UNIVERSIDAD TECNICA
FEDERICO SANTA MARIA

DEPARTAMENTO DE FÍSICA

FÍSICA COMPUTACIONAL

Homework #3

Due to November 4

Please solve the following problems and email your solutions to both Prof. Florez and Prof. Carquín. Comprehensive instructions to handle your software are expected as well as a detailed description of your programs' structure.

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Problem #1:

Implement a 3-vector class (3-dimensional vector) that contains the following member functions or operators when it corresponds (you are free to choose the implementation that better suits you):

1. Multiplication by a scalar (float)
2. Vector sum
3. Dot product
4. Vector product
5. Implement a main function that takes as input from the keyboard the two vectors and a float number.

Problem #2:

Implement the class "trigonometric functions" that calculates the values of the sine and cosine trigonometric functions using their power series expressions for this purpose. Optimize the calculation taking only a number of terms in the series that allows you to have a precision of two decimal places. Define also the functions: tangent, secant y co-secant. Use members, functions and data with static y const in a consistent way when necessary.

Problem #3:

Develop a class of 2 × 2 matrices of double precision floating point variables that has the features listed below.

1. An overridden default constructor that initializes all entries of the matrix to zero.
2. An overridden copy constructor.
3. A constructor that specifies the four entries of the matrix and allocates these entries appropriately.
4. A method (function) that returns the determinant of the matrix.
5. A method that returns the inverse of the matrix, if it exists.
6. Overloading of the assignment operator, allowing us to write code such as A = B; for instances of the class A and B.
7. Overloading of the unary subtraction operator, allowing us to write code such as A = -B; for instances of the class A and B.
8. Overloading of the binary addition and subtraction operators, allowing us to write code such as A = B + C; or A = B - C; for instances of the class A, BandC.
9. A method that multiplies a matrix by a specified double precision floating point variable.

Problem #4:

Compute the "stretch-factor" γ for a relativistic particle for speeds approaching the speed of light, i.e. for β = v/c=0.9, 0.99, 0.999, 0.9999.... Compute this in two ways, first as $\gamma = 1/\sqrt{1-\beta^2}$ and then as $\gamma = 1/\sqrt{(2-\epsilon)\epsilon}$ where ε = 0.1, 0.01, 0.001, 0.0001.... Suppose that the fractional error in the calculation is required to be one part in one thousand or less. What is the maximum value of β for which this accuracy can be obtained, if one computes it using the former method?

Problem #5:

Polynomial: Write a class for polynomials that should at least contain:

- A constructor giving the degree of the polynomial;
- A dynamic array/vector/list of double to store the coefficients;
- A destructor; and
- A output function for ostream. Further members like arithmetic operations are optional.