Scientific Computing Software (Maple, Matlab)

Course for Bachelor Degree students in Southern Federal University

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Description of the course

- **Course title:** Scientific Computing Software (Maple, Matlab)
- **Bachelor Degree program:** Theoretical Computer Science and Information Technologies
- **Language of instruction**: English
- **Status of the subject:** major subject, compulsory module
- **Year and semester:** 4^{th} year, one semester
- **Workload: 5 ECTS**
  - 180 hours total, including 18 hours of lectures, 52 hours of practice, 74 hours of independent study, and 36 hours to prepare for exam
  - Lectures: 1 hour per week
  - Practice: 3 hours per week

15-Week Journey

- Weeks 1-4: Maple (Symbolic Computing)
- Weeks 5-9: MATLAB (Numerical Computing)
- Weeks 10-13: Advanced Topics & Integration
- Weeks 14-15: Project Presentations & Review

Why Scientific Computing Matters in IT

Data Science & Machine Learning

- Numerical algorithms are the backbone

Simulation & Modeling

- Test systems before deployment

Optimization

- Resource allocation, scheduling, performance tuning

Cryptography

- Symbolic computation for algorithm verification

Algorithm Development

- Prototype before implementing in production

Visualization

- Present complex data effectively

Course Learning Outcomes

By the End of This Course, You Will Be Able To:

1. Navigate and program proficiently in both Maple and MATLAB
2. Write structured programs with proper software engineering practices
3. Perform symbolic manipulation for algorithm derivation and verification
4. Implement core numerical methods (linear algebra, ODEs, optimization)
5. Create professional visualizations for data exploration
6. Analyze algorithm performance (time and memory complexity)
7. Process large datasets using vectorized operations
8. Integrate symbolic and numerical approaches for hybrid problem-solving
9. Automate workflows through scripting and batch processing
10. Document and present computational results professionally

Prerequisites & Assumptions

Mathematics:

- Calculus (differentiation, integration, ODEs)
- Linear Algebra (matrices, eigenvalues, linear systems)
- Basic numerical methods (recommended)

Programming:

- At least one programming language (Python, Java, C++, etc.)
- Control structures (loops, conditionals)
- Functions and basic data structures

What You DON'T Need:

- • No prior experience with Maple or MATLAB
- • No advanced mathematics beyond standard 3rd-year courses

Textbooks & Resources

Required Documentation:

- Maple User Manuals – Maplesoft Documentation Center
- MATLAB Documentation – MathWorks Help Center
- MATLAB Onramp – Interactive tutorial

Recommended Textbooks:

- Moler, C. Numerical Computing with MATLAB. SIAM, 2004.
- Quarteroni, A. Numerical Mathematics. Springer, 2007.
- Attaway, S. MATLAB: A Practical Introduction. 2018.

Online Communities:

- MaplePrimes – mapleprimes.com
- MATLAB Central – File Exchange, Cody, Answers

Final Project Guidelines

- Topic: Apply scientific computing to an IT/CS problem

Example Topics:

- Machine learning algorithm implementation
- Network traffic analysis and simulation
- Cryptographic algorithm analysis
- Image processing application
- Resource optimization in IT systems
- Data mining and pattern discovery
- Recommender system development

Requirements:

- Use both symbolic and numerical methods
- Implement algorithms efficiently
- Visualize results professionally
- Document thoroughly and present clearly

14-Week Schedule Summary (tentative)

- Week 1: Introduction & Maple Environment
- Week 2: Maple Programming
- Week 3: Symbolic Mathematics
- Week 4: Advanced Maple + Project Proposal
- Week 5: Introduction to MATLAB
- Week 6: MATLAB Programming
- Week 7: Numerical Linear Algebra
- Week 8: Data Fitting & Integration
- Week 9: Ordinary Differential Equations
- Week 10: Optimization
- Week 11: Partial Differential Equations
- Week 12: Visualization
- Week 13: Maple-MATLAB Integration
- Week 14-15: Project Presentations & Review
- Maple (Weeks 1-4) | MATLAB (Weeks 5-13) | Both (Week 14-15)

Course Policies

- Attendance:
- Required for practice sessions
- >2 absences require documented justification
- Late Submissions:
- 10% deduction per day up to 5 days
- No submission after 5 days without prior arrangement
- Academic Integrity:
- Individual work unless explicitly stated
- Collaboration guidelines will be provided
- Code Quality:
- Must be well-commented and formatted
- Must run without errors
- Communication:
- Email: aanasedkina@sfedu.ru
- private message in MS Teams

Getting Started

- **What to Do This Week**:

? Install Maple and MATLAB (or ensure lab access)

? Review the course syllabus

? Familiarize yourself with the course website https://edu.mmcs.sfedu.ru/course/view.php?id=901

? Complete the Week 1 pre-reading and exercises

? Bring questions to the next session

- **Software Access**:

• Computer Lab: Available with all software installed

• Free Alternatives: Octave (MATLAB alternative)

- Questions? Ask during lectures or email/write in MS Teams the instructor.