronics

Career Cluster	STEM
Course Code	17106
Prerequisite(s)	None
Credit	.5
Program of Study and Sequence	Foundation courses – cluster course – Introduction to Energy/Power – specialized pathway course – capstone experience
Student Organization	None
Coordinating Work-Based Learning	Field trips/tours, guest speakers
Industry Certifications	None
Dual Credit or Dual Enrollment	TBD
Teacher Certification	Technology Education
Resources	Occupational Safety and Health Administration (OSHA)-http://www.osha.gov Institute of Electrical and Electronics Engineers –https://wwwIEEE.org

Course Description:

The Introduction to Electronics course is designed to provide a basic understanding electronics which include how to design and create components, diagnose, troubleshoot and repair electronic components. Through classroom study and hands-on experience, students prepare for work within the electronics field using current technology, safety and ethical procedures.

Program of Study Application

This is a pathway course in the STEM cluster Electronics pathway. It is recommended that the course be preceded by a series of foundation courses and a cluster course in STEM, and followed by a more specialized pathway course such as Robotics.

Course Standards

Indicator # E1 Determine general technical literacy skills

Webb Level	*Sub-indicator*	*Integrated Content*
One Recall	E 1.1 Employ appropriate units and abbreviations in electronics. *Examples:* • Tabulate whole number expressions to appropriate electronic exponential expressions • Recognize differences between electronic exponential expression and scientific notation • Define abbreviations used in a schematic diagram	Math skills
Two Skill/Concept	E 1.2 Determine unknown values in multiple types of electronic circuits *Examples:* • Calculate unknown electronic unit values using given or measured values • Apply appropriate formula to solve for unknown values in a variety of circuits • Apply ratings of resistors based on color bands	Math skills
One Recall	E 1.3 Identify proper terminology in electronics *Examples:* • Label and identify the parts of a circuit • List the parts of a circuit • Draw a parallel and series circuit	

Notes:

Indicator # E2 Demonstrate proficiency in electronic safety

Webb Level	*Sub-indicator*	*Integrated Content*
Two Skill/Concept	E 2.1. Determine physiological responses to electrical shock *Examples:* • Classify ways electrical shock can damage the human body • Tell how electrical shock can cause death • Summarize safety concerns in various working environments	Safety skills General classroom procedures Program procedures Review OSHA handbook
One Recall	E 2.2. Demonstrate proper safety procedures in the use of soldering and electronics testing equipment *Examples:* • Use proper personal protective equipment • Define methods to reduce the severity of electrical shock • State and follow all safety rules based on *Occupational Safety and Health Administration* (OSHA) standards	*OSHA

Notes:

Indicator # E3 Demonstrate proficiency in circuit assembly

Webb Level	*Sub-indicator*	*Integrated Content*
Two Skill/Concept	E 3.1. Construct a circuit using schematic symbols for identified components *Examples:* • Apply resistor color code to identify proper resistor values • Determine proper polarity for electrolytic capacitors • Distinguish components correctly in relation to a schematic diagram	
Two Skill/Concept	E 3.2. Construct circuit boards using correct soldering principles and techniques *Examples:* • Connect components in proper position on circuit board • Show ability to handle components carefully • Determine proper amounts of solder to cover the connection	
Three Strategic Thinking	E 3.3. Determine cause of non-operational circuits *Examples:* • Assess a non-operational bread-board circuit • Draw conclusions to select proper test equipment for repair of faulty circuits • Investigate and repair circuit board	

Notes:

Indicator # E4 Determine proper use of electronic test equipment

Webb Level	*Sub-indicator*	*Integrated Content*
One Recall	E 4.1. Measure resistance, voltage, and current in circuits *Examples:* • Match test leads in proper positions • Arrange meter selector switch in proper position • Recite meter reading using correct measurement values	
One Recall	E 4.2. Classify equipment for signal analysis *Examples:* • List equipment that provides signal outputs • Identify equipment that measures signals • Identify the various signals	

Notes:

Indicator # E5 Troubleshoot circuits for proper operation

Webb Level	*Sub-indicator*	*Integrated Content*
Two Skill/Concept	E 5.1. Calculate voltage, current, and power solutions in circuits *Examples:* • Predict correct formula or law to solve for unknown values • Show calculated values using proper measurement values • Make observations for proper operation of circuits	
Two Skill/Concept	E 5.2. Troubleshoot solutions to analyze circuit operation *Examples:* • Estimate the values of components within a circuit • Graph calculated and measured values • Compare values to determine if they are within circuit parameters	

Notes:

Indicator # E6 Explore electronics career options

Webb Level	*Sub-indicator*	*Integrated Content*
Three Strategic Thinking	E 6.1 Research career opportunities in electronics fields *Examples:* • Investigate and research career opportunities in the electronics field using career exploration software • Investigate the career exploration software to research educational requirements for chosen career path • Formulate a report about career opportunities in the electronics field • Revise and update student portfolio	Internet ethics Job Services High school counselors Community/ Industry SDMyLife BLS.gov Robotics, engineering, and electronics Career Development
One Recall	E 6.2 Explore career outlook for robotic applications *Example:* • Identify jobs that will be created/eliminated by robotics • List new robotics related careers	

Notes:

Engineering Design and Development

Career Cluster	STEM
Course Code	21007
Prerequisite(s)	None
Credit	.5
Program of Study and Sequence	Engineering Pathway, Energy Pathway, and Robotics Pathway.
Student Organization	None
Coordinating Work-Based Learning	Interviewing industry professionals, guest speakers, tours, field trips
Industry Certifications	None
Dual Credit or Dual Enrollment	TBD
Teacher Certification	Technology Education
Resources	Community members, industry professionals

Course Description:

Engineering Design and Development is a pathway course in the STEM Engineering Pathway, STEM Energy Pathway, and STEM Robotics Pathway. Students are engaged in an instructional program that integrates academics, problem solving, communication, and technical preparation and focuses on career awareness. This course is designed to provide the student with an engaging opportunity to research, design, innovate and develop technological artifacts (products). This course will prepare students for direct entry into a career, advanced educational opportunities, and lifelong learning.

Program of Study Application

This is a pathway course in the STEM cluster Energy pathway. It is recommended that the course be preceded by a series of foundation courses and a cluster course in STEM, and followed by a more specialized pathway course such as Engineering, Energy and Robotics.

Course Standards

Indicator # EDD 1 Identify a technologically related problem

Webb Level	*Sub-indicator*	*Integrated Content*
Three Strategic Thinking	EDD 1.1 Examine current state of a problem *Example:* • Investigate a needs assessment to determine relative importance of the problem • Formulate pros and cons of a current problem • Compare current problem to similar problems	
Three Strategic Thinking	EDD 1.2 Research solution options to solve problem *Example:* • Investigate possible solutions • Investigate other options via the Internet, library, interviews, etc. • Draw conclusions from research by interviewing industry professionals	Consider implications of human subjects research Professional ethics Soft skills Communication
Three Strategic Thinking	EDD 1.3 Propose new solutions to solve problem *Example:* • Develop a logical design plan, identify, and resolve logic errors • Formulate a course of action to solve the chosen problem	
Four Extended Thinking	EDD 1.4 Identify the best solution *Example:* • Analyze the pros and cons of each solution • Analyze potential solutions • Prove and defend the best solution • Propose solution ideas to team members	Soft skills: • Presentation • Teamwork

Notes:

Indicator # EDD 2 Construct a prototype of the solution to problem

Webb Level	*Sub-indicator*	*Integrated Content*
Two Skill/Concept	EDD 2.1 Construct a prototype to model solution *Example:* • Sketch a prototype of the product • Show product specifications • Construct product according to specifications	
Four Extended Thinking	EDD 2.2 Test prototype for effectiveness *Example:* • Design a product for safety testing • Identify safety factors in a given product or process • Collect data on prototype tests • Analyze the data for prototype effectiveness	Ethics Lab safety and training

Notes:

Indicator # EDD 3 Analyze test data results for prototype performance

Webb Level	*Sub-indicator*	*Integrated Content*
Four Extended Thinking	EDD 3.1 Analyze test results *Example:* • Analyze product performance data • Chart and graph data • Synthesize test results	
Three Strategic Thinking	EDD 3.2 Make decisions based on test result data *Example:* • Assess performance needs • Critique product improvements • Design concept models based on data results	
Four Extended Thinking	EDD 3.3 Redesign the product to meet performance needs *Example:* • Evaluate and sketch changes made to prototype • Judge findings of prototype performance • Apply changes to prototype	

Notes:

Indicator # EDD 4 Communicate solution(s) and the prototype for others

Webb Level	*Sub-indicator*	*Integrated Content*
Four Extended Thinking	EDD 4.1 Communicate solutions for product *Example:* • Create a presentation of the final product for potential clients • Compose a report for potential clients • Design final product options to meet client demand based on needs and responses	Soft skills • Communication • Customer Service • Teamwork • Time management • Organization • Listening

Notes:

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Robotics

Career Cluster	STEM
Course Code	21009
Prerequisite(s)	None
Credit	.5
Program of Study and Sequence	Foundational Courses, Cluster Courses, Pathway Courses, Capstone Experience
Student Organization	None
Coordinating Work-Based Learning	industry tours of local businesses utilizing robotic systems
Industry Certifications	None
Dual Credit or Dual Enrollment	TBD
Teacher Certification	Technology Education
Resources	BEST Robotics: http://www.bestinc.org/ FIRST Tech Challenge: http://www.usfirst.org/roboticsprograms/ftc STEM Robotics 101: http://stemrobotics.cs.pdx.edu/node/190?root=291 Career Research: www.sdmylife.com and http://www.onetonline.org

Course Description:

This robotics course emphasizes the design, building, operation, application, and documentation of robotic systems. Students follow the engineering design process, apply basic programming skills, and explore how robots and automated systems are used in industry.

Students will have an understanding of the historical and current uses of robots and automated systems; programmable circuits, interfacing both inputs and outputs; proficient ethical standards for engineering and technology professions; and testing of robots.

Program of Study Application

This is a STEM Pathway Course for the Robotics Pathway, preceded by a Foundational Course(s) and a Cluster Course(s).

Career Cluster: STEM

Course: Robotics

Course Standards

Indicator # RBT 1 Identify components of a robotic system.

Webb Level	*Sub-indicator*	*Integrated Content*
One Recall	RBT 1.1 Describe the parts necessary to make a robot. *Examples:* • Create a report explaining the interaction between Microprocessor, Sensors, Intelligent Controls, and Motors. • Write a research report indicating historical and current Robotic systems.	
Two Skill/ Concept	RBT 1.2 Examine the relationships among the subsystems. *Examples:* • Explain the purposes of the mechanical, electrical, and software subsystems. • Describe how these subsystems work together within the whole robotic system.	

Notes:

Career Cluster: STEM

Course: Robotics

Indicator # RBT 2: Understand safety procedures and ethical issues inherent to robotics.

Webb Level	*Sub-indicator*	*Integrated Content*
Two Skill/ Concept	RBT 2.1. Demonstrate proper safety procedures *Examples:* • Operate and use proper personal protective equipment	
Two Skill/ Concept	RBT 2.2. Determine how to apply OSHA Compliant Lockout – Tag-out procedures *Examples:* • Examine process • List hazard areas	
Two Skill/ Concept	RBT 2.3. Examine current ethical issues. *Examples:* • Review the ethical standards for engineering and technology professions. • Discuss intellectual property.	IEEE Code of Ethics: http://www.ieee.org/about/corporate/governance/p7-8.html

Notes:

Indicator # RBT 3 Construct, analyze and troubleshoot circuits.

Webb Level	*Sub-indicator*	*Integrated Content*
Three Strategic thinking	RBT 3.1. Build circuit according to schematic diagram *Examples:* • Chose proper electronic components to construct a circuit • Assemble circuit in accordance with schematic diagram	
Three Strategic thinking	RBT 3.2. Calculate circuit parameters *Examples:* • Employ correct formula or law to solve for unknown parameters • Record calculated parameters using proper measurement parameters	
Three Strategic thinking	RBT 3.3. Measure circuits parameters *Examples:* • Select and use proper test equipment to measure required parameters • Record calculated parameters using proper measurement parameters	
Three Strategic thinking	RBT 3.4. Compare calculated and measured solutions to analyze circuit operation *Examples:* • Graph calculated and measured parameters • Compare parameters to determine if they are within circuit parameters • Inspect circuit operation	

Notes:

Career Cluster: STEM

Course: Robotics

Indicator # RBT 4: Design, build and analyze a robotic system.

Webb Level	*Sub-indicator*	*Integrated Content*
Three Strategic thinking	RBT 4.1 Build and program a robot to perform a specified task. *Example:* • Use mechanical tools, such as motors, gears, and gear trains in the construction of a robotic system and program • Use VEX, NXT, or other kits to create robotic system	
Three Strategic thinking	RBT 4.2 Test the robot for any flaws in hardware or bugs in software components. *Examples:* • Test individual subsystems and the system as an entire unit	
Three Strategic thinking	RBT 4.3 Write a technical report evaluating the system performance. *Examples:* • Document a Robotic project's Circuit Diagrams, Block Diagrams and Flowcharts as well as the Robotic project's design and implementation procedures. • Present the final project as a team.	Soft Skill: Presentation, communication, teamwork

Notes:

Career Cluster: STEM

Course: Robotics

Indicator # RBT 5 Research career opportunities and industry applications

Webb Level	*Sub-indicator*	*Integrated Content*
One Recall	RBT 5.1 Explore career opportunities in the robotics field *Examples:* • Identify human careers replaced by robotics. • Research and report on a specific career of interest in the robotics field. • Write a biography about a historic person in the field of robotics	Soft Skills: written communication, presentation
Three Strategic Thinking	RBT 5.2 Investigate commercial application of robotic systems *Examples:* • Create a report demonstrating the progression of use and acceptance in the medical field • Take a field trip to a local industry that utilizes robotic systems	Career Development

Notes:

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Introduction to Energy/Power

Career Cluster	STEM
Course Code	20101
Prerequisite(s)	None
Credit	.5
Program of Study and Sequence	Foundation courses – cluster course – Introduction to Energy/Power – specialized pathway course – capstone experience
Student Organization	None
Coordinating Work-Based Learning	Community/industry speakers
Industry Certifications	None
Dual Credit or Dual Enrollment	TBD
Teacher Certification	Technology Education
Resources	O*Net - http://www.onetonline.org Occupational Safety and Health Administration (OSHA)-www.osha.gov

Course Description:

The Introduction to Energy and Power course is designed to provide a basic understanding of the various types of energy, how energy is obtained and the relationships among work, energy, and power. Students will also study the history and effects of energy on society, alternative power, safety and ethics.

Program of Study Application

This is a pathway course in the STEM cluster Energy pathway. It is recommended that the course be preceded by a series of foundation courses and a cluster course in STEM, and followed by a more specialized pathway course such as Alternative Energy Systems and Electronics.

Course Standards

Indicator # EP 1 Analyze the history of energy/power sources

Webb Level	*Sub-indicator*	*Integrated Content*
Two Skill/Content	EP 1.1 Examine the historical development of energy/power production *Example:* • Construct a timeline depicting the development of engines • Collect and summarize data orally or on paper about a famous inventor • Organize an oral report on the development of a power system	Soft skills • Presentation • Organization • Time management • Communication
One Recall	EP 1.2 Assess the impact of energy/power on the way people live and work *Example:* • List various energy sources and machines used prior to the 21st century • Name an invention and write a short paper describing its impact on society, both positive and negative • Define how the past use of energy and machines has negatively impacted the planet Earth	Internet ethics History/Social Studies Trends

Notes:

Indicator #EP 2 Examine the relationships among work, energy, and power

Webb Level	*Sub-indicator*	*Integrated Content*
One Recall	EP 2.1 Define work, power, and energy *Example:* • Define work, power, and energy • Recall the mathematics formula that calculates power	
Two Skill/Concept	EP 2.2 Examine the relationship between power and energy sources *Example:* • Compare difference between weight, mass, and force • Apply equations to find missing information pertaining to work, energy and power • Estimate the efficiency of a machine	

Notes:

Indicator # EP 3 Understand the transmission of energy and power

Webb Level	*Sub-indicator*	*Integrated Content*
One Recall	EP 3.1 Understand how a mechanical system operates *Example:* • Classify power trains as being either direct or indirect • List the various parts of a power train • Identify the parts of a power train	
Two Skill/Concept	EP 3.2 Understand the types of simple machines *Example:* • Sketch an example of a simple machine • Classify the mechanical advantage of various simple machines • Summarize the mechanical advantage of various simple machines	
Two Skills/Concepts	EP 3.3 Understand both liquid and gas forms of power transmission *Example:* • List the various forms of fluid power • Compare results from actions applied on liquids and gases • Interpret the laws that govern fluids	
One Recall	EP 3.4 Understand the laws that govern electricity *Example:* • State Ohm's Law • Match energy terms and symbols to units of measure • Define electrical quantities	

Notes:

Indicator # EP 4 Understand alternative energy

Webb Level	*Sub-indicator*	*Integrated Content*
Two Skill/Concept	EP 4.1 Understand the sources of alternative energy *Example:* • Compare and contrast the types of alternative energy sources • Organize and prepare a presentation on synthetic fuels • Classify possible alternative energy sources	Trends
Three Strategic Thinking	EP 4.2 Analyze the sources of alternative energy *Example:* • Develop a logical argument on the environmental pros and cons for any one of the alternative energy sources • Investigate one or more of the alternative energy sources • Draw a model of an alternative energy apparatus	

Notes:

Indicator # EP 5 Implement safety with power technology

Webb Level	*Sub-indicator*	*Integrated Content*
Two Skill/Concept	EP 5.1 Examine safety issues relating to mechanical systems *Example:* • Relate and follow safety rules pertaining to moving mechanical systems • Show the proper method of lifting • Apply lab safety rules	Lab safety OSHA
Two Skill/Concept	EP 5.2 Employ safety practices with fluids *Example:* • Apply safety rules relating to high-pressure lines • Show the proper cleanup method for fluids • Apply proper storage methods for flammable/toxic liquids	
One Recall	EP 5.3 Identify fire classification and extinguishers *Example:* • Identify the types of fires • List which extinguisher will fight which type of fire • Identify the locations of fire extinguishers in the lab	Fire department
Two Skill/Concept	EP 5.4 Employ safety practices with electricity *Example:* • Show how to use proper personal protective equipment • Apply safety rules based on *Occupational Safety and Health Administration (OSHA)* standards • Organize policies for the lab based on various emergency situations	Lab Safety OSHA

Notes:

Indicator # EP 6 Understand scientific concepts for energy and power technology

Webb Level	*Sub-indicator*	*Integrated Content*
One Recall	EP 6.1 Understand how energy converts from one form to another *Example:* • Recall the concept of the Law of Conservation of Energy • Compare between potential and kinetic energy • Identify the sources of energy	Physical Science
Two Skill/Concept	EP 6.2 Understand the categories of energy *Example:* • Classify the sources of energy • Summarize various methods of transferring energy • Identify uses of sources of energy	Ethics of Efficiencies Physical Science
Three Strategic Thinking	EP 6.3 Understand that an engine performing work exhausts thermal energy that cannot be retrieved to the surroundings *Example:* • Compare efficiency of various types of light bulbs • Compare efficiency for multiple energy sources • Investigate and define the Law of Thermodynamics	
Three Strategic Thinking	EP 6.4 Understand which energy sources can be renewable and non-renewable *Examples:* • Investigate examples of renewable energy sources • Investigate examples of nonrenewable energy sources • Compare methods that are being used to conserve energy	

Notes:

Indicator # EP 7 Explore energy and power career options

Webb Level	*Sub-indicator*	*Integrated Content*
Three Strategic Thinking	EP7.1 Research career opportunities in energy and power fields *Examples:* • Investigate and research career opportunities in the energy and power fields using career exploration software • Investigate the career exploration software to research educational requirements for chosen career path • Formulate a report about career opportunities in the energy and power fields • Revise and update student portfolio	Internet ethics Job Services High school counselors Community/ Industry SDMyLife BLS.gov Robotics, engineering, and electronics Career Development

Notes:

Alternative Energy Systems

Career Cluster	STEM
Course Code	21057
Prerequisite(s)	None
Credit	.5
Program of Study and Sequence	Foundational Courses, Cluster Courses, Pathway Courses, Capstone Experience
Student Organization	None
Coordinating Work-Based Learning	None
Industry Certifications	None
Dual Credit or Dual Enrollment	TBD
Teacher Certification	Technology Education
Resources	Teaching Renewable Energy: http://www.ucsusa.org/sites/default/files/legacy/assets/documents/clean_energy/renewablesready_fullreport.pdf National Renewable Energy Laboratory: http://www.nrel.gov/docs/gen/fy01/30927.pdf http://www.nrel.gov/education/educational_resources.html

Course Description:

This course serves as an introductory course in alternative energy. This is a survey of wind, biomass, solar, geothermal, and other non-traditional energy sources.

Program of Study Application

This is a STEM Pathway Course for the Energy Pathway, preceded by a Foundational Course(s) and a Cluster Course(s).

Career Cluster: STEM

Course: Alternative Energy

Course Standards

Indicator # AES 1 Understand the historical development of alternative energy systems

Webb Level	*Sub-indicator*	*Integrated Content*
Three Strategic thinking	AES.1.1 Understand the historical background of alternative energy generation *Examples:* • Define alternative, renewable, and nonrenewable energy. • Identify various energy generation technologies throughout history • Analyze the significance of energy generation and the growth of society • Explain the relationship between energy production and public demand	
Three Strategic Thinking	AES.1.2 Analyze the role of society in the use of energy generation methods *Examples:* • Evaluate the demand levels for energy usage for industrialized nations • Summarize the influence energy has had on developing nations • Summarize the influence energy systems had on technological advancements	
Four Extended thinking	AES.1.3 Analyze the cultural, socioeconomic and political effects of alternative energy technologies *Examples:* • Identify factors affecting the price of electricity • Analyze resource allocation, such as using renewable resources (like ethanol) for energy as compared to using these resources for other uses (like food).	

Three Strategic thinking	AES.1.4 Understand the environmental impact of energy production and consumption. *Examples:* • Identify the relationship between fossil fuels and greenhouse gases • Investigate extraction processes of raw materials used for fuel • Evaluate the impact individuals can have on the environment from the reduction of energy use	Algebra, geography

Notes:

Career Cluster: STEM

Course: Alternative Energy

Indicator # AES 2 Understand the types of major energy systems

Webb Level	*Sub-indicator*	*Integrated Content*
Three Strategic Thinking	AES.2.1 Analyze the characteristics of wind energy generation systems *Examples:* • Identify various types of wind energy systems • Analyze structures in wind energy systems • State that wind energy can be used to generate electricity	
Four Extended thinking	AES.2.2 Analyze the characteristics biomass energy generation systems *Examples:* • Identify the various types of biomass systems • Identify the types of biomass • Analyze the various processes used to convert biomass into energy	
Four Extended thinking	AES.2.3 Analyze the characteristics of solar energy generation systems *Examples:* • State that solar energy can be used to generate electricity • State the energy conversion taking place in solar panels • Analyze the environmental benefits for using solar energy systems	marine & hydrokinetic energy
Four Extended thinking	AES.2.4 Analyze the characteristics of geothermal energy generation systems *Examples:* • Identify the various types of geothermal systems • Compare the advantages and disadvantages of using geothermal energy • Analyze the various processes used to convert geothermal into energy	

Two Skill/Concept	AES.2.5 Analyze the characteristics of traditional energy generation systems *Examples:* • Identify the processes involved when using nuclear energy to generate electricity • Identify the processes involved when using hydroelectric approaches to generate electricity • State the environmental benefits for using traditional energy systems	
Four Extended thinking	AES 2.6 Model an alternative energy system. *Examples:* • Build a device to lift a weight with the most appropriate alternative power supply. • Create a functioning scale model of an alternative energy system	

Notes:

Career Cluster: STEM

Course: Alternative Energy

Indicator # AES 3 Research alternative energy careers and trends in energy development

Webb Level	*Sub-indicator*	*Integrated Content*
Three Strategic thinking	AES3.1 Identify careers in alternative energy. *Example:* • Investigate jobs in each of the alternative energy fields. • Research, create a report, and present your findings on a career of interest in alternative energy.	
One Recall	AES3.2 Identify future energy resources. *Example:* • Identify new fields of study, such as Marine Hydrokinetic Energy.	

Notes:

Introduction to Engineering

Career Cluster	STEM
Course Code	21001
Prerequisite(s)	None
Credit	.5
Program of Study and Sequence	Foundation courses – cluster course – Introduction to Engineering – specialized pathway course – capstone experience
Student Organization	None
Coordinating Work-Based Learning	Industry, guest speakers, field trips
Industry Certifications	None
Dual Credit or Dual Enrollment	TBD
Teacher Certification	Technology Education
Resources	O*NET - https://www.**onet**online.org/ Brinell Hardness Test Methods - www.hardnesstesters.com › Applications National Society of Professional Engineers – https:// www.**nspe**.org

Course Description:

The Introduction to Engineering course is designed to provide a foundation in engineering for students in South Dakota. Students are engaged in an instructional program that integrates academics and technical preparation and focuses on career awareness and ethics in engineering. This course will prepare students for advanced educational opportunities. Topics addressed in Introduction to Engineering include: exploring the field of engineering, understanding materials and processes used in engineering, investigating systems used in engineering and practicing effective communication.

Program of Study Application

This is a pathway course in the STEM cluster Engineering pathway. It is recommended that the course be preceded by a series of foundation courses and a cluster course in STEM, and followed by a more specialized pathway course such as Industrial and Bioprocess Engineering, Mechanical Drafting & Design or Architectural Drafting.

Course Standards

Indicator # IE 1 Examine the fields of engineering

Webb Level	*Sub-indicator*	*Integrated Content*
Three Strategic Thinking	IE.1.1 Examine the evolution of engineering *Example:* • Assess the influence of engineering on history • Differentiate two different fields of engineering • Formulate a time line of major engineering development • Investigate engineering events that affected the world	• Discuss ethics of engineers • Discuss good and bad designs and how they affect people
One Recall	IE.1.2 Identify the types of engineers *Example:* • Define a job description of an engineer • Identify the work tasks, duties, and responsibilities of different types of engineers • During a field trip, recall and state the activities of an engineer	Code of Ethics for Engineers: NSPE (National Society of Professional Engineers)
One Recall	IE.1.3 Describe the engineering team *Example:* • Illustrate the duties of the members of the engineering team • Identify work setting/environments of engineering teams • Identify various branches of engineering	Soft Skills • Teamwork • Responsibility • Leadership

Notes:

Indicator # IE 2 Investigate various engineering systems

Webb Level	*Sub-indicator*	*Integrated Content*
One Recall	IE.2.1 Identify various types of engineering systems *Example:* • Define each engineering system and give an example for each • Match engineering systems to common processes • List the components of an engineering system	
Two Skills and Concepts	IE.2.2 Apply engineering systems to solve problems *Example:* • Construct circuits from a schematic diagram • Construct a mechanical system from visual or written instructions • Construct/modify a device to control the temperature in an enclosure	

Notes:

Indicator # IE 3 Apply the engineering process to a product

Webb Level	*Sub-indicator*	*Integrated Content*
Two Skill/Concept	IE.3.1 Design a product *Example:* • Graph and interpret thumbnail sketches to create ideas • Modify a three view orthographic projection of a design • Construct a design of a doghouse using computer-aided design (CAD)	
Two Skill/Concept	IE.3.2 Construct a three-dimensional (3-D) model *Example:* • Construct a scale model • Relate 3-D printouts to explore form, function, and feel • Construct a 3-D floor plan	
Two Skill/Concept Three Strategic Thinking	IE.3.3 Build and test a prototype *Example:* • Revise and use the prototype in real-world conditions • Assess a feasibility study on the prototype • Draw conclusions from data generated from testing the prototype	
Two Skill/Concept Four Extended Thinking	IE.3.4 Develop a system to produce a final product *Example:* • Organize and construct an assembly line that would effectively and efficiently produce a final product • Create a process that would allow for product development • Create and design a flow chart demonstrating the product development process	Soft Skills: • Teamwork

Notes:

Indicator # IE 4 Demonstrate effective communication

Webb Level	*Sub-indicator*	*Integrated Content*
Two Skill/Concept Three Strategic Thinking	IE.4.1 Demonstrate effective oral communication *Example:* • Organize and present a speech that addresses environmental issues related to engineering • Develop a logical argument and a solution to solve a problem • Cite evidence of the importance of each step in the engineering design process through an oral presentation	Soft skills • Communication • Teamwork • Organization • Leadership • Time management • Presentation
Three Strategic Thinking Four Extended Thinking	IE.4.2 Demonstrate effective written communication *Example:* • Formulate a report summarizing how an engineering system works • Create a set of directions to assemble a product • Design a newspaper editorial and prove your view on a controversial engineering issue	Soft skills • Communication • Organization • Time management
Four Extended Thinking	IE.4.3 Demonstrate effective graphic communication *Example:* • Design and present an idea for a product to the class using software application of choice • Design and connect concepts learned using publishing software and graphic programs • Analyze and defend prototype data to the class using charts and graphs	Ethics Language Arts skills Math skills Soft Skills • Communication • Presentation

Notes:

Indicator # IE 5 Examine testing procedures used on materials in engineering

Webb Level	*Sub-indicator*	*Integrated Content*
Three Strategic Thinking	IE.5.1 Analyze materials based on their properties *Example:* • Compare and contrast materials used in engineering • Assess availability and cost of materials	
Three Strategic Thinking	IE.5.2 Analyze material testing procedures *Example:* • Investigate the physical factors of the material(s) • Compare the cost factor(s) for various testing processes • Draw conclusions from the Brinell Hardness test on materials	

Notes:

Bioprocess Engineering

Career Cluster	STEM
Course Code	Pathway course
Prerequisite(s)	None
Credit	.5
Program of Study and Sequence	Foundational course, cluster course, and career pathway course
Student Organization	None
Coordinating Work-Based Learning	None
Industry Certifications	None
Dual Credit or Dual Enrollment	TBD
Teacher Certification	Technology Education
Resources	http://www.iseek.org/careers/viewCareers?id=15

Course Description:

This course is designed to provide information on broad application of ever-emerging field of bioprocessing for students in South Dakota. Students are engaged in an instructional program that integrates academics and technical preparation and focuses on career awareness in bioprocess engineering. This course will prepare students for advanced opportunities that lie in the area of biotechnological advancement. The student will apply the knowledge of engineering and biological sciences to design and develop a process capable of ameliorating environmental pollution, producing valuable products and applying novel technologies to produce alternative sources of transportation fuel. Topics that will be covered in this course include: water and wastewater treatment plants, recycling and reuse, and fermentation processes.

Program of Study Application

This is a pathway course in the STEM cluster engineering pathway. It is recommended that the course be preceded by a series of foundation courses, a cluster course in STEM and more specialized pathway courses such as Introduction to Engineering, Engineering Design and Development, and Introduction to Manufacturing and followed by dual credit course and/or capstone course.

Course Standards

Indicator # BE 1: Understand the basic concepts of bioprocess system and biotechnological processes

Webb Level	*Sub-indicator*	*Integrated Content*
Level, Recall and Thinking	BE 1.1 Identify bio-based products Examples: • List different types of the products that you think are based on biological materials and can be recycled and reused. • Compare and contrast products that are processed and unprocessed	Physical sciences, chemistry, biology Industry tours and field visits
Level Recall and Understanding	BE 1.2 Identify microbial processes that can be implemented in bioprocessing Examples: • List different types of microbial processes used for food and feed production • Demonstrate ways that microorganisms can be used to convert waste to valuable products	
Level Understand Demonstrate	BE 1.3 Understand how biotechnology can be integrated with engineering Examples: • Show how agricultural products are modified to produce several products in large scale • Evaluate ways that perishable food products are being stored for longer periods of time without deteriorating the quality.	Industry visits

Notes:

Indicator # BE 2 Apply basic knowledge of biological science and engineering in developing products

Webb Level	*Sub-indicator*	*Integrated Content*
Level Recall, thinking, explaining	BE 2.1 Understand how raw materials are used for developing products Example: • List various types of snack foods that you like to eat and the raw materials that are used to produce them. Differentiate between various types of food that you eat or drink on a daily basis. Explain how these products might have been developed	Industry visits, product development etc.
	BE 2.2 Understand how the chemical composition of a raw material affects the design process Example: • Differentiate between the biochemical components of different food products; for example banana and corn. Can banana be stored the same way as corn? Why or why not? • Analyze what kind of storage design would banana require as compared to corn	Industry tours, Grocer

Notes:

Indicator # BE 3 Understand issues associated with implementation and operation of biotechnological processes

Webb Level	*Sub-indicator*	*Integrated Content*
	BE 3.1 Analyze problems associated with bioprocessing; for example, environmental, technical, sustainable Example: • Discuss ethical issues associated with bioprocessing • Analyze economic and environmental impacts of bioprocessing • Differentiate between sustainable and non-sustainable bioprocessing techniques • Identify different procedures used in biotechnological processes	
	BE 3.2 Understand how to operate a bioreactor Examples: • Label the components of a bioreactor. • List different types of products that can be produced from agricultural products. Understand what kind of reactors or operating machine you may need for producing these products • Understand what kind of skills you may need to operate a bioreactor	

Notes:

Indicator # BE 4 Career exploration in bioprocess engineering

Webb Level	*Sub-indicator*	*Integrated Content*
	BE 4.1 Explore the role of bioprocess engineering in an agriculture related area Example: • List different types of products that are produced from agricultural products, for example, candles, corn syrup, potato chips, bioethanol etc. • Describe the methods for using corn starch and corn stove to produce bioethanol	
	BE 4.2 Understand the role of bioprocess engineering in food processing Example: • Describe how milk can be processed to produce cheese, yogurt and other dairy products • Explore how fresh produce are transported from the area of production to the consumer without compromising quality • Analyze different means of food storage technologies • Analyze the importance of packaging systems and proper labels for effective deliver of quality agricultural products	
	BE 4.3 Understand how bioprocess engineering is critical to water and wastewater treatment technologies Example: • Describe how drinking water is processed for a city or municipality • Compare different types of wastewater treatment technologies • Describe how waste water from drainage or sewage is treated • Critique the importance of proper solid waste management	

	BE 4.4 Understand how bioprocess engineering can improve the rural economy Example: • Identify ways that agricultural products can be converted/modified to produce the high value products, for example corn to corn ethanol, distillers dried grains (DDGs) to animal feed • Identify the fact that corn stover and other grasses such as switchgrass can be converted to ethanol which has higher market value and demand • Identify ways that oils from soybean or corn can be converted into transportation fuels (e.g. biodiesel)	

Notes:

Indicator # BE 5 Understand workplace ethics and professionalism in bioprocess engineering

Webb Level	*Sub-indicator*	*Integrated Content*
Level 1: Recall Level 2: Skill/ Concept	BE 5.1 Investigate and demonstrate understanding of professionalism and workplace ethics in the technological environment. Example: • Identify different work environments and recognize appropriate professional attire. • Demonstrate an understanding of professional ethics issues such as plagiarism, copyright and intellectual property laws. • Differentiate between possible ethical choices. Role play to model different possible outcomes. • Brainstorm potential responses to various workplace ethics violations	Health, hygiene, personal attire Language arts, English Teamwork

Notes:

Indicator # BE 6 Understand safety and health in bioprocessing engineering

Webb Level	*Sub-indicator*	*Integrated Content*
Level 1: Recall	BE 6.1 Understand implications of health and public safety standards Example: • List the safety procedures and equipment used in various technology sectors. • Demonstrate and understand the importance and use of safety equipment. • Evaluate the effectiveness of safety tools available for a given task. • Analyze potential consequences to self and others of not following health and safety standards. • Design a plan to improve the safety of a bioprocessing work environment.	

Notes: Please refer to OSHA safety guidelines for more information and resources