10 YEARS OF ELECTRONIC LEARNING MANAGEMENT SYSTEM USAGE AT THE FACULTY OF AERONAUTICS AND ITS NEW POSSIBILITIES

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Summary. The first part of the work is contained historical and statistical information about usage of the electronic learning management system Moodle LF at the Faculty of Aeronautics at Technical University in Košice. The system was put into operation in September 2008. Currently, practically all students of the faculty use the system Moodle LF. At present, the system includes 157 courses and also 47 courses completed during the bachelor and diploma works.

The second part describes new technologies and new trends in the application of this form of learning management. For users, teachers and students we have prepared a new version of the system Moodle LF2 which is also supported with the system Sage Math. We proposed a course of Applied and Numerical Mathematics based on MIT opencourseware and a special textbook as an application of the new system.

Keywords: Electronic Learning Management System; Moodle; SageMath; Faculty of Aeronautics; MIT Opencourseware;

1. HISTORICAL OVERVIEW

Learning management system Moodle LF in full operation used from September 2008. Students can log in to the first course of 9/20/2008. Currently (May 2016) the system uses next to every student and most teachers. The system was implemented and entered into service by the team of authors of this article.

Some information and statistics of system uses to date of 5/25/2016:

- Account numbers: 3303 (accounts are not deleted)
- Number of active courses: 157,
- Number of courses completed during the final and diploma works: 47
- Number of activities in the system: approx. 4 millionth
- System Version: 1.95
- OS: CentOS 6.3
- Web site: http://moodle.leteckafakulta.sk

Moodle LF can be considered an electronic communications interface between students and teachers, which may also serve to complete leading and managing courses. More detailed information on the system in the Slovak language can be found at: http://people.tuke.sk/peter.szabo/flatpress/?page=moodle2.

2. NEW TOOLS

Over the past 10 years there was created new support technologies for e-learning courses as: mathematics, physics, electrical engineering and programming.

Leading universities have created and opened courses such as *MIT opencourseware*, see [3]. These courses serve us as an example for the design of the structure of our courses.

Open source alternative *SageMath* serves [5] as a means for studying numerical and applied mathematics as well as for the study calculus, elementary to very advanced number theory, cryptography, commutative algebra, group theory, graph theory, numerical and exact linear algebra.

Basic reading belongs to each course. Usually, basic literature [1] is also available in electronic form. E-book reader Adobe Digital Editions is used to protect copyrights authors of such literature.

3. A COURSE DESIGN IN TERMS OF FACULTY OF AERONAUTICS

Our new e-learning management system (Moodle LF2) for mathematics, physics, programming and electronics contains the following technologies:

1) *Moodle v. 3.2* [4] - the course management (teachers, students, course materials, submission assignment, grading)
2) *SageMath v. 6.10 (7.20*) [5] - study of the subject, problem solving, development assignment.
   - Each student needs to know the server name and login information (login, password) to the systems. These data should be provided on the first hour of the course.
3) *Adobe Digital Editions* - work with study literature (reading books in format .epub)
   - Getting Adobe ID is one task of the first hour of the course. It is necessary to study literature reading.

We suggest a course about Numerical and Applied Mathematics that is used to demonstrate how to apply the new system Moodle LF2. This is just an example of possible applications of an e-learning management system and computational mathematics.

2.1. Course content

The proposed course abut Applied and Numerical Mathematics includes the following content:

0. theme: **Structure of the course**

0.1 Content of the course (Syllabus, Readings, Calendar, Lecture Summaries and Tools)

0.2 Tools and logins (Moodle, SageMath, Adobe Digital Editions, Adobe ID, Oracle VM VirtualBox)

1. theme*:* **Work with Sage Math**

1.1 Sage Notebook (Sage version 6.10)

1.2 Sage version 7.x (Interactive Python, Parallel programming, Computing Clusters, Jupyter Notebooks, SageMathCloud)

2. theme: **Computations**

2.1 Sage Cell, Sage Math editor, Sage version: how to run Sage code

2.2 Basic Arithmetic Operations, floating point operations

2.3 The order of operations, parentheses (no brackets)

2.4 Decimal representation of floating point number, precision

2.5 Constants, Comments

2.6 Library functions (sqrt, is_prime, factor, gcd, lcm, abs, ln, log, sin, cos, tan, divisors, matrix, inverse matrix, det, (multiplication of matrices), sum, is_even, is_power_of_two, is_pseudoprime, is_squarefree)

2.7 Working with strings (print statement, string operations)

2.8 Solving Equations and Inequalities (method solve, find_root, comparison operator, assignment operator, system with exact solution, with no solution, with infinitely many solution)

2.9 Calculus functions (user defined mathematical functions, computation of function values, operations with functions: derivative, diff, integrate, Taylor expansions, limits of function, composition of two function, show expression, method full_simpilfy)

3. theme: **Graphs, Sage Interact and Elementary Statistics**
3.1 Plotting 2D graphs
3.2 Plotting 3D graphs
3.3 Sage interact - interactive graphs, outputs
3.4 Scatter Plots – Line of Best Fit and More
3.5 Elementary Statistics: Mean, Median, Histograms, and Bar Charts

4. theme: **Taylor polynomials and Riemann Sum**
4.1 Equations of Lines
4.2 Tangent Lines and Plots
4.3 Taylor polynomials
4.4 Riemann Sum - definite integral

5. theme: **Numerical Integration and Solving Equations**
5.1 Trapezoidal Rule for Numerical Integration
5.2 Bisection Algorithm for Solving Equations
5.3 Newton–Raphson Algorithm for Solving Equations

... and still other eight lessons. Each theme also includes a so called *Sage Notebook* what is the practical demonstration of the individual computations and algorithms. A such *Sage Notebook* can also use the teacher and the student.

2.2. Syllabus

Course Meeting Times
Lectures: 2 sessions / week, 1.5 hours / session

Prerequisites
Field of mathematical prerequisites:
- Simplify math expression
- Solving systems of lin. equations (Cramer's rule)
- The least square method - Linear Regression
- Polynomial approximation
- Elementary functions - drawing
- Function value computation
- Differentiation features
- Matrix calculus (multiplication, inverse matrix)
- Complex numbers
- Limits sequence
- Infinite number series, convergence criteria
- Conic - drawing

The assignments will involve basic computer programming in the system SageMath (this class encourages you to learn SageMath if you don't already know it)

Course Description

The basic course of Applied and Numerical Mathematics is the story of how to work with mathematics in engineering disciplines. The course includes working with: functions, derivatives, integrals, Taylor and Fourier series and transform, differential equations, matrices and elementary statistics. Most scientists and engineers are sooner or later faced with computing tasks that require some knowledge of applied and numerical mathematics.

Course content

Part I: **Working with SageMath**
- Sage environment
- Computations
- Graphs, Sage Interact and Elementary Statistics

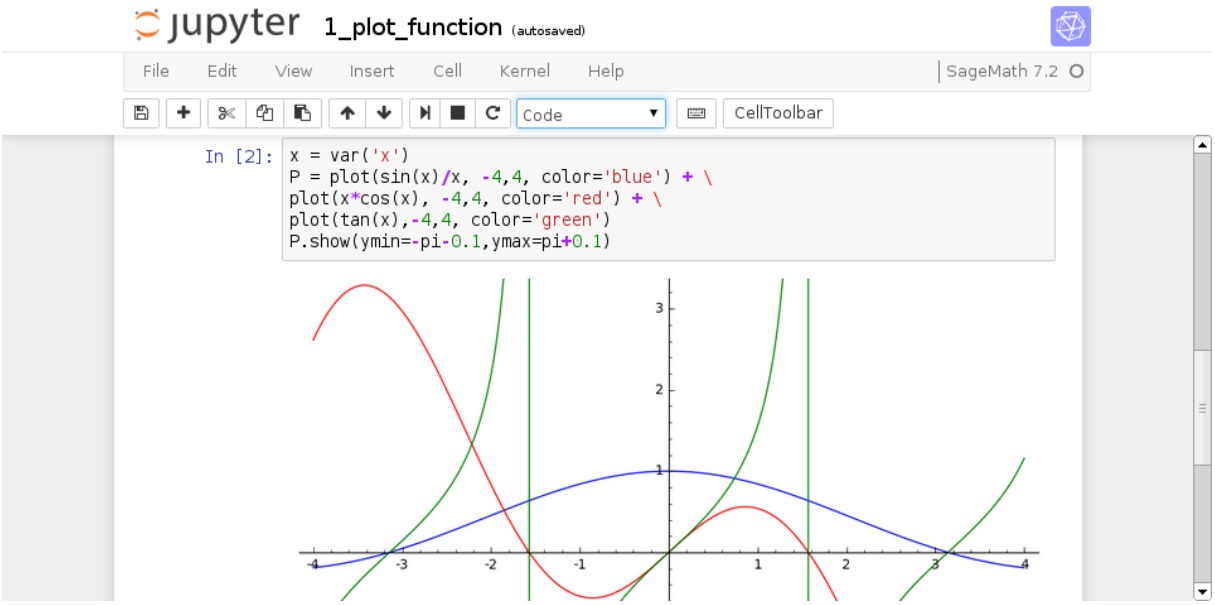

Figure 1 Working with SageMath

Part II: **Numerical analysis**
- Taylor polynomials and Riemann Sum
- Numerical Integration and Solving Equations

...
Part III: **Applied mathematics**
...

Grading

Homework: 40%
Final exam: 60%

The homework problem sets will consist of both theoretical problems and numerical experiments. No late copy will be allowed. The assignment need to be addressed in the system Sage Math and should be sent to the Moodle LF2. Collaboration is allowed, but the codes and copies you turn in must be original and written by you.

2.3. Reading and sources

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Faculty of Aeronautics, Technical University of Košice

Basic reading for the course is the book:

1) Mezei, R. A. (2016), An Introduction to Sage Programming with Applications to Sage Interacts for Numerical Methods, see [1].

Reader need to have *Adobe ID* for reading the electronic version of this book. Some examples of the algorithms and methods of applied mathematics can be found in the book:

2) Cormen, T. L.; Charles E. Leiserson, C. E. & Rives, R. L. (2003), Introduction to Algorithms, see [2]

And the Internet:

1) Demanet, L. (2012), 'Introduction to Numerical Analysis', http://ocw.mit.edu/courses/mathematics , MIT Opencourseware, see [3]
2) Applied technologies, e-learning system and computational mathematics tools, are on our servers: 'Moodle LF2' available at http://moodle2.leteckafakulta.sk and 'SageMath' available at http://sagemath.leteckafakulta.sk.

4. CONCLUSION

The first part of the article contains information about our experience with electronic learning management system Moodle LF at Faculty of Aeronautics.

The second part of article described a course that uses the latest free electronic learning management system, computing mathematics and cloud computing technologies. For students added value of such course is the practical application of numerical computations in addition theoretical knowledge. The used system SageMath cover all major fields of numerical mathematics and programming. The proposed course will be applied in the future.

4. LITERATURE LIST

References

Books:

[1] Mezei, R. A. (2016), *An Introduction To Sage Programming With Applications To Sage Interacts For Numerical Methods*, John Wiley & Sons, Inc., Hoboken, New Jersey, 230 p.

[2] Cormen, T. L.; Charles E. Leiserson, C. E. & Rives, R. L. (2003), *Introduction to Algorithms*, McGraw-Hill Book Company, The Massachusetts Institute of Technology, 885 p.

Web sites:

[3] Demanet, L. (2012), *'Introduction to Numerical Analysis'*, http://ocw.mit.edu/courses/mathematics, MIT Opencourseware.

[4] www.leteckafakulta.sk (2016), *'Moodle LF2'*. Available at: http://moodle2.leteckafakulta.sk

[5] www.leteckafakulta.sk (2016), *'SageMath LF'*. Available at: http://sagemath.leteckafakulta.sk