INTEGRATIVE PROJECT IN COMPUTER SCIENCE AND MATHEMATIC

420-204-RE

PROJECT DELIVERABLE-1

Team

Duc Vinh (Steven), Maesha, Matthew, Sabrina

Team Name

Side Characters

List of Program Courses and Concepts

List all the program courses that you have already taken or are currently taking and list their key concepts. If there is a discrepancy between team members where a team member did not take a certain course, mention it.

Course	Concepts
Calculus 1 (201-NYA)	Limits, differentiation, related rates
Introduction to Programming (201-RE)	OOP concepts, classes, inheritance
Calculus 2 (201-NYB)	Integration, volume of solids of revolution, series & sequences
Data Structures and Object Orientation (202-RE)	Data structures, FileIO,
Linear Algebra (201-NYC)	Matrix algebra, vector geometry, vector spaces
Program Development in a Graphical Environment (203-RE)	JavaFx. Animation, libraries, css, csv
Mechanics (203-NYA)	Kinematics and dynamics: forces, energy & work, momentum
Waves, Optics, & Modern Physics (203-NYC)	Wave kinematics & dynamics, optical interference and diffraction, spherical lenses and mirrors, relativity, quantum & nuclear physics

Project Idea

Each team member must think of and choose a project idea then work with their teammates to select the more convenient ones.

Team Name:	Side characters
Team Member's name and Project Idea 1:	Sabrina Amoura Optics simulator : 4 experiments (one by each team member) Ideas: double slit experiment, refraction, single slit diffraction, photoelectric effect https://javalab.org/en/double_slit_en/
Team Member's name and Project Idea 2:	Matthew Hantar Electricity and Magnetism project (electric circuit, electric field, electric charge, magnetic field)
Team Member's name and Project Idea 3:	Duc Vinh (Steven) Lam explosive charge simulation: collision simulator but with explosive charges or spring propelled items
Team Member's name and Project Idea 4:	Maésha Mahmud Machine learning, 3D simulation, chatbots?, something with database/sql, productive app?, vectors? https://www.hackathon.physics.mcgill.ca/Hackathon_Projects_Ideas_2020.pdf
Selected Project Ideas and why:	Optics Simulator Out of the ideas suggested, building an optics/waves simulator is the most "doable" given the fact that the scientific portion has already been thoroughly covered by all 4 members. Additionally, the topic gives a lot of flexibility in terms of what sub-concepts to choose from, giving us the possibility to create several different but related simulations.

Project Description

Describe you project idea, in brief, all while addressing the following points:

Concept

- Describe the physical and/or mathematical concept(s) behind the project.

Concept Aspects

- Identify and list the main aspects of the concept such as the problem it addresses, the proposed solution, the solution category among other approaches' categories.
- The possible variable parameters that would control the user interface animating the concept.

Typical Input

- Describe the typical input for the solution of the applied concept to work.

Expected Output

- Describe the expected output and how the user interface would look like and what it would allow the user to do.

Feasibility

- List the JavaFX, or similar technology, elements, and implementation components that you expect to use to implement the project.
- Justify the feasibility in terms of timeline and team tasks assignment.

Individual part

- For each team member, describe their individual part and how it would integrate with the whole project with other team members parts.

This project will consist of a set of simulations covering sub-concepts under the generic concept of “optics”.

1) Double-slit experiment (Sabina)

This simulation consists of a visual representation of a double-slit experiment using monochromatic light. A laser shining through two slits will create a fringe pattern on a screen that accurately depicts the interference and diffraction minimums/maximums. The user will be able to adjust the width of the slits, the spacing between slits, the wavelength of the light, and the distance between the screen and the slits. The intensity at different points on the screen will be graphed.
Reference: https://phet.colorado.edu/en/simulations/wave-interference

2) Reflection/refraction (Matthew)

A ray will be directed towards a surface that will create refracted rays. The angle of the ray will be indicated on the screen. There can be multiple surfaces such as oil, water, air, and other substances that the user can choose from a list of options that will have different index numbers. The project will show the pi and the 0 reflections, depending on the refraction index and the lightwave that is shone on the project. Also, the thing that will be reflected will either be either a wave or a ray. This sub-project will be feasible because it uses material that we have learned in our previous physics classes. The project is going to be made using JavaFX and probably some libraries.
Reference: https://phet.colorado.edu/en/simulations/bending-light

3) Spherical lenses (Steven)

The user will be able to add converging and diverging lenses on a horizontal line. A displaceable and resizable object will also be placed on this line, and its principal rays of light will be emitted from a point toward the closest lens. The result will be a virtual or real image with a ray diagram containing the location of the focal points, the distance of the object, and the image as well as the lens. The user will be able to modify the focal points and the distances between lenses/objects. By adding additional lenses, the user can create a multi-lens system, which will have its final image displayed. Alternatively, the user could also fine-tune the radius of the curvature, the index of refraction, and the diameter of the lenses. This will allow them to predict the image and height of the object.
Reference: https://phet.colorado.edu/en/simulations/geometric-optics

4) Photoelectric effects (Maesha)

Light shining on a plate connected to a current that the user will be able to change. The intensity of the light and the wavelength can also be modified by the user. An animation of photons can be seen to be ejected from one side of the plate to the other depending on the light. There will also be a pop-up slide that shows the graph of the current versus the battery voltage and light intensity and the electron energy versus light frequency. In order to create this simulation, we will be using JavaFX, Scene builder, and CSS.
Inspiration: https://phet.colorado.edu/en/simulations/photoelectric