THE GOVERNOR'S SCHOOL for SCIENCE AND TECHNOLOGY

POS Course Descriptions 2023-2024 SY

Advanced Chemical Analysis (4471): *(2 weighted high school science credits)*
This course focuses on the fundamental principles and laws of chemistry. Extensive laboratory work will serve as the basic tools for students to explore chemistry topics. The course will provide insights into inorganic and organic chemistry. The students will study advanced concepts such as kinetics, acid/base chemistry, equilibrium, thermochemistry, nuclear chemistry and electrochemistry. The course will emphasize problem solving and higher order thinking skills through chemical calculations. *Advanced Chemical Analysis is a college-level course with a strong focus on laboratory work. It examines topics typically studied during the first year of college by science majors. Prerequisite: High School Chemistry*

Advanced Biological Analysis (4371): *(2 weighted high school science credits)*
In the fall semester, topics in the field of cell and molecular biology will be addressed, some of which include the roles of biological macromolecules, cellular organization and metabolism, and cellular processes such as communication, reproduction, respiration, and photosynthesis. In addition, mechanisms of inheritance and control of gene expression will be examined, followed by a study of developments in biotechnology. In the spring semester, evolution, phylogeny, and the diversity of living things will be discussed, with a special focus on the anatomy and physiology of plants and animals. The laboratory experience is a major component of the course, allowing students the opportunity to use technologies applied in research as well as medical and forensic laboratories while designing their own experiments and analyzing and interpreting their results. The anatomy and physiology of various vertebrate organ systems will be compared while dissecting animals in the laboratory. *Advanced Biological Analysis is a college-level course that examines the topics typically studied during the first year of college by biology majors. Prerequisite Advanced Chemical Analysis.*

Calculus-based Engineering Physics I: (4571-1): *(2 weighted high school science credits)*
This is a mathematical rigorous course that investigates the principles of classical mechanics and thermodynamics. Includes kinematics, Newton's laws of motion, work, energy, momentum, rotational kinematics, dynamics and static equilibrium, elasticity, gravitation, fluids, simple harmonic motion, calorimetry, ideal gas law, and the laws of thermodynamics. The course covers calculus-based introductory physics with laboratory sequence. It provides the student with a broad understanding of the general concepts and principles of the physical universe, and prepares the student for advanced study in physical sciences and engineering through development of skills in problem solving, critical thinking and quantitative reasoning, and an understanding of the methods of scientific inquiry and experiments. The course is the first year of a two-year calculus-based introductory physics course with laboratory sequence. *Prerequisites: Calculus*.

Calculus-based Engineering Physics III and IV: Modern Physics and Applied Physics: Engineering Design Principles (4580): *(2 weighted high school science credits)*
Learning fundamental knowledge of engineering and physics disciplines and the requisite skills to perform research, problem-solve, innovate, and create opportunities in the real world are the overarching goals of this course. Extending the first-year physics material, the course includes investigations in modern physics topics such as relativity, quantum mechanics, and nuclear physics, including, for example, conceptual understanding and practical applications of the wave function, Schrodinger's Equation, and radiation and radioactivity. The course also includes a series of project-based engineering learning experiences to help the student acquire and apply the skills, tools, and best practices of the engineering profession. Learning tools include, for example, computer programming with C++ language with object-oriented programming, hands-on design and troubleshooting of solid-state electronics and digital systems, and industry standard computer-aided-design software, and additive manufacturing fabrication systems. In challenging keystone projects, students are tasked to identify real-world engineering problems or opportunities, to propose and seek client approval for their unique solutions or innovations, then to design, build, and demonstrate their final products. The keystone experiences include professional engagement with research and engineering leaders invited from community organizations such as NASA, SNAME, and the Jefferson Labs. *Prerequisites: Engineering Physics I, Calculus*.

In 2024-2025 SY, the second year-long Calculus-based Engineering Physics III & IV course will change to **Calculus-based Engineering Physics II (45471-2).** This course covers waves, electromagnetism and optics. Includes mechanical waves and sound, electrostatics, Ohm's law and DC circuits, magnetic forces and magnetic fields, electromagnetic induction, AC circuits, ray optics, and wave optics. The is a calculus-based introductory physics course with laboratory sequence. It provides the student with a broad understanding of the general concepts and principles of the physical universe, and prepares the student for advanced study in physical sciences and engineering through development of skills in problem solving, critical thinking and quantitative reasoning, and an understanding of the methods of scientific inquiry and experiments. Part II of II.

Computational Physics (4525): (2 *weighted high school science credits)*
Teaches fundamental principles of physics and scientific programming in Python. Based on college-level Physics 201 and 202, the course covers forces, Newton's laws of motion, conservation laws, gravity, properties of matter, oscillations, optics, electricity, magnetism, and special relativity. In the first semester, students study college physics and Python as two separate subjects. Then, during the second semester, programming skills are applied to the solution of physics problems. The concepts are reinforced through weekly labs, hands-on demonstrations, and projects. *Prerequisite: Algebra II/Trig.*

Computation Science: Engineering Design, Innovation & Entrepreneurship (4550): *(2 weighted high school science credits)* Learning fundamental knowledge of design innovation and science disciplines and the requisite skills to perform research, problem-solve, innovate, and create opportunities in the real world are the overarching goals of this course. The course also includes a series of project-based learning experiences to help the student acquire and apply the skills, tools, and best practices of the STEM profession. Learning tools include, for example,

industry standards and research modeling and simulation software, hands-on design and troubleshooting of solid-state systems, and industry standard computer-aided-design software, and additive manufacturing fabrication systems. In challenging keystone projects, students are tasked to identify real-world engineering problems or opportunities, to propose and seek client approval for their unique solutions or innovations, then to design, build, and demonstrate their final products. *Prerequisites: Computational Physics and Pre-Calculus.*

College Modern Pre-Calculus (3162): *(1 weighted high school math credit)*
This course is an intensive, rigorous approach to mathematics designed to prepare students for college calculus. First semester, students will focus on the algebraic and geometric properties of polynomial, rational, exponential, logarithmic, and trigonometric functions, and engage in discussions about how these models are represented in the real world. Second semester, students will learn the analytic properties of trigonometric functions and geometric conics, as well as learning the properties of polar coordinates, vectors, matrices, parametrics, and sequences and series. *The course concludes with an introduction to calculus.*

College Calculus (3177): *(1 weighted high school math credit)*
This course covers 2 semesters of university-level calculus for scientists and engineers, emphasizing understanding and application. The first semester covers limits and continuity of functions, techniques and applications of differentiation, and introduces integration. The second semester covers applications and advanced techniques of integration, differential equations, sequences and series, and analytical geometry. Upon completion of this course, students will understand both the geometric and rate of change analyses of differential and integral calculus. Students will apply their understanding of calculus to modeling real-world situations mathematically and be able to solve those mathematical models. *Successful completion of this course will prepare students to enroll in multivariable calculus / linear algebra*.

Multivariable Calculus (3178): *(1 weighted high school math credit)*
In multivariable calculus, students extend their study of calculus from the plane into 3-dimensional space and beyond. After an initial examination of geometry and algebra of 3-space, students will use differential and integral calculus to study the nature of curves and surfaces in 3-space, Topics include linear approximations of curves and surfaces in 3-space, optimization of functions in several variables, and use of integral calculus to study area, volume, and other applications. The semester concludes with an examination of the calculus of vector fields. *Prerequisite GSST College Calculus or completion of AP Calculus BC with a score of 5 on the exam, or a score of 4 and permission of the instructor.*

Linear Algebra (3180): *(1 weighted high school math credit)*
In linear algebra, students use matrix theory to solve systems of linear equations and apply knowledge of the determinant to describe the nature of those solutions. The algebra and applications of linear transformations will be studied in both real and general vector spaces. Students will calculate eigenvalues and eigenvectors of linear transformations and use these to diagonalize linear systems. Applications include best fit functions and solutions of systems of 1st order, linear differential equations. *Prerequisite GSST College Calculus or completion of AP Calculus BC with a score of 5 on the exam, or a score of 4 and permission of the instructor.*

Differential Equations (3179): *(1 weighted high school math credit)*.
The year-long course introduces the methods, theory, and applications of differential equations. The course introduces first-order, second and higher-order linear equations, series solutions, linear systems of first-order differential equations, and the associated matrix theory. P*rerequisite for Differential Equations is successful completion of GSST College Calculus.*

Research Methodology & Ethics (4610): *(1 weighted high school elective credit).*
This year-long course provides junior STEM students with knowledge and experiences on how to conduct scientific researches and engineering projects. Students will study contemporary issues in scientific research while conducting independent scientific research and engineering projects outside of class. Students are encouraged to select projects consistent with their strand or career goals. Course topics include research design strategies, data analysis and representation (with and without computer-assistance), norms of conduct for ethical research behavior, and the historical basis for current research regulations, among others. All students must conduct a review of the primary literature to support their research design assumptions, prepare and present a plan of their proposed research for institutional review and approval, conduct their studies and report their findings via formal technical paper as well as oral presentation. Participation in regional science and engineering fairs are highly encouraged, learning fundamental knowledge of the engineering method, design for human use, and entrepreneurship are requisite skills today to perform research, problem-solve, innovate, and create opportunities in the real world. The engineering design content of the course requires that students first understand and then continuously improve their skills in the engineering method, the fundamentals of design for human use, and the mindset and skills of entrepreneurship.

Honors Research & Mentorship (4612): (2 weighted high school elective credits). Students explore advanced topics in scientific research with an emphasis on scientific literature and methods leading to the preparation of a research proposal in conjunction with their mentorship work. Students will prepare research documents using LaTeX for professional documents preparation. Mentorship involves students in concentrated research or project development in firms and laboratories throughout the Tidewater region. Students are supervised by mentors who are scientists, engineers, physicians and other professionals. Students plan, implement, document and present research or projects chosen in consultation with their mentors. Students refine their research and presentation techniques, problem-solving, critical thinking and leadership skills. Students gain proficiency with statistical software like Excel for presentation and analysis of data. Students will explore the new and young field of data science at an introductory level that provides a broad overview of the use and application of data science in daily life. Moreover, students will learn to think critically with regard to the ethics of data collection and analysis in research, industry, and government. Programming will be an integral part of the course material and assignments. Students will learn how to program in R, a program for statistics and data science. Overall, topics that are covered include introductory statistics, use and ethics of data analysis, collection, and use, and programming of data analysis programs in R. *This course provides students with an opportunity to integrate theory, knowledge and application through a research experience*.