Fourier Series and their Engineering Applications Using Computer Algebra System

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***Abstract*— The focus of this presentation is solving engineering model problems using Maple, a Computer Algebra System (CAS), which sometimes substitutes the exact mathematical proofing. While composing the topics of a course of mathematics, rapid development of computer algebra systems was used for the new teaching-learning model which developed deeper connection between the mathematics and engineering. On the other hand, in this way students with limited mathematical skills are also able to understand more complex tasks. Considering the possibilities of the new strategies, test results will be better and students' bad preconceptions about mathematics will decrease. Prerequisite of the strategy is the students' basic computational knowledge. These new type of teaching-learning process helps the integration of mathematics and special engineering subjects, and helps the better understanding between mathematician and engineer.**

I. Introduction

Mathematical competence is the ability to understand, judge, do, and use mathematics in a variety of intra- and extra-mathematical contexts and situations in which mathematics plays or could play a role [1[, [2]. The recommendation for engineering students is to reach the following competences: thinking and reasoning mathematically, posing and solving mathematical problems, modelling mathematically, representing mathematical entities, handling mathematical symbols and formalism, communicating in, with, and about mathematics, making use of aids and tools. The required mathematical knowledge is divided into different levels. While solving model problems we tried to take advantage of the opportunities offered by the Maple computer algebra system

II. History

At University of Pécs we have used MAPLE (a computer algebra system) for teaching mathematics for 15 years. a lot of didactical projects are dealing with the role of computer algebra (CAS) in teaching mathematics [4], [5], [6]., how is used in the engineering practice [6], [7], [8], [9].. We reflected on how the systemic use of technology may impact recruitment, entrance and retention and how it is used for different topics of mathematics.

In the engineering society there are two different opinions about mathematics. One is that mathematics is only for mathematicians, engineers use computers and software to solve their problems. The other opinion is that engineers can calculate anything with the help of a simple calculator. Reflecting to these opinions we think that computer algebra systems connect mathematicians and engineers in problem solving.

III. Teaching Fourier Series

A. Pseudo-code phase

White box (everything is explained [3]): if we have enough time, students have basic knowledge of integration, and series of function, prove the lemmas by hand, and after it use MAPLE only checking.

Black box: (Less time) solving them with Maple command.

B. Semi-automated phase

We construct the parts of the complete algorithm a stand-alone procedures, or use the built-in commands (functions, procedures) of Maple

C. Automatic phase (functional programming phase)

White box: for whom, who wants to know more about how to construct a MAPLE procedure (students of informatics)

Black box: for whom, who has the basic knowledge of the development of a series, but he/she wants to use it in the engineering practice. For whom, who does not want to know why, but only how.

IV. Engineering Applications

A. Fourier transformation

Maple has a package namely *inttrans*, after understanding the connection between the Fourier series and the Fourier transformation the user can calculate the Fourier and the inverse Fourier transform with the built in commands.

B. Vibration of a cord

C. Heat transition in two dimensions

Using Maple we compare the results of the analytical (Fourier series solution) and that of the numerical (finite-difference method) methods using and show the Maple procedure to automatize the calculation in a general case

V. Conclusion

Probably the most basic, most complex, and from didactic point of view very critical question about the usage of CAS concerns the usage of the modules. In one respect, using modules, CAS executes the majority of the operative activities, on the other hand it renders different delineation and representation methods in quick and easy

access. Due these experiment-based, explorative learning gains an effective tool using white box-black box technique in teaching.

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