

**Homework #14**  
**Engineering 0012/0711 - Fall 2009**

**Due: Monday, November 16**

1. Within a complex electronic circuit, the voltage ( $V$ ) varies with time ( $t$ ) according to the formula

$$V = \frac{3}{2} - \frac{12}{\pi^2} \sum_{i=1}^{\infty} \frac{1}{(2i-1)^2} \cos \frac{(2i-1)\pi t}{3}$$

where  $-3 < t < 3$ .

Formulas of this type are known as *Fourier series*. They *approximate* the correct value for  $V$ , with the approximation becoming increasingly accurate as the number of terms in the series increases.

Apply what we've learned about *looping* (**while**, **for**) and *branching* (**if – else**, **switch case**) to write a complete C program that will allow the user to answer one of the following three options.

- a. This option will allow the user to calculate the voltage for a given value of time. Write the program in such a manner that the time ( $t$ ) and the number of terms in the series ( $n$ , where  $i = 1, 2, \dots, n$ ) are entered as input quantities. The program should display the values of  $t$ ,  $n$  and  $V$  to the screen. Include a provision for repeated program execution (for example, by displaying **Again? (Y/N)** at the end of each calculation, after the results have been displayed.

Test your program with the following sets of data:

$$t = 2.4, n = 5$$

$$t = 2.4, n = 9$$

$$t = -1.4, n = 7$$

- b) This option will accept only  $t$  and some value  $\epsilon$  as input quantities. Continue adding terms in the series until you reach a point where the absolute value of the term you about to add is less than or equal to  $\epsilon$ . The program should display the values of  $t$ ,  $\epsilon$ ,  $V$  and display  $n$  the number of terms used to find  $V$ . Include a provision for repeated program execution (for example, by displaying **Again? (Y/N)** at the end of each calculation, after the results have been displayed.

Test your program for the following sets of data:

$$t = 2.4, \epsilon = 0.01$$

$$t = 2.4, \epsilon = 0.005$$

$$t = -1.4, \epsilon = 0.02$$

- c) This option will find the *change* in voltage between times  $t_2$  and  $t_1$ , where  $t_2 > t_1$ . Write the program in such a manner that the times ( $t_2$  and  $t_1$ ) and the number of terms in the series ( $n$ , where  $i = 1, 2, \dots, n$ ) are entered as input quantities. Display the values of both times  $t_2$  &  $t_1$ ,  $n$ , the voltage  $V$  at each time and the change in voltage ( $\Delta V$ ) for each data set. Include a provision for repeated program execution (for example, by displaying **Again? (Y/N)** at the end of each calculation, after the results have been displayed.

Test your program for the following sets of data:

$$t_1 = 0 \qquad t_2 = 2 \qquad n = 5$$

$$t_1 = 0.5 \qquad t_2 = 2 \qquad n = 7$$

$$t_1 = -1.5 \qquad t_2 = 0.5 \qquad n = 9$$

The program should also print all the screen output for each section to a file. Have the program append the results if the users repeats the program for different input values. (Allow the user to enter the filename.)

Finally have the entire program in a loop to allow the user to do a different option(a, b or c).

Remember that your program must be stylistically well written as well as mathematically correct. As indicated in the last assignment, your program must include comments, liberal use of whitespace, and proper indentation. In addition, the program should include prompts for the input data, and should display the output in a manner that is clearly labeled and unambiguous.

Check the script as you design it to make sure it fits all the requirements. Have FUN!!!!!!!!!!!!

Drop the .cpp file.

Note: Your script must have a header section in comments that identifies:

Team members

Engineering 0012 T,H 00:00-00:00

Instructor:

Date:

Assignment number (i.e., Homework 14)  
purpose of script

Also, you will be graded on programming style. Use white space, comments, indenting, etc.