

# 2018 TJHSST High School Student Technology Institute Course Descriptions

## Science Writing and Communication

Are you interested in reading and writing about science – whether for use in science fair projects, IB extended essays, senior research or capstone projects, science competitions like Siemens or the DuPont Challenge, or just general interest? Reading primary science articles can be quite difficult (and sometimes quite boring), because many aren't written very well. With new trends in science writing and more fields focusing on effective communication, being able to write science clearly is becoming increasingly necessary in today's scientific and technical fields. But becoming a better writer requires practice, feedback, and revision opportunities. We will work through the stages of science writing that will be based on topics of individual student interest. The skills we'll cover and the opportunities the students will have to practice their writing will include: strategies for reading scientific articles efficiently, annotating primary sources, synthesizing information, writing an abstract and literature review in APA style, and presenting research in a professional manner. (No previous experience with science writing is necessary; students will be able to work starting at whichever level they're comfortable.)

Suggested course prerequisites: None.

Length of course: 1 week

Dates Offered: June 25 – June 29; July 9 – July 13; July 16 - 20

Registration Fee: \$200/week

## Machine Learning 101 with Tensorflow

This will be computer programming course in which students will learn to develop Neural Networks in Tensorflow. Over the course of a week, students will learn to create, train and use several of the fundamental types of Networks – including Feed Forward, Convolutional and Recurrent. Students will gain familiarity with the work flow within Tensorflow as well as fundamental concepts of Deep Learning, including Regression, Gradient Descent, convolution and classification.

Suggested course prerequisites: AP Computer Science

Length of course: 1 week

Dates Offered: June 25 – June 29; July 9 – July 13

Registration Fee: \$200/week

## Audio Programming and Computational Music

In the context of computer programming, students will explore and implement multiple digital audio techniques. Topics covered will include the nature of digital audio and signals, basic synthesis techniques (e.g. Additive and Subtractive Synthesis, Envelopes and Amplitude and Frequency Modulation), and effects programming (e.g. Reverb, IIR and FIR filtering, and pitch shifting etc.). Students will apply the concepts through their own functionally generated music.

Suggested course prerequisites: AP Computer Science

Length of course: 1 week

Dates Offered: June 25 – June 29; July 9 – July 13

Registration Fee: \$200/week

## Rise of the SuperBugs: A Crash Course in MicroBiology and Scientific Techniques

In this hands-on lab course we'll dig into microbial diversity, culturing and staining techniques, microbial genetics, and evolution of microbial resistance as we study introductory microbiology. Labs include sampling and culture of bacteria, transformation, and staining and visualizing samples. We'll also discuss current events and discoveries related to antibiotic resistance while working on summaries, infographics, or short videos to inform the public about the nature of science, evolution, and antibiotic resistance.

Suggested course prerequisites: Biology 1

Length of course: 1 week

Dates Offered: July 9 – 13; July 16 – 20

Registration Fee: \$200/week

## Cancer Biology Project Development

In this 2 week-long hands-on institute, students will utilize current methods such as bioinformatics, PCR, qPCR, fluorescence microscopy, immunostaining and cancer cell culture to experimentally test a hypothesis of their own interest.

Suggested course prerequisites: Biology 1 and Chemistry 1

Length of course: 2 week

Dates Offered: July 9 – 13 & July 16 – 20

Registration Fee: \$400

## Brain Machine Interface: Using Machine Learning to Analyze and use Human Brain Signals

This course will begin by covering some basic neuroanatomy and brain function. Then it will progress into some theory of Electroencephalography and basic Machine Learning algorithms. The course will conclude with students building an EEG based AI that can be used to control devices directly from brain activity.

Suggested course prerequisites: AP Computer Science or other programming experience.

Length of course: 1 week

Dates Offered: July 9 – 13; July 16 – 20

Registration Fee: \$200/week

## Instrumental Methods of Chemical Analysis

Integrating and building upon prior knowledge from Chemistry I and AP Chemistry, students will explore chemistry through advanced laboratory projects. This course is offered to students who wish to explore areas of advanced chemical analysis and research methods. The focus of course will include project areas related to inorganic synthesis methods and analytical methods. Day 1 and 2 will include applications related to Visible Spectroscopy through several different real-world applications for inorganic compound characterization. Day 3 and part of Day 4 will involve organic synthesis followed by comprehensive characterization methods. Day 4 and 5 will round out the studies with applications utilizing fluorescence spectroscopy and other methods as time allows. Throughout the week students will be compiling their knowledge, experiences, and results in a comprehensive report to show-case what they have learned. The nature of such a course requires students to already be proficient in Chemistry having already completed AP Chemistry, and also requires that students be prepared to work responsibly and collaboratively through advanced laboratory offerings.

The skills gained would help students to better understand how to develop projects for competitions such as the Science Fair or other National level programs.

Suggested course prerequisites: AP Chemistry & Algebra 2/Trig (or equivalent)

Length of course: 1 week

Dates Offered: June 25 – June 29

Registration Fee: \$200/week

## Crash Course in Classical Lagrangian Mechanics

Lagrangian formulations are used in theoretical physics to describe dynamical systems of all kinds. Students learn the fundamental structure of physical models expressed in this language.

Suggested course prerequisites: AP Physics C

Length of course: 1 week

Dates Offered: June 25 – June 29

Registration Fee: \$200/week

## AP Physics C: Mechanics, the BIG IDEAS for Prospective Students

Students who plan to study AP Physics-C in the coming year will benefit from the overview of the structure of Newtonian Mechanics covered in the course. All major conceptual elements of Newtonian Mechanics are introduced and the big picture is revealed. This course will prove useful for ‘whole picture learners’ who understand the pieces by their relationships with the whole conceptual structure.

Length of course: 1 week

Dates Offered: July 9 – July 13

Registration Fee: \$200/week

## Crash Course in QuBits

Students become familiar with two state quantum spinor systems known as QuBits.

Length of course: 1 week

Dates Offered: June 25 – June 29

Registration Fee: \$200/week

## Explorations in Marine and Environmental Science

This course is a non-credit introduction to research, careers, and issues in the marine and environmental sciences. In this course students will have a wealth of experiences from the mountains to the sea. This class is designed to help students prepare to conduct quality research, and also to provide a unique set of experiences for students interested in pursuing a career in these fields. Field experiences vary from visiting a fish hatchery, and traveling streams in the Shenandoah Valley, to studying, collecting, and boating in the Occoquan River, and further to working at a commercial shellfish farm, participating in a research trawl survey, and beach surveying in the Atlantic Ocean. Students will also travel to local museums for behind-the-scenes programs.

\*\*\* This course includes an overnight field trip to Eastern Shore Virginia, 20-22 July.

Dates: July 16 - 28th

Total Cost: \$700 / 2 weeks (includes field trip and lab fees as well)

## Power and Energy Systems COMBINED with Computer Controlled Prototyping

This combined course will allow students to experience two different aspects of Engineering. Students will spend half a day doing each topic, then switch after lunch.

Power and Energy Systems is a hands on lab that will focus on the different ways we create and transfer energy into a usable form. We will be discussing gearing, engines and alternative energies. Students will have a chance to rebuild a 4 stroke gasoline engine, and learn about where our energy systems have come from as well as where they are headed.

Computer Controlled Prototyping focuses on the fundamentals of programming and operating computer controlled (CNC) machinery. Students will learn how to prepare material for both a CNC lathe and CNC mill, properly locate the material, and execute programs to create custom components. Students will also learn how to use computer aided design software to create custom designs and then program the machines to create those parts. Once machined, students will assemble their parts to create a working prototyping.

Suggested course prerequisites: Some Computer Assisted Design (CAD) experience would be beneficial.

Length of course: 1 week

Dates Offered: June 25 – June 29 Registration Fee: \$200/week