Crawford Central School District

Cochranton Junior Senior High School

STEM Academy - STEM 11 and STEM 12

Course Description: This program is designed for the students whose academic ability and intrinsic motivation have earned them an opportunity to apply for extended learning challenges specific to the areas of Science, Technology, Engineering, and Mathematics. Selected students work with their STEM Advisor to follow a supplemental curriculum embedded with individualized elements best suited for the student. Elements of learning may include online course work, student projects and presentations, field trips, job shadowing, career exploration, post-secondary education visits, and more. Assignments and activities associated with the STEM Academy function concurrently with students' normal courses of study.

Note: The STEM Academy program is structured as two Independent Study courses: STEM 11 and STEM 12

STEM 11 is the first of two courses in the STEM Academy where selected students explore applications of Science, Technology, Engineering, and Mathematics. This independent study course emphasizes the cross curricular connections of the STEM disciplines and looks further to real-world applications. Students work through the curriculum and activities with the STEM Advisors.

Prerequisite: Selection by the STEM Committee

Corequisites: **Science**: AP Physics I **and** either Honors Chemistry II or Honors Biology II
Math: Pre-Calculus or higher
Electives: *Either* Accelerated Computer Programing II, CADD I, II, or III
English: Challenge English III

Note: This course meets periodically throughout the school year and is worth 1 credit.

STEM 12 is the second of two courses in the STEM Academy where students coming from STEM 11 delve deeper into more specific areas of Science, Technology, Engineering, and Mathematics. This independent study course challenges the student to explore STEM topics most aligned with their post-secondary pursuits. Students work through the curriculum and activities with the STEM Advisors.

Prerequisite: STEM 11 and Teacher Recommendation

Corequisites: **Science**: AP Physics II **and** *either* Honors Chemistry II or Honors Biology II
Math: Calculus or higher
Electives: *Either* AP Computer Science Principles, AP Computer Science, CADD I, II, or III
English: AP English Literature
Social Studies: *Either* Psychology/Sociology or AP Psychology

Note: This course meets periodically throughout the school year and is worth 1 credit.

Unit Title: **Global Initiative Activity**

Connections: PA Standards/STEEL Standards, Connections to reading, math, or science

Essential Questions: What is the problem or need?
Who has the problem or need?
Why is it important to solve?
How can we solve it using STEM?

Resources/Activities: Samsung Solve or similar initiative, laptops, computer lab,

Concept	**Competencies**	**Vocabulary**	**Standards**
Global Initiative – Define a personal, school, or community problem/issue and develop a STEM solution to solve it.	The STEM Engineering process follows these basic steps: • ASK – Define the problem. • IMAGINE – Brainstorm solutions. • PLAN – Consider how to best solve the problem. • CREATE – Construct your solution. • TEST – Determine how well your solution works. • IMPROVE – Make your solution better.	• Design thinking process • Peer review • Iteration • Efficiency • Prototype • Revaluation	3.5.9-12.PP 3.5.9-12.H 3.5.9-12.I (ETS) 3.5.6-8.I 3.5.9-12.S 3.5.9-12.T (ETS)

Unit Title: **Automated Task Oriented Robotics Programming**

Connections: PA Standards/STEEL Standards Connections to Science, Technology, Engineering and Math

Resources/Activities: Universal Robotics E-Learning Module, UR3E Robotic Arm, Mobile Stand, Cognex 7802 Vision System, UR Compatible Conveyor, UR Compatible Conveyor Sensors, RobotIQ Gripper.

Concept	Competencies	Vocabulary	Standards
Students will be able to identify and interpret how task-oriented equipment such as a robotic arm function.	Students will be introduced to: • The robot itself • Movements of the arm, • PLC (Tablet) User interface, • I/O's and functions • Collision and Interference Detection • Cartesian Coordinate System and movements within a 3-dimensional space	• Digital Inputs • Digital Outputs • Analog Inputs • Analog Outputs • Control Box • Protective Stop • Teach Pendant • Freeride	1B-AP-11 2-AP-13 2-AP-15 **STEEL STANDARDS** 3.5.9-12.DD 3.5.9-12. B 3.5.9-12. C 3.5.9-12. E 3.5.9-12. F 3.5.9-12. G 3.5.9-12. H 3.5.9-12. I 3.5.9-12. K 3.5.9-12. N
Students will be able to prepare the robot for a continuous looping pick-and-place task/operation.	Students will learn to: • Connect an end effector. • Connect and configure sensors and conveyors. • Use Freeride waypoint programming to preform a basic pick and place task. • Use looping within basic programming.	• Tool Connector • Inputs • Safety Control Board • End Effector • Torque • Payload • Center of Gravity • Looping	

Students will use Cognex Vision as a decision-making automated extraction tool to ***collect*** data using digital image technology	Students will learn to: • Connect to the Cognex Visions Systems Insight Explorer • Identify a Robotic Emulator • Connect to an IP Address defined specifically for the robotic arm. • Sort: Color, Size, Shape, etc. • Measurement: Size, Shape, etc. • Material Handling: Robotics, Conveying, etc. • Assembly: Capping, Filling, etc. • Identification: Text, Bar Code, Lot #, etc.	• Emulator • IP Address • Lot Identification • Go/No-Go • Tolerances	**STEEL STANDARDS** 3.5.9-12.DD 3.5.9-12. B 3.5.9-12. C 3.5.9-12. E 3.5.9-12. F 3.5.9-12. G 3.5.9-12. H 3.5.9-12. I 3.5.9-12. K 3.5.9-12. N 3.5.9-12. O 3.5.9-12. P 3.5.9-12. AA-FF
Students will be able to use the Cognex Vision System to ***load*** data and create a workflow part identification setup	Students will learn to: • Get Connected to the Visions System • Setup and Image • Load an image • Generate a Pattern Setup • Locate a Part • Determine a Blob Area • Setup Range Limits • Measure Distances • Measure Edge • Determine Bad Parts • Use the String Tool		

Students will be able to create, test and analyze robotic automated go/no-go (Pass/Fail) workflow using various hardware and software available	Students will use tools such as the UR3E Robotic Arm, Conveyor, Sensors, and Cognex Vision System to solve an underlying inspection problem to Pass/Fail and Pick/Place objects.		

Unit Title: **Automated Flight and Autonomous Programming**

Connections: PA Standards/STEEL Standards, Connections to math and science standards

Resources/Activities: Introduction to drone flight, FAA Remote Pilot – Small Unmanned Aircraft Systems manual

Concept	**Competencies**	**Vocabulary**	**Standards**
Introduction to drones and safety basics of unmanned flight	Students will learn to unpack the drones, insert batteries and SD cards, charge batteries, remove/replace props, pair RC to drone, and basic safety guidelines	• Drone • Autonomous flight • Unmanned flight • Remote control • Props • Altitude • Airspeed	3.5.9-12.DD
Synopsis of FAA Remote Pilot – Small Unmanned Aircraft Systems	While students are not required to obtain an FAA license, we will briefly cover several of the most important points in the FAA training manual.	• Atmospheric pressure • Cloud types • Temp / Dew Point • Payload weight/balance • Physiological effects on pilot performance • Latitude/longitude • No-fly zones	3.3.9-12L 3.3.9-12M 3.3.9-12S
Planning and preparation for Drone Engineering and Flight Challenge	Students will devise the course and events for the pilot year of our challenge.	• Autonomous flight • Aerial acrobatics • Waypoint programming	3.2.9-12.I 3.2.9-12.J 3.2.9-12.K

Unit Title: **Career Exploration and Work-Based Learning Experiences**

Connections: Career Education and Work Standards

Resources/Activities: Career Planning Software (Smart Futures), Guest Speaker (K12 Career Education Alliance), Job Shadows, Presentation/Portfolio

Concept	Competencies	Vocabulary	Standards
Evaluate career clusters from a career planning assessment	Complete universal interest profiler	• Realistic • Investigative • Artistic • Social • Enterprising • Conventional	13.1.11.A 13.1.11.B 13.1.11.D
Describe career professionalism and soft skills	Schedule and arrange for a job shadow with a company representation	• Initiative • Soft Skills • Professionalism • Time Management • Networking	13.2.11 E 13.3.11 B 13.3.11 E
Observe and evaluate careers of interest	Research companies, interview professionals, and reflect on experiences by completing job shadows	• Job Shadow • Internship • Career Cluster • Industry-recognized credential • Confidentiality	13.1.11 B 13.1.11 C 13.1.11 D 13.1.11 F 13.3.11 A 13.3.11 E 13.3.11 F 13.3.11 G
Design an artifact to showcase career exploration, coursework, and career plan	Present to an authentic audience	• Portfolio • Professional Development • Post Secondary education/training	13.1.11 D 13.1.11 H 13.2.11 C 13.2.11 D

Unit Title: **Programming and related technology**

Connections: PA Standards/STEEL Standards Connections to reading, math, or science

Essential Questions: What is Javascript programming?
What is an algorithm?
Why is it important to solve?
How can we solve it using STEM?

Resources/Activities: Sphero Robots, Robotic Arm, Drone Technology

Concept	Competencies	Vocabulary	Standards
Sphero Mazes	• Design and develop a custom maze using a design process • Utilize a standard unit of measure • Describing a programming challenge, like a maze, in parts, then programming BOLT to accomplish each discrete part in sequence • Analyzing how three inputs—heading, speed, and duration—govern BOLT's execution of roll blocks to gain precision over the robot's movement • Programming an if…else control to execute different groups of code when a BOLT sensor gathers data within different ranges • Collaborate on program with a partner using Pair Programming ○ communicating with a learning partner to adjust the values in a comparator	• Algorithm • Accelerometer • Gyroscope • Infrared sensors • Compass • Heading	CS Standards 1B-AP-11 2-AP-13 2-AP-15

	• using trial and error to program BOLT's path through a maze		

Unit Title: **STEM Mindset**

Connections: PA Standards/STEEL Standards Connections to Science, Technology, Engineering and Math

Resources/Activities: Laptop, Video Editing Software, Camera Equipment

Concept	Competencies	Vocabulary	Standards
Understanding how Math is applied to larger venues in the Real-World (i.e. Statistics and Data Analysis applied to Referees in the NBA)	Watch a video on Statistics and Data Analysis (Or other mathematical concepts) being applied to the Real-World and be able to write a review of the video and where they might also see mathematics being applied in other areas or businesses.	• Varies based on the video • Data Analysis • Observational Studies • Sample Sizes • Sample Surveys • Correlations	CC.2.4.HS.B.5 A1.2.3.2.1, A1.2.3.2.2, A1.2.3.2.3, A2.2.3.2.1, A2.2.3.2.2, A2.2.3.2.3
Devise, film, and edit and professional caliber video connecting current STEM interests with future career goals.	Gather footage during a field trip, import and sort clips, write and record a narrative script, organize footage into timeline, edit clips, share final video.	Video format, orientation, still images, video clips, b-roll, timeline, transitions, pacing, audio fading	CC.1.5.6.C
Explain and develop skills that are essential for solving unique problems	Apply communication, leadership, and problem-solving skills to a team building challenge (e.g. Toxic Waste Dump, Bomb Defusal Simulation, etc.)	• Teamwork • Critical Thinking • Problem-Solving • Perseverance • Adapt	3.5.9-12.I (ETS)

Unit Title: **STEM Teaching & Leadership**

Connections: PA Standards Connections to math, technology or science

Resources/Activities: Laptops, projectors, science equipment, drones, spheros

Concept	Competencies	Vocabulary	Standards
Planning presentations to a targeted audience	Meet with advisors to define a STEM activity to be presented to a younger age group Specify the required time and materials needed to accomplish the activity Determine the capabilities of the targeted audience Brainstorm activity components and choose a specific activity plan	• Age-appropriate learning • Targeted audience	3.5.9-12.I (ETS) 3.4.9-12.B 3.5.9-12.U
Research STEM concepts related to a teachable topic	Research the underling science, technology, math or engineering concepts behind the activity	• Dissection • Coding • Green screen • Virtual reality	3.5.9-12.P
Learn leadership skills in running the activity	Teach the activity to a younger age group Take the role as a leader for the audience to guide the activity		3.5.9-12.Q I
Reflect on success and/or failure of implementation of activity plans	Design changes to the activity to make it improved for the next session Assess what went well and could have been improved	• Success • Failure • Implementation	3.5.9-12.W 3.5.9-12.MM

Unit Title: **STEM Field Trips**

Connections: PA Standards Connections to math, technology or science

Resources/Activities: Local business, colleges, industries, local business associations

Concept	Competencies	Vocabulary	Standards
Engineering/Mathematics and Technology focused fieldtrip(s)	Students will visit a local business, university, college, or work with a business association to experience the versatility of technology and how it is implemented in various ways in local industry	• Design process • Cost analysis • PLC • Career pathway	3.5.9-12.I.ETS 3.5.912.Y.ETS 3.2.9-12.P 3.5.9-12.FF
	Students will be able to have hands-on experience within an industry-type setting where they can compare and contrast how the principles of science govern what they are witnessing to what they have learned in a classroom setting.	Key physics and engineering vocabulary will be used based on the nature of the specific fieldtrip	3.2.9-12.I 3.2.9-12.J
	Students will be able to collaborate with their peers as well as professionals in creative problem-solving scenarios.	• Test • Improvements • prototype	
Biology and Ecology focused fieldtrip(s)	Students will be able to gain a variety of practical skill, experiences, and perspectives on key issues pertaining to biology and ecology by working with local agencies, Pennsylvania state parks	• Organismal biology • Human impact • Diversity	3.1.9-12.M 3.1.9-12.N 3.1.9-12.R 3.1.9-12.Q

	Students will be able to explain and understand the relationship between animal behavior and disease ecology to plant community ecology, plant-animal interactions, and rapid evolution.	• Microbiology • Mating systems • Symbioses	