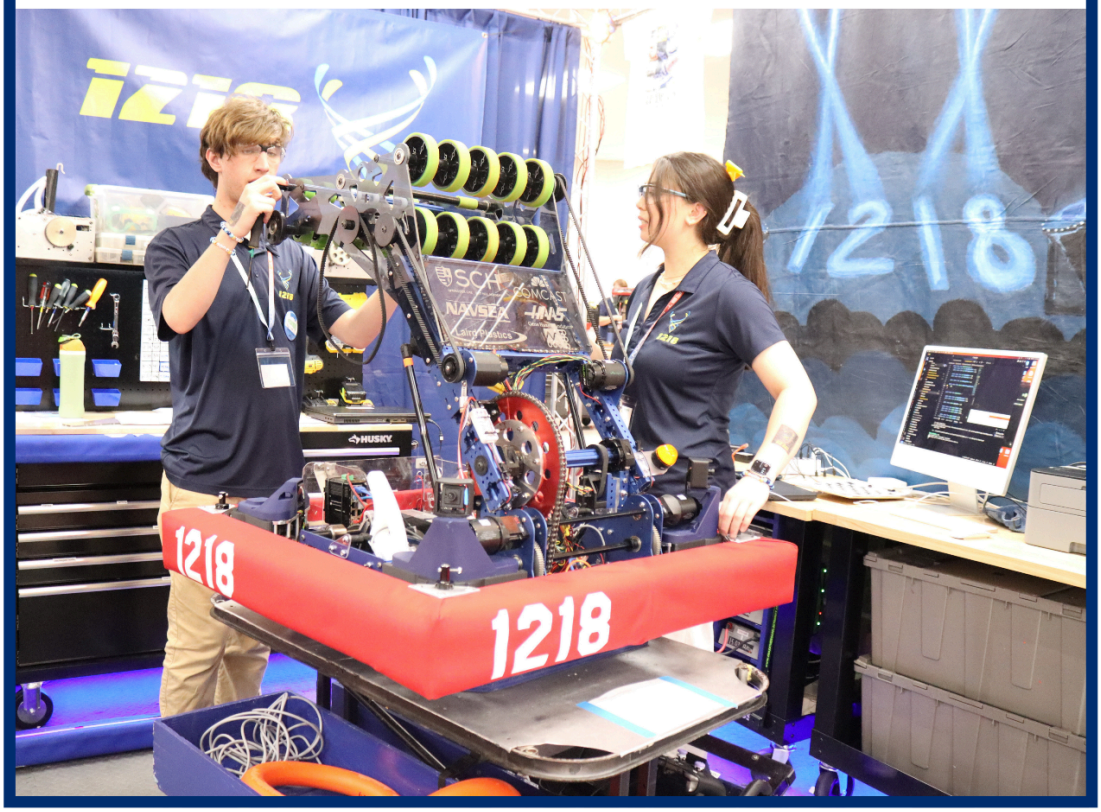
ENGINEERING, ROBOTICS, & COMPUTER SCIENCE

2025-2026

COURSE CATALOG



Department Chair: Daniel Jacobs (djacobs@sch.org)

SCH Academy encourages every student to explore engineered solutions to real-world problems. Through a broad-reaching curriculum that integrates concepts from Mechanical and Materials Engineering, Biomedical Engineering, Electrical and Computer Engineering, and Computer Science, students have the opportunity to innovate from their first conceptual design to their fully realized solution. Through hands-on projects, our courses challenge students to design, build, test, and analyze not just physical prototypes, but also advanced models and simulations of complex systems.

Central to this mission is employing design thinking principles from the initial stages of research and need-finding to the final stages of testing, analyzing, and communicating their solution to a broad audience. Whenever possible, we collaborate with internal and external companies and technical experts to sponsor student design projects that maximize the impact that our students have on the broader community. Students are encouraged to think across the traditional departmental boundaries to propose projects that integrate the skills developed in Engineering and Robotics with projects that integrate with Science, Art, and Math.

In addition, students are welcome to participate in our world-class robotics team where they will compete with students from around the world in the FIRST Robotics Challenge.

Computer-Aided Design and Manufacturing

Grades 10–12; elective; fall semester; ½ credit

> The course introduces students to Mechanical and Materials Engineering with hands-on individual and team projects that make full use of the rapid prototyping, high-speed manufacturing, and instrumentation capabilities of the Engineering and Robotics Laboratory. Students will learn to use Autodesk, one of the most common programs for computer-aided design (CAD) in college and industry, to design three-dimensional parts and assemblies. Furthermore, students are exposed to the concepts of designing for manufacturability and material strength analysis as they bring their projects to life on the SLA and FDM 3D Printers, the laser engraver, the lathe and the Tormach computer numerical controlled (CNC) mill and router machines. Students will be able to validate their prototypes with the Vernier Structures & Materials Tester. The final design project challenges students to work with real-life constraints of time, cost, weight, and size to iterate and validate multiple prototypes. Recent projects include: an airless volleyball, a manual pill sorter for the elderly, a pocket multi-tool, an multi-joint action figure, and assistive devices to help people with impairment pick up dropped phones and easily close winter jackets.

Computer Programming Methodology

Grades 10–12; elective; fall semester; ½ credit

> Designed for students without any prior programming experience, this course introduces students to Software Engineering through programming and algorithmic problem solving that has applications to a wide variety of disciplines in science, math, and engineering. Through group and individual projects, students will practice modern software engineering principles: program design, decomposition, encapsulation, abstraction, and

testing, emphasizing the production of robust and efficient code. The course is designed around the Python language and will teach the core concepts of object-oriented programming and debugging as well as more advanced elements such modules, packages and integrating third-party libraries for scientific computation and analysis. Students will also be introduced to Git for version control and learn how to organize and protect their work while working in a team. The final design project challenges students to create a software application for a specific science, math, or engineering problem. Potential projects include: the analysis of experimental data, statistical analysis of sports or e-sports data, image processing, and the creation of graphical user interfaces.

Design and Control of Mechatronic Systems

Grades 10–12; elective; spring semester; ½ credit

This course introduces students to Mechanical Engineering and Electrical and Computer Engineering through the multidisciplinary study of mechatronics i.e. systems with integrated electrical and mechanical components. This course teaches students to develop systems that interact with the physical world in a meaningful manner. Students will learn to write desktop and embedded programs that make intelligent decisions based on data and create systems that sense and physically act on the environment.

Students are encouraged to pursue projects about any physical system that can be instrumented to improve its interaction with the real-world. Robotics is just one area that exists in mechatronics. All prototypes originating in the CEL 10 innovation studio are excellent projects to refine and improve in this course. Previous projects include: data acquisition systems for high altitude gliders and balloons, control of an electric transmission of a go-kart, robotic arms, a functional student-sized hovercraft, control of 4 and 8 motor drones, and a 3D printer that prints chocolate.

Human Movement Biomechanics

Grades 10–12; elective; spring semester; ½ credit

This course will introduce students to Biomedical Engineering and Mechanical Engineering through the interdisciplinary study of Biomechanics. Through in-class projects, students will learn about the experimental techniques used to capture and analyze human movement, such as motion capture, wearable sensors, and force plates. Students will also learn about how modeling and simulation are used in research and product design by using OpenSim, an open source software system for biomechanical modeling, simulation and analysis. By introducing students to perspectives from a variety of disciplines (i.e. applications in sports medicine, physical and occupational therapy, and rehabilitation), students will gain a deeper understanding of how the study of human movement has led to many scientific breakthroughs and successful engineered products.

Honors Engineering Design Project

Grades 11, 12; elective; full year; 1 credit

Prerequisite: Two of the Previous Electives, and departmental approval

This honors-level Design course is for students who have demonstrated their ability to successfully complete their independent projects in the previous electives. Students may propose any project that has clear deliverables for each of the 4 foundational concepts in the department (i.e. “design - built - test - analyze”). All project proposals should be approved by the Department Chair well in advance of enrollment deadline. Previous projects include: development of an electric power transmission for the go-kart, a system for converting unpowered folding wheelchairs to powered, a system for converting a gas lawn mower to electric, and high-energy particle sensing platforms for high-altitude balloon research.

Honors Engineering Research Project

Grades 11, 12 elective; semester; 1/2 credit

Prerequisite: Two of the Previous Electives and departmental approval

This honors-level research course is for students who have demonstrated their ability to successfully complete their independent projects in the previous electives. Students may propose any project that has clear deliverables for each of the four foundational concepts in the department (i.e. “design - built - test - analyze”). In addition, student proposals should be able to clearly state the new knowledge gained by their work and have plans to deliver their work at local and/or national science competitions such as the PA Governor’s STEM Competition, the PA Junior Academy of Sciences (PJAS) science competition, and the International Science and Engineering Fair.

Upper School Robotics (Team 1218)

Students are encouraged to join the robotics team and participate in the annual FIRST Robotics Competition. FIRST is an international robotics competition in which teams of high school students compete by designing, programming, and driving a large-scale robot in a 3v3 team game.

Each year, roughly half of the team focuses on building, programming, and testing the robot and the other half performs critical strategic and data analysis, organizes impact and outreach events for the community, and coordinates the business plan to recruit corporate sponsors. Together all of these elements are judged in the run up to the qualification.

Important:

The Robotics team activity starts with the fall activities fair and runs through the winter and spring sports seasons. After the fair, the team focuses on welcoming its new members and competing at the local off-season events with the previous year’s robot. The Build phase runs January - February, starting with the kick-off livestream on the 1st Saturday in January. During the build phase the team runs multiple evening and Saturday practices. The Competition phase runs from March - May.

Participation in the FIRST Robotics Competitions may include travel to regional and national competitions. Each competition consists of three full days (Thursday–Saturday or Friday–Sunday) of competitions plus travel time. The regional events are generally held in the eastern PA and NJ area. If the team qualifies, the world championship is held in the US (e.g.

Hartford, CT, Washington, DC, St. Louis, MO, Detroit, MI, and Houston, TX). Competition schedule is determined by FIRST and may occur over SCH Spring Break.

While attendance at these competitions is optional, students participating in the Robotics Activity are encouraged to plan on attending at least one. The travel costs associated with attending the competition (food, lodging, and travel) are the responsibility of the student. However, the program runs competitions, hosts fundraisers, and engages corporate sponsors year round to reduce family contribution as much as possible.