

GSST End of the Year Newsletter

Important Dates:

May 16 - Last Day to order GSST Yearbook

- \$14 cash or check (to NHREC); bring to Dr. Patterson, A-61

May 25 - GSST Last Day of Regular Classes - Grades Submitted 3 p.m.

- All students expected to attend

May 26 - All Juniors & Seniors Encouraged to Attend GSST

- AM and PM Sessions

- Senior Farewell Celebration ([Party Flyer here](#)).
- Junior Research Mentorship Orientation, Math Placement for AY22-23, Club Planning

May 27 - All Juniors Encouraged to Attend GSST

- Regular GSST AM and PM Session Schedule

- Orientation for AY22-23
- Rising Senior Celebration (Awards Ceremony, Party for rising seniors [LINK](#))

June 1, 2022 - New Student Orientation; This will take place virtually at 6:30 PM. For more information [click here](#).

June 7, 2022 - [Senior Celebration](#); Drop in to pick up certificates and awards between 6-7 PM followed by senior social ending at 8 PM. Light refreshments and limited seating available.



Strand Updates:

Biological Sciences:

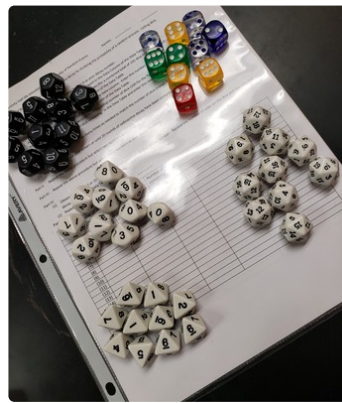
The chemistry students spent 4th quarter studying the topics of nuclear chemistry, entropy, free energy and electrochemistry. They particularly enjoyed the weeks spent on the study of organic chemistry - alkanes, alkenes, alkynes, aromatics and functional groups. They built organic compounds, made and determined the properties of soap, created nice (sort of) smelling esters, analyzed the caffeine content in tea and studied the properties of carbohydrates, proteins and amino acids. The students will show off their laboratory skills on the lab practical given at the end of the semester.

The biology students began the last quarter studying plant diversity and reproduction and are now studying animal diversity, anatomy, and physiology. Dissection, microscopy, and experimentation have all been conducted in lab.



Making Soap!

The chemistry students reacted a fat with sodium hydroxide to create mini bars of soap. Recycled crayons were used for a touch of color.



Exploring Radioactive Decay

The chemistry students completed a lab activity simulating radioactive decay. They studied the probability of a random process by selecting a decay number and then rolling 6-8-10-12 and 20-sided dice. Working collaboratively, they discovered how the half-life changed as the number of sides on the dice increased.



Comparative Anatomy & Physiology

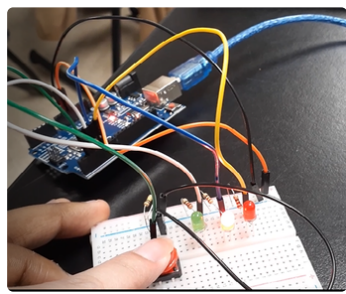
Biology students have been dissecting various animal specimens to compare their anatomical structures as they study the anatomy and physiology of various organ systems. Here, Damaris Arias (Lafayette HS) and Jessica Phan (Bethel HS) study a bullfrog.

Engineering:

Junior Year Engineering/Physics

As the school year approaches the finish line, we awe at how much every student has grown! They still remember how difficult the projectile motion was, but now they solve differential equations to solve the circuits with inductors and capacitors, the use integration to find self-inductance of the wire, and soon enough they will see the role of basic circuit elements (resistors, capacitors, inductors) in the alternating current circuits. The focus is to link mathematically advanced problems and their solutions to the general ideas of energy conservation and electric current for better conceptual understanding of the material. The last quarter engineering project aims to prepare students for the next year collaboration project with the College of William and Mary. We are learning basics of Arduino circuits and coding.





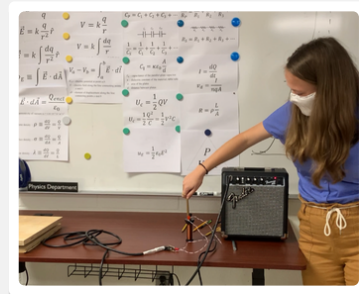
Spaceship Project

In this project, students built something that could have been a spaceship interface in a 1970s science fiction movie. They made a cool control panel with a switch and lights that turn on when you press the switch. You can decide whether the lights mean "Engage Hyperdrive" or "Fire the lasers!". A green LED will be on, until you press a button. When the Arduino gets a signal from the button, the green light turns off and two other lights start blinking.



What the future holds

It is all about team work, collaboration, and creativity. Students are charged with the task to come up with the questions that they will study next year. Professor Kidwell and his team introduced Arduino project and students quickly started generating ideas of what sensor-loaded Arduino could bring to their study, so that the meaningful results of this exploration would help our community. Pollution, sea level, and many other projects were suggested by our juniors.



Physics Demo

Third quarter project was a success! Students came up with demonstrations that were relevant to both, first and second semesters of physics. Picture shows Mara Collier (Gloucester HS) demonstrating Barkhausen effect, series of sudden changes in the size and orientation of ferromagnetic domains, or microscopic clusters of aligned atomic magnets, that occurs during a continuous process of magnetization. The amplifier allowed us to hear these changes.

Senior Year Engineering/Physics

During the last quarter, senior engineering/physics students are learning quantum mechanics of various physical systems and hydrogen atom with Schrodinger's equation. They learn purely quantum effects such as quantum tunneling and quantum entanglement. In EDIE lab, senior computational science and engineering/physics strand students work together to finalize and prototype their projects. They also work on AirDuino project in collaboration with the College of William and Mary chemistry department where they are designing enclosures and mounting apparatus for their devices. Finally, in computer programming with C++ course, after learning all essential knowledge, especially object oriented programming techniques, students are working on a final project in which they program an ATM machine with all essential features implemented.



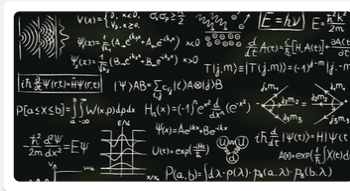
EDIE lab

senior computational science and engineering/physics strand students work together to finalize and prototype their projects

```
368 int lcd_create_map_value_to_empty_val
369 {
370     memset(empty, 0, 0);
371     int i = 0;
372     int tmp;
373
374     tmp = percent1 / 10;
375     printf("percent1 = %d, tmp = %d\n", percent1, tmp);
376     for(i = 7; i >= 0; i--)
```

C++ course

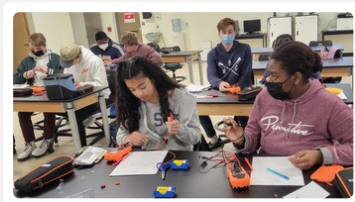
students are working on a final project in which they program an ATM machine



Quantum Mechanics

students are learning quantum mechanics of various physical systems and hydrogen atom with Schrodinger's equation. They learn purely quantum effects such as quantum tunneling and quantum entanglement.

Computational Sciences



Multimeters

Using multimeters, students are exploring electric voltage of different objects.



Electric Fields

Students are mapping electric fields produced by charges.



Electric Potential

Students are mapping equipotential lines produced by charges.



Van de Graaff generator

A **Van de Graaff generator** is an electrostatic generator that uses a moving belt to accumulate electric charge on a hollow metal globe.



Before

A student is about to experience a dramatic effect. When a student puts a hand on the sphere, the electrons will spread out onto that person as they repel the other electrons.



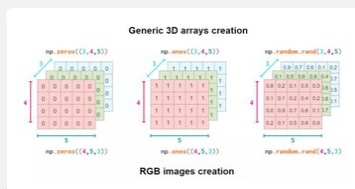
After

They are most obvious in a person's hair because the like charges of the electrons repel each other and cause the hairs to stand up and spread away from each other.



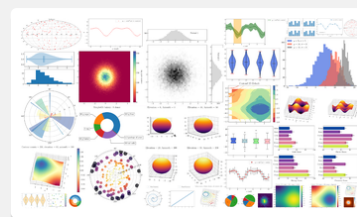
NumPy

NumPy is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays.



3D Arrays

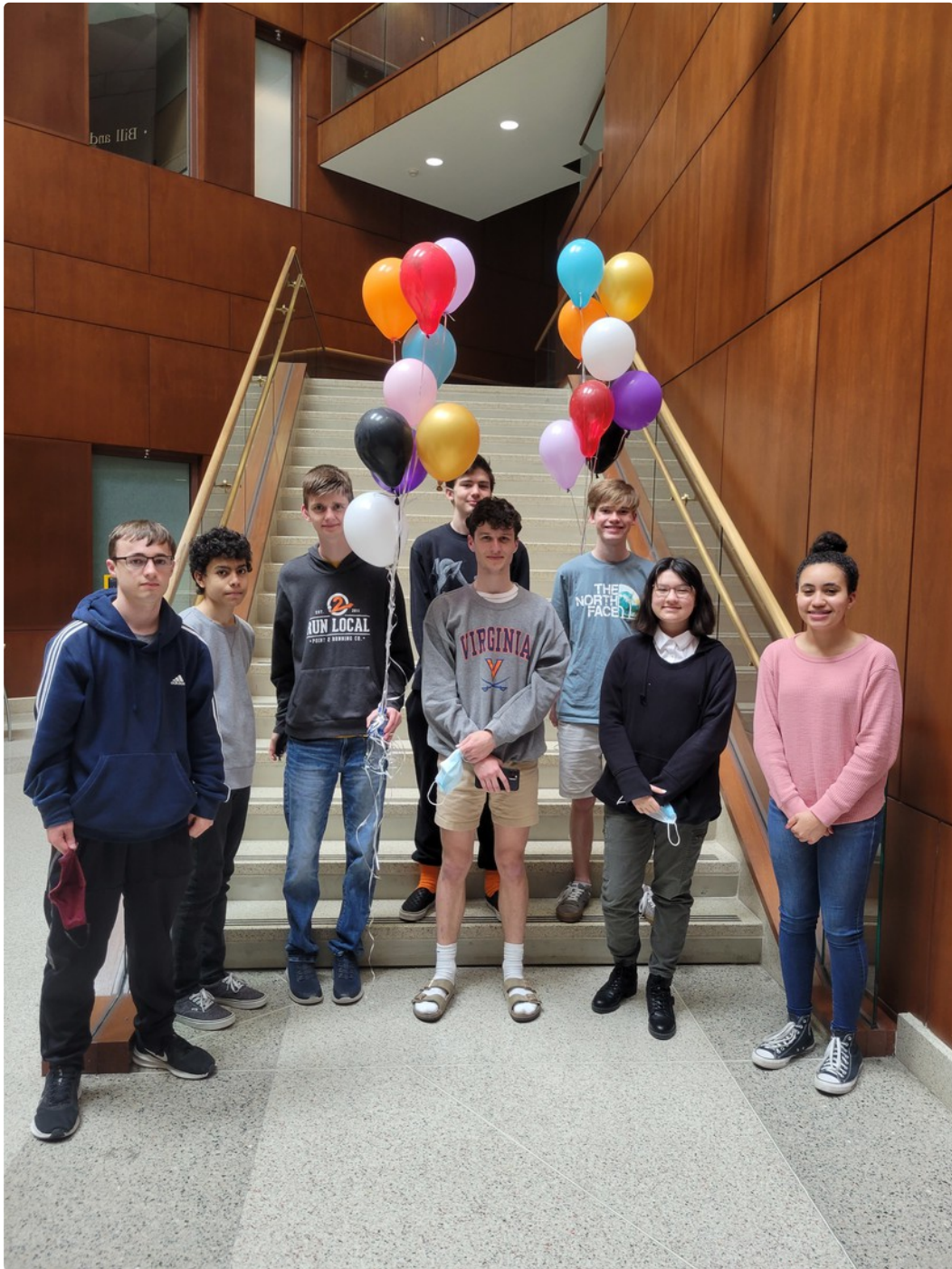
Students getting better and better at NumPy. NumPy allows the creation of 3D or N-Dimensional arrays.



Matplotlib

Matplotlib is a plotting library for the Python programming language and its numerical mathematics extension NumPy. Students use these libraries to produce high-quality plots.

Students in the computational science strand have recently participated in two programming competitions—one for UVA's own High School Programming Contest and the other for CodeQuest by Lockheed Martin. While our students did not win the competitions, we are incredibly proud of them for participating and taking the initiative in their programming careers.





Students in GSST Computational Science are also participating in Great Computer Challenge at WHRO near ODU later this month.



Senior Computational Science

Seniors in the Computational Science program have been learning more in-depth object-oriented programming with C++ using virtual functions, polymorphism, and pointers to make complex programs. These students have demonstrated an ability to design programs and implement them as necessary while maintaining best coding practices.


```

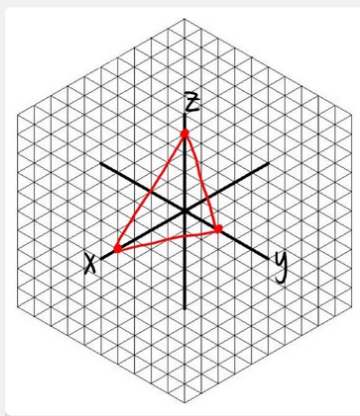
28 cout << endl;
29
30 string *names[5];
31 double **miles;
32 int rows = 5;
33 int columns = 7;
34 miles = new double*[rows];
35
36 for (int row = 0; row < rows; row++)
37     miles[row] = new double[columns];
38
39 double *avg1, *avg2, *avg3, *avg4, *avg5;
40
41 getData(names, miles);
42 print(miles, 5, 7);
43
44 avg1 = new double(average(miles, 0));
45 cout << avg1 << endl;
46 avg2 = new double(average(miles, 1));
47 avg3 = new double(average(miles, 2));
48 avg4 = new double(average(miles, 3));
49 avg5 = new double(average(miles, 4));
50
51 cout << "Name      Day 1    Day 2    Day 3    Day 4    Day 5    D
52 output(names, miles, avg1, 0);
53 output(names, miles, avg2, 1);
54 output(names, miles, avg3, 2);
55 output(names, miles, avg4, 3);
56 output(names, miles, avg5, 4);
57
58
59 return 0;
60 }
61
62 void getData(string *names[5], double **miles)
63 {
64     ifstream file;
65     file.open("input.txt");
66
67     for(int i=0;i<5;i++){
68         for(int j=0;j<7;j++){
69             file >> names[i];
70             file >> miles[i][j];
71         }
72     }
73
74     double average(double **miles, int k)
75     {
76         double avg = 0;
77         for(int j = 0; j < 5; j++){
78             for(int i=0;i<7;i++){
79                 avg += miles[j][i];
80             }
81             avg /= 7;
82         }
83         return avg;
84     }
85
86 void output(string *names[5], double **miles, double *average, int k)
87 {
88     cout << setw(15) << setfill(' ') << left << names[k];
89     for(int i=0;i<7;i++){
90         cout << setw(10) << setfill(' ') << left << fixed << showpoint << setpr
91         cout << setw(7) << setfill(' ') << right << fixed << showpoint << setprecis
92     }
93
94 void print(double **p, int rowSize, int columnSize)
95 {
96     for (int row = 0; row < rowSize; row++)
97     {
98         for (int col = 0; col < columnSize; col++)
99             cout << setw(5) << p[row][col];
100         cout << endl;
101     }
102 }

```

Math Updates

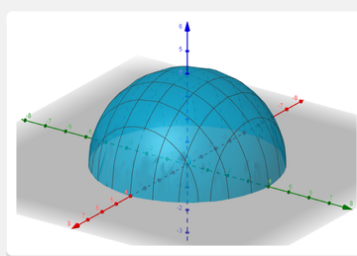
Applied Calculus

Students are in their final unit exploring 3D. They are learning how to plot points, graph planes, using coordinate traces to identify quadratic surfaces, identifying the domain and range, partial derivatives, and how to find minimums and maximums.



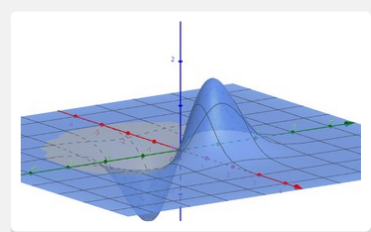
Graphing Planes

How to graph a 3D plane on a 2D paper. Here is the plane $x + 2y + z = 4$



Domain & Range

Using GeoGebra 3D to explore the domain and range of a function $z = f(x, y)$



Extrema

Using GeoGebra 3D to visualize the minimums, maximums, and saddle points of 3D graphs.

Calculus

This quarter, students are learning about sequences and series. Did you know you can write a function as the sum of a sequence? The knowledge of Taylor and Maclaurin series allow us to estimate the

$$4. \int_0^1 x^2 e^{-x^2} dx, |error| < 0.001$$

$$x^2 e^{-x^2} = x^2 \cdot \sum_{n=0}^{\infty} \frac{(-1)^n x^{2n}}{n!} = x^2 \sum_{n=0}^{\infty} \frac{(-1)^n x^{2n}}{n!} = \sum_{n=0}^{\infty} \frac{(-1)^n x^{2n+2}}{n!}$$

$$\int_0^1 x^2 e^{-x^2} dx = \sum_{n=0}^{\infty} \frac{(-1)^n}{n!} \int_0^1 x^{2n+2} dx = \sum_{n=0}^{\infty} \frac{(-1)^n}{n!} \left[\frac{x^{2n+3}}{2n+3} \right]_0^1$$

$$= \sum_{n=0}^{\infty} \frac{(-1)^n}{n!} \frac{(1)^{2n+3}}{2n+3} - \sum_{n=0}^{\infty} \frac{(-1)^n}{n!} \frac{(0)^{2n+3}}{2n+3}$$

$$a_n = \frac{(-1)^n}{n! (2n+3)}$$

$$a_1 = -0.0063$$

$$a_2 = 0.000558 < 0.001$$

$$\Rightarrow n=1 \Rightarrow 2 \Rightarrow n=1$$

$$\int_0^1 x^2 e^{-x^2} dx \approx \sum_{n=0}^1 \frac{(-1)^n}{n! (2n+3)} = 0.355416$$

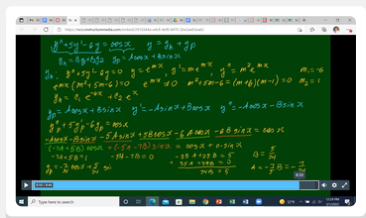
Applying the direct comparison test to prove that the given series converges.

Applying the Ratio Test to identify what values we can plug in for x and have the series converge.

Combining integrals and the Alternating Series Estimation Theorem to calculate the value of the definite integral

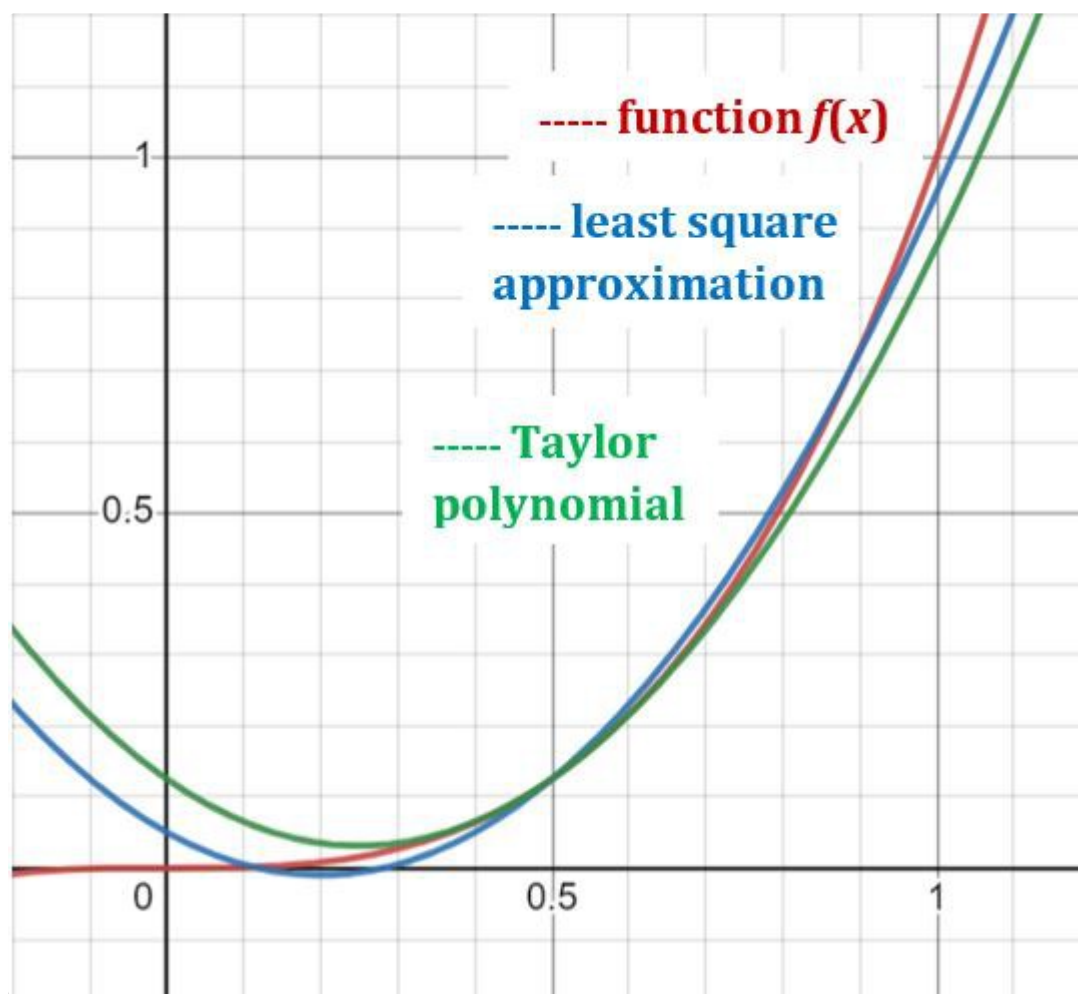
Differential Equations

Students summarized different approaches of solving differential equations, including the separable DE, solutions by the integrating factor, exact equations, solutions by substitution, Bernoulli's equations, Reduction of Order, Homogeneous Linear Equations with Constant Coefficients, Undetermined Coefficients by Annihilator Approach, Variation of Parameters, Series Solutions.



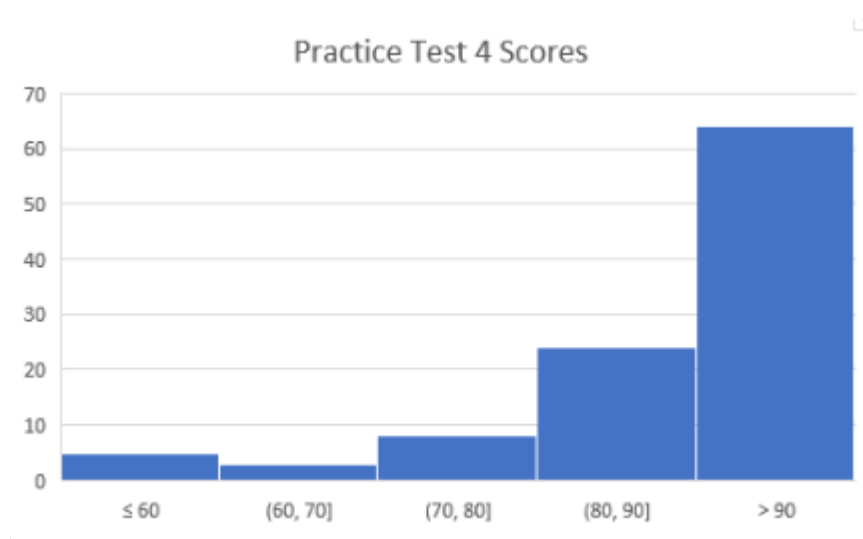
Linear Algebra

Students in the second half of this course ventured into more abstract concepts. They have generalized the properties in 2D or 3D real space to any inner product vector spaces, which has vast implications to other science fields, such as least square regression, best approximation, Fourier series.



Prepping for the end of the year!

Things are looking good as we prepare for the last test of the year with Practice Test 4!



Research Updates:



Science Fair Winners!

Claire Chang and Olivia Chang (Tabb High School) were awarded 1st Award of Excellence for Senior Division at the Tidewater Science and Engineering Fair. The title of their research project is Flies on the Fly: A Novel Research on Thiamine as a Preventative Measure to Traumatic-Brain-Injury-Induced Locomotive Ability Loss. They qualified to compete at the International Science and Engineering Fair in May.

GSST 2021-22 T-shirt Design Team

Hannah Bunting, Camden West, Alexia Jennings, and Kaitlyn Kinslow pose for a picture in the new GSST T-shirt that they designed.



GSST College Commitment Day



