

**This sheet is to be returned at the conclusion of the lab session.**

Student Name: \_\_\_\_\_

Student Number: \_\_\_\_\_

### **ENG 1D04, Lab 7, Marked Assignment 3, Methods, Loops, and Arrays, Wednesday**

This assignment has to be submitted via ELM before 2:10 pm. **Assignments will not be accepted after this time.** Please remember to submit your work early and resubmit often. **You should not wait until the end of the lab to start submitting.** You must do the assignment on your own. Conversations between students will not be permitted. You cannot bring reference material into the lab or access information through the Internet. You may use the Visual C# help, Notepad, and the Calculator program.

### **Background**

Let  $\mathbf{R}$  be the set of real numbers,  $f : \mathbf{R} \rightarrow \mathbf{R}$  be a continuous function that maps real numbers to real numbers, and  $[a, b]$  be a closed interval of real numbers (i.e., a set  $\{x \in \mathbf{R} \mid a \leq x \leq b\}$ ). The function  $f$  *attains an internal maximum* on the closed interval  $[a, b]$  if there is an  $x$  in the closed interval such that  $f(a) < f(x)$  and  $f(b) < f(x)$ .

### **Overview**

Assume the function  $f$  is specified by the equation

$$f(x) = \sin(x).$$

Your program will check whether this function attains an internal maximum on a given closed interval  $[x_0, x_{19}]$ . The closed interval will be represented by an evenly spaced, increasing finite sequence  $[x_0, \dots, x_{19}]$  of 20 sample points.

Design, implement and test the application described in the requirements below. Name the application

*MacID\_StudentNumber\_LabSection\_Lab7*

where *MacID*, *StudentNumber*, and *LabSection* are your MacID, student number, and lab section (written as *Lxy*), respectively. When done, compress the project and similarly name the zip file

*MacID\_StudentNumber\_LabSection\_Lab7.zip*

Details of what you must submit are specified below.

### **Requirements**

1. A method with the heading `double f(double x)` that computes the function  $f$  specified above.
2. A graphical user interface (GUI) consisting of a form with the controls described below. The text **Check the Internal Maximum Property** is at the top of the form. (The placement of the controls is your decision.)
3. One input label box with the label **Left Point =**, followed by a text box to accept the left point  $x_0$  of the closed interval.

4. One input label box with the label **Right Point =** , followed by a text box to accept the right point  $x_{19}$  of the closed interval.
5. An output label box with label **Result** to show the result of checking whether the function  $f$  attains an internal maximum on the closed interval.
6. A **Build Input Array** button that when clicked (1) creates an array of type `double [ ]` of length 20 that holds the values  $x_0, \dots, x_{19}$  and (2) displays the values of the array in a message box with one value per line. The  $x_i$  are evenly spaced from  $x_0$  to  $x_{19}$  (i.e., the distance between  $x_i$  and  $x_{i+1}$  should be the same for all  $i$  with  $0 \leq i \leq 18$ ). Note: The user only inputs  $x_0$  and  $x_{19}$ ; the other  $x_i$  are computed by your program.
7. A **Build Output Array** button that when clicked (1) creates an array of type `double [ ]` of length 20 that holds the values  $f(x_0), \dots, f(x_{19})$  and (2) displays the values of the array in a message box with one value per line.
8. A **Check Property** button that when clicked replaces the label **Result** by **Definitely Attains an Internal Maximum** if the array of outputs shows that  $f$  attains an internal maximum on  $[x_0, x_{19}]$ . Otherwise the output label **Result** is replaced by **Likely does not Attain an Internal Maximum**.
9. A **Clear** button that when clicked causes the input text boxes to be cleared of their values. It also restores the output label box back to the original value of **Result**.
10. When the application starts, the two input text boxes are empty.

## Design

In your project folder include a separate text document (using Notepad) with the file name *Name\_LabNumber\_Lab7.txt* where *Name* is your name and *LabNumber* is your lab section. The report will answer two questions, one related to design and the other related to testing. The testing question is given below. The design question is:

If the `f` method implemented a different continuous function than  $f$  above, would the rest of your program need to be modified?

## Implementation in Visual C#

Implement the requirements listed above.

## Testing

In the *Name\_LabNumber\_Lab7.txt* file, answer the following testing question:

Some closed intervals on which  $f$  does attain an internal maximum should be tested. Give an example of such a closed interval.

## Side Remark

If  $f$  is a differentiable function that has an internal maximum on a closed interval, then  $f$  has a point in the closed interval where the derivative of  $f$  is 0.