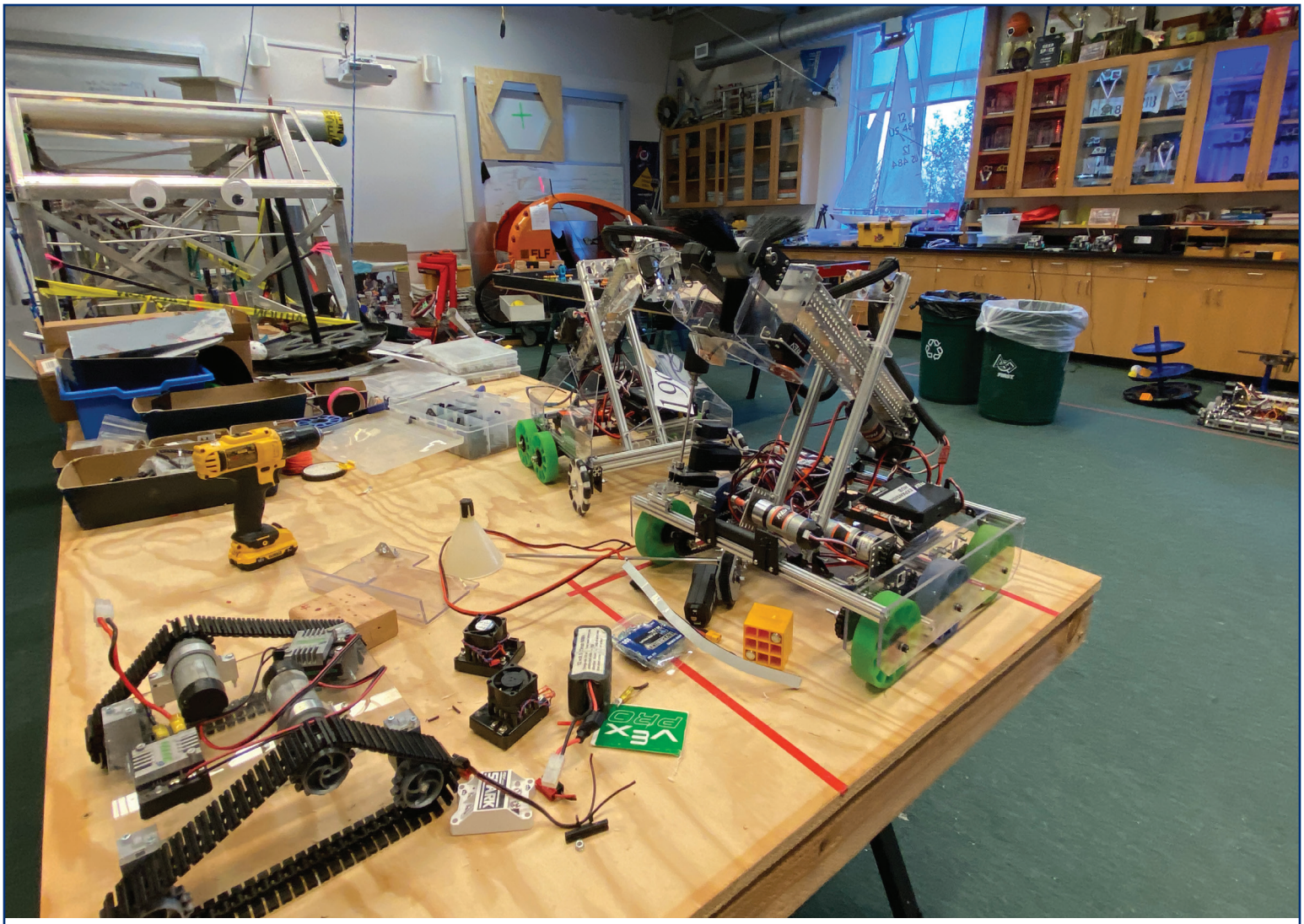

2022-2023
COURSE CATALOG

ENGINEERING ROBOTICS & COMPUTER STUDIES

GENERAL INFORMATION

Dept. Chair: Peter Randall – prandall@sch.org

SCH Academy challenges every student in the Upper School to explore the process of design and fabrication of complex objects and systems. Through a broad-reaching curriculum starting with the 9th and 10th grade seminars on design, prototyping, and fabrication through the 12th grade advanced programming and CAD/CAM courses, SCH allows each student to develop the skills to see and work in three dimensions, employ rigorous design processes, and learn the techniques of prototyping and fabrication. Students who choose to are able to participate in our world-class robotics program where they will compete with the best pre-engineering students from around the world.

MECHANICAL ENGINEERING, CAD, AND CAM
Grades 10–12; elective; fall semester; ½ credit
This one-semester fall course is a precursor to the spring Engineering Design and Robotics course for those students interested in Mechanics, CAD (computer aided design), and CAM (computer aided manufacturing). This course will explore the use of AutoDesk Fusion 360 for the design of complex three-dimensional objects and their manufacture through the use of the Tormach CNC (computer numerically controlled) milling machine, MakerBot 3D printer and Epilog laser cutter. Each student will be challenged to design and manufacture a specific mechanical device, such as a gearbox, drivetrain, or other mechanical system, to meet specific design criteria for our FRC Robotics platform or a specific design project for the school community or others. In addition to the core mechanical and design curriculum, students will be challenged to work with real-life constraints of time, cost, weight, and size as well as working in groups and presenting their projects to competitive review.

PROGRAMMING REAL-WORLD SYSTEMS
Grades 10–12; elective; fall semester; ½ credit
This course offers students an introduction to computers, computer sciences, programming, and microprocessor control systems. For this course, we will be using the "C," Java, and LabVIEW programming languages. Students will begin by exploring the history of computers and programming. Starting with the C programming environment, we will focus on the software development method, algorithms, data and control structures, and structured programming techniques. We will follow that with work in Java and the LabVIEW graphical programming environment. We will spend a significant amount of time working on the special challenges of programming robots. Working with a variety of sensors and control systems, students will develop algorithms that will direct a robot to solve a maze of unknown structure or drive in a predetermined path. Students will explore the unique challenges of programming for the "real world" where systems have momentum, friction counts, and gravity is the law, not just a good idea.

ENGINEERING, DESIGN, AND ROBOTICS 1
Grades 10–12; elective; spring semester; ½ credit
Prerequisite: Mechanical Engineering, CAD, CAM and departmental approval
This course will introduce students to the engineering and scientific aspects of problem solving. This completely project-based course allows the students to work on a design-and-build project of their own choosing (subject to faculty approval). Depending on the project, students will have to learn CAD/CAM, real-time programming, mechanics, and fabrication. Students will learn how to operate some of the sophisticated tools, such as the CNC Milling Machine, 3D printer, and laser cutter. Recent projects have included a fully functional student-sized hovercraft, an eight-motor "Octocopter" with microprocessor- controlled gyro stabilization and GPS navigation, a self-navigating model sailboat, a four-wheel independently steerable robot drive system, and a 3D printer that prints chocolate. We are currently working on a multi-year project to construct a Bede 4C four-passenger single-engine airplane. It is important to recognize that as a project-based class, there is minimal direct instruction and students will be required to be self-motivated to learn new material on their own and complete their project on time and on budget.

MECHATRONICS 301
Grades 10–12; elective; spring semester; ½ credit
Prerequisite: Mechanical Engineering, CAD, CAM, and departmental approval
Mechatronics is the intersection of mechanical and electrical/electronic engineering. In this course (fashioned after a junior level engineering course from Columbia University), we will develop solutions to challenges based on the Arduino microprocessor, a variety of sensors, the C programming language, and various mechanical systems. Students will be required to develop a mastery of C without any direct instruction. They will be provided with source material, tutorials, and support, but must be sufficiently self-motivated to work independently to develop their own expertise. While the basic challenges are progressive and predefined to develop the required skills, the final challenge will be unique and students may find that they are working on entirely different projects or parts of a larger project. In the past, challenges have included the development of an autonomous weather station to be flown in a high altitude glider, the navigation and control system for the high

altitude glider, reprogramming the control system for an FRC robot from the competition-required cRIO to an Arduino processor and an Arduino-based control system for a 5-axis mechanical arm.

HONORS ENGINEERING, DESIGN, AND ROBOTICS
Grades 11, 12; elective; full year; 1 credit
Prerequisite: Engineering, Design, and Robotics 1 and departmental approval
This honors-level Engineering and Design course is for accomplished engineers. Students in this class must have completed Engineering, Design, and Robotics 1 and obtained faculty permission to take this course. Students who have had either CAD/CAM or Real-Time Programming will be at a distinct advantage. It is important to recognize that as a project-based class, there is minimal direct instruction and students will be required to be self-motivated to learn new material on their own and complete their project on time and on budget.

AERONAUTICAL ENGINEERING AND PRIVATE PILOT "GROUND SCHOOL"
Grades 11, 12; elective; full year; 1 credit
This course is being taught in conjunction with our Design and Engineering project to build a Bede 4C four-passenger airplane. Covering such topics as aerodynamic principles, airplane electrical and mechanical systems, navigation, meteorology, communications, and flight performance, this course will prepare students to take the FAA Private Pilot Knowledge Test. This course will be taught with a variety of content, including textbooks, online and video-based tutorials, and flight simulators. This course does not include any flight training, which needs to be obtained from an FAA-certified flight instructor.

ASSOCIATED ROBOTICS ACTIVITY
During the spring semester, students are encouraged to join the SCH Robotics Activity and participate in the annual FIRST Robotics Competition. FIRST is an international robotics competition in which teams of high school students compete by building a large-scale robot (2' x 3' x 5' and 150 lbs.) that accomplishes a particular task. Students will work on a specific part of this problem as part of the team. The Robotics Activity runs through the winter and spring sports seasons and is most intense during the design and building phase (January and February). Space will be limited.

Important: 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. In the past, these competitions have run from early March to late April and have included destinations in Hartford, CT, Washington, DC, St. Louis, MO and Detroit, MI, in addition to the local events in the Philadelphia area. One competition has historically occurred over spring break. While attendance at these competitions is optional, students participating in the Robotics Activity are encouraged to plan on attending at least one. If the student chooses to attend a particular competition and is not able to raise sufficient funds through various student fundraising activities, the travel costs associated with attending the competition (food, lodging, and travel) will be charged to the student's account. In the past, these costs have been as follows: Local $0; National $600.