MIDTERM ESSAY: Applied Calculus for IT

CODE: 501031

I.   Rules
- Each essay is conducted by a group of **one or two students**.
- The essay consists of 2 parts: the Programming part and the Report part.
- Only use Python and the following Python libraries: **math, numpy, sympy, matplotlib**.

II.   Programming part (8.0 points)

This part is consist of a programing task as follows:

Task 1. Given two functions as follows:

$$f(x) = x^2 - 2Ax - A^2$$

$$g(x) = -x^2 + 4Ax + A^3$$

In regard to the value of the constant **A**, you manually select any integer number **from 10 to 99**, for ex., $A = 15$, or $A = 41$, or $A = 86$ …

Implement the following requirements:

a (4.0 points). Find and print out intersection points of $f(x)$ and $g(x)$. Plot the graphs of $f(x)$ and $g(x)$ functions, and the intersection points in the same figure. The following information must be presented in the figure: figure title, labels of the graphs.

Here is a sample output:

```
1a. Intersection point 1 : ( -158.622201475220 , 37412.0009336151 )
1a. Intersection point 2 : ( 293.622201475220 , 57762.9990663849 )
```
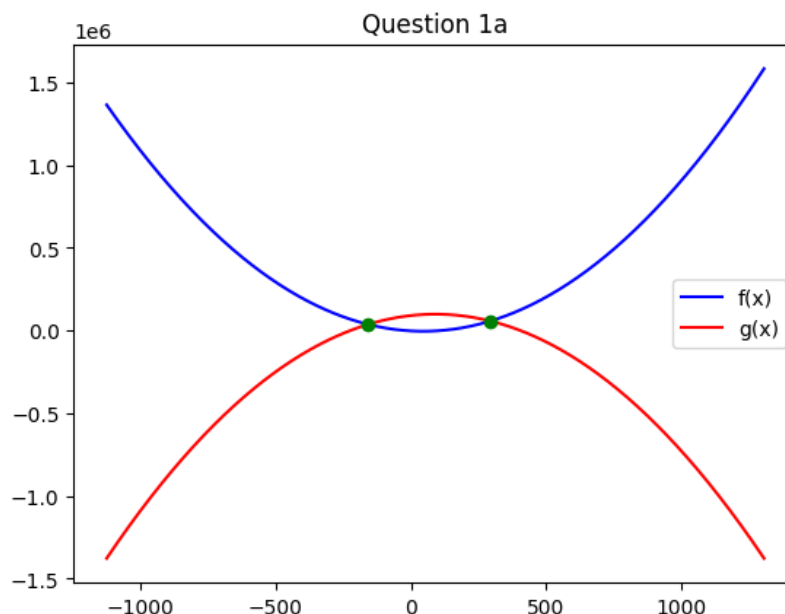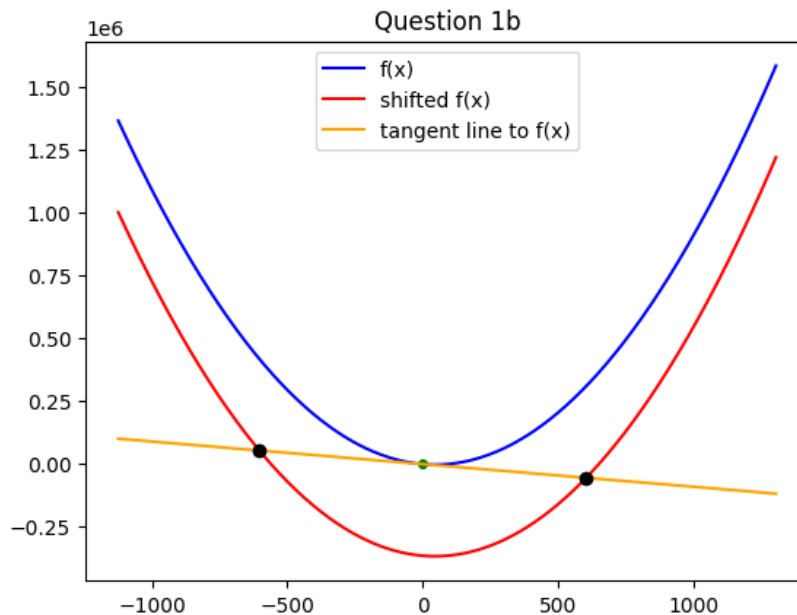
b (3.0 points). Find and print out the equation of the tangent line (T) to $f(x)$ at the point $(0, -A^2)$. Shift the graph of the function $f(x)$ down $\mathbf{4A^3}$ units, then find and print out intersection points of the shifted graph of $f(x)$ and the tangent line T. Plot the original graph $f(x)$, the shifted graph of $f(x)$, the tangent line, the tangential point, and the intersection points in the same figure. The following information must be presented in the figure: figure title, labels of the graphs.

Here is a sample output:

Equation of the tangent line to the curve f(x) : -90*x - 2025
1b. Intersection point 1 : (-603.738353924943 , 52311.4518532449)
1b. Intersection point 2 : (603.738353924943 , -56361.4518532449)

c (1.0 point). Find and print out the equations of the tangent lines to $f(x)$ through the point $(0, -4A^3)$. Plot the graph of $f(x)$ function, the tangent lines, the tangential points, and the point $(0, -4A^3)$ in the same figure. The following information must be presented in the figure: figure title, labels of the graphs.

Here is a sample output:

Equation of the tangent line 1 to the curve f(x) : -1294.11793442337*x - 364500.0
Equation of the tangent line 2 to the curve f(x) : 1114.11793442337*x - 364500.0
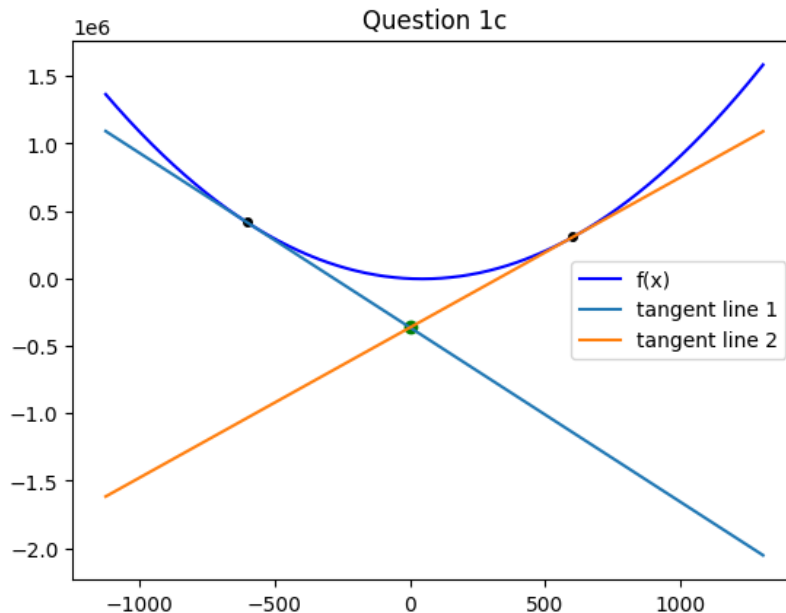
Notes:

- You could use any color for graphs and points though they must be visible. All sub-tasks are independent; thus, you could implement the tasks in an arbitrary order.
- Students are **not allowed to** do it manually by writing the results directly to the source code file. Cases done manually as above will not be scored.

III.   Report part (2.0 points)

1. The report must be submitted in **PDF format**, and the content must be written based on the report/essay format of the Faculty of Information Technology. **In case students do not follow the Faculty's format, they will receive 0 points for the Report part.**

2. The report must include the following contents:

   a. Chapter 1: Methodology of Solving Tasks **(1.0 point)**

   Write a short description of the solving methods used in each **Task 1a, 1b, and 1c** in the "Programming part". For ex.:

   - Initialize x-values, y-values
   - Solve the equation ... to find roots
   - ….

b. Chapter 2: Source codes and outputs **(1.0 point)**

Create images of all source codes and corresponding outputs in the "Programming part", and insert them into this chapter. The images must be clear, and properly laid out. The images captions and descriptions are also required.

Hint: To get a clear and high quality image, you could make an image for each sub-task's source code/results.

IV. Submission guideline

- Filenames of the source code and the report files must be the **Student IDs**, for ex.,
  - A group of only one student with student ID 521H1495 will submit a Python source file named **521H1495.py** and a report file named **521H1495.pdf**
  - A group of two students with student IDs 521H1234 and 522H4321 will submit a Python source file named **521H1234_522H4321.py** and a report file named **521H1234_522H4321.pdf**
- Students submit **a Python source file and a report file** to the "**MidTerm_Essay**" assignment on Elearning website of the practical class.
- Students must ensure that the Python source files are not corrupted during execution. The source code with errors will not be scored.
- Python source files must be saved in the correct format (**file extension is .py**). The source files in the wrong format will not be scored.

V. Regulations

- The result of this essay will be the Midterm score.
- **Student who copy their friends's essay will be scored 0.**
- **If a student's work shows signs of copying each other, the student will attend an interview with the lecturer.**

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