Syllabus: Senior Thesis Seminar MAT-481
Fall 2020, Spring 2021

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2. **Volume of academic load**: 1 meeting per week (75 minutes, 15 working weeks; load for students – 3 credit hours in each semester)

3. **The purpose of the seminar** is to help students choose the direction of their research, topics of senior theses, and thesis supervisors; you will also get support and consultations in the process of preparation and design of the senior thesis

4. **Assessment**: the grade is determined by attendance of the seminar and the work for the thesis preparation.

5. **Highlights of the seminar**:

   - *September-October*: Presentations of the AMI Department professors about their research. As part of these presentations, teachers also formulate topics that are offered to students for research and prospective senior theses; 3rd year students of the AMI Program are also invited to these sessions.
   - *November-December*: Reports and presentations of the 4th year AMI students as the result of Internship (educational and work experience).
   - *February-April*: Consultations on senior theses, finalization of the results, preparation of presentations for thesis defense at the State Attestation Committee.

Structure and Rules of the Thesis

AUCA Bachelor's final qualifying work is written in the English language. The structure of the work includes a number of mandatory and optional elements. Mandatory elements of the work are as follows:

- title page
- abstract
- table of contents
- introduction
- main part of the document
- conclusion
- reference list
- additional elements
  - acknowledgements
  - glossary (conventions, abbreviations, terms)
  - appendix

Description of the Structural Elements

A sample **cover page** is provided, it is not numbered.

An **abstract** is a short description of the work performed. The purpose of the abstract is to give the reader the first idea of the essence and the main results of the work. The abstract is **located on the second sheet** of work, its volume **does not exceed one page, generally half a page**. Examples of abstracts are presented on page 7.

The **table of contents** includes a listing of **all sections and subsections** of the work, starting immediately after the table of contents. Table of contents lines end with the numbers of pages where the beginning of the corresponding part of the document is located. Examples of the table of contents is presented on pages 8 and 9.

The **introduction** contains a short verbal statement of the problem and provides a rational relevance of the selected topic. The introduction also **formulates goals and objectives**, implemented in the process of working on the project. Already in the introduction, you can refer to information sources, if necessary to substantiate the relevance of the topic work. Sometimes the introduction provides a brief description of main results.

The **main part** of the thesis contains an overview of the current state of the problem, based on on the analysis of information (literary) sources, formulation of

the solved (investigated) problems, a review of methods for solving the problem under consideration and related problems, as well as description of the research results carried out personally by the author of the thesis, including experiments, if they are required on the assignment for the thesis. The main part of the thesis is usually divided into sections and subsections (chapters and paragraphs), which are numbered in Arabic numerals: "2. Method ... the second section (chapter); "2.1 Shear Stress ... the first subsection (paragraph) of the second section; "2.1.2 Wall Shear Stress ... the second part of the first subsection, the second section, etc. The titles of sections and subsections should be worded concisely and reflect their content.

The **first section** (chapter) of the main part of the thesis contains an overview of the current state of problems based on the analysis of information (literary) sources. When linking to a source of information in this section should not attempt to characterize the cited article, monograph, study guide, or information of the Internet resource in in general: it should be noted those ideas and results that are directly related to the topic of your work. References to literary sources can be continued as well can be repeated, as necessary, in other sections of the main part of the work. It is not recommended to call this section "Literary Review it is better to come up with a name, reflecting the theme of the thesis, for example, "Mathematical models and methods of magnetotelluric monitoring". Otherwise, the content of the main part of the thesis is completely determined by the author.

In the **conclusion**, the work done is summarized: the main results are formulated, their scientific novelty and practical significance (if any) are noted. Maybe also indicate the prospects for the development of the considered direction. Examples of conclusion can be found on pages 10 and 11.

List of information sources (**list of references**) contains the bibliographic description of all information sources used in the process of working on the thesis. Don't list articles or monographs on which there is not a single reference in the text of the work. Use a variety of forms of bibliographic description, including and specially structured options. We offer a simplified structure: **information about each of the sources in the List is arranged in the order of their mention in the text** and **formulated in the original languages**. When mentioned in the text, literary source numbered with an Arabic numeral in square brackets (for example, [13]), under the same number this the source is also on the List. Some examples are given on pages 5 and 6.

If the above additional elements are present in the thesis structure, then Acknowledgments and Glossary appear immediately after the table of contents in the order shown. Appendix is located at the very end, after references. The Appendix contains materials which were not included in the main text of the work, but which allow to reveal more fully the essence of conducted research. It can be additional tables, figures, diagrams complex algorithms, program printouts, proofs of auxiliary statements, etc.

Rules for the Thesis

General Rules

- for the design of the thesis, either MS Word with MathType, or LaTeX are recommended
- the minimum length of the thesis (including all annexes) should be 25 pages, the maximum length 60 pages
- the thesis is printed on A4 paper, vertical orientation, single-sided printing only
- fonts must be consistent, except for tables and formula indices, they may be smaller. Section titles may be typed in capital letters, italics or boldface may be used for emphasis
- new section must begin on a new sheet
- sheet numbers are placed on the outer bottom corner, the title page and pages completely occupied by figures can not be numbered, but must be counted
- figures should be numbered, captioned, and referenced in the text. Numbering can be continuous or section internal
- formulas must only be numbered if they are referenced in the text

Margins

Page Side	Margin, cm
Left	3
Upper	2
Lower	2
Right	1.5

Typesetting

Parameter	Value
Font Size	12 pt
Font	Times New Roman
Indentation	1.25cm
Line Spacing	1.5
Text Alignment	Block Text

Bibliography Formatting Examples

Books

1. Stommel H. The Gulf Stream. –Univ.California Press, 1965. -243 p.
2. Марчук Г.И., Саркисян А.С. Математическое моделирование циркуляции океана. –Москва: Наука, 1988. –302 с.

Articles

1. Birkhoff G., Diaz J.B. Non-linear network problems // Quart. Appl. Math. -2005. -V. 13, N. 4. -P. 431-443.

2. Ильин А.М. Разностная схема для дифференциального уравнения с малым параметром при старшей производной // Матем. заметки. -1969. -Т. 6, Вып. 2. -С. 237-248.

Materials from Conferences and Similar

1. Osinov V.I. Qualitative study of an extreme problem in pattern recognition theory // Mathematical methods of image recognition: Tr. International conference - Erevan: VC AN Armenia. -1985. -P. 28-34.

URLs

1. Ivanov A.A. Programming peculiarities in C, url: http://www.citforum.ru

Applied Mathematics and Informatics Program

Title of Thesis

Name of a student

A Thesis Submitted to the Applied Mathematics and Informatics Program of American University of Central Asia in Partial Fulfillment of the Requirements for the Degree of
Bachelor of Arts

Author
Name

Certified by Thesis Supervisor
Name

Accepted by
Sergey Sklyar
Head of Applied Mathematics and
Informatics Program, AUCA

May 2019

Bishkek, Kyrgyz Republic

Example Abstracts

In the United States, cardiovascular disease is the number one cause of death for both men and women. Heart attacks and strokes can happen because of atherosclerosis, or plaque build-up inside arteries, which obstruct blood flow to the heart and brain. One common site of atherosclerosis is the carotid artery bifurcation. This study looks at how the angle between the branching arteries of the bifurcation affects the potential for atherosclerosis by running flow simulations through virtual models of the bifurcation. The higher the wall shear stress, turbulence intensity, and turbulence kinetic energy at the bifurcation, the lower the chance of atherosclerosis. There is an optimal angle at which this occurs.

В работе предложен новый численный метод для решения квазилинейных гиперболических и параболических уравнений. В основу положен модифицированный метод характеристик и алгоритм адаптации сетки. Предложенный метод и его варианты тестировались на многочисленных модельных задачах. Результаты тестирования показали высокую точность предлагаемых алгоритмов, гораздо более высокую, чем классические разностные схемы первого и второго порядка (Лакса-Вендроффа, Мак-Кормака и т.д.).

Example Conclusions

When we first started this study, we hypothesized that the narrower the angle between the branching arteries, the higher the turbulence intensity, turbulence kinetic energy, and wall shear stress, and thus the lower the chance of atherosclerosis. The first two simulations we ran were on the wide angle and average angle models. The data from these two simulations led us to believe that our hypothesis was correct. However, when the data came back from the simulation on the narrow angle model, it was clear that our hypothesis needed to be revised. The highest values of all three measures occurred in the average angle model, indicating that the least chance of atherosclerosis occurs when the branching arteries are about 50° apart. This means that instead the lowest angle being best, there is an optimal angle at which the three measures are highest.

В работе предложен новый метод численного решения квазилинейных уравнений гиперболического и параболического типов, метод условно назван адаптивно-характеристическим. На его основе построены вычислительные алгоритмы, решающие задачу Коши для квазилинейного гиперболического закона сохранения и параболического уравнения Бюргерса. Построены многочисленные тестовые примеры, позволяющие проиллюстрировать работу предложенного метода.
Выполненные теоретические построения, численные эксперименты и анализ результатов позволяют сделать следующее заключение.

1. Доказана эквивалентность задачи Коши для квазилинейного гиперболического уравнения и краевой задачи для характеристической системы.

2. Разработан численный метод решения краевой задачи для характеристической системы, который обладает достаточной «гибкостью» для модификации, позволяющей повышать порядок точности метода и решать задачи параболического типа.

3. Разработанный метод и его модифицированные варианты обладают более высоким порядком точности, чем классические разностные схемы первого и второго порядков (Лакса-Вендроффа, Мак-Кормака, TVD-схема Хартена).

4. Поскольку составной частью алгоритма является механизм адаптации вычислительной сетки, то одним из его положительных качеств можно считать его небольшую ресурсоемкость: он требует на порядок меньшее количество узлов, чем классические разностные схемы. Повышенный порядок точности обеспечивается за счет сгущения сетки в тех областях, где наблюдаются большие градиенты решения.

Результаты выполненных расчетов и их качественное согласие с экспериментальными данными позволяют сделать общий вывод о том, что предложенный адаптивно-характеристический метод дает хорошее приближение к точному решению. А разработанный на его основе программный код может быть рекомендован для использования в научных и инженерных расчетах различных задач гидро и газодинамики, механики сплошной среды и во многих других областях.